Technological greenness and long-run performance†

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Abstract

Firms' investments in green technology are crucial for investors' alignment to the Net Zero target. However, it is still unclear whether firms that invest in green technologies are rewarded by the market, particularly in the long run. Using a science-based technological measure of greenness, we find that the adoption of sustainable technologies is associated with better future financial and operating performance. Firms with greener technologies do not just appeal to investors' pro-social preferences but also represent better firms. The results are especially strong in countries characterized by higher financial development, and for firms with better climate-related disclosure.

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1. Introduction

A growing stream of research analyzes the short-run performance of green stocks (e.g., Bolton and Kacperczyk (2021, 2023); Avramov et al. (2022); Pástor et al. (2022); Zerbib (2022); Aswani et al. (2023)), defined as shares of firms with lower levels of Greenhouse Gas (GHG) emissions or higher Environmental, Social, and Governance (ESG) scores. However, little is known about how firms' investments in green technology affect their performance, in particular over longer time horizons. Such investments are crucial to deliver on economic decarbonization and on the Paris Agreement (IEA (2021)) and, differently from GHG emissions or ESG scores, are less prone to misreporting and greenwashing issues.

Adopting a long-term perspective is important because green technologies become more accessible and less costly over time, gradually overtaking fossil fuel in terms of both capacity and efficiency (IEA (2023)). This process is gradual, and the full potential of green technologies is only observable with some delay. In

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turn, a better understanding of green technologies favors cooperation between countries and decreases regulatory uncertainty. Jointly, these factors should create a progressively more stable and favorable environment for green tech firms. In this paper, we shed light on this issue by analyzing the long-run stock performance of firms that carry out structural investments in green technology.

Edmans (2023) warns that research on sustainability should shift from an analysis of off-the-shelf metrics to a broader perspective of long-term value creation. Measures of greenness should matter to the degree that they contribute to generating value for shareholders in the long run, much like any other type of investment. Correspondingly, sustainability targets should be more granular and represent a means to an end rather than a goal in and of themselves. In this paper, we heed this call. Our use of a structural measure of technological greenness, together with an analysis of long-run economic outcomes, represents a first attempt to build a more comprehensive perspective of what constitutes greenness and why it matters.

To derive theoretical guidance, we consider the asset pricing model from Hirshleifer and Teoh (2003). We study the pricing of green tech stocks in a setup with arbitrageurs and pro-social investors, where the latter derive nonpecuniary utility from investing in accordance with their social preferences (e.g., Riedl and Smeets (2017); Barber et al. (2021); Dittmann et al. (2023)), such as green investing (e.g., Zerbib (2022)). We find that when economic fundamentals do not change, the prices of green stocks mainly reflect the green preferences of pro-social investors. As a result, green stocks trade above their fundamental value and yield lower subsequent returns. When fundamentals do change, for example due to green technology improvements, the prices of green stocks also reflect the availability of this new information. If not all investors promptly update their evaluations accordingly, the neglected information can more than compensate the impact of green preferences. Green stocks can then trade below their fundamental value and yield higher returns.

We argue that these two dynamics describe green stocks at different time horizons. In the short run, there is little new information about the slow-moving long-term prospects of green investments. Therefore, overpricing prevails. In the long run, such information becomes available to investors. Accordingly, green stocks eventually yield higher returns. While previous studies test and find some evidence for the former prediction, little is known about the latter.[1] Filling this gap is the main aim of our paper.

There is disagreement on which measure of sustainability might be more appropriate to empirically identify green firms, broadly defined as firms that are more environmentally-friendly. Most studies consider either firm-level ESG ratings (e.g., Ramelli et al. (2021); Avramov et al. (2022); Pástor et al. (2022); Zerbib (2022)), or GHG emissions (e.g., Alessi et al. (2021); Bolton and Kacperczyk (2021, 2023); Bolton et al. (2022); Aswani et al. (2023)). While both types of measures provide information on the degree of greenness of a firm, they also present some challenges. Ratings may capture potentially contradicting factors (Berg et al. (2022); Edmans (2023)) and not always represent an accurate description of a company's operations,

[1] Recent research finds evidence that green stocks indeed underperform brown stocks (e.g., Alessi et al. (2021); Bolton and Kacperczyk (2021, 2023)). However, other studies challenge some of these findings due to issues with measuring greenness (Aswani et al. (2023)) and disentangling realized from expected returns (Pástor et al. (2021, 2022); Atilgan et al. (2023)).

as attested for example by rating disagreement across vendors (Avramov et al. (2022)). Carbon emissions do not necessarily identify structural features of a firm's energy profile, neglect any green activities of the firm (Edmans (2023)), and partly overlap with other firm characteristics (Aswani et al. (2023)).

