Climate Policy and the Long-Run Interest Rate: Insights from a Simple Growth Model

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Long-run real interest rates have generally declined over the past 40 years. Research points to a number of potential reasons, including demographic trends, income inequality, and supply-side forces (Rachel and Summers, 2019). Some experts have suggested that climate change, and the policies adopted to address it, could lead to new shifts in the long-run interest rate (Schnabel, 2021; Mongelli, Pointner and van den End, 2022). We use a simple growth model to study how a carbon tax could affect the long-run interest rate.

We find that the effect of a carbon price on the long-run interest rate depends on how its growth rate compares to the growth rates of the prices of coal, oil, and natural gas. The carbon price reduces the long-run interest rate if and only if it grows faster than at least one fossil fuel price. Otherwise, it has no effect. The intuition is that the carbon tax affects the long-run interest rate through total factor productivity (TFP) growth. Higher tax-inclusive fossil fuel price growth reduces TFP growth, which in turn reduces the long-run interest rate. In the long run, the growth rate of each tax-inclusive fossil fuel price will either equal the growth rate of the pre-tax price or the growth rate of the carbon tax, whichever is largest. Therefore, the carbon tax affects TFP growth and the long-run interest rate, if and only if it grows faster than at least one fossil fuel price.

We quantify the interest-rate impacts for policy-relevant carbon tax paths and for the least-cost tax that achieves net-zero emissions. Motivated by the Clean Competition Act (CCA), we start by considering a carbon tax that grows at 5 percent per year (Whitehouse, 2023).[1] If fossil fuel prices grow at their average historical rates—0.7 percent for coal, 3.0 percent for natural gas, and 3.7 percent for oil—we find that this tax would reduce the long-run interest rate by 25 basis points. If fossil fuel prices are constant in the long run, the reduction is 77 basis points, because the carbon price has a larger effect on the growth rate of the tax-inclusive energy prices in this case.

We next consider the carbon tax that achieves net-zero emissions at the lowest non-environmental welfare cost. We find the least cost path that keeps cumulative emissions below a pre-determined level. According to standard Hotelling (1931) logic, this constraint implies that the least-cost carbon tax grows at the rate of interest. At the same time, the interest rate depends on the growth rate of the carbon tax. These two conditions jointly determine the long-run interest rate along the path to net zero. We find that the long-run interest rate falls by 8 basis points if fossil-energy prices grow at their historical rates and by 54 basis points if fossil-energy prices are constant. For context, the long-run interest rate has fallen by approximately 300 basis points in the past 40 years (Rachel and Summers, 2019). A decrease of 54 basis points would amount to 18 percent of the historical decline.[2]

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[1] The CCA proposes a performance standard for industries that are both carbon-intensive and exposed to international trade. Performance standards set targets for pollution per unit of output. Companies meeting the standard would pay no carbon price. The real carbon price for industries not meeting the standard would increase by 5 percent per year.

[2] Mehrotra (2024) shows that climate policy can decrease the interest rate along the transition path in a neoclassical model without growth. Benmir, Jaccard and Vermandel (2020) show that a pro-cyclical carbon tax can reduce aggregate volatility (from non-climate shocks), which decreases precautionary savings, putting upward pressure on

I. Model

We study a simple neoclassical growth model. We outline its main features here and relegate the derivations to the Appendix. The time step is one year. Gross output, Q, is produced from capital, K, labor, L, and energy services, E: $Q_t = K_t^{\alpha} E_t^{\nu} (A_t L_t)^{1-\alpha-\nu}$. Energy services are produced from clean energy, indexed by $i = 0$, and three types of fossil energy indexed by $i = 1, 2, 3$: $E_t = \bar{E} \prod_{i=0}^{3} (E_t^i)^{\gamma_i}$, where $\gamma_i \in (0, 1)\ \forall i$ and $\sum_{i=0}^{3} \gamma_i = 1$. Parameter $\bar{E}$ sets the units for energy services. We measure fossil energy in units of carbon emissions so that one unit of any type of fossil energy in our model generates one unit of emissions.

