

From carbon policy to consumer prices

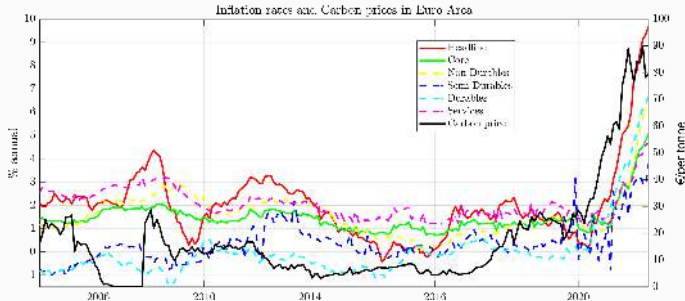
The economic impact of carbon caps in the Euro Area

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Carbon prices tripled just as inflation took off



- 2020: COVID-19; 2022: the invasion of Ukraine disrupts supply chains. **Carbon prices more than tripled** over the same period
- Higher energy inflation hits energy-intensive sectors such as utilities and food, and **disproportionately lower-income households**
- Policymakers must cut emissions *and* limit these regressive effects

Model time series

Research questions and approach

- **Q1.** How do rising carbon prices affect inflation and its components?
- **Q2.** How are they transmitted to the rest of the macroeconomy?
- **Approach:** Bayesian structural VAR on Euro Area monthly data, 2005–2022
- Carbon policy shock identified with a novel set of **zero and sign restrictions**
- Historical decomposition asks whether the shock can explain the sharp inflation swings around the post-2020 changes in climate policy and recent events

Why it matters

A better understanding of the impact of carbon pricing, including potentially regressive effects, so that policymakers can make informed decisions.

Preview of results

- **Inflation:** carbon policy shocks have a significant impact on Euro Area inflation. After Phase 4 (2021) carbon prices account for a significant portion of its variation, marked and enduring for energy and non-durable goods, more restrained elsewhere
- **Components:** industrial goods are more affected than services, though not as much as one might expect. Transportation, Utilities and Food have the highest pass-through; Communications is the only component where prices fall after two years
- **Macroeconomy:** higher inflation (also excluding food and energy), then lower industrial production, higher unemployment and a trade deficit; stock prices fall, sovereign and high-yield rates rise
- Results are robust to various changes in the model structure

This suggests the European Commission might have been overly optimistic in introducing Phase 4.

Related literature: three strands

1. **Emissions and allowance prices:** the EU ETS lowers emissions even at low prices (Bayer and Aklin 2020); allowance prices respond to fuel and energy prices, politics and regulatory uncertainty (Rickels et al. 2007; Knopf et al. 2014; Boersen and Scholtens 2014; Hintermann et al. 2016)
2. **Macro and inflation effects, mixed:** little or no effect on inflation or GDP (Konradt et al. 2022); contractionary output effects (McKibbin et al. 2017; Goulder and Hafstead 2017); unequal burden (Känzig 2023; Mangiante 2023); higher short-term inflation and volatility (Santabárbara and Suárez-Varela 2022); EUAs as an inflation hedge (Pardo 2021)
3. **Sectors:** effects differ across sectors (Ho et al. 2014; Lee et al. 2008; Choi et al. 2010; Santos et al. 2018)

Benchmarks. Moessner (2022) (35 OECD economies, 1995–2020): a \$10 rise in ETS prices lifts energy inflation by 0.8 pp and headline by 0.08 pp. Krämer and Solveen (2021): German climate policy could add half a point a year in the transition.

- **New estimates** of the effects of the EU ETS in the Euro Area on inflation and the macroeconomy
- **Method:** SVAR identified by a novel set of zero and sign restrictions for carbon policy shocks
- **Sectoral consumer prices:** components and sub-components of the HICP, which the paper states have not been extensively studied
- Also speaks to unintended consequences of the EU ETS (Müller and Teixidó 2021) and to the literature on the effects of Russia's invasion of Ukraine

Carbon pricing seen through consumer prices, not only emissions or aggregate output.