In this paper, we overcome these issues by considering a tangible measure of greenness that is based on a firm's technology. Using a global sample of utility firms, we hand-collect the proportion of each firm's revenues (expressed as energy capacity) derived from renewable and fossil fuel sources. We use this information to construct a firm-level index of technological greenness that attaches a score between +1 (indicating entirely green firms) and -1 (indicating entirely brown firms) to each firm in the sample. The advantage of this approach is threefold. First, it considers a structural measure of greenness that has a direct bearing on firm operations. Second, it takes into account all the firm's activities on both the renewable and the fossil fuel side. Third, it represents a relative measure of greenness that has no obvious relation with a firm's characteristics (e.g., size) and can be directly compared across firms.

The aim of our study is to use low-frequency (annual) data to test the long-run predictions of our theoretical model. We estimate the effects of technological greenness on a firm's financial and operating performance over a multi-year window, thereby complementing previous studies that analyze such effects in the short run (typically at the monthly frequency) and focus on GHG emissions or ESG scores. Furthermore, the global nature of our sample allows us to exploit cross-country variation in our variables of interest (notably financial development) to shed light on the economic mechanism underlying our results. Our paper then not only speaks to previous global studies of green stocks (e.g., Bolton and Kacperczyk (2023)), but also provides more general insights on how firms' green investments are priced by the market.

Our results can be summarized as follows. Consistent with the model's predictions, we find that greener stocks are associated with higher long-run returns. The magnitude is sizable, as a one-standard deviation increase in a firm's technological greenness is followed by an increase in its cumulative stock returns of 15.1% over a five-year period. Interestingly, we find no evidence of reversals when we analyze future returns year by year rather than cumulatively. Our findings then suggest that there is no overreaction to a firm's disclosure of technological greenness, consistent with a gradual impounding of information as it becomes available.

Consistent with our model prediction that the positive long-run returns of green stocks reflect an improvement in fundamentals, we find that green tech firms exhibit a gradual increase in future valuations and superior future operating performance. We also provide evidence that green tech firms exhibit especially high long-run returns in financially developed countries, consistent with the view that such countries provide easier access to external finance (e.g., Rajan and Zingales (1998)) – a crucial requirement for structural investments such as those in green technologies. Altogether, these findings suggest that the relation between firms' technological greenness and long-run stock returns reflects genuine economic improvement rather than investors' green preferences or a risk premium.

Finally, we analyze the stock market reaction to a firm's disclosure of its degree of technological greenness. We perform two groups of tests. First, we find that firms that disclose to be highly green exhibit higher long-run returns than firms that are less green or do not disclose at all. The effect is especially strong in the period that followed the Paris Agreement, with the only notable exception of the United States likely due to the less climate-friendly policies of its administration at the time. These pricing mechanisms also characterize a firm's disclosure of ESG scores and GHG emissions, as also shown in previous research (e.g., Ramelli et al. (2021); Chen and Xie (2022)), but the effects are stronger for our measure of technological greenness and apply to a broader set of countries. The results suggest that the market primarily considers assessments of sustainability of a more structural and tangible nature over other available measures, consistent with our claim that the latter are comparatively less reliable indicators of a firm's degree of greenness.

In the second group of tests, we analyze the market reaction to greenness disclosure regardless of the degree of greenness. The intuition is as follows. Firms can decide whether or not to disclose how green they are. When doing so, they can only observe the degree of greenness of firms who already disclose, which are relatively few, but not the others. In light of this, the incentive to disclose should be stronger for firms that believe to be reasonably green with respect to the rest. Correspondingly, we expect the stock market to reward firms that disclose their degree of greenness, irrespective of how green they are, with higher long-run returns. We find evidence consistent with this prediction, and the results are again stronger for technological greenness compared with the alternative measures. Investors then seem to set up the right incentives for firms to become greener and disclose it.

Our paper contributes to a burgeoning literature on climate finance (e.g., Giglio et al. (2021); Edmans and Kacperczyk (2022)). While most existing studies focus on short-run dynamics, our paper looks into the long-run performance of green stocks. Our approach can help reconcile the mixed evidence that characterizes the returns on green assets (e.g., Pástor et al. (2022); Aswani et al. (2023); Bolton and Kacperczyk (2023)). In addition to green preferences or risk considerations (e.g., Pástor et al. (2021); Zerbib (2022)), our findings stress the importance of considering a long time horizon for two reasons. First, market learning fully takes place only in the long run for complex investments that are hard to evaluate (e.g., Hirshleifer and Teoh (2003)), such as those in green technologies. Second, noise and mispricing are arbitraged away in the long run (e.g., Greenwood (2005)), thereby reducing the discrepancy between expected and realized returns on green stocks (Pástor et al. (2021, 2022); Atilgan et al. (2023)).

