Navigating Climate Policy Shocks: Optimal Monetary Policy Responses*

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*The views expressed are those of the authors and do not necessarily reflect the official policy or position of the Bank of England, the Deutsche Bundesbank, and the Italian Ministry of Economy and Finance

Motivation

Why Climate Policy Matters for Central Banks (CBs)

"In short, climate policy has consequences for us as a central bank pursuing our primary mandate of price stability"

(C. Lagarde - International Climate Change Conference, 2021)

- Although setting appropriate climate policies will be a primary focus for fiscal authorities, there are aspects that directly speak to the way **monetary policy** is conducted.

Motivation

Why Climate Policy Matters for Central Banks (CBs)

> *"In short, climate policy has consequences for us as a central bank pursuing our primary mandate of price stability"*
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- Although setting appropriate climate policies will be a primary focus for fiscal authorities, there are aspects that directly speak to the way **monetary policy** is conducted.
- Shocks affecting the supply side of the economy, as several climate policies do, can create a policy **trade-off** for CBs, as they push the output gap and inflation in opposite directions.

This Paper: Research Questions

- What is the optimal monetary policy response to carbon pricing and green subsidy shocks and what is driving it?
- How do different Taylor rules perform compared to the optimal policy?
- What are the welfare costs of stabilizing headline inflation, which is the inflation measure that many CBs are targeting?

What We Find

Transmission of Climate Policy Shocks:

- Carbon Pricing Shocks (↑): Inflationary and contractionary.
- Green Subsidy Shocks (↑): Deflationary and expansionary.

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Optimal Monetary Policy (OMP) Response:

- Focused primarily on output stabilization.
- Driven by **complementarities** between energy and other consum.goods/prod.inputs.

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Optimal Monetary Policy (OMP) Response:

- Focused primarily on output stabilization.
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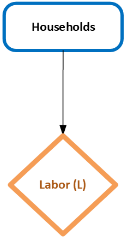
Taylor rules:

- Dual mandate rules imply lower welfare costs compared to rules targeting only inflation.
- Core inflation better than headline in terms of welfare but the gap narrows when energy and other consum. goods/prod.inputs are complements.

What We Do

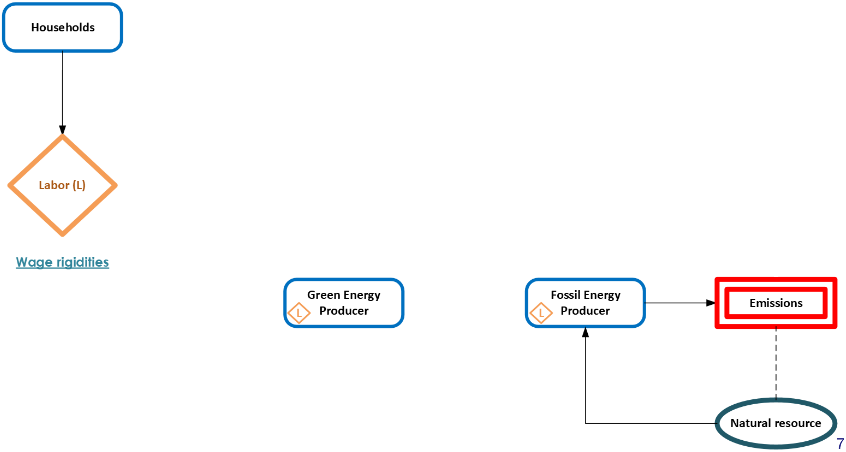
- Environmental New Keynesian energy model:
  - Wage and price rigidities (Calvo, 1983).
  - Fossil and green energy sectors.
  - Energy used in both consumption and production.
  - Complementarity between energy and other goods/inputs.
  - Emission flow and emission stock.
- Two policy scenarios:
  - Carbon pricing shock reducing emissions by 5% per annum with revenues redistributed lump-sum.
  - Green subsidy shock financed lump-sum.
- Dynamic and welfare analysis for:
  - The economy in which prices and wages are fully flexible.
  - The Baseline economy under OMP.
  - The Baseline economy under different Taylor rules.

