Climate Risk Pricing: Are Green Stocks Riskier?

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Abstract

A large literature studies how green stocks can hedge the risk of negative stock returns in connection with increases in carbon taxes. To complement this empirical literature, we develop a theoretical model of climate risk pricing. Counter to standard arguments in the literature, we show that investors should buy *brown* stocks from a hedging perspective under reasonable assumptions. Indeed, given that carbon taxes are currently below the social cost of carbon, increases in carbon taxes raise welfare, so investors should hedge the risk of lower carbon taxes leading to climate destruction. Our results imply that individual risk concerns can perversely affect the greenium, lowering the cost of capital for brown firms relative to green.

Keywords: climate risk, ESG investing, sustainable finance, greenium

JEL Codes: E44, G12, H23, Q5

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A burgeoning literature aims at finding portfolios that hedge climate risk in stocks (Engle et al., 2020; Krueger et al., 2020; Bolton and Kacperczyk, 2021, 2023; Ardia et al., 2023; Faccini et al., 2023; Sautner et al., 2023) and corporate bonds (Huynh and Xia, 2021; Seltzer et al., 2022). This literature is not based on a formal theoretical model, but relies on the argument, for example articulated by Bolton and Kacperczyk (2021), that "major curbs in CO_2 emissions are likely to be introduced over the next decade. Primarily affected by these curbs are the companies with operations generating high CO_2 emissions," so "one would expect to see the risk with respect to carbon emissions to be reflected in the cross-section of stock returns."

But, are such emission curbs a risk that investors should hedge? More broadly, does hedging demand lead to higher returns to green or brown firms? In other words, do investors' risk considerations affect firms' cost of capital in a way that promotes green or brown real investment?

We present an environmental macro-finance model to address these questions. We find that, under intuitive conditions, brown assets serve as hedges, while green assets contain systematic risk. Hence, risk considerations imply lower required returns to brown assets relative to green, which perversely affects firms' incentives for a green transition.

To understand our result, consider first a simple setting with two time periods. Given that the current carbon tax and its projected future path is well below most estimates of the social cost of carbon, welfare will increase if carbon taxes unexpectedly rise. In other words, the representative investor should view such an event as one that results in less destruction from climate change, thus higher wealth, and lower marginal utility.

Instead, the investor might seek to hedge the scary scenario in which carbon taxes unexpectedly fall, leading to an acceleration in climate change with potentially devastating effects on welfare. In this scenario of lower aggregate welfare, the marginal utility is high, so this is the relevant scenario to hedge.

So, investors who worry about climate risk should hedge by buying brown stocks that profit from an untaxed burning of fossil fuels, even if this behavior is the very reason for the climate destruction. In other words, investors might seek to ensure that they can buy the higher ground when the world floods. By analogy, sports fans who wish to hedge the risk

that their team loses sometimes bet on the opposing team. Either your team wins, or you make some money. Similarly, if you really worry about climate change, you hedge by betting on the other team — brown firms in this case.

While these insights capture the main intuition for our result, the real world — and our actual dynamic model — has many time periods, which makes the argument more subtle. Indeed, in the real world (and our model), increases in carbon taxes only gradually lead to an environmental benefit, but immediately lowers output as production is switched to greener firms. Hence, an increase in carbon taxes toward the social cost of carbon reduces aggregate consumption at first, but simultaneously increases consumption growth due to the lower damage to the environment.

In other words, a higher carbon tax makes the representative household poorer in the short term and richer in the long term, relative to the scenario in which the carbon tax stays too low. We show that the total effect of these changes is that the representative household's marginal utility goes up when the carbon tax increases. Therefore, brown assets have lower expected returns in equilibrium.

The results have implications for whether sustainable investment can address climate change. A key mechanism with which green investment is hoped to address climate change is by lowering the cost of capital of green firms, while raising the cost of capital for brown firms. In other words, green investment is hoped to lower the cost of capital of green firms relative to brown, termed a negative "greenium." This greenium can arise simply out of investors' preferences for owning green assets (Pástor et al., 2021; Pedersen et al., 2021). However, many investors are not willing to give up significant returns to own greener assets and many institutional managers have a fiduciary duty to maximize financial returns (Edmans et al., 2024). Therefore, the literature on climate risk proposes that a greenium can arise instead from risk considerations and, furthermore, central banks impose climate stress tests (Acharya et al., 2023). Unfortunately, we show that investors' individual climate risk concerns can move the greenium in the opposite direction, thus hurting climate change rather than addressing it.