A related and emerging strand of research analyzes firms' green tech innovation by looking at R&D activity, and specifically the creation of patents (e.g., Kuang and Liang (2022); Cohen et al. (2023); Hege et al. (2023); Reza and Wu (2023)). Although such investment also represents a tangible metric of greenness, it is often an incremental technological improvement that does not necessarily have a wide impact on a firm's operations (Bolton et al. (2023)), with correspondingly mixed impact on firm value (e.g., Andriosopoulos et al. (2022); Hege et al. (2023)). Conversely, our focus on structural energy capacity represents a more direct measurement of a firm's technological greenness. More generally, investment in green innovation seems path-dependent (Aghion et al. (2016); Bolton et al. (2023)). Our findings of a positive relation between green tech and long-run firm value and performance provides novel support to this view.

The paper is organized as follows. In Section 2, we introduce our theoretical model. In section 3, we describe the data. In Section 4, we present our baseline regressions. In Section 5, we carry out further tests to pin down the economic channel underlying our results. In Section 6, we study the market reaction to green tech disclosure. In Section 7, we offer some concluding remarks.

2. Model

We consider a three-period economy with one stock from Hirshleifer and Teoh (2003), where investors can be either informed or uninformed. To identify and process the arrival of new information about the stock's fundamental value, investors need to expend resources c. The probability that they do so is $f(c)$, with $f'(c) < 0$. Function f, then, also represents the proportion of informed investors in the economy and we take it as exogenously given. The economy has three dates. At time 0, investors form expectations over the stock's future cash flow. At time 1, new public information arrives about the stock's value, which can be incorporated by expending resources c, and investors can trade with each other. At time 2, the stock makes a terminal payoff and the firm is liquidated.

We apply this setup to study the stock price of a firm that invests in green technologies. When the firm makes a green tech investment (time 1), this information is processed differently by the two investor types. Arbitrageurs expend resources to analyze it and correctly update their evaluations of the company stock. Uninformed investors, on the other hand, do not expend such resources and therefore do not update their evaluations. The intuition is as follows. As in Hirshleifer and Teoh (2003), the information that is presented in an easily processed form is absorbed more easily than information that is harder to evaluate. Green technology, due to its complexity, belongs in the latter category.

In addition to this information processing structure, we also introduce green preferences. Previous research shows that some investors have a pro-social preference for environmentally-friendly firms (e.g., Riedl and Smeets (2017); Barber et al. (2021); Dittmann et al. (2023)), deriving higher utility from holding green stocks over and above the expected monetary payoff (Pástor et al. (2021); Zerbib (2022)). In our setup, such investors belong in the uninformed category (e.g., Riedl and Smeets (2017); Hartzmark and Sussman (2019); Brière and Ramelli (2022)). Therefore, we respectively refer to the two investor types in our model as arbitrageurs and pro-social investors.[2]

As in Chen et al. (2002), we assume that the stock's fundamental value is equal to $F + \epsilon$, where ϵ is a normally distributed shock with a mean of zero and variance of one. At time 1, the green tech investment modifies the fundamental value to $F + \Delta + \epsilon$, where Δ is only observed by arbitrageurs. Each investor is endowed with an initial wealth of W_0 and x_0 units of the stock. At the intermediate time 1, investors can buy or sell securities in exchange for cash, defined as claims to terminal consumption C, at price S_1.

[2] The results that follow are similar if uninformed investors engage in partial rather than no information updating (see Appendix A.1.), and if informed investors also exhibit green preferences (see Appendix A.2.).

The position thus attained in the stock is denoted as x, and the terminal payoff of the security is S_2. An individual's terminal consumption is then $C = W_0 + x_0 S_1 + x(S_2 - S_1)$.

Investor types are denoted by ϕ, indicating either arbitrageurs ($\phi = A$) or pro-social investors ($\phi = B$). All investors have mean-variance preferences, but pro-social investors also derive direct utility from holding green stocks. We assume that these two utility components are additively separable.[3] Therefore, total utility of investor type ϕ can be expressed as:

$$U^{\phi}(x^{\phi}) = u^{\phi}(x^{\phi}) + v^{\phi}(x^{\phi}), \tag{1}$$

where:

$$u^{\phi}(x^{\phi}) = E_1^{\phi}\left(x^{\phi}(S_2 - S_1)\right) - \frac{\gamma}{2}\mathrm{var}_1^{\phi}\left(x^{\phi} S_2\right) \tag{2}$$

is the mean-variance component, and

$$v^{\phi}(x^{\phi}) = x^{\phi} g^{\phi} \tag{3}$$

is the direct utility component.[4] Parameters γ and g^{ϕ} respectively represent the coefficient of absolute risk aversion, assumed to be equal across investor types, and the degree of green preferences of investor type ϕ. For arbitrageurs, $g^A = 0$. For pro-social investors, $g^B = g > 0$.