The Model



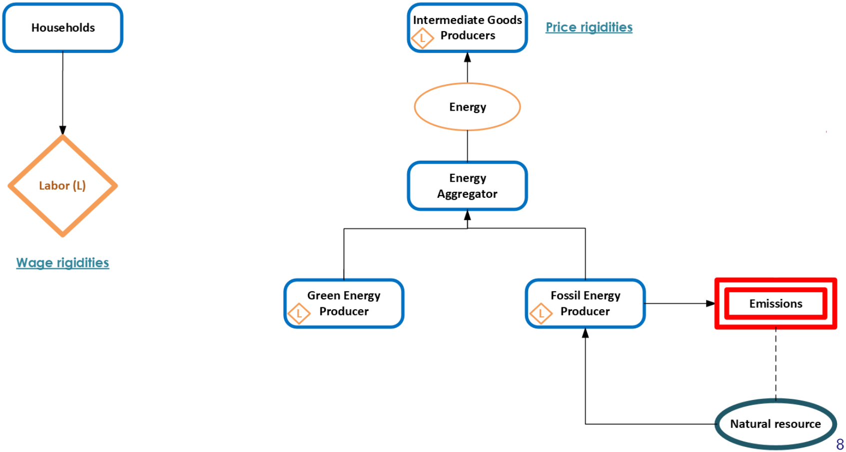
Wage rigidities

The Model



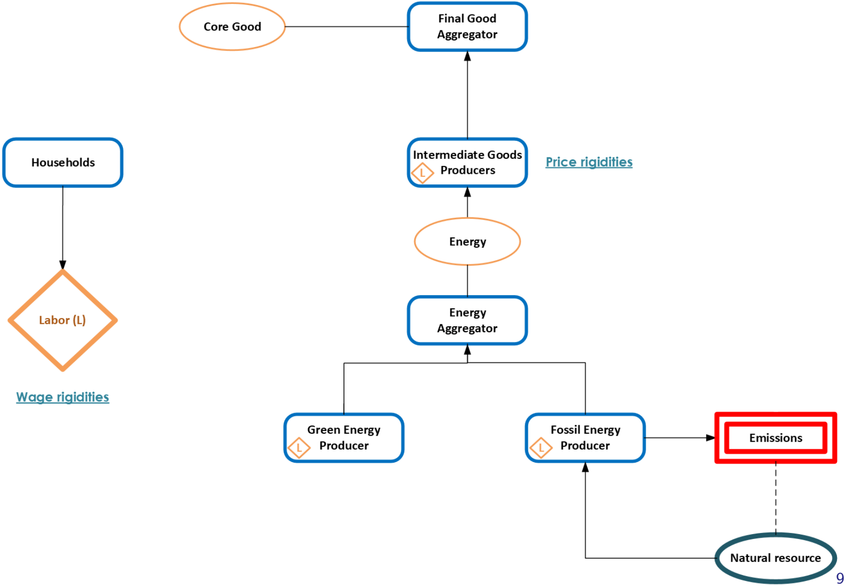
Households
Labor (L)
Wage rigidities
Green Energy Producer
L
Fossil Energy Producer
L
Emissions
Natural resource

The Model

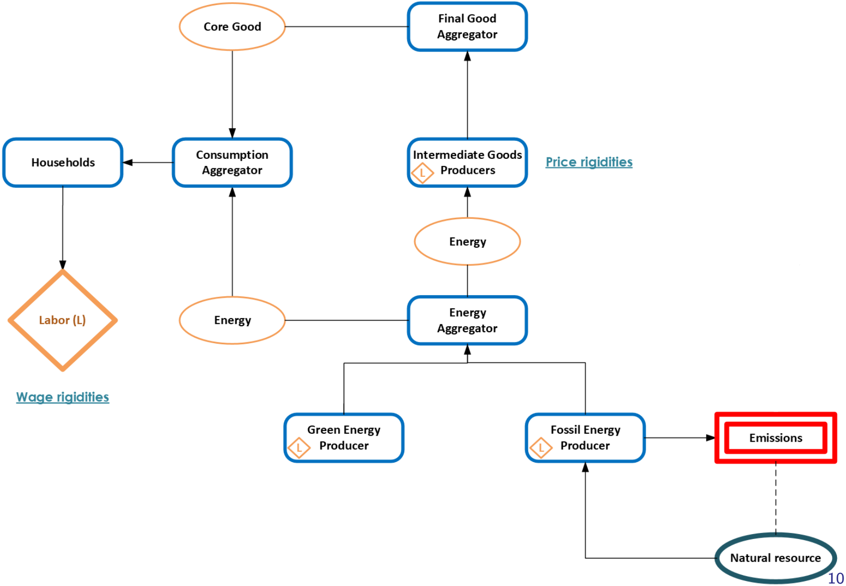


Households
Labor (L)
Wage rigidities
Intermediate Goods Producers
L
Price rigidities
Energy
Energy Aggregator
Green Energy Producer
L
Fossil Energy Producer
L
Emissions
Natural resource

The Model


Core Good
Final Good Aggregator
Households
Intermediate Goods Producers
L
Price rigidities
Energy
Labor (L)
Energy Aggregator
Wage rigidities
Green Energy Producer
L
Fossil Energy Producer
L
Emissions
Natural resource

The Model


Core Good
Final Good Aggregator
Households
Consumption Aggregator
Intermediate Goods Producers
L
Price rigidities
Energy
Labor (L)
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Energy Aggregator
Wage rigidities
Green Energy Producer
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Fossil Energy Producer
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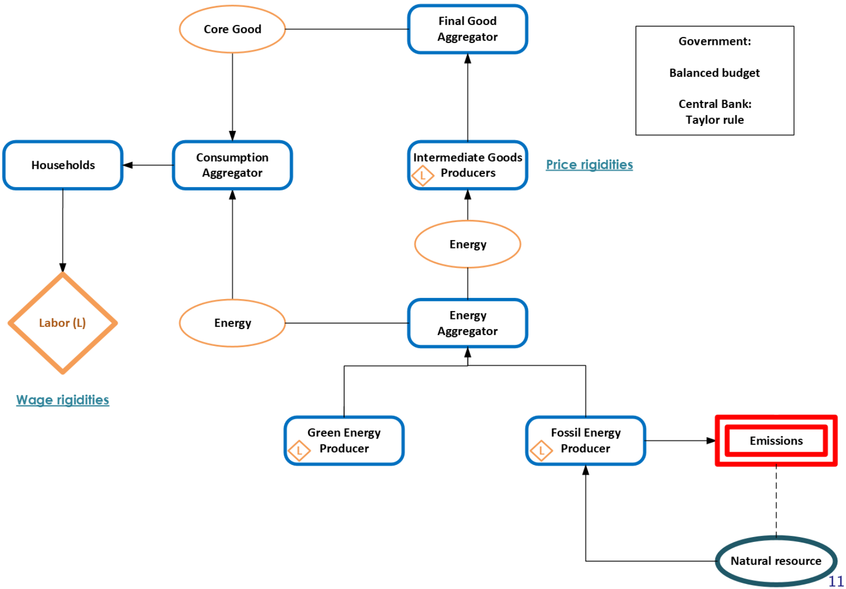
Emissions
Natural resource

The Model


Core Good
Final Good Aggregator
Government:
Balanced budget
Central Bank: Taylor rule
Households
Consumption Aggregator
Intermediate Goods Producers
L
Price rigidities
Energy
Labor (L)
Energy
Energy Aggregator
Wage rigidities
Green Energy Producer
L
Fossil Energy Producer
L
Emissions
Natural resource

Households' consumption basket is defined as a CES aggregate of energy goods $C_{E,t}$ and core goods $C_{Y,t}$:

$$C_t = \left[\varpi_{CE}^{\frac{1}{\sigma_C}} C_{E,t}^{\frac{(\sigma_C - 1)}{\sigma_C}} + (1 - \varpi_{CE})^{\frac{1}{\sigma_C}} C_{Y,t}^{\frac{(\sigma_C - 1)}{\sigma_C}} \right]^{\frac{\sigma_C}{(\sigma_C - 1)}},$$

where $\sigma_C \in (0, 1)$.
The energy bundle includes fossil (F) and green (G) energy:

$$C_{E,t} = \left[\varpi_{CF}^{\frac{1}{\sigma_E}} C_{EF,t}^{\frac{(\sigma_E - 1)}{\sigma_E}} + (1 - \varpi_{CF})^{\frac{1}{\sigma_E}} C_{EG,t}^{\frac{(\sigma_E - 1)}{\sigma_E}} \right]^{\frac{\sigma_E}{(\sigma_E - 1)}},$$

where $\sigma_E > 1$.