More broadly, the model illustrates that, in the presence of externalities, individual risk considerations can differ from collective ones. To mitigate the collective climate risk, carbon

taxes should be introduced as soon as possible and the economy should invest in green assets. However, given that carbon taxes are introduced too slowly, an investor has the incentive to hedge climate risk by buying brown stocks that pay off if regulators let such firms burn fossils at the expense of the environment.

Does the model's results for investor behavior describe well the real world? Since our result is counter to conventional wisdom, there are likely few, if any, investors who buy brown stocks as a hedge. Green investors buy green stocks either to align their investments with their values or to lower the cost of capital for green firms (Bonnefon et al., 2025). Some investors also claim to buy green stocks based on a risk argument similar to that in the existing literature (Giglio et al., 2025), but risk is often a minor argument, perhaps because of its tenuous foundation, as we show. Hoping to address climate change by confusing investors about the sign of their hedging demand is unlikely to be a sustainable path toward net zero emission.

We also note that there do exist conditions under which buying green stocks serves as a hedge. For example, if there is a risk (however unlikely under the current political conditions) that the carbon tax is raised well above the social cost of carbon. Also, while we have focused on so-called transition risk (the risk of increased carbon taxes), physical risk (the risk that environmental damage starts to materialize) is associated with other considerations still. Indeed, whether a firm is exposed to the physical damage of climate change may depend on characteristics like its geographical location, and might not be related to whether the firm is green or brown. Our model assumes that physical risk affects all firms equally, but there are differences across firms in the real world. Further, transition and physical risks could be interlinked, e.g., if carbon taxes rise due to news about the severity of climate change, which also affects the risk pricing. Hence, the general point is that risk considerations are far more complex than green preferences, and individual risk considerations need not address overall environmental risks.

The paper is related to several literatures in addition to the climate risk papers already cited. Our model can be viewed as a simple and tractable integrated assessment model in the spirit of Nordhaus (1994), Peck and Teisberg (1992), Golosov et al. (2014), Daniel et al. (2019), and other papers surveyed in Nobel Committee (2018). The paper is also related

to the literature on the greenium, e.g., Pástor et al. (2022), Bolton and Kacperczyk (2021), Zhang (2023), and Eskildsen et al. (2024). In a model without risk, Pedersen (2023) shows how the greenium translate into an equivalent carbon tax, thus showing how much required returns must change to drive a green transition. Other welfare and political considerations of sustainable finance are discussed by Hong et al. (2023), Allen et al. (2023), and Heeb et al. (2023).

1 Model

We consider a production economy populated by firms and a representative household who invests, works, and consumes at each time $t \in [0, \infty)$. Given the focus on sustainability, a distinguishing feature of our model is the externality that each firm's operations have on future production. We now proceed to describe each element of the model.

1.1 Firm producing final goods

A competitive firm produces Y_t units of a final good, which are sold to households for consumption. The final good is produced using as inputs intermediate goods in amounts y_{it} for all $i \in [0, 1]$. The final-good production function is

$$Y_t = \int_0^1 y_{it}^{\alpha} di, \tag{1}$$

where $\alpha \in (0, 1)$. Here, an α close to 1 means that intermediate goods are easily interchangeable, while a smaller α corresponds to more distinct goods.

The final good is used as numéraire, meaning that the final good is sold to households for the price of 1, while the endogenous price of each intermediate good is p_{it}. Thus, the operating profit, π_t, of the final-good firm equals

$$\pi_t = \int_0^1 \left(y_{it}^{\alpha} - p_{it} y_{it}\right) di. \tag{2}$$

1.2 Firms producing intermediate goods

Each intermediate-good firm $i \in [0, 1]$ produces an output, y_i, by employing l_i units of labor according to the production function

$$y_{it} = A_t l_{it}, \tag{3}$$

where A_t is a productivity process, common to all firms.

Each firm also creates emissions e_i proportional to the amount it contributes to the final-good production, described in equation (1):

$$e_{it} = f_i y_{it}^{\alpha}, \tag{4}$$

where f_i is the "fossil intensity" of the firm's technology.

Emissions are taxed at a rate τ_t, so that firm i pays a carbon tax of $\tau_t e_{it}$. The firm also has labor cost $w_t l_{it}$, where w_t is the wage. Hence, each intermediate good firm realizes a profit, π_{it}, at time t of

$$\pi_{it} = p_{it} y_{it} - \tau_t f_i y_{it}^{\alpha} - w_t l_{it}. \tag{5}$$

Intermediate good producers are monopolistically competitive, meaning that they set their price, p_{it}, to maximize their profit, taking wages and productivity as given.

