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Green targeted lending operations in the Euro Area ☆

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ABSTRACT

In this paper, we construct a Dynamic Stochastic General Equilibrium (DSGE) model to examine the implications of dual rates for green lending. We demonstrate that implementing a distinct interest rate for banks engaged in green lending can effectively mitigate transition risks while channeling more capital towards green production sectors and firms for an immediate cut of emissions and net zero emission economy targets.

"We should intensify efforts to green our lending operations, including the collateral framework"

[Isabel Schnabel, 2024]

1. Introduction

Concern about climate change has evolved into an urgent issue. Given the recent communication from the European Central Bank (ECB), this paper studies potential green lending policies to mitigate transition risks for the economy.

Our work contributes to the growing body of research on environmental economic models. The seminal work by Nordhaus (1977) introduces a Dynamic Integrated Climate Economy (DICE) model. explores other contributions to Environmental Business Cycle models citeheutel2012should and Annicchiarico and Di Dio (2015). Research on green quantitative easing and macroprudential policies, including studies by Benmir and Roman (2020), Carattini et al. (2021), Ferrari and Landi (2021), Abiry et al. (2022), and Ferrari and Nispi Landi (2023), analyze with brown and green sector models, aiming to explore policies that allocate effects between these sectors to mitigate transition risks. However, these studies often neglect the default risk within the production sector. Our study shares similarities with (Giovanardi et al., 2023) and Chan et al. (2024), integrating working capital into climate policy studies. Nonetheless, Giovanardi et al. (2023) does not incorporate carbon pricing into the model. Chan et al. (2024) do not model a permanent introduction of an ambitious carbon price.

We construct a New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) model with green and brown sectors, a carbon price, and banking sectors, which can have two different bank lending rates (dual rates). To this end, we impose two separate lending rate rules for a significant carbon price hike. We show that the dual-rated framework can direct more resources and enlarge the green sector, reducing the effect of an ambitious carbon policy. Most importantly, our paper shows that the “climate-rewarded” borrowing rate does not significantly affect inflation (see Figs. 1 and 3).

2. Theoretical model

Our model incorporates two types of firms: brown and green. Both types of firms are subject to financial frictions and reserve requirements. The model is based on the work of Le (2023) and is calibrated to the Euro Area.

2.1. Green and Brown financial intermediates

If their productivity falls too low, firms are more likely to declare bankruptcy, which increases the default risk associated with bank

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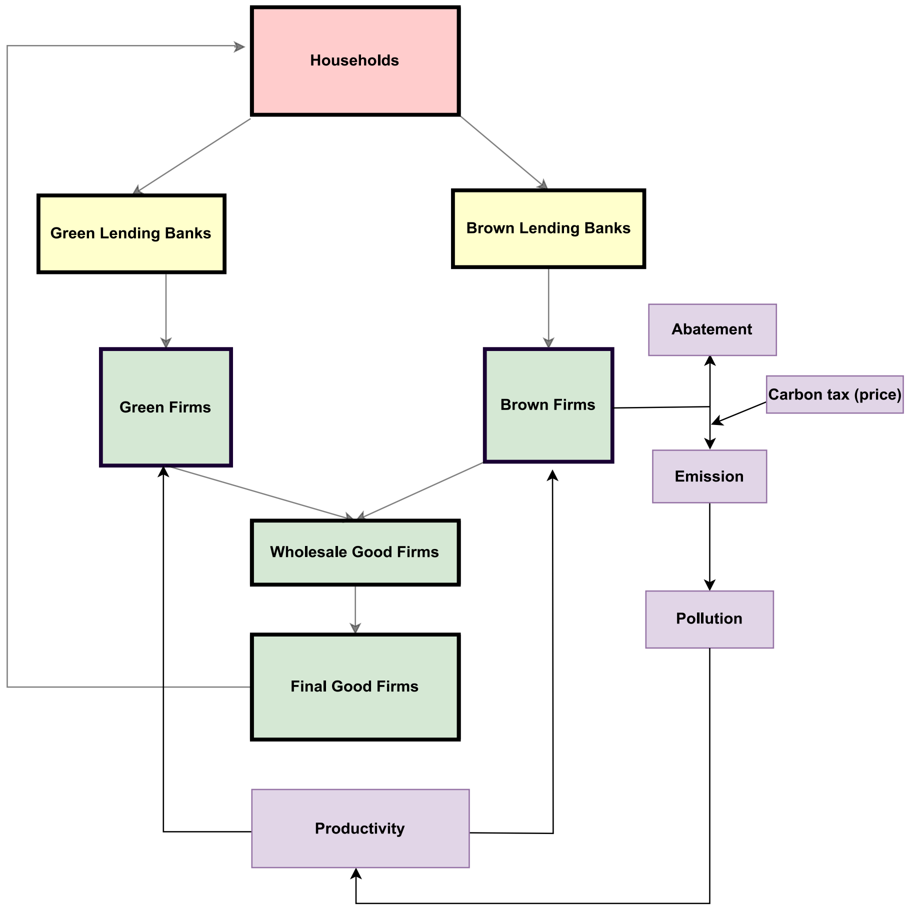