Calibration Summary

Key calibration values of the economy:

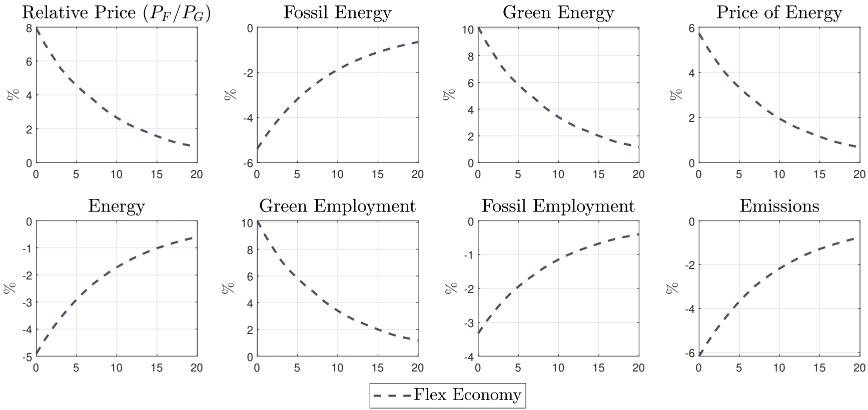
- Shares of energy in consumption and production: 6% and 7%.
  (OECD TiVa database, 2024)
- Share of fossil energy in overall energy: 80%.
  (OECD TiVa database, 2024)
- Energy consumption and core consumption are complements: substitution elasticity equals 0.4.
  (Coenen et al. 2024, Diluiso et al. 2021)
- Energy and labor in production are complements: substitution elasticity equals 0.4.
  (Coenen et al. 2024, Diluiso et al. 2021)
- Price and wage contracts have a duration of 4 quarters.

Steady State Parametrization

Flex. Economy's Response to a Carbon Pricing Shock

Energy Variables and Emissions

Expenditure effects prevail: energy prices increase and energy demand decreases.

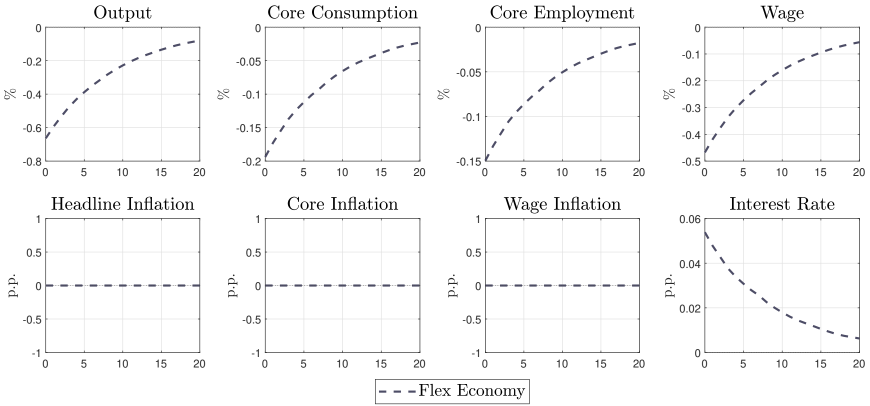


Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state. Time in quarters.

Flex. Economy's Response to a Carbon Pricing Shock

Macroeconomic Variables

Higher energy costs lead to a decrease in consumption and output. To align with the fall in consumption, the real interest rate increases.

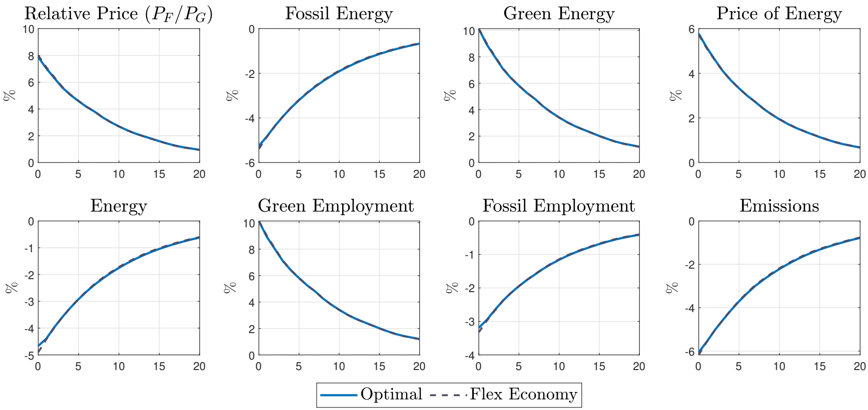


Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state. Time in quarters.

OMP Response to a Carbon Pricing Shock

Energy Variables and Emissions

OMP mimics quite closely the Flex equilibrium but energy demand decreases by less due to wage rigidities.



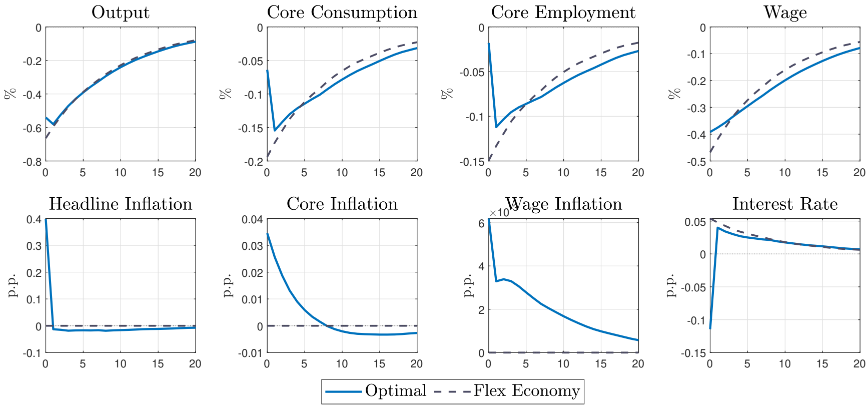
Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state. Time in quarters.