Background: the EU ETS and its four phases

Phase	Years	Design of the cap
1	2005–2007	Cap set at the individual level: each company receives allowances based on its past emissions
2	2008–2012	Cap set at the sectoral level: the overall cap is divided among sectors
3	2013–2020	“Linear reduction factor” gradually lowers the overall cap
4	2021–2030	Stronger linear reduction factor and a “market stability reserve”

- The world’s largest emissions trading system: over 11,000 carbon-intensive installations and airlines, 31 countries
- Firms trade allowances in a secondary market, an incentive to cut emissions
- Phase 4 was revised in 2018–2020; it covers, among others, commercial flights, energy-intensive industry and heat and electricity production

Data and Method

$$\mathcal{D}_0 y_t = \mathcal{D}_+ x_t + \eta_t, \quad \eta_t \sim \mathcal{N}(0, I_n), \quad x_t = [y_t', \dots, y_{t-\ell}']'$$

- **Baseline** $y_t = [\zeta_t, \pi_t^{\text{Headline}}, \pi_t^{\text{Energy}}, y_t^p, u_t, e_t, nx_t]'$: carbon futures price, headline and energy inflation, industrial production, unemployment, REER, trade balance
- **Financial version** adds share prices, high-yield spread, Euro STOXX 50 volatility, sovereign stress indicator, 3-month interbank rate and central bank assets
- Monthly data, **2005m1–2022m8**, in levels; **six lags**; dummies for the Phase 1–2 transition, COVID-19 and the invasion of Ukraine
- Independent normal-Wishart prior with Litterman-type shrinkage; Gibbs sampler with 10,000 iterations and 9,000 burn-in
- GHG emissions are not in the baseline (see robustness)

Data sources

Hyperparameters

Identifying a tightening of climate policy

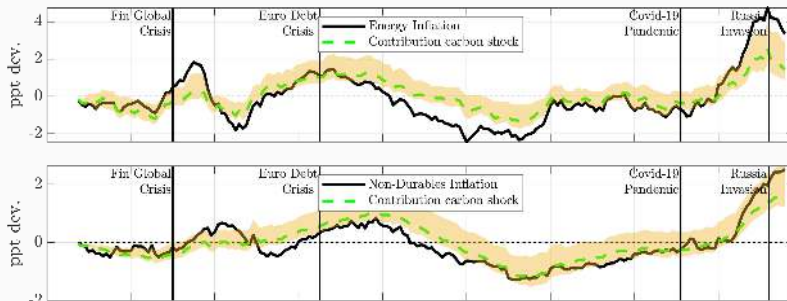
Shock \ variable	π^{Headline}	π^{Energy}	ζ (carbon price)	y^p	u	e	nx
Climate policy	↑	↑	↑	0	0	0	0

Notes: Sign and zero restrictions on the impact matrix, implemented with the algorithm of Arias et al. (2018).

1. **Carbon price up:** tighter policy cuts the supply of allowances, raising their price
2. **Both inflation rates up:** the main channel is power prices when generation relies on fossil fuels. Energy production is about 30% of EU GHG emissions. Supporting evidence: Santabárbara and Suárez-Varela (2022), Hensel et al. (2023), and Känzig (2023)
3. **Other variables do not react on impact:** policy changes take time to propagate

Results

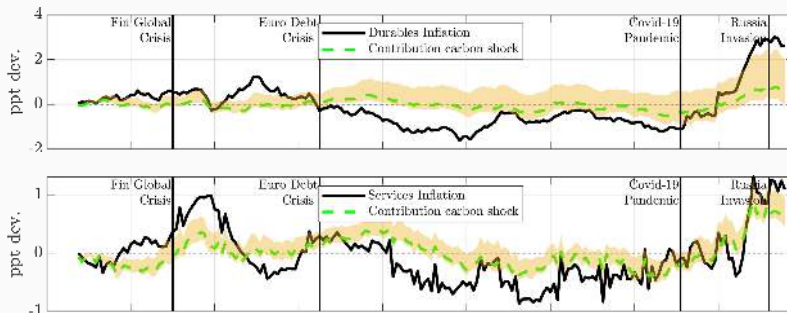
Historical decomposition (1): energy and non-durables



Notes: Solid line: inflation (deviation); dashed: contribution of the carbon shock, with 68% bands.