Investor type ϕ solves:

$$\max_{x^{\phi}} \; E_1^{\phi}\left(x^{\phi}(S_2 - S_1)\right) - \frac{\gamma}{2}\mathrm{var}_1^{\phi}\left(x_i^{\phi} S_2\right) + x^{\phi} g^{\phi}. \tag{4}$$

The first-order conditions yield:

$$x^A = \frac{E_1^A(S_2) - S_1}{\gamma \mathrm{var}_1^A(S_2)} \tag{5}$$

for arbitrageurs, and

$$x^B = \frac{E_1^B(S_2) - S_1 + g}{\gamma \mathrm{var}_1^B(S_2)} \tag{6}$$

for pro-social investors. These two demand functions can be included in the market-clearing condition:

$$f x^A + (1 - f) x^B = x_0. \tag{7}$$

To derive the equilibrium price, we assume that the green tech investment improves the fundamental value of the firm ($\Delta > 0$), reflecting the better long-run operating performance of green technologies and a progressively more favorable regulatory framework (IEA (2023)). Arbitrageurs correctly update their expectations of the terminal payment from the stock to $F + \Delta$. Conversely, pro-social investors do not revise their initial expectation F. The market-clearing condition then yields:

Proposition 1. *In the presence of positive fundamental news, the green tech stock trades below its fundamental value if the news shock is large enough:*

[3] See, for example, Conlisk (1993) for an application of this setup to model direct utility from gambling. More generally, this is a common specification to model utility coming from different sources coded as separate mental accounts (e.g., Lopes (1987); Shefrin and Statman (2000); Barberis et al. (2001); Barberis and Huang (2008)).

[4] The linearity of $v^{\phi}(x^{\phi})$ is for simplicity to ensure tractability.

$$S_1 = fE_1^A(S_2) + (1-f)E_1^B(S_2) = F + \Delta - (1-f)(\Delta - g). \quad (8)$$

i.e., if $\Delta > g$, as long as pro-social investors are present in the market ($1 - f \in (0, 1)$).[5] Next, we define stock returns, denoted by r_2, in dollar terms as in Chen et al. (2002). It is easy to see that:

Proposition 2. *In the presence of positive fundamental news, the green tech stock yields positive expected returns if the news shock is large enough:*

$$E_1(r_2) \equiv E_1(S_2) - S_1 = F + \Delta - (F + \Delta - (1-f)(\Delta - g)) = (1-f)(\Delta - g). \quad (9)$$

The intuition is that pro-social investors do not update their expectations to include the new (positive) information, which leads them to underestimate the true value of the stock if $\Delta > g$.

Note that the magnitude of parameter Δ can describe the pricing of green tech stocks at different time horizons. The investment in green technology improves firm operations in the long run. Over a shorter time window, the value of Δ is lower. As a result, the positive impact of green preferences on the stock price through parameter g can be dominant in the short run, thereby yielding negative (rather than positive) expected returns for green tech stocks. While previous research provide some empirical evidence for this prediction, we complement these studies by testing our model's predictions for long-run returns in the empirical analysis below.

Also note that the investors in our model can be mapped to investor categories identified in previous research. A growing body of research shows that the relatively more and less informed investors that populate modern theoretical asset pricing models can be thought of as hedge funds and mutual funds, respectively, due to the former being relatively more sophisticated and able to take short positions (e.g., Chen et al. (2002); Hong and Sraer (2013, 2016)).[6] The category of relatively less informed investors can be extended to include retail investors as well, as both individuals and institutions are prone to biases (e.g., Barber and Odean (2002); Hong and Kostovetsky (2012)).

Another recent strand of research shows that some investors, much like the general public, exhibit pro-social preferences. They tend to shun stocks issued by firms whose core business is not considered to be morally sound (Hong and Kacperczyk (2009)), or firms that promote high pay inequality between managers and rank-and-file workers (Pan et al. (2022); Dittmann et al. (2023)). Such preferences seem especially strong among retail investors and mutual funds (e.g., Riedl and Smeets (2017); Hartzmark and Sussman (2019); Brière and Ramelli (2022)).

[5] For simplicity and without loss of generality, we assume zero-net supply ($x_0 = 0$) as in Hirshleifer and Teoh (2003), and no disagreement over the variance of the asset's payoff ($\text{var}_1^A(S_2) = \text{var}_1^B(S_2) = \text{var}_1(S_2)$) as in Hong and Sraer (2016).

[6] Attesting to this interpretation, mutual funds are the driving force behind the investor sentiment index (DeVault et al. (2019)), which captures changes in stock demand not explained by economic fundamentals (Baker and Wurgler (2006)).

3. Data

We gather a novel data set of technological greenness that includes 165 utility firms located in 31 countries over the period from 2011 to 2021. We complement this sample with other global utility firms for which we have financial and accounting (but not technological) data, for a sum total of 1,000 firms from 77 countries. We refer to these two samples as the restricted and the extended sample, respectively.

In Table 1, we report some summary statistics. In Panel A, we consider the extended sample. The structural features of the median firm include a book-to-market ratio of 0.73, a market capitalization of €0.38 billion, a ratio between liabilities and assets of 1.49, a ratio between capital expenditures and total assets of 0.05, and a total value of property, plant, and equipment of €0.23 billion. On the operating side, the median firm exhibits revenue growth of 0.05, growth in earnings per share of -0.05, and return on equity of 0.08. On the market side, the median firm exhibits stock returns of 0.00, stock return volatility of 0.32, and a beta of 0.75.