Green Subsidy

OMP Response to a Carbon Pricing Shock

Macroeconomic Variables

OMP weights the output gap more than inflation: the policy rate initially decreases.



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Flexible Wages
Green Subsidy

Optimal Monetary Policy: Main Drivers

Complementarities in production and consumption lead to additional terms in the welfare function reflecting movements in relative prices.
Welfare

- **Complementarities in production:**
  changes in the energy cost shares due to the shocks require a larger drop in real wages and employment to stabilize marginal costs. Cost Shares
- **Complementarities in consumption ("negative demand channel"):**
  changes in energy cost shares act as a distortionary tax on labor income. Cost Shares

Monetary Policy under Headline Inflation Targeting

Monetary policy is conducted according to the following rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\iota_R} \left[\left(\frac{\Pi_{C,t}}{\Pi_C}\right)^{\iota_\pi} \left(\frac{Y_t}{Y_t^*}\right)^{\iota_y}\right]^{1-\iota_R},$$

where Y_t^* is output under flex prices and wages and R and Π_C are steady state values for interest rate and **headline inflation**, defined as:

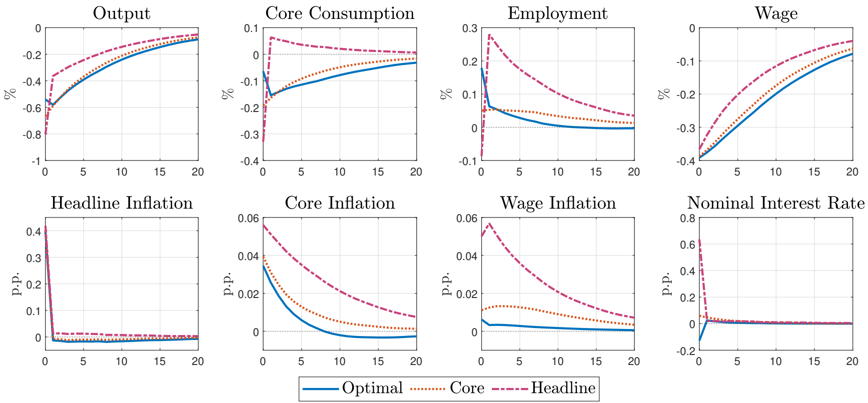
$$\Pi_{C,t} = \left[\varpi_{CE}\left(\Pi_{CE,t}\frac{P_{CE,t-1}}{P_{C,t-1}}\right)^{1-\sigma_C} + (1-\varpi_{CE})\left(\Pi_{CY,t}\frac{P_{CY,t-1}}{P_{C,t-1}}\right)^{1-\sigma_C}\right]^{\frac{1}{1-\sigma_C}},$$

where $\Pi_{CE,t}$ is energy inflation rate and $\Pi_{CY,t}$ is **core inflation**.

OMP vs. Taylor Rules

Carbon Pricing Shock

Core targeting: aligns more closely with OMP. Headline targeting: larger initial drop in C and Y, faster recovery, more persistent inflation.



Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state. Time in quarters.

Green Subsidy

Welfare Costs of Different Taylor Rules

Carbon Pricing Shock

Targeting core is better in terms of welfare. However, the welfare gap between core and headline targeting narrows in the presence of:

- complementarities (Baseline);
- dual mandate Taylor rules.

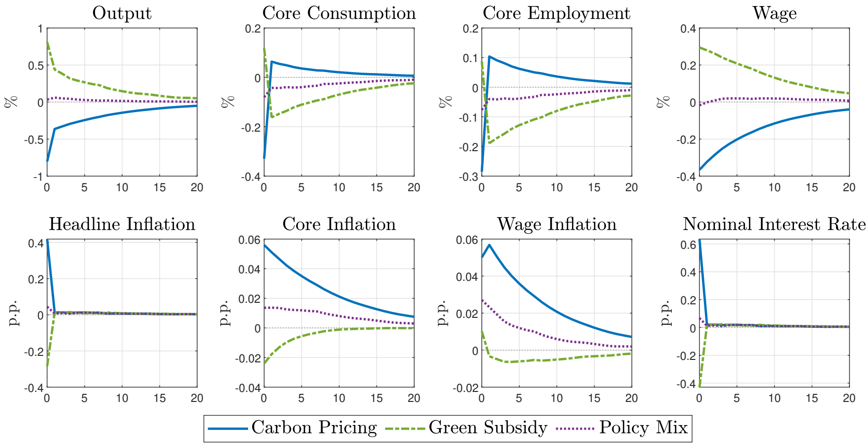
	Headline	Core
Cobb-Douglas $\iota_\pi = 1.5, \iota_y = 0,\ \iota_R = 0$	.091	.078
Baseline $\iota_\pi = 1.5, \iota_y = 0,\ \iota_R = 0$	.047	.043
Cobb-Douglas - Dual mandate $\iota_\pi = 1.5, \iota_y = 0.5,\ \iota_R = 0$	.074	.072
Baseline - Dual mandate $\iota_\pi = 1.5, \iota_y = 0.5,\ \iota_R = 0$	.042	.041

Note: % dev. of unconditional mean welfare under the rule from unconditional mean welfare under OMP.