- Energy and non-durables move closely together; in the last inflationary episode the shock contributes about **half** of energy inflation and closer to **75%** of non-durables
- One possible explanation: energy inflation still depends mainly on commodity prices, despite the growing role of carbon pricing

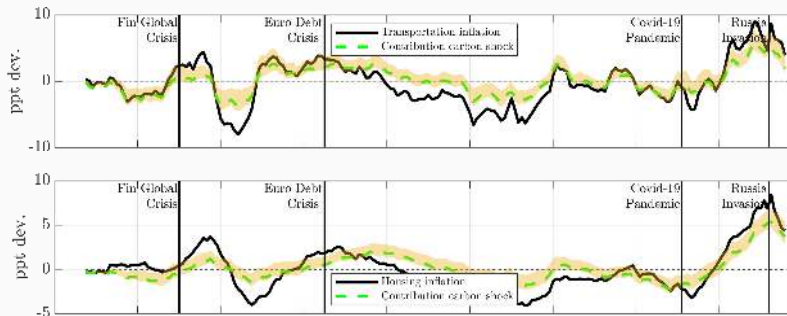
Historical decomposition (2): durables and services



- **Durables** are the least sensitive: the contribution is significant only in 2022, about 25% of the variation
- **Services**: lower inflation, with positive contributions in the same periods as energy; the persistent rise after 2020 is likely due to transportation
- **Semi-durables**: the response to the last surge was transitory

All five categories

Historical decomposition (3): transportation and housing



- **Transportation:** a significant rise in transport prices in 2022; with the fall in carbon prices, also part of the 2009 deflation
- **Housing, electricity and gas** (17.9% of consumer spending), like transportation, is heavily influenced
- **Food and beverages** (16.6%) are sensitive to energy prices; restaurants and hotels less so. **Recreation and culture:** only a transitory rise after 2020. Household equipment, clothing and communications: small, transitory changes

Food, recreation, others

Two-year pass-through to consumer prices

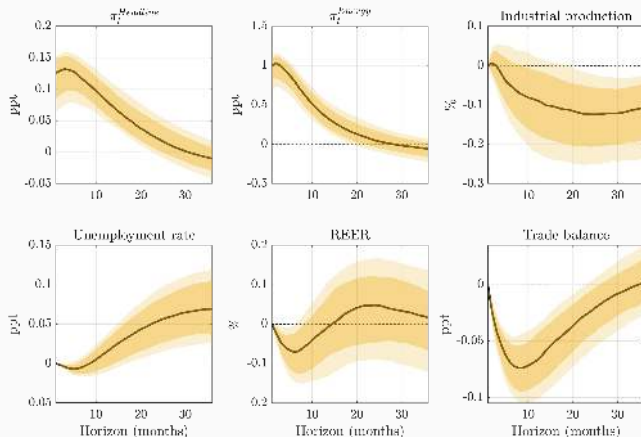
	Σ_{24}	$\max_{24}$
Carbon	35.375	4.0438
Headline	1.987	0.1305
Core	0.1436	0.0403
<i>Components</i>		
Energy	11.467	1.0357
Non-durables	1.2299	0.0608
Semi-durables	1.1601	0.1648
Durables	1.0739	0.0603
Services	0.6274	0.0628

- **Categories:** non-durables (1.23), semi-durables (1.16) and durables (1.07) lead; services are weakest (0.62), though the gap is smaller than one might expect
- **Sub-components:** highest for transportation (4.05), housing (2.93) and food (2.43). Communication turns negative around year two, which new technology can explain

<i>Sub-components</i>	Σ_{24}	$\max_{24}$
Transportation	4.049	0.4495
Housing	2.9341	0.2157
Food	2.4337	0.155
Education	1.4231	0.2379
Household	1.1932	0.0596
Alcoholic	1.077	0.097
Clothing	1.0189	0.2906
Rest. & Hotel	0.7957	0.0635
Recreation	0.7882	0.2549
Health	0.7321	0.0592
Miscellaneous	0.538	0.0391
Communication	−0.3596	0.0907

Notes: 24-month cumulative (Σ_{24}) and peak ($\max_{24}$) responses; sorted by Σ_{24} .