Fig. 1. A bird-eye view of the model.

loans. Hence, banks must set a higher lending rate, $Z_{B,t}$, on all types of loans to offset the expected costs of monitoring and liquidation in the event of bankruptcy. For brown firms, we characterize total emission costs, $cost_t^E$.

$$cost_t^E = \frac{\theta_1(\mu_t)^{\theta_2} y_t^B + \tau_t^e(1-\mu_t)\gamma_1 y_t^B}{\tilde{A}_{B,t}(N_{B,t-1}+B_{B,t})} \tag{1}$$

where $\bar{\omega}_{B,t}$ is defined as:

$$\bar{\omega}_{B,t} = \frac{Z_{B,t}B_{B,t}}{\tilde{A}_{B,t}(N_{B,t-1}+B_{B,t})(1-cost_t^E)} \tag{2}$$

The term $\tilde{A}_{B,t}$ represents the rate of return on the firm's portfolio, which is funded by a combination of borrowing and internal funds.

The optimization problem is defined below, where $f(\bar{\omega}_{B,t})$ and $g(\bar{\omega}_{B,t})$ represent the portions of firm value in the brown sector allocated to borrowers and lenders, respectively:

$$\max \tilde{A}_{B,t}(N_{B,t-1}+B_{B,t})(1-cost_t^E)f(\bar{\omega}_{B,t}) \tag{3}$$

$$\tilde{A}_{B,t}(N_{B,t-1}+B_{B,t})(1-cost_t^E)g(\bar{\omega}_{B,t}) \geq r_{B,t}B_{B,t} \tag{4}$$

As lending is subject to reserve requirements, we have the following conditions.

$$(r_{G,t}-1)(1-\tau) = R_t^{env}-1 \tag{5}$$

$$(r_{B,t}-1)(1-\tau) = R_t-1 \tag{6}$$

In line with the ECB's suggestion of green targeted lending operations, this paper introduces a second operational rate for green lending banks, R_t^{env}. Instead of a single Taylor rule, we introduce an additional Taylor rule for R_t^{env}.

$$\ln\left(\frac{R_t^{env}}{R_{ss}}\right) = \rho_r ln\left(\frac{R_{t-1}}{R_{ss}}\right) + (1-\rho_r)\left(\rho_y ln\left(\frac{Y_t}{Y_{t-1}}\right) + \rho_\pi ln\left(\frac{\Pi_t}{\Pi_{ss}}\right) + \rho_e ln\left(\frac{e_t}{e_{ss}}\right)\right) \tag{7}$$

$$\ln\left(\frac{R_t}{R_{ss}}\right) = \rho_r ln\left(\frac{R_{t-1}}{R_{ss}}\right) + (1-\rho_r)\left(\rho_y ln\left(\frac{Y_t}{Y_{t-1}}\right) + \rho_\pi ln\left(\frac{\Pi_t}{\Pi_{ss}}\right)\right) \tag{8}$$

As outlined by Bernanke et al. (1999), the connection between the productivity threshold and the leverage ratio, established through the incentive maximization process, is expressed as:

$$\frac{N_{B,t-1}}{(N_{B,t-1}+B_{B,t})(1-cost_t^E)} = -\frac{g'(\bar{\omega}_{B,t})}{f'(\bar{\omega}_{B,t})}\frac{\tilde{A}_{B,t}f(\bar{\omega}_{B,t})}{r_{B,t}} \tag{9}$$

At the end of period t, the total net worth of firms includes the profits of firms that have survived and the income of the entrepreneur in that sector. The variable δ_B represents the manager's survival rate.

$$N_{B,t} = w_{B,t}^e H_{B,t}^e + \delta_B \tilde{A}_{Bt}(N_{B,t-1}+B_{B,t})(1-cost_t^E)f(\bar{\omega}_{B,t}) \tag{10}$$

The problem of the green sector is identical with a zero environmental policy cost, $cost_t^E = 0$.