Green Subsidy

The Role of Fiscal Policy

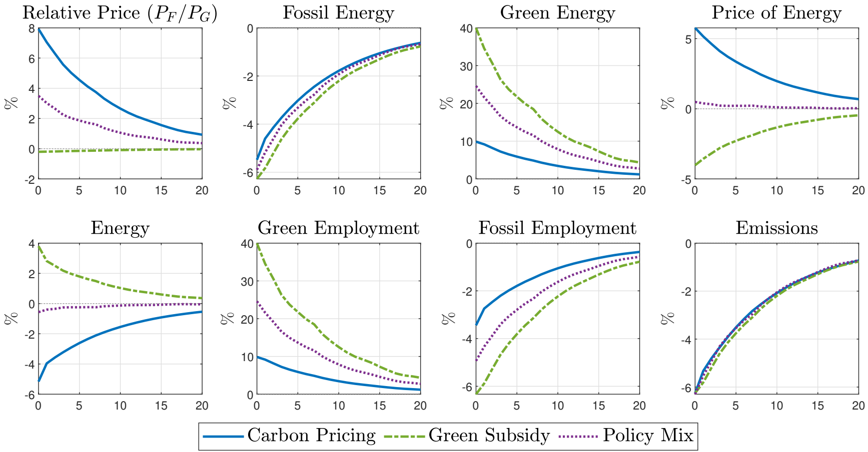
Macroeconomic Variables



Note: Results in percentage dev. (%) from the steady state. Prices in real terms. The size of the shocks is equalized in terms of emissions reduction within the first year. Time is in quarters.

The Role of Fiscal Policy

Energy Variables and Emissions



Note: Results in percentage dev. (%) from the steady state. Prices in real terms. The size of the shocks is equalized in terms of emissions reduction within the first year. Time is in quarters.

Conclusions and Policy Recommendations

- Climate policy shocks pose a trade-off between stabilizing inflation and output.
- Monetary policy should focus on output, looking through (dis)inflationary effects of these shocks.
- Targeting core inflation reduces welfare costs compared to headline inflation. However, the welfare gap narrows with complementarities in production and consumption.
- Under dual mandate rules, headline performs almost as well as core.
- A well-designed climate policy, on its own, can reduce economic volatility, limiting the need for monetary intervention.

Thank you

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Appendix

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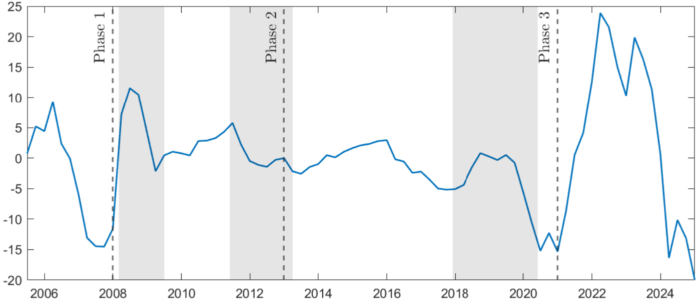
Cyclical Fluctuations in Carbon Price under the EU ETS



Note: The figure reports the cyclical component of the series of the price of EUA futures contracts (converted to quarterly frequency) derived via HP filtering. Vertical dashed lines show the end of each phase of the ETS (Phase 4 ongoing). Grey bars indicate periods of recessions for the Euro Area according to OECD indicators.

Related Literature

Macroeconomic Effects of Climate Policies:

- Transition (e.g. Coenen et al. 2024; Nakov and Thomas, 2023; Olovsson and Vestin, 2023; Sahuc et al. 2024).
- Carbon pricing **shocks** (Kaenzig, 2023; Berthold et al. 2025).

Contribution: We analyze the OMP response to climate policy shocks and the implications of targeting different inflation measures.

OMP Responses to Energy (Supply) Shocks:

- Optimality of targeting rules when energy shocks affect the economy (e.g. Aoki, 2001; Bodenstein et al. 2008; Natal 2012).

Contribution: We explicitly model energy production and differentiated energy sectors.

The Model

Households' Utility and Budget Constraint

Household h maximizes utility out of consumption C_t and labor $N_t(h)$:

$$U_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{1}{1-\zeta} C_t^{1-\zeta} - \chi \frac{N_t(h)^{1+\varphi}}{1+\varphi} \right),$$

subject to:

$$P_{C,t} C_t + B_t = W_t(h) N_t(h) + D_t + R_{t-1} B_{t-1} + T_t,$$

where B_t are one-period risk-free bonds, D_t dividends, T_t lump-sum transfers, W_t nominal wage and $P_{C,t}$ the consumption price index. Households have some monopoly power in the labor market.

wage rigidities

The Model

Households' Wage Setting

Each household has some monopoly power in the labor market and posts the wage at which they are willing to supply labor.

The aggregate demand for households' labor is equal to the sum of firms' labor demands in the three sectors: $N_t = N_{Y,t} + N_{F,t} + N_{G,t}$.

Following Calvo (1983), each period only a fraction $1 - \theta_W \in (0,1)$ of households can re-optimizes its posted nominal wage. The optimal wage W_t^* is:

$$W_t^{*\,1+\varphi\sigma_{W,t}} = \frac{\sigma_{W,t}}{\sigma_{W,t}-1} \frac{\mathbb{E}_0 \sum_{k=0}^{\infty} (\theta_W \beta)^k \chi W_{t+k}^{\sigma_{W,t}(1+\varphi)} N_{t+s}^{(1+\varphi)}}{\mathbb{E}_0 \sum_{k=0}^{\infty} (\theta_W \beta)^k \lambda_{t+k} W_{t+k}^{\sigma_{W,t}} N_{t+s}}.$$

back

The Model

Intermediate Good Sector (Sticky Prices)

Output $Y_{j,t}$ (used entirely for core consumption) is produced by monopolistically competitive firms using labor $N_{Y,j,t}$ and a bundle of energy inputs $M_{E,j,t}$:

$$Y_{j,t} = \left[\varpi_Y^{\frac{1}{\varepsilon_Y}} \left(A_{Y,t} N_{Y,j,t} \right)^{\frac{(\varepsilon_Y - 1)}{\varepsilon_Y}} + (1 - \varpi_Y)^{\frac{1}{\varepsilon_Y}} \left(M_{E,j,t} \right)^{\frac{(\varepsilon_Y - 1)}{\varepsilon_Y}} \right]^{\frac{\varepsilon_Y}{(\varepsilon_Y - 1)}},$$

where $\varepsilon_Y \in (0,1)$.