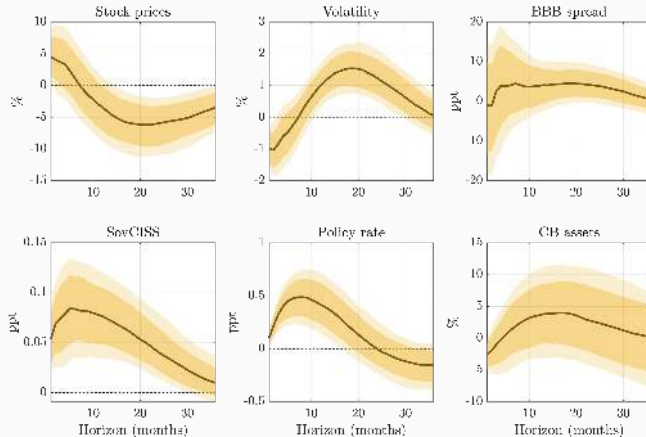
Real effects of a climate policy shock



Notes: Normalized to raise energy inflation by 1 pp on impact; median, 50% and 68% bands.

- Inflation: headline peaks near 0.13 pp (previous slide); it rises even excluding food and energy
- **Industrial production** falls for about two years (about -0.1% at its peak, per the text)
- **Unemployment** rises persistently
- REER depreciates slightly and recovers in under a year; the **trade balance** falls, which can be an argument for a carbon border tax
- Costly reallocation frictions are a common explanation in energy-related models

Financial markets



Notes: Normalized to raise the policy rate by 0.1 pp on impact; identified with the method of Plagborg-Møller and Wolf (2021).

- **Stock prices:** a slight rise at first, then a significant fall over the next two years; volatility increases
- **Sovereign stress** affected significantly; **BBB spreads** are not significantly affected
- **Policy rate** tightens in the short term, up to the second year; the **central bank balance sheet** does not change
- Amplification through the financial accelerator is present but less pronounced than the real effects

How much of the variance does the shock explain?

Horizon (months)	Headline	Energy	Ind. prod.	Unemp.	REER	Trade bal.
12	70.90	73.10	1.71	2.87	2.02	15.97
36	54.03	59.69	7.22	22.91	4.71	15.74

Notes: Median share (%) of forecast error variance due to the climate policy shock; shares normalized to sum to 100%.

- **Inflation:** at 12 months the shock accounts for about 71% (headline) and 73% (energy) of the variance, falling to 54% and 59% at 36 months
- **Real variables:** small in the short run, growing with the horizon. Unemployment: about 3% at 12 months, 22.9% at 36 months
- A plausible reason for the inflation result: energy shocks propagate quickly through production costs

- **Excluding the invasion of Ukraine:** broadly similar; a more detrimental effect on industrial production and a smaller trade deficit
- **Excluding the pandemic:** similar responses, but activity effects are more substantial (a larger fall in industrial output, higher unemployment)
- **ECB assets** added: baseline unaffected, except that the REER moves closer to zero
- **GHG emissions** added: the specification is non-stationary; REER persistently negative and wider bands for industrial production
- **Model specification:** lag length (1 by SC, 4 by AIC), the S_0 matrix, diffuse and sum-of-coefficients priors, hyperparameters, block exogeneity, linear trend, no constant

Overall, the paper reads the results as robust to different specifications and assumptions.