2.2. Calibration and model validation

Our model is calibrated using the Euro Area data and is consistent with the New Area Wide Model-II (NAWM-II) (see Tables 1 and 2).

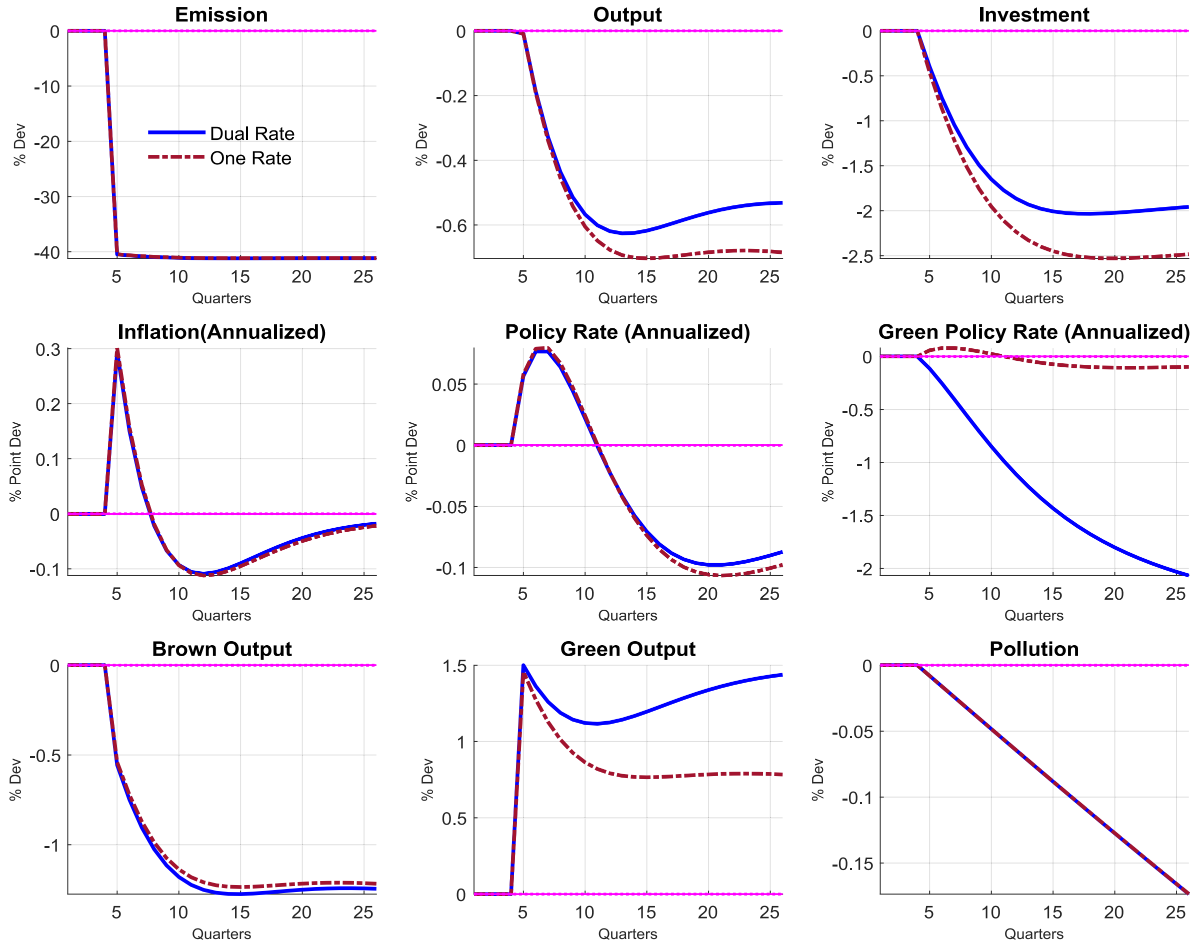

Fig. 2. The IRFs of an unanticipated shock after 5 periods. Impulse responses are expressed as percentage deviations from the initial steady states. The blue line represents our model with dual policy rules, while the red dashed line depicts the model with only one policy rule.