The energy composite is an aggregate of green and fossil energy:

$$M_{E,j,t} = \left[\varpi_{MG}^{\frac{1}{\varepsilon_E}} M_{EG,j,t}^{\frac{(\varepsilon_E - 1)}{\varepsilon_E}} + (1 - \varpi_{MG})^{\frac{1}{\varepsilon_E}} M_{EF,j,t}^{\frac{(\varepsilon_E - 1)}{\varepsilon_E}} \right]^{\frac{\varepsilon_E}{(\varepsilon_E - 1)}},$$

where $\varepsilon_E > 1$.

price rigidities

The Model

Energy Sectors (Flexible Prices) and Emissions

Green energy is produced using labor $N_{G,t}$:

$$E_{G,t} = A_{G,t} N_{G,t}.$$

Fossil energy is produced using labor $N_{F,t}$ and fossil resources O_t:

$$E_{F,t} = \left[\varpi_O^{\frac{1}{\varepsilon_F}} \left(A_{F,t} N_{F,t} \right)^{\frac{(\varepsilon_F - 1)}{\varepsilon_F}} + (1 - \varpi_O)^{\frac{1}{\varepsilon_F}} O_t^{\frac{(\varepsilon_F - 1)}{\varepsilon_F}} \right]^{\frac{\varepsilon_F}{(\varepsilon_F - 1)}},$$

where $\varepsilon_F \in (0,1)$. Emissions are proportional to the use of fossil resources: $X_t = \xi O_t$ and the emissions stock Z_t evolves as:

$$Z_t - \overline{Z} = (1 - \delta_Z) \left(Z_{t-1} - \overline{Z} \right) + X_t + X_t^{RoW},$$

where $\overline{Z}$ is the pre-industrial concentration of pollutant, $\delta_Z \in (0,1)$ is a decay rate and X_t^{RoW} are emissions from the rest of the world.

The Model

Intermediate Good Sector: Price Setting

Marginal costs are a function of wage W_t and the producer energy price index $P_{ME,t}$:

$$MC_t = \varpi_Y^{(1-\varepsilon_Y)} \frac{W_t}{\Delta_t A_{Y,t}} + (1-\varpi_Y)^{(1-\varepsilon_Y)} P_{ME,t}.$$

Following Calvo (1983), only a fraction $1-\theta_Y \in (0,1)$ of firms can change prices in period t, choosing an optimal price $P^*_{CY,t}$ such that:

$$\frac{P^*_{CY,t}}{P_{CY,t}} = \frac{\sigma_t}{\sigma_t - 1} \frac{\mathbb{E}_t \sum_{k=0}^{\infty} \theta_Y^k Q_{t,t+k} \frac{MC_{t+k,t}}{P_{CY,t+k}} \left(\frac{P_{CY,t+k}}{P_{CY,t}}\right)^{\sigma_t} Y_{t+k}}{\mathbb{E}_t \sum_{k=0}^{\infty} \theta_Y^k Q_{t,t+k} \left(\frac{P_{CY,t+k}}{P_{CY,t}}\right)^{\sigma_t - 1} Y_{t+k}},$$

where $P_{CY,t}$ is the sectoral price of core goods.

back

Climate Policy and GDP

Government runs a balanced budget at all times:

$$T_t = \tau_{o,t} P_O O_t - \tau_{g,t} P_{G,t} E_{G,t},$$

where $P_{G,t}$ is the price of green energy and P_O the price of fossil resources, determined exogenously on international markets. The fiscal instruments $\tau_{o,t}$ and $\tau_{g,t}$ are modeled as AR(1) processes.

Total output in the model is defined as:

$$GDP_t = P_{CY,t} C_{Y,t} + P_{CE,t} C_{E,t}.$$

Steady State Targets

	Description	Value
$P_{CE}C_E/P_C C$	Share of energy in consumption	0.06
$P_{ME}M_E/P_{CY}Y$	Share of energy in production	0.07
$E_F/(M_E + C_E)$	Share of fossil energy in total energy	0.80
$P_O O/P_F E_F$	Share of fossil fuels in fossil energy production	0.70
$X/(X + X^{row})$	Share of Euro Area emissions	0.073
Z	Stock of carbon (GtC)	891

Data sources: OECD Trade in Value-Added (TiVA) database and Emissions Database for Global Atmospheric Research (EDGAR).

Back

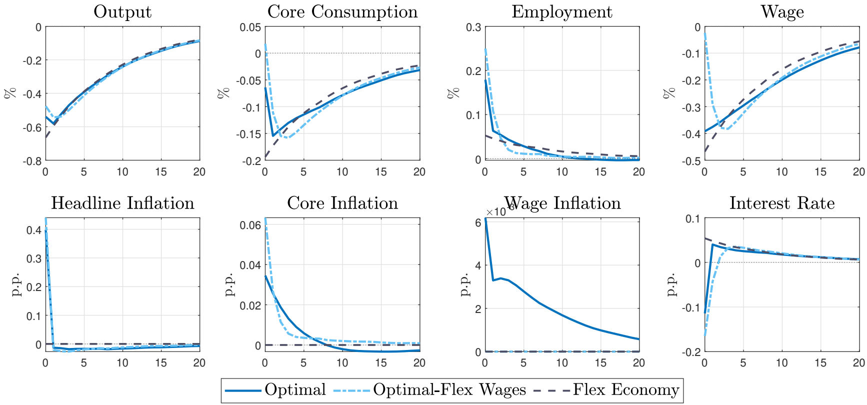
Calibration

	Description	Value
Preferences Parameters		
β	Discount factor	0.99
ζ	Risk aversion coefficient	1.5
φ	Inverse of Frisch elasticity	0.7
Price and Wage Setting		
θ_Y	Calvo's price parameter	0.75
θ_W	Calvo's wage parameter	0.75
Consumption		
σ_C	Elasticity between C and C_E	0.4
σ_E	Elasticity between C_{EG} and C_{EF}	2
ϖ_{CE}	Weight of energy in consumption	0.06
ϖ_{CF}	Weight of fossil energy in consumption	0.80
Production		
ε_Y	Elasticity between N_Y and M_E	0.4
ε_E	Elasticity between M_{EG} and M_{EF}	2
$1-\varpi_Y$	Weight of energy in production	0.08
ϖ_{MG}	Weight of clean energy in production	0.20
ε_F	Elasticity between N_F and O	0.3
$1-\varpi_O$	Weight of fossil resources in production	0.7