No Ukraine invasion

No pandemic

Limits and caveats

- The **identification** rests on sign and zero restrictions motivated by the paper's reading of the carbon market
- **Excluding the pandemic or the invasion** changes the *strength* of some responses, mainly industrial production and the trade balance
- The emissions specification is non-stationary, which can reduce the reliability of the impulse responses
- The paper notes that other methods can offer a more nuanced approach to the effects of climate policy on inflation and its components
- Country-specific effects, and the national measures against soaring energy prices, are left to future research

Conclusion and policy implications

- A stricter carbon regime has **short-term economic costs**: lower output, a worsening trade balance and higher unemployment; milder effects in financial markets
- After Phase 4 (2021) climate policy shocks contribute significantly to several inflation categories; the paper suggests the Commission may have been too optimistic in not weighing the pandemic and the conflict
- **Policy**: review and improve Phase 4 given the new economic landscape; governments should consider measures to mitigate effects on inflation

Thank you!

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Backup

Data description and sources

Label	Description	Source
ζ_t	Carbon prices for the Euro Area	Bloomberg
π_t	Inflation rates	Eurostat/Own
y_t^p	Total industry excluding construction, Euro Area	FRED
e_t	Real broad effective exchange rate, Euro Area	FRED
u_t	Harmonized unemployment rate	Bloomberg
nx_t	Trade balance, Euro Area	FRED/Own
s_t	Total share prices, all shares, Euro Area	FRED
h_t	ICE BofA Euro High Yield Index	FRED
v_t	Euro STOXX 50 volatility	stoxx.com/Own
c_t	Composite indicator of sovereign systemic stress	ECBW
m_t	90-day interbank rates, Euro Area	FRED
a_t	Central bank assets, Euro Area	FRED

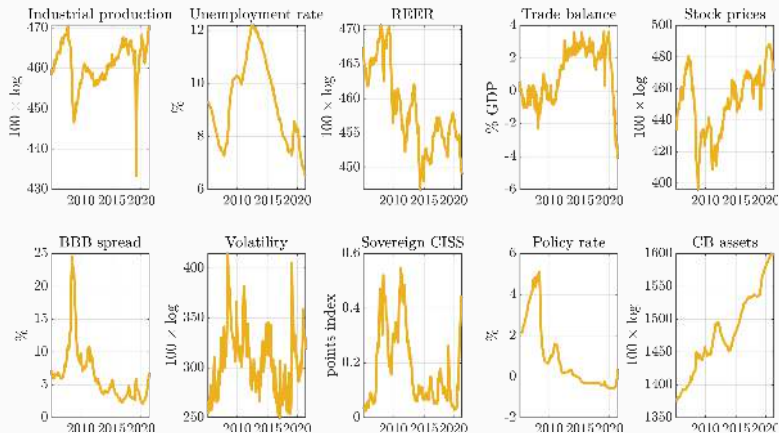
Notes: Monthly series covering 2005m1–2022m8.

Prior hyperparameters

	Value	Description	Observation
ρ	1	autoregressive coefficients	used in all models
λ_1	0.1	overall tightness	varied in a robustness model
λ_2	0.5	cross-variable weighting	varied in a robustness model
λ_3	1	lag decay	varied in a robustness model
λ_4	10^5	exogenous variable tightness	used in all models
λ_5	0.0001	block exogeneity shrinkage	used in the block exogeneity model
λ_6	1	sum-of-coefficients tightness	used in the sum-of-coefficients model

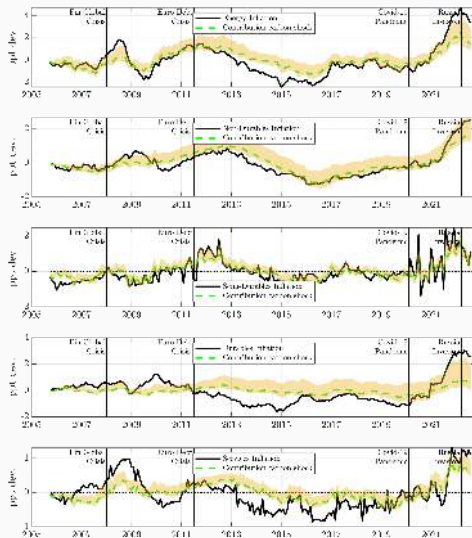
Prior variances follow Litterman (1986) as in Dieppe et al. (2016); the residual covariance has an inverse Wishart prior (Karlsson 2013).