Table 1
Parameterization for the Euro Area.

Parameter	Value	Notes
ε	3.8571	NAWM-II
$1-\alpha$	0.3530	$\frac{I}{y} = 0.21(NAWM-II)$
κ_P	71.2043	NAWM-II (Calvo parameter)
δ	2.5%	NAWM-II
β	0.9988	Annual real interest rate of 2% (NAWM-II)
φ	2	NAWM-II
κ	0.85	To match moments
θ	0.68	Giovanardi et al. (2023)
σ	1.5	
δ_x	0.0035	Gibson and Heutel (2020)
$\tilde{e}^{row}$	2.7955	$\frac{e^{row}}{e} = 15.31$
γ_1	0.499	Estimated in Ferrari and Pagliari (2021)
θ_1	0.0335	Gibson and Heutel (2020)
θ_2	2.6	Gibson and Heutel (2020)
ρ_e	0.015	To keep the green bank rate positive
ρ_π	2.74	NAWM-II
ρ_y	0.1	NAWM-II
ρ_r	0.93	NAWM-II

Table 2
Model performance. The EA data covers the period from 1999Q1 to 2019Q4 and is taken from Eurostat.

		GDP_t	C_t	I_t	Π_t
Standard deviation (in %)	Data	1.19	0.66	2.85	0.28
	Our model	1.19	0.58	2.65	0.28
Standard deviation relative to GDP	Data	1	0.55	2.39	0.23
	Our model	1	0.48	2.22	0.24
Correlation with GDP	Data	1	0.83	0.84	0.42
	Our model	1	0.98	0.99	0.26
Autocorrelation	Data	0.90	0.90	0.68	0.22
	Our model	0.95	0.94	0.95	0.55

3. Numerical simulation

In this section, we conduct two scenarios, a 40% emission reduction and a net-zero emission by 2050 using an increasing carbon price.

3.1. An unanticipated increase of carbon price

In the fifth period, we introduce an unanticipated, substantial increase in the carbon price to generate a 40% emissions reduction. This policy shock generates significant economic disturbances, consistent with findings from Carattini et al. (2021) and Coenen et al. (2023), who also simulate the scenarios.

Fig. 2 illustrates the impulse response functions (IRFs) of a carbon price increase designed to achieve a 40% reduction in emissions. Thus, there is a drop in demand, which results in lower output. Initially, when the carbon price is introduced unexpectedly, the cost increase outweighs other factors, leading to higher inflation. However, with time, people adapt to the lasting effects of the carbon price, causing