[Table 1 here]

In Panel B, we report summary statistics for the firms in the restricted sample. The median firm is substantially larger, with a market capitalization of €5.99 billion, leverage of 2.39, and value of property, plant, and equipment of €3.92 billion. The other characteristics, however, are similar. The large size of these companies also implies that they are comparatively easier to evaluate, with less room for mispricing (e.g., Baker and Wurgler (2006, 2007); Baker et al. (2012)). This feature is also compounded by the relatively low stock market volatility and a low market beta that is largely below one, indicating defensive stocks. This is an important insight to inform the empirical analysis that follows.

In Panel C, we report summary statistics for the sources of firm-level energy capacity in our restricted sample. We observe data on several energy sources. The median firm's green energy capacity (expressed as a percentage of total energy capacity) includes solar (0.9%), waste (0.7%), wind (6.3%), hydro (15.7%), and nuclear (18.5%), whereas fossil energy capacity includes gas (32.8%) and coal (33.2%).[7] The median firm is then predominantly fossil, with some green investments.

4. Baseline regressions

Our main test equation is as follows:

$$y_{i,t+h} = \alpha_t + \beta x_{i,t} + \gamma^{'} Z_{i,t} + \epsilon_{i,t+h}. \tag{10}$$

The dependent variable (y) is the future annual stock return of firm i, measured either over year $t+h$ or cumulatively over a multi-year period until year $t+h$, with $h = 1, \ldots, 5$. The main independent variable (x) is our index of technological greenness, defined as the firm-level total percentage green capacity minus total

[7] Due to the nature of utility companies' business operations, we do not have oil capacity in the sample.

percentage fossil capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results. The vector of controls (Z) includes a rich set of firm-level accounting measures, including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. In our baseline specifications, we include year fixed effects and cluster standard errors by firm.[8]

We aim to analyze how investors evaluate green technologies in the long run. We are especially interested in newer technologies that are associated with greater uncertainty about performance and returns. To this end, we primarily define the total green energy capacity of a firm as the sum of solar, waste, and wind energy sources. We exclude hydro energy because it is already a well-established technology, which makes it comparatively less uncertain for investors to evaluate. We also do not include nuclear energy due to its controversial nature, as the negative perception of some investors towards its usage may potentially bias our estimates. Nevertheless, we obtain similar results when including these two additional energy sources. On the other hand, we define the total fossil energy capacity of a firm as the sum of gas and coal. Our index of technological greenness, defined as the difference between total renewable capacity and total fossil capacity, then takes on values between -1 and 1.

Considering long-run returns is especially important to test our model predictions for at least two reasons. First, market learning over complex investments fully takes place only in the long run (e.g., Hirshleifer and Teoh (2003)). This element is crucially important to correctly evaluate green investments, whose impact on firm operations (captured by parameter Δ in our model) can only be observed in future periods. Second, arbitrage forces align prices with fundamental values in the long run (e.g., Greenwood (2005)). Our analysis of stock returns over a multi-year horizon then also helps us decrease the potential confounding effect of noise or mispricing, thereby reducing the discrepancy between realized and expected returns on green stocks (Pástor et al. (2021, 2022); Atilgan et al. (2023)).

The estimates of our test equation are in Table 2. We find that a one-standard-deviation increase in technological greenness is associated with an increase in future returns of 2.2% in year 1 (t-stat 2.77), 2.3% in year 2 (t-stat 3.19), 3.6% in year 3 (t-stat 4.31), 4.7% in year 4 (t-stat 4.18), and 2.7% in year 5 (t-stat 2.20). The results suggest that the market observes the degree of greenness of a firm's technology, and gradually learns to incorporate its relation with the firm's fundamentals over time. Interestingly, we find no evidence of reversals. It seems then that there is no overreaction to the disclosure of technological greenness. In contrast, there seems to be a gradual impounding of green tech information as it becomes available. In additional tests, we find that the estimates are robust to controlling for a stock's market beta (see Table A1), indicating that the results are not driven by structural differences in sensitivity to systematic risk.[9]

[8]In the analysis below, we find similar results using alternative specifications.

[9]Since we have fewer observations for market beta, we confine its inclusion to robustness checks.

[Table 2 here]

Furthermore, we re-estimate our test equation for future cumulative stock returns. The results, reported in Table 3, mirror those from Table 2 and yet are statistically stronger. A one-standard-deviation increase in technological greenness is associated with an increase in future cumulative returns of 5.2% over years 1 and 2 (t-stat 3.60), 8.8% over years 1 to 3 (t-stat 4.51), 13.4% over years 1 to 4 (t-stat 4.94), and 15.1% over years 1 to 5 (t-stat 4.19). Our results suggest that adopting greener technologies is associated with a long-run increase in stock market value that is not explained by other well-known firm-level economic fundamentals.