Each type of energy is produced from the final good at cost, p_t^i, which grows at rate g_{p^i}. Production is perfectly competitive implying that p_t^i is also the energy price. We order the fossil energy types based on the growth rate of their price: $0 \leq g_{p^1} \leq g_{p^2} \leq g_{p^3}$. The government can impose a per-unit tax on carbon emissions, $\tau_t > 0$, which raises the price of fossil energy type i from p_t^i to $p_t^i + \tau_t$. The tax grows at rate g_τ. The government returns all tax revenue back to households through lump-sum transfers, T_t. Value added, Y_t, is gross output minus energy costs: $Y_t = Q_t - \sum_{i=0}^{3} p_t^i E_t^i$.

The household side of the model is standard. Households have CRRA preferences over consumption, C_t, with relative risk aversion parameter σ. Households choose consumption and saving to maximize utility, subject to the budget constraint $C_t + K_{t+1} = (1 + r_t)K_t + w_t L_t + T_t$, where w_t is the wage and r_t is the interest rate. The first-order conditions for the household problem yield the usual consumption-Euler equation which implies that the interest rate in period $t + 1$ depends on consumption growth from period t to $t + 1$, $g_{C,t+1}$: $r_{t+1} = (1 + g_{C,t+1})^{\sigma}/\beta - 1$. Parameter β is the discount factor.

Our outcome of interest is the long-run interest rate, which we define as the interest rate on the balanced growth path.

Definition 1. *A* balanced growth path (BGP) *is a path along which C_t and K_t grow at constant rates, g_C^* and g_K^*. We use asterisks (∗) to denote BGP values. An* asymptotic balanced growth path *(ABGP) is a BGP that cannot be reached with finite prices and quantities.*

As in any neoclassical growth model, long-run consumption growth depends entirely on TFP growth. Thus, any impact of the carbon tax on the long-run interest rate must stem from its impact on long-run TFP growth. TFP in period t is given by:

$$TFP_t = \frac{Y_t}{K_t^{\tilde{\alpha}} L_t^{1-\tilde{\alpha}}} = \underbrace{A_t^{1-\tilde{\alpha}}}_{\text{Technology}} \times \underbrace{\nu^{\frac{\nu}{1-\nu}} \left(p_t^E\right)^{\frac{-\nu}{1-\nu}}}_{\text{Energy Prices}} \times \underbrace{\left(1 - \nu \left(\gamma_0 + \sum_{i=1}^{3} \gamma_i \frac{p_t^i}{\tau_t + p_t^i}\right)\right)}_{\text{Rebating} \rightarrow \text{Constant}},$$

where $\tilde{\alpha} \equiv \alpha/(1-\nu)$ is the share of value added paid to capital, and $p_t^E \equiv \tilde{\gamma}(p_t^0)^{\gamma_0} \prod_{i=1}^{3} (p_t^i + \tau_t)^{\gamma_i}$ is the price-index for energy services. The first term is the standard productivity term from the neoclassical growth model. The second term captures the effect of the price of energy services on productivity. Higher (tax-inclusive) energy prices reduce energy use, lowering output for a given combination of capital and labor. This effect is limited by energy's small factor share in gross output, ν. The last term arises from rebating the carbon tax revenue.

The long-run growth rate of TFP equals: $\ln(1+g_{TFP}^*) = (1-\tilde{\alpha}) \ln(1+g_A) - \frac{\nu}{1-\nu} \ln(1+g_{P_E}^*)$, where g_A is exogenous technology growth and $g_{P_E}^*$ is the growth rate of the price of energy services. The rebating term drops out in the long run, because it converges to a constant.

interest rates.