1.3 Aggregate emission and climate destruction

Since emission arises from each intermediate-goods producer via (4), aggregate emission is

$$e_t = \int e_{it}\, di = A_t^{\alpha} \int f_i l_{it}^{\alpha}\, di. \tag{6}$$

Aggregate emission affects the climate, which in turn affects the economy's productivity,

A_t. Specifically, productivity grows as follows:

$$d\log(A_t) = \mu\, dt + \sigma\, dB_t - \phi A_t^{-\alpha} e_t\, dt. \tag{7}$$

To understand this productivity growth, note that μ is the "normal" technical growth in the absence of climate problems. Further, B_t is a standard Brownian motion that captures the randomness in innovations or technology shocks, and $\sigma > 0$ captures the volatility of these shocks. The last term is the novel part, which captures the idea that higher aggregate emission lowers productivity as emissions lead to floods and other disruptions. The parameter $\phi > 0$ captures the severity of these climate issues.

1.4 Asset prices and returns

The endogenous price of the final-goods-producing firm is P_t and the price of any intermediate goods producer is denoted P_{it}. The corresponding (instantaneous) returns are given by dR_t and dR_{it}, where, for example, the latter is defined as

$$dR_{it} \equiv \frac{dP_{it} + \pi_{it} dt}{P_{it}}. \tag{8}$$

1.5 Government policy

The government changes a carbon tax from firms, which is refunded to households, as the government balances its budget. The carbon tax rate, τ_t, is a time-homogeneous Markov chain, which takes one of N values, $\tau^1 \leq \tau^2 \leq ... \leq \tau^N$. If the carbon tax is τ^n, then it switches to τ^m with intensity $\lambda_{n,m}$. In other words, over a small time period Δt, it switches with probability $\lambda_{n,m}\Delta t$. The carbon tax can only go up or down by one notch at each switch. In other words, $\lambda_{n,n+1} > 0$ and $\lambda_{n,n-1} > 0$, but $\lambda_{n,m} = 0$ when $|m - n| > 1$.

1.6 Households

The representative household has recursive preferences as specified by Duffie and Epstein (1992) with an intertemporal elasticity of substitution (IES) to be equal to unity:

$$V_t = E_t\left[\int_t^\infty h(C_s, V_s)\, ds\right] \tag{9}$$

$$h\left(C_t, V_t\right) = \beta(1-\gamma)V_t\left(\log\left(C_t\right) - (1-\gamma)^{-1}\log\left((1-\gamma)V_t\right)\right). \tag{10}$$

where $\gamma > 1$ is the risk aversion and $\beta > 0$ is a subjective discount rate.

We highlight that we require the risk aversion to be higher than unity. With unitary IES, this condition is necessary (but not sufficient) for a higher future consumption growth to translate to a lower marginal utility.

For future convenience, let $c_t = \log(C_t)$ and define implicitly the process v_t such that the value function V_t is written as

$$V_t = \frac{\beta^{\gamma-1}}{1-\gamma}C_t^{1-\gamma}e^{(1-\gamma)v_t} = \frac{\beta^{\gamma-1}}{1-\gamma_t}\, e^{(1-\gamma)(c_t+v_t)}. \tag{11}$$

The household supplies all of its labor, L, for wage earnings $w_t L$, and receives a government transfer equal to the sum of all carbon taxes. The household chooses its consumption C_t at each time and its investment in firms and risk-free money-market account paying interest rate r_t to maximize its utility. The household's budget constraint is

$$dW_t = W_t\left(\theta\, dR_t + \int \theta_i\, dR_{it} + \theta_r r_t\, dt\right) + w_t L\, dt + G_t\, dt - C_t\, dt, \tag{12}$$

where the government transfer, $G_t = \int \tau_t e_{it}\, di$, balances the budget and the portfolio weights add up to unity, $\theta + \int \theta_i di + \theta_r = 1$. In other words, the household's wealth grows via its financial returns, wage income, government tax rebates, and is reduced by consumption.

1.7 Equilibrium

An equilibrium consists of a collection of intermediate-good prices, p_{it}; labor quantities, l_{it}; a wage rate, w_t; a financial portfolio, $(\theta_t, \theta_{it}, \theta_{rt})$; firm values, P_{it} and P_t; and an interest rate,

r_t, such that: (i) all firms maximize profits; (ii) the household maximizes its utility; (iii) the labor market, the markets for intermediate goods, and the markets for financial assets clear.