Back

OMP Response to a Carbon Pricing Shock

Macroeconomic Variables

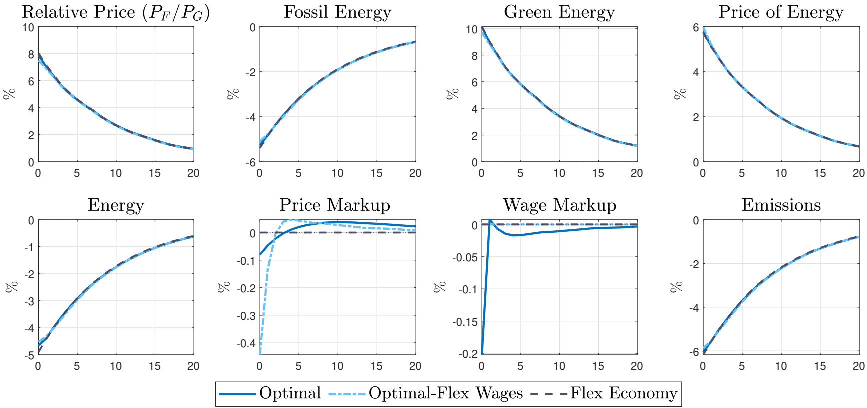


Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state.Time in quarters.

Back

OMP Response to a Carbon Pricing Shock

Energy Variables and Emissions



Note: Results in percentage dev. (%) from the steady state. Time in quarters.

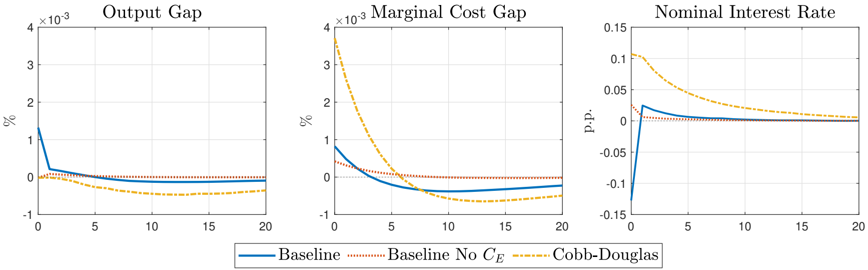
Back

OMP Response to a Carbon Pricing Shock

Different Structures of the Economy

The presence of energy in consumption magnified the policy trade-off.

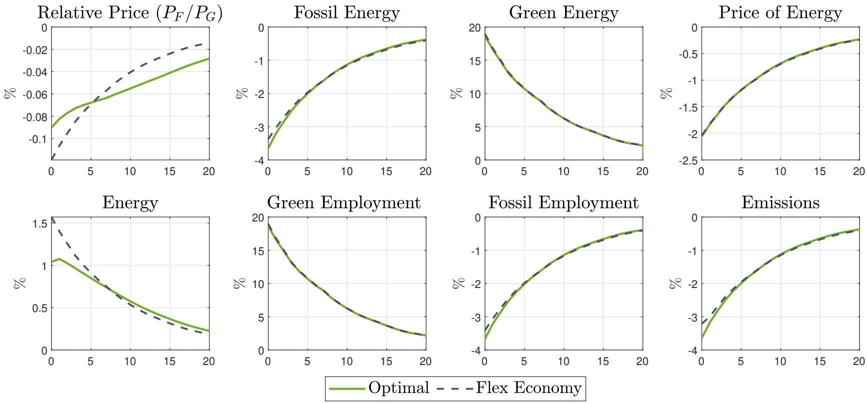
In the absence of complementarities or without energy in consumption OMP raise the rate to stabilize inflation.



Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the Flex economy. Time in quarters.

OMP Response to a Green Subsidy Shock

Energy Variables and Emissions



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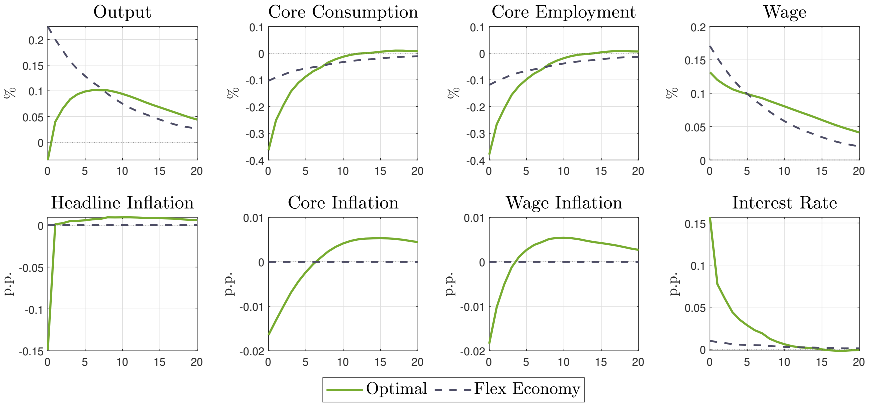
Back

OMP Response to a Green Subsidy Shock

Macroeconomic Variables



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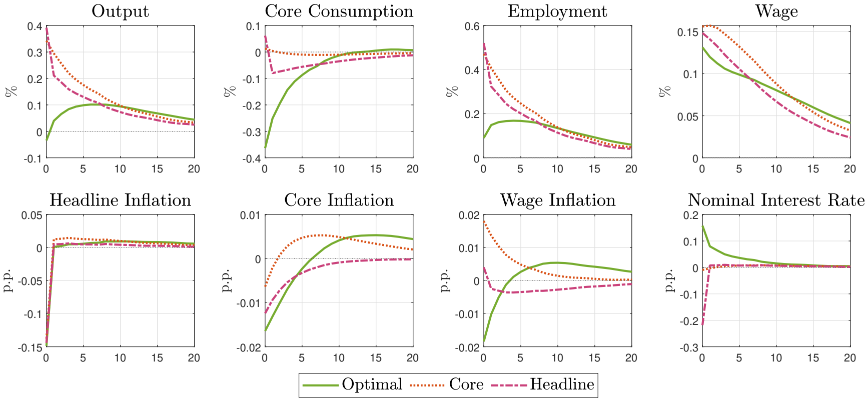
Back