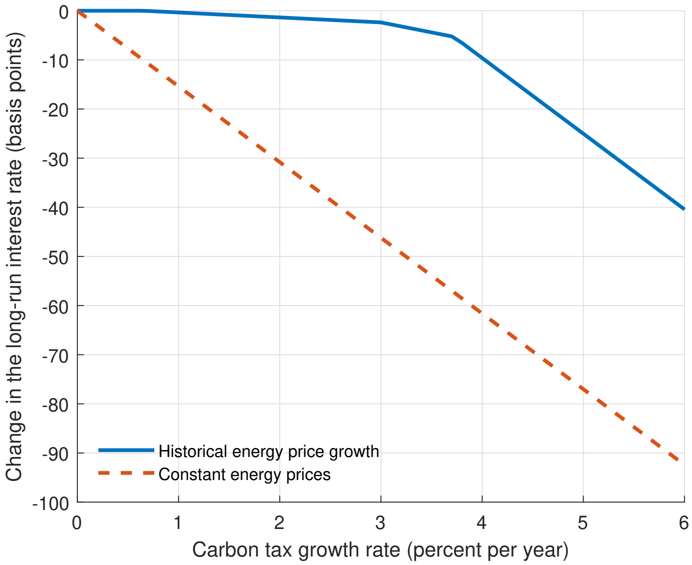
As a result, any impact of the carbon tax on long-run TFP growth stems from its effect on $g^*_{P_E}$. In turn, $g^*_{P_E}$ depends on the growth rate of the clean energy price and on the growth rates of each tax-inclusive fossil energy price. Each tax-inclusive fossil energy price grows at the maximum of the carbon tax growth rate and the growth rate of the pre-tax price. Hence, the carbon tax affects $g^*_{P_E}$ if and only if it grows faster than the slowest growing fossil energy price (i.e., if $g_\tau > g_{p^1}$). We use this result to characterize the effect of the carbon tax on the long-run interest rate.

Proposition 1. *On the asymptotic balanced growth path, the change in the long-run interest rate between a world with a carbon tax and a world without is:* $\Delta r^* \approx -\frac{\sigma}{1-\tilde{\alpha}} \times \frac{\nu}{1-\nu} \sum_{i=1}^{3} \gamma_i \left(g_\tau - g_{p^i}\right) \mathbf{1}\{g_\tau \geq g_{p^i}\}$, *where* $\mathbf{1}\{\cdot\}$ *is the indicator function.*

Proposition 1 shows that a carbon tax affects the long-run interest rate only if it grows faster than the slowest-growing fossil energy price. Otherwise, it has no effect. Optimal climate policy in many climate models includes a gradually rising carbon price (see e.g. Barrage and Nordhaus, 2023). The majority of carbon pricing systems around the world feature rising carbon prices. For example, prices in the EU ETS, the world's largest emissions trading system, more than doubled from approximately 30 dollars per ton in 2019 to over 60 dollars per ton in 2024. The Clean Competition Act in the U.S. proposes a performance standard with a carbon price that grows at 5 percent per year.

II. Quantitative Implications

Figure 1. Effect of a Carbon Tax on the Long-Run Interest Rate



We parameterize the model using standard values and quantify the effects of alternative carbon tax policies on the long-run real interest rate. We compute average real fossil-energy price growth rates and energy factor shares over 1974–2022, using data from the EIA (U.S. Energy Information Administration, 2025). We measure real prices per unit of carbon emissions as expenditures divided by emissions for coal, natural gas, and oil, deflated by the GDP deflator. The resulting average growth rates are 0.7, 3.0, and 3.7 percent, respectively. We measure fossil-energy factor shares as expenditure shares of coal, natural gas, and oil in total end-use energy expenditures, with the clean-energy share inferred as a residual. This yields factor shares of approximately 0.05 for coal, 0.15 for natural gas, 0.55 for oil, and 0.26 for clean energy. We set the energy share in gross output to $\nu = 0.085$ (Casey, 2024), the capital share in value added to $\tilde{\alpha} = 0.33$, and the inverse intertemporal elasticity of substitution to $\sigma = 1.5$.