[Table 3 here]

We also perform four sets of robustness checks. First, we find that the estimates are robust to controlling for market beta (see Table A2). Second, we show that the estimates are similar when expanding our definition of greenness to hydro and nuclear energy sources (see Table A3). Third, we find similar estimates for a number of alternative empirical specifications, including firm fixed effects and clustering by year, firm and year fixed effects, pooled OLS regressions with double clustering by both firm and year, and Fama-MacBeth regressions (see Table A4).[10] Fourth, we find similar results when identifying tech greenness in a more structural way as a three-year moving average instead of yearly observations, which addresses the concern that some firms may change their degree of tech greenness more often than others (see Table A5).

5. Testing the green tech channel

We acknowledge that high long-run stock returns can reflect not only better economic fundamentals, but also a potential risk premium for adopting uncertain green technologies. We tease out these two stories by shedding light on the economic channel underlying our results. To this end, we study how technological greenness is related to valuations (subsection 5.1), and operating performance (subsection 5.2). We also carry out a direct test of the hypothesis that sustainability conveys information on future economic fundamentals by exploiting cross-country variation in financial development (subsection 5.3).

5.1. Firm valuations

To disentangle the two competing explanations, we start the analysis from firm valuations. We re-estimate our main test equation by replacing future stock returns with the future firm-level market-to-book ratio. Our priors are as follows. An improvement in economic fundamentals implies that the relation between current greenness and future valuations should be positive and increasing over time (see Eq. 8). Conversely, the risk story implies a negative relation due to the impounding of a discount for risk.

[10] Robustness to the inclusion of firm fixed-effects is interesting for two reasons. First, it indicates that within-firm changes in tech greenness are also associated with higher long-run returns. Second, it suggests that the results are not merely driven by unobservable time-invariant measures of firm quality.

The results are in Table 4. We find an overall positive association between technological greenness and future valuations, with a gradual increase in both the economic and the statistical magnitude. A one-standard-deviation increase in technological greenness is associated with an increase in the future market-to-book ratio of 3.2% in year 1 (t-stat 1.83), 6.0% in year 2 (t-stat 1.82), 9.4% in year 3 (t-stat 2.26), 13.1% in year 4 (t-stat 2.47), and 18.0% in year 5 (t-stat 2.79). Altogether, this empirical pattern is consistent with a gradual and steady improvement in economic fundamentals.

[Table 4 here]

5.2. Operating performance

One direct implication of the fundamentals story is that firms that exhibit higher technological greenness should also be associated with better operating performance in the long run. We test this conjecture by considering a firm's future return on equity, which arguably represents the most relevant metric of operating performance from a shareholder's perspective.

The results are in Table 5. Consistent with the fundamentals story, we find a positive and strong association between technological greenness and future operating performance. A one-standard-deviation increase in technological greenness is associated with an increase in return on equity of 1.0% one year ahead (t-stat 2.81), 1.3% two years ahead (t-stat 2.83), 1.8% three years ahead (t-stat 3.33), 1.7% four years ahead (t-stat 3.04), and 1.6% five years ahead (t-stat 2.60).

[Table 5 here]

To estimate the overall long-run effect, we repeat the analysis for cumulative return on equity. The estimates, reported in Table 6, indicate that a one-standard-deviation increase in technological greenness is associated with an overall long-run increase in return on equity of 7.6% over a five-year period (t-stat 2.95). Similarly, we find an estimate of 6.6% when we replace return on equity with sales growth (see Table A6). The latter result indicates that greenness affects firms' operating performance not only through a decrease in costs but also through an increase in revenues, thereby suggesting that green preferences on the part of consumers may partly explain the results.

[Table 6 here]

Although sizable, the magnitude of the relation between technological greenness and cumulative five-year operating performance is about half of its counterpart from the analyses of valuations and stock returns (18.0% and 15.1%, respectively). At first glance, this discrepancy suggests that the market may reward green tech companies beyond a tangible improvement in firm operations. To shed light on this issue, we turn to the analysis of operating risk. The intuition is as follows. Financial markets may price not only the first moment of operating performance but also the second one. If green tech companies not only perform better but also exhibit lower operating risk, then it is possible to reconcile the above results.

To test this conjecture, we define operating risk as the three-year moving standard deviation of a firm's return on equity. The results are presented in Table 7. We find a strong and stable negative relation between operating risk and technological greenness, suggesting two potential dynamics. First, this negative association may indicate that safer firms self-select into green investments. The intuition is that their operations are stable enough to introduce more uncertain investment in green technologies. Second, the relation persists over time also after the increase in greenness has taken place.