OMP vs. Taylor Rules

Green Subsidy Shock



Note: Results in percentage dev. (%) and percentage point dev. (p.p.) from the steady state. Time in quarters.

back

Welfare Costs of Different Taylor Rules

Green Subsidy Shock

	Headline	Core
Cobb-Douglas $\iota_\pi = 1.5, \iota_y = 0,\ \iota_R = 0$	.0712	.0709
Baseline $\iota_\pi = 1.5, \iota_y = 0,\ \iota_R = 0$	.0425	.0425
Cobb-Douglas - Dual mandate $\iota_\pi = 1.5, \iota_y = 0.5,\ \iota_R = 0$	.0707	.0705
Baseline - Dual mandate $\iota_\pi = 1.5, \iota_y = 0.5,\ \iota_R = 0$	.0422	.0421

Note: % dev. of unconditional mean welfare under the rule from unconditional mean welfare under OMP.

Back

Welfare Approximation

A second order approx. of HHs' utility $\int_0^1 (U_t(h) - U)\,dh/(U_C\,C)$ yields:

$$\left(\widehat{c}_t - (\zeta - 1)\frac{\widehat{c}_t^{\,2}}{2}\right) - \chi\frac{N^{1+\varphi}}{C^{1-\zeta}}\left(\widehat{n}_t + (1+\varphi)\frac{\widehat{n}_t^{\,2}}{2} + \varphi\sigma_W^2\frac{var(\widehat{w}_t(h))}{2}\right)$$

We can define $\widehat{c}_t + \frac{1-\zeta}{2}\widehat{c}_t^{\,2} \propto$

$$\widehat{y}_{C,t} - \frac{\zeta - 1}{2}(\widehat{y}_{C,t})^2 - \omega_{CE}(1-\omega_C)(1-\sigma_{CE})\,\sigma_C\frac{(\widehat{p}_{CE,t} - \widehat{p}_{CY,t})^2}{2}$$

For the energy share $\omega_{CE} > 0$ and $\sigma_C < 1$, volatility in relative prices of energy and core goods affect welfare negatively. This ("consumption cost") disappears, if either $\omega_C = 0$ or $\sigma_C = 1$.

Welfare Approximation (cont.)

Labour part: $\widehat{n}_t + (1+\varphi)\left(\widehat{n}_t^{\,2}\right)/2 \propto$

$$\sigma_W^2 \frac{var(\widehat{w}_t(h))}{2} + \frac{\sigma^2}{\varpi_Y}\frac{var(\widehat{P_C}_t(j))}{2} + \widehat{n}_{Y,t}^{gross} + cov(\widehat{n}_{Y,t}^{gross})$$

$$+\frac{(1-\varepsilon_Y)\varepsilon_Y}{\varpi_Y}\frac{(\widehat{P}_{Y,t}^{Inp.})^2}{2} + \frac{(1-\varepsilon_F)\varepsilon_F}{\varpi_o}\frac{(\widehat{P}_{F,t}^{Inp.})^2}{2}$$

If energy and labor are complements in production, i.e. $\varepsilon_F < 1$ and $\varepsilon_Y < 1$, volatility in relative prices $\widehat{P}_{Y,t}^{Inp.}$ and $\widehat{P}_{F,t}^{Inp.}$, negatively affects welfare.

Back

Varying Costs Shares in Production

First-order approximation of Real Marginal Costs:

$$\hat{mc}_t - \hat{p}_{CY,t} = [(1-\tilde{\alpha}_Y) + \tilde{\alpha}_Y(1-\tilde{\alpha}_{MG}) + \tilde{\alpha}_Y\tilde{\alpha}_{MG}(1-\tilde{\alpha}_O)](\hat{w}_t - \hat{p}_{CY,t}) + \tilde{\alpha}_Y\tilde{\alpha}_{MG}\tilde{\alpha}_O(\hat{p}_{O,t} - \hat{p}_{CY,t})$$

where

$$\tilde{\alpha}_Y \equiv (1-\varpi_Y)\left(\frac{P_{ME}}{MC}\right)^{1-\varepsilon_Y}, \tilde{\alpha}_{MG} \equiv (1-\varpi_{MG})\left(\frac{P_F}{P_{ME}}\right)^{1-\varepsilon_E}, \tilde{\alpha}_O \equiv (1-\varpi_O)\left(\frac{P_O}{P_F}\right)^{1-\varepsilon_F}.$$

P_{ME}=price of energy, P_F=price of fossil energy, P_O=price of fossil fuels.

- A planner aiming for price stabilization faces a greater trade-off in response to carbon pricing shocks when the economy is more dependent on fossil fuels and fossil energy and highly labor-intensive in the core sector (a larger drop in wage is required)
- Green energy substitution can partially offset the impact of a shock affecting the price of fossil fuels.

Back

Varying Costs Shares in Consumption

First-order approximation of total consumption:

$$\hat{c}_t = (1-\tilde{\alpha}_{CE})\hat{y}_t - \sigma_E \tilde{\alpha}_{CE} \left\{ [\tilde{\alpha}_{CF}\tilde{(}1-\alpha_O) + (1-\tilde{\alpha}_{CF})](\hat{w}_t - \hat{p}_{CE,t}) + \tilde{\alpha}_{CF}\tilde{\alpha}_O(\hat{p}_{O,t} - \hat{p}_{CE,t}) \right\} \tag{1}$$

where

$$\tilde{\alpha}_{CE} \equiv \varpi_{CE} (P_{CE})^{1-\sigma_C}, \ \tilde{\alpha}_{CF} \equiv \varpi_{CF} \left(\frac{P_F}{P_{CE}}\right)^{1-\sigma_E} \ \tilde{\alpha}_O \equiv (1-\varpi_O)\left(\frac{P_O}{P_F}\right)^{1-\varepsilon_F}.$$

- A carbon price shock acts as a tax on labor income when core consumption and energy consumption are complements.
- The negative effect on consumption is magnified in economies heavily reliant on fossil resources, but mitigated by the availability of green energy.

Back