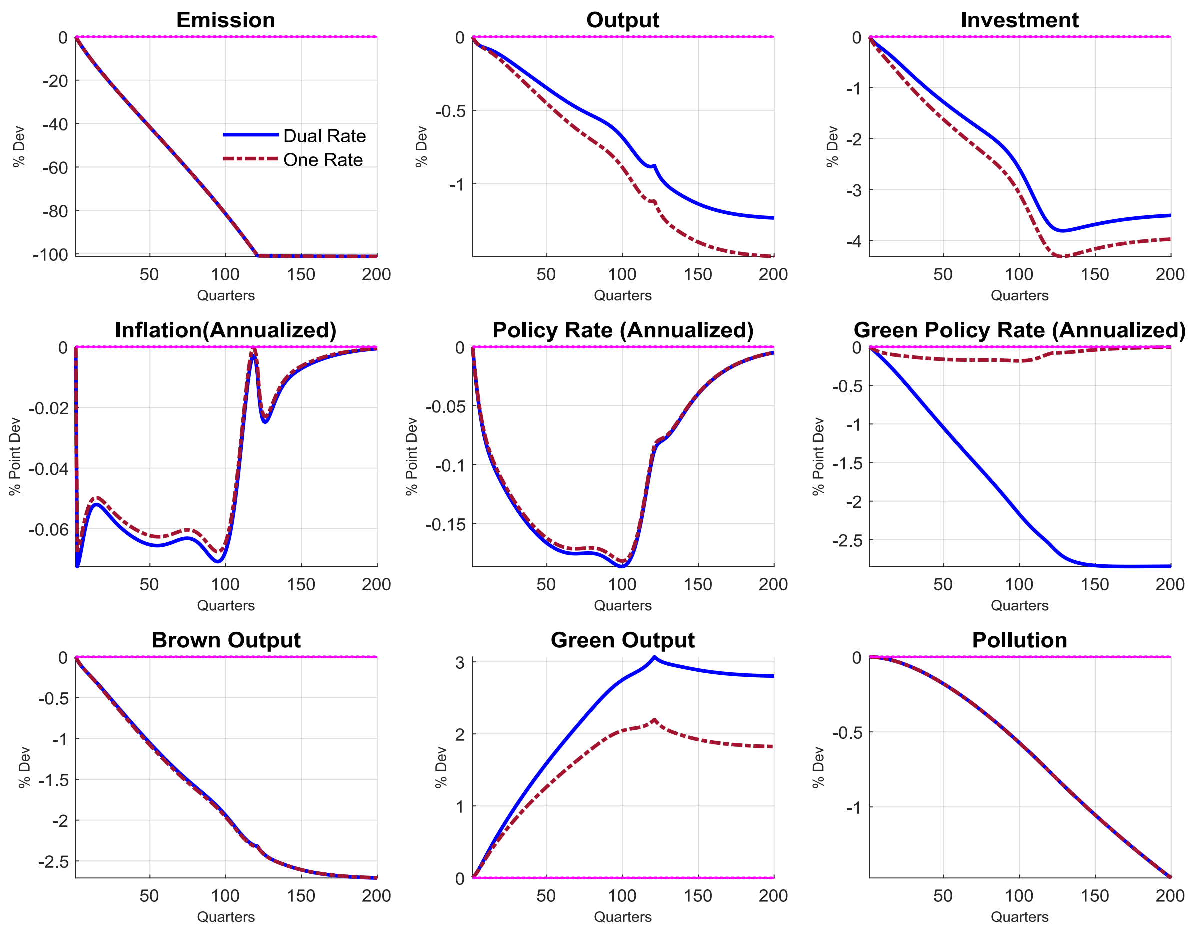

Fig. 3. The IRFs of an anticipated linearly increasing carbon price. Impulse responses are expressed as percentage deviations from the initial steady states. The blue line represents our model with dual policy rules, while the red dashed line depicts the model with only one policy rule.

demand to decrease gradually and resulting in a mild deflationary effect. This simulation desires to bring the economy to new steady states. Notably, in the depicted graph, rates for green and brown banks diverge.

The dual-rate lending policy effectively mitigates the economic costs of the transition. The transmission can be traced back to easing borrowing finance costs for green banks, which boosts green sector production. Hence, it reflects the most on the mitigation of investment. Because of the substitution effect, the brown output becomes slightly worse. Overall, this can direct more capital to the green sector and help to expand the green size, which helps mitigate the effect of carbon prices.

3.2. *Anticipated carbon price: Net zero emission economy*

In this part, we simulate a 30-year path to net-zero emissions using a gradually increasing carbon price, similar to Ferrari and Nispi Landi (2023). While the overall results align with their findings, quantitative differences emerge. Given the prolonged carbon price trajectory spanning 120 quarters, we solve the model under perfect foresight, incorporating full nonlinearities to capture the household's complete anticipation of the carbon price path.

Similar to a 40% cut in emissions, we observe a significant recessionary effect during the transition. Notably, inflationary pressures remain muted despite rising marginal costs associated with the carbon price. Because the household anticipates the increase in the carbon price, they know that their income will decrease. Hence, they reduce the demand in advance and create a mild deflationary effect.

Consistent with the previous analysis, including the emission inside the green rule helps them react more aggressively and create the wedge between brown and green financing rates for the banks.[1] By creating financial incentives for the green sector, we increase its size. This results in a milder recession with the same emission target.

4. Conclusion

This paper explains whether the "green lending operations" from the ECB can be implemented in a DSGE model. We show that it can allocate more resources to green sectors. Hence, it accelerates the transition path and mitigates the economic cost of the carbon price. Although the quantitative aspects are subject to uncertainty, central banks around the world can implement the dual rates framework to support the green transition.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econlet.2024.111893.

[1] We ensure that the financing rate with the reserve requirement stays at the positive territory.

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