2 Solution and Results

2.1 Intermediate-good firms and equilibrium wage

The final-good firm's profit (25) has first-order condition with respect to intermediate good i given by

$$p_{it} = \alpha y_{it}^{\alpha-1}. \tag{13}$$

This relation determines the demand curve for good i as

$$y_{it} = \left(\frac{\alpha}{p_{it}}\right)^{\frac{1}{1-\alpha}}, \tag{14}$$

which naturally decreases in price. Based on this demand curve, the intermediate-good firm i chooses its price p_{it}, or equivalently its labor input l_{it}, to maximize its profit

$$\pi_{it} = p_{it}y_{it} - \tau_t f_i y_{it}^{\alpha} - w_t l_{it} = (\alpha - \tau_t f_i) y_{it}^{\alpha} - w_t l_{it} = (\alpha - \tau_t f_i) A_t^{\alpha} l_{it}^{\alpha} - w_t l_{it}. \tag{15}$$

The optimal labor follows as

$$l_{it} = \left(\frac{A_t^{\alpha}\alpha(\alpha - \tau_t f_i)}{w_t}\right)^{\frac{1}{1-\alpha}}. \tag{16}$$

Given that $y_{it} = A_t l_{it}$, we see that output increases in productivity, A_t, and decreases in the carbon tax, $\tau_t f_i$, and wage, w_t. We impose the condition $\alpha > f_i \tau^N$ for all i, preserving an interior operating solution for all firms.

The equilibrium wage is found by equating labor demand with its supply, L:

$$L = \int l_i di = {w_t}^{-\frac{1}{1-\alpha}} A_t^{\frac{\alpha}{1-\alpha}} \alpha^{\frac{1}{1-\alpha}} \int (\alpha - \tau_t f_i)^{\frac{1}{1-\alpha}} di. \tag{17}$$

Hence, the equilibrium wage can be written as

$$w_t = A_t^{\alpha} \bar{w}_{\tau_t}, \tag{18}$$

where the first term, A_t^{α}, is a "trend component" that depends on the economy's productivity. The second term, $\bar{w}_{\tau_t}$, the "carbon-tax-regime component," can be computed explicitly for each value of the prevailing tax, τ_t:

$$\bar{w}_{\tau_t} = \alpha L^{\alpha-1} \left(\int (\alpha - \tau_t f_i)^{\frac{1}{1-\alpha}} di \right)^{1-\alpha}. \tag{19}$$

Having solved for the equilibrium wage, we can plug it into (16) to get each firm's equilibrium labor choice,

$$l_{it} = \left(\frac{A_t^{\alpha} \alpha(\alpha - \tau_t f_i)}{A_t^{\alpha} \bar{w}_{\tau_t}} \right)^{\frac{1}{1-\alpha}} = \left(\frac{\alpha(\alpha - \tau_t f_i)}{\bar{w}_{\tau_t}} \right)^{\frac{1}{1-\alpha}} =: l_{i\tau_t}, \tag{20}$$

where the last expression indicates that the labor choice only depends on the carbon tax regime.

Given an expression for the equilibrium labor choice, the corresponding output, profit, emission, and aggregate emission follow immediately:

$$y_{it} = A_t l_{i\tau_t} \tag{21}$$

$$\pi_{it} = (\alpha - \tau_t f_i) A_t^{\alpha} l_{i\tau_t}^{\alpha} - A_t^{\alpha} \bar{w}_{\tau_t} l_{i\tau_t} = A_t^{\alpha} \left((\alpha - \tau_t f_i) l_{i\tau_t}^{\alpha} - \bar{w}_{\tau_t} l_{i\tau_t} \right) =: A_t^{\alpha} \, \bar{\pi}_{i\tau_t} \tag{22}$$

$$e_{it} = f_i y_{it}^{\alpha} = A_t^{\alpha} \, f_i l_{i\tau_t}^{\alpha} \tag{23}$$

$$e_t = A_t^{\alpha} \int f_i l_{i\tau_t}^{\alpha} \, di. \tag{24}$$

We see that each of these equilibrium values decompose into a trend component (depending on A_t) and tax-regime component (depending on τ_t).