Time series used in the model

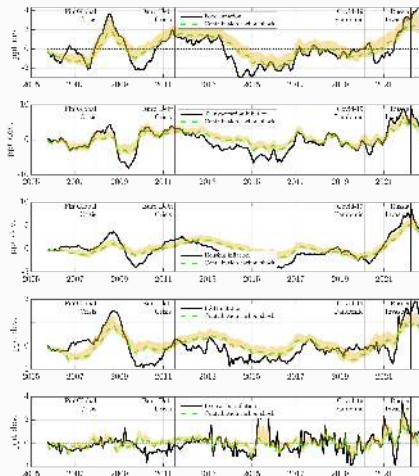


Notes: The paper's appendix figure, "Time series used in the model".

Historical decomposition: all five categories

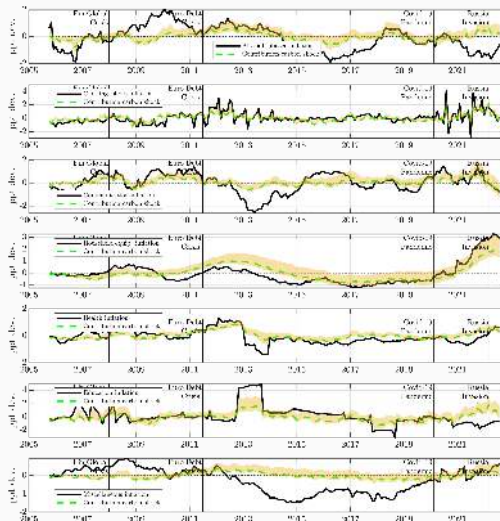


Historical decomposition: food, transport, housing, R&H, recreation

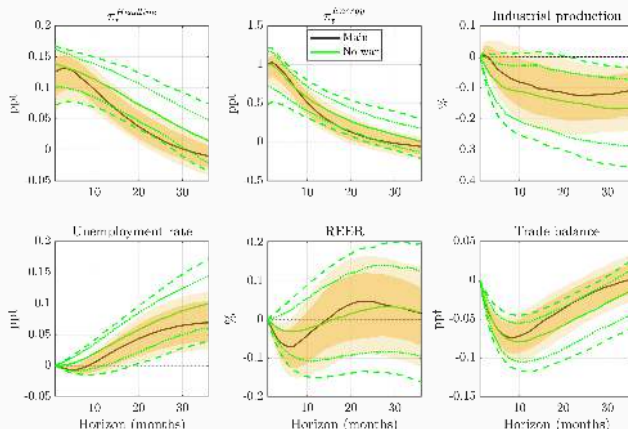


Remaining components

Historical decomposition: remaining components

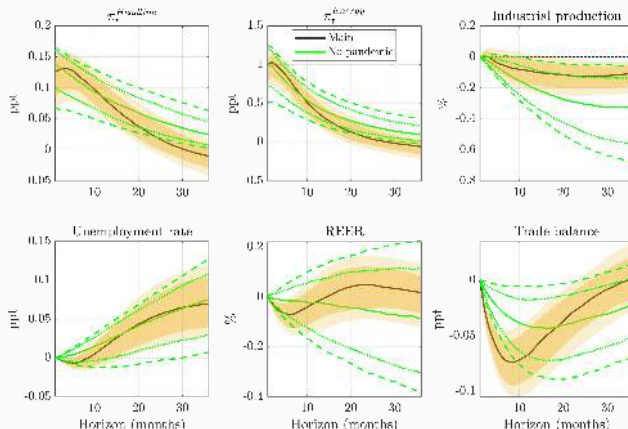


Robustness: excluding the invasion of Ukraine



Notes: Main model against the model without the invasion period (green); same variables and order as the baseline impulse responses.

Robustness: excluding the pandemic



Notes: Main model against the model without the pandemic period (green); same variables and order as the baseline impulse responses.

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