[Table 7 here]

One potential concern with these results is that although green firms exhibit lower firm-specific risk, they may still be more exposed to systematic risk. To test this conjecture, we perform an additional analysis using a firm's market beta as our dependent variable. The results, reported in Table A7, follow a similar empirical pattern to that from Table 7 as technological greenness is inversely related to a firm's future market beta. All in all, the adoption of green technologies is associated with a decrease in both operating and market risk. These results help reconcile the discrepancy in magnitude between the findings on market prices with those on operating performance, and more generally indicate that the high long-run stock returns associated with technological greenness are unlikely to represent compensation for risk.

5.3. Financial development

Firms that rely more on external finance grow faster in countries characterized by more developed financial systems (e.g., Rajan and Zingales (1998)). This mechanism is especially relevant in our analysis. Green tech investments are typically large and depend on the availability of external finance, as attested for example by the reliance on debt of the firms in our sample (see Table 1). Green tech firms should then exhibit better economic prospects (i.e., a higher value of parameter Δ from our model), other things being equal, if located in financially developed countries. If so, the pricing error introduced by uninformed investors should be more pronounced in such countries, thereby leading to higher long-run returns.

To test this conjecture, we exploit cross-country variation in financial development. We define a country's degree of financial development as the (standardized) ratio between total banking credit and real GDP, calculated as a country-level average between 1975 and 1990. In predetermining this variable, we seek to avoid the potential confounding effect of current economic condition and smooth out time variation in the size of banking credit due for example to booms or busts in the financial system (see, e.g., Rajan and Zingales (1998); Pagano and Pica (2012); Montone and Zwinkels (2020)). The choice of a banking measure over a stock market measure of financial development reflects the fact that the firms in our sample largely depend on debt to carry out their investments.

The results, reported in Table 8, lend support to our conjecture. We find that a one-standard-deviation increase in technological greenness is associated with an increase in five-year cumulative stock returns of 11.0% (t-stat 2.52), and a one-standard-deviation increase in financial development amplifies the magnitude of this effect by a further 12.0% (t-stat 2.36). Therefore, the magnitude varies widely across countries with different degrees of financial development.

[Table 8 here]

We also re-estimate our test equation by excluding non-OECD countries from the sample. The intuition is that OECD economies are more integrated and financially developed, which in turn should make the baseline results even stronger for these countries. The estimates, reported in Table 9, are consistent with this line of reasoning.

[Table 9 here]

In additional tests, we repeat our analysis by replacing the continuous measure of financial development with a dummy variable that takes on value one for countries that lie above the median value, and zero otherwise. We find that the results from Table 8 are confined to countries with an above-median level of financial development (see Table A8). We also find that the results do not reflect observable differences in systematic risk related to financial development (see Table A9). Finally, we find that the results are robust to the inclusion of country-year fixed-effects, which addresses the concern that the results may reflect country-specific time trends in energy prices rather than access to external finance (see Table A10).

Altogether, the results suggest that the market recognizes the better economic prospects of green firms in the long run. The absence of return reversals and the large size of the firms in our sample provide further support to this conclusion, as large firms are comparatively safer (e.g., Perez-Quiros and Timmermann (2000); Cooley and Quadrini (2006)) and easier to evaluate (e.g., Baker and Wurgler (2006, 2007); Baker et al. (2012)). Therefore, the high long-run returns on green tech stocks seem to reflect genuine (and, on this evidence, correct) expectations for future fundamentals.

6. Does it pay to disclose?

In the last part of the paper, we study how markets react to a firm's disclosure of its degree of greenness. This analysis also allows us to exploit the extended sample, pooling together firms that disclose with those that do not. We divide our empirical tests in three parts. First, we analyze the market reaction to the disclosure of technological greenness (subsection 6.1). Second, we compare this effect with the one from the disclosure of alternative measures of greenness (subsection 6.2). Finally, we analyze how the reaction to disclosure changed in year 2016 after the Paris Agreement and the Trump election in the United States (subsection 6.3).

6.1. Disclosing technological greenness

In the first group of tests, we analyze whether the stock market rewards top green firms, defined as those that belong in the top 30% of the index of technological greenness in a given year. Specifically, we compare their returns with the returns on non-publishers, defined as firms that do not disclose any information on the degree of greenness of their technology. To this end, we exclude the middle 40% and the bottom 30% green publishing firms from the analysis.

The results are in Table 10, Panel A. We find that top green firms exhibit substantially higher long-run stock returns than non-publishers. Being a top green firm in a given year is associated with an increase in cumulative stock returns, relative to non-publishers, of 14.6% over the subsequent two years (t-stat 4.49), 26.2% over the subsequent three years (t-stat 5.14), 37.8% over the subsequent four years (t-stat 5.17), and 42.9% over the subsequent five years (t-stat 4.49).

[Table 10 here]

Next, we analyze whether the market rewards or punishes bottom green firms. The intuition is based on a mechanism of type revelation. When a firm decides whether or not to disclose its degree of greenness, it does not know the degree of greenness of fellow non-publishers or their willingness to disclose it. In this instance, only the firms that believe to be reasonably green with respect to all others should disclose their technological greenness. In light of this, the top green firms in our restricted sample are likely the greenest firms in our extended sample (not just the restricted one). On the other hand, the firms that disclose but turn out to be comparatively less green are likely to be still greener than non-publishing firms.