Figure 1 shows how a carbon tax changes the long-run real interest rate in our model. The solid blue line plots the results assuming that fossil fuel prices grow at their historical average rates. The carbon tax has no effect on the long-run interest rate if its growth rate is below coal price growth (0.7 percent). As the growth rate of the tax rises, so does its impact on energy-service price growth and hence on the long-run interest rate. A carbon tax that grows at 5 percent per year would reduce the long-run interest rate by 25 basis points if fossil fuel prices grow at historical rates. The dashed orange line plots the change in the long-run interest rate if fossil fuel prices are constant. Under the maintained assumption that fossil fuel price growth will not be negative in the long run, constant fossil-fuel prices maximize the gap between the carbon tax growth and fossil-fuel price growth, yielding an upper bound on the interest rate impact. In this scenario, a carbon tax that grows at 5 percent per year would reduce the long-run interest rate by 77 basis points.

We now consider the impact on the long-run interest rate from a carbon tax policy that achieves net-zero emissions with the lowest (non-environmental) welfare cost. To characterize the least-cost policy, we study the associated social planning problem. The planner chooses sequences of consumption, investment, and energy to maximize the present discounted value of lifetime utility subject to the resource constraint and a carbon budget ($E^{\max}$) that caps cumulative emissions: $\sum_{t=0}^{\infty} \sum_{i=1}^{3} E_t^i < E^{\max}$.

Adding the carbon budget to an otherwise standard optimization problem brings in the familiar intuition from the Hotelling (1931) model of optimal resource management. Rather than limiting extractable fossil resources, the constraint limits allowable emissions. Optimality then implies that the gap between marginal product and marginal cost of fossil fuels rises at the rate of interest. This equilibrium can be implemented in a decentralized economy with a carbon tax equal to the gap between price and marginal cost, which grows at the rate of interest.

Proposition 2. *Consider the social planner problem described above. The optimal allocation can be implemented with a tax:* $\tau_t^{nz} = \beta^{-t} C_t^{\sigma} \Omega$, *where* Ω *is the multiplier attached to the cumulative emissions constraint. This tax grows at rate* $g_\tau^{nz} = r_{nz}^*$, *where* r_{nz}^* *is the interest rate in the decentralized equilibrium along the optimal path to attain net zero.*

Combining Propositions 1 and 2, we solve for the long-run interest rate, r_{nz}^*, under the least-cost net-zero carbon tax. We set the long-run growth rate of technology to 2 percent and the long-run growth rate of clean-energy prices to zero. We then choose β for each fossil-fuel price growth scenario so that the interest rate without a carbon tax equals 4 percent. We find that r_{nz}^* equals 3.92 percent if fossil fuel prices grow at their historical rates and equals 3.46 percent if fossil fuel prices are constant. Thus, the least-cost net-zero tax reduces the long-run interest rate by between 8 and 54 basis points, depending on the long-run growth rates of fossil energy prices. The effect of the least-cost tax on the long-run interest rate is independent of the size of the carbon budget (equivalently, the temperature target). While the carbon budget affects the level of the tax, it does not affect its growth rate, which is what matters for the long-run interest rate.

In our main analysis, the elasticity of substitution across energy types equals one, a choice required for balanced growth and consistent with long-run evidence in Casey, Gao and Kruse-Andersen (2025). However, other studies find higher elasticities (e.g., Papageorgiou, Saam and Schulte, 2017). Our qualitative results change only if the elasticity becomes so high that fossil energy is no longer an essential input. In this case, the effect of a carbon tax on the long-run interest rate depends on whether it induces a complete switch to clean energy. Absent such a switch, our main results hold. With a switch, the price of energy services equals the price of clean energy, and the carbon tax has no further effect on TFP growth or the long-run interest rate. The long-run interest rate could be higher or lower than its value without a tax, depending on how clean energy price growth compares with fossil-energy price growth.

III. Conclusion

We show that the effect of a carbon tax on the long-run interest rate is governed by a simple growth comparison. If the carbon tax grows faster than the price of at least one fossil fuel, then it raises the growth rate of the price of energy services, reduces TFP growth, and lowers the long-run interest rate. If it grows more slowly than all fossil fuel prices, then it has no effect. This mechanism operates alongside other forces associated with climate change and climate policy that may also shift interest rates, including changes in precautionary savings, capital demand, and technological growth.

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