2.2 Equilibrium final-good output and its growth

The final-good firm's profits are a constant fraction, $1-\alpha$, of its output:

$$\pi_t = \int \left(y_{it}^{\alpha} - p_{it} y_{it}\right) di = \int \left(y_{it}^{\alpha} - \alpha y_{it}^{\alpha-1} y_{it}\right) di = (1-\alpha) Y_t, \tag{25}$$

where the second equality uses (13). The output of the final good is found by integrating the equilbrium intermediate good outputs:

$$Y_t = \int y_{it}^{\alpha} di = A_t^{\alpha} \int l_{i\tau_t}^{\alpha} di = A_t^{\alpha} e^{\bar{c}_{\tau_t}}, \tag{26}$$

defining the detrended log consumption $\bar{c}$ through the last equation.

Having derived the aggregate consumption, we compute its dynamics using Ito's lemma:

$$\frac{dY_t}{Y_t} = g_{\tau_t}\, dt + \alpha\sigma\, dB_t + e^{\Delta \bar{c}_{\tau_t}} - 1, \tag{27}$$

where the growth rate conditional on remaining in the current tax regime, g_{τ_t}, is

$$g_{\tau} = -\phi\alpha e_{\tau} + \alpha\mu + \frac{1}{2}\alpha^2\sigma^2. \tag{28}$$

We see that aggregate emission, e_{τ}, lowers consumption growth due to its climate effects. Further, the aggregate emission is determined by the tax regime. Naturally, consumption growth also increases with the technological productivity growth, μ, and the last term is the standard convexity effect.

We note that (28) describes the consumption growth in each state as long as the tax rate does not change, but the overall consumption growth (27) also has a jump component due to changes in the tax rate.

2.3 Utility and marginal rates of substitution

The representative investor consumes the entire output of the final good in equilibrium. Given this consumption process, the agent derives utility V_t as specified in (9). The agent's marginal rate of substitution process, which is a stochastic discount factor (SDF) in this

economy, is well known (see, for instance, Duffie and Epstein (1992)) to be given by

$$\xi_t = h_C(C_t, V_t) e^{\int_0^t h_V(C_s, V_s) ds}, \tag{29}$$

where we recall that h is the utility flow (10), while h_C and h_V are its partial derivatives.

Using the rewriting (11), the SDF can be expressed as

$$\xi_t = A_t^{-\alpha\gamma} e^{\int_0^t \beta(1-\gamma)(\log(\beta) - v_t) ds} e^{-\gamma \bar{c}_{\tau_t} + (1-\gamma) v_t}. \tag{30}$$

Furthermore, in the appendix we verify that v_t only depends on the tax regime, and write $v_t = \bar{v}_{\tau_t}$. We let

$$\bar{\xi}_{\tau_t} \equiv e^{-\gamma \bar{c}_{\tau_t} + (1-\gamma)\bar{v}_t} \tag{31}$$

be the SDF component that captures the market price of jump risk.

The value function solves the Hamilton-Jacobi-Bellman (HJB) equation

$$0 = h(C_t, V_t) + \frac{1}{dt} \mathrm{E}[dV_t]. \tag{32}$$

Using Ito's lemma and equations (11) and (10), we can rewrite the above equation[1] as the system of n equations with n unknowns $\bar{v}_{\tau^n}$

$$\beta \left(\bar{v}_{\tau^n} + \bar{c}_{\tau^n} \right) = \sum_m \lambda_{n,m} \frac{e^{(1-\gamma)(v_{\tau^m} + \bar{c}_{\tau^m} - v_{\tau^n} - \bar{c}_{\tau^n})} - 1}{1-\gamma} + g_{\tau^n} + \beta \bar{c}_{\tau^n}. \tag{33}$$

In each of these equations, the term on the left-hand side is effectively the agent's value function.[2] The term $g_{\tau^n} + \beta \bar{c}_{\tau^n}$ shows that this value function is determined by the sum of two terms: the discounted sum of future growth, $\beta^{-1} g_{\tau^n}$, and the current consumption level, $\bar{c}_{\tau^n}$. We see here explicitly the concern for both future growth and current consumption that recursive preferences introduce. Higher taxes reduce current consumption $\bar{c}$, while increasing the expected consumption growth g. When the latter effect dominates, a higher tax results

[1] We omit an additive constant, whose effect is absorbed in the level of ξ.

[2] The complete expression for the value function is $A_t^{\alpha} (1-\gamma)^{-1} e^{(1-\gamma)(\bar{v}_{\tau_t} + \bar{c}_{\tau_t})}$.

in higher utility.

The summation term on the right-hand side of equation (33) accounts for the tax-regime changes, through the associated jumps to the value function.

From now on, we specialize to two types of firms, "brown" and "green," characterized by emission parameters f_b, respectively f_g, with $f_b > f_g$. A mass m_g are of type g, and a mass $m_b = 1 - m_g$ are of type b. We will also impose the parametric condition $\phi f_b < \beta$, which ensures that the socially optimal values of l_g and l_b are non-zero.

The proposition below confirms that, when the tax rate is low enough, the growth effect of increasing taxation is sufficiently strong relative to the current consumption effect that the marginal utility decreases. Informally put, a higher tax corresponds to a good state of the world.

Proposition 1 *There exists a value $\bar{\tau} > 0$ such that, for $\max_{n,m} \lambda_{n,m}$ small enough, the detrended marginal utility process $\bar{\xi}_\tau$ decreases in τ for $\tau \leq \bar{\tau}$ and increases in τ for $\tau > \bar{\tau}$.*

2.4 Asset prices

Having determined an SDF for our economy, we can use it to price all traded assets, in particular the shares of intermediate-good firms. Specifically,

$$P_{it} = \mathrm{E}_t \left[\int_t^\infty \frac{\xi_s}{\xi_t} \pi_{is} \, ds \right] \tag{34}$$

$$= A_t^\alpha \mathrm{E}_t \left[\int_t^\infty \frac{\xi_s}{\xi_t} \frac{A_s^\alpha}{A_t^\alpha} \bar{\pi}_{is} \, ds \right]. \tag{35}$$

Since the dynamics of ξ and A depend only on the Markov state τ, the expectation on the right-hand side of equation (35) is only a function of τ_t. We can therefore write

$$P_{it} = A_t^\alpha \, p_{i\tau_t}. \tag{36}$$

It then follows that the return on stock i can be written as

$$dR_{it} = \frac{dP_{it} + \pi_{it}dt}{P_{it}} \tag{37}$$

$$= \frac{dA_t^\alpha}{A_t^\alpha} + \frac{\bar{\pi}_{i\tau_t}}{p_{i\tau_t}}dt + \frac{p_{i\tau_t} - p_{i\tau_{t^-}}}{p_{i\tau_{t^-}}}, \tag{38}$$

where the last term captures the return due to a jump in the tax rate at time t.

By a standard argument, the expected return difference between the two types of stock, when the current state is τ^n, is given by the covariance of this excess return and the SDF:

$$\frac{1}{dt}\mathrm{E}_t^n\left[dR_t^g - dR_t^b\right] = \frac{1}{dt}\mathrm{Cov}_t^n\left(dR_t^g - dR_t^b, \frac{d\xi_t}{\xi_t}\right) \tag{39}$$

$$= \sum_m \lambda_{nm}\left(1 - \frac{\bar{\xi}_{\tau^m}}{\bar{\xi}_{\tau^n}}\right)\left(\frac{p^g_{\tau^m}}{p^g_{\tau^n}} - \frac{p^b_{\tau^m}}{p^b_{\tau^n}}\right). \tag{40}$$

Since higher taxes hurt brown-firm profits more than green-firm ones, it is natural to conjecture that green-firm returns are higher than brown-firm returns when taxes go up. The following lemma confirms this conjecture.

Lemma 1 *Whenever* $\tau > \tau'$, $\frac{p^g_\tau}{p^g_{\tau'}} - \frac{p^b_\tau}{p^b_{\tau'}} > 0$.

Combining Proposition 1, Lemma 1, and equation (40), we obtain the main asset-pricing result:

Proposition 2 *Provided that* $\max_{n,m}\lambda_{n,m}$ *is sufficiently low, the expected return of brown firms is lower than that of green firms if the tax rate is low and higher if the tax rate is high.*

The proposition confirms the intuition that brown firms have lower expected returns when taxes are too low — as may be the case currently in a large part of the world.

3 Conclusion

Climate risk is one of the major risks facing the society as a whole and each investor individually. As is well-known, society's best response is to introduce a carbon tax equal to the social cost of carbon, but how should investors respond if the carbon tax is below this level?

We show that, under certain conditions, risk associated with the level of the carbon tax can be hedged by buying brown assets. Said differently, green stocks contain systematic climate risk for two reasons: First, these stocks suffer when carbon taxes are so low that renewable energy becomes less competitive. Second, it is in this low-tax scenario that the climate is destroyed, leading to low aggregate welfare and high marginal utility.

Therefore, these risk considerations can increase the required return of green firms relative to brown firms. Such a pricing of climate risk would make real investments in brown firms more attractive, thus pushing the economy in the wrong direction from the point of view of the climate.

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