In light of this consideration, investors may still want to reward the least green firms despite being at the bottom of the greenness ranking. To test this conjecture, we repeat our empirical tests by replacing the top 30% green dummy with a bottom 30% green dummy, and excluding the middle 40% and top 30% green firms from the analysis so as to effectively compare bottom green firms with non-publishers. The results are in Table 10, Panel B. We find some evidence that investors do in fact reward bottom green firms with higher long-run returns, although the coefficient is rather small compared with top green firms (Panel A) in both magnitude and statistical significance.

Finally, we pool together top, middle, and bottom green firms into one category (publishers) to compare how the market discriminates between publishing and non-publishing firms. The results are in Table 10, Panel C. We find that publishing in a given year, regardless of the degree of technological greenness, is associated with large and highly significant cumulative long-run returns. The effect is equal to 7.0% over two years (t-stat 3.01), 11.8% over three years (t-stat 3.31), 16.2% over four years (t-stat 3.29), and 18.1% over five years (t-stat 2.94). Although the magnitude is smaller than the one for top green firms (Panel A), publishing information on technological greenness seems to be strongly rewarded by the market.

6.2. Disclosing greenness: Alternative measures

In the second group of tests, we introduce two additional measures of greenness in the analysis. Specifically, we consider the disclosure of ESG scores and GHG emissions (scope 1) in addition to technological greenness. For each of these additional measures, we respectively introduce a dummy variable that takes on value one for firms that belong in the top 30% ESG ranking or the bottom 30% GHG emissions ranking, and zero otherwise. Then we carry out a horse race between our dummy for top green tech firms and these two alternative dummies.

In a preliminary analysis, we find that the pairwise correlation coefficient between these measures is positive and highly significant, but far from perfect. Our dummy for top green tech firms exhibits a correlation coefficient of 31% with the dummy for top ESG firms and 16% with the dummy for bottom GHG emissions firms (p-value < 0.001 for both). The latter two measures, on the other hand, exhibit a correlation coefficient of 32% (p-value < 0.001).

The results are in Table 11, Panel A. We find that top green firms are rewarded with higher cumulative long-run stock returns along all three competing dimensions. However, the coefficient of the dummy for technological greenness is by far the largest in both magnitude and significance. Being a top green firm is associated with subsequent five-year cumulative stock returns of 35.7% for technological greenness (t-stat 3.85), 12.4% for ESG scores (t-stat 1.83), and 21.8% for GHG emissions (t-stat 2.54). The results are similar in Panel B, where we replace the ESG score with the environmental score only.

[Table 11 here]

Finally, we analyze how the market compares publishers (no matter the score) with non-publishers across these three dimensions of greenness. Interestingly, our preliminary analysis shows that the probability of being a publisher is similar for all three measures. We find that 13% of the firms in our extended sample disclose their degree of technological greenness, whereas 20% of firms disclose their ESG score and 12% of firms disclose the level of their GHG emissions.

The estimates are in Table 11, Panel C. We find that our results from Table 10 continue to hold, although with lower magnitude and significance possibly due to the high correlation across the competing measures. Nonetheless, the coefficient of the dummy for technological greenness is again the one that exhibits the strongest magnitude and statistical significance of the three. Interestingly, being an ESG publisher is not associated with higher long-run returns.

6.3. The Paris Agreement and the Trump election

In the final group of tests, we acknowledge that year 2016 was marked by two important events regarding climate action worldwide. First, it was the year that saw the effective start of the implementation of the Paris Agreement, signed in November 2015. Second, it was the year in which Trump was elected as president of the United States with a program that was openly hostile to climate policies. In light of the first event, we expect the status of being a top green firm to be rewarded even more after the Paris Agreement, due to the more favorable perspective and regulatory framework that resulted from it. The second event, on the other hand, clearly countered the first one but only for firms based in the United States. Therefore, we expect U.S. green firms to benefit comparatively less from the Paris Agreement effect.

To test this conjecture, we re-estimate the model from Table 11, Panel A, by introducing interaction terms with a dummy that takes on value one for year 2016, and zero otherwise, and a dummy that takes on value one if the country where the firm's headquarters are located is the United States, and zero otherwise. To make the estimation possible, we replace year fixed effects with clustering by year. We alternatively introduce the three competing dummies for top green firms from the previous analysis (along with their interaction terms), and finally include them all together into the same empirical model.

As our dependent variable for these tests, we calculate cumulative stock returns over a two-year period. This is for two reasons. First, a two-year period is sufficient to observe the impounding of fundamental information into stock prices (e.g., Dasgupta et al. (2011)). Second, this period coincides with Trump's first term in office after the 2016 election. This is important for U.S.-based firms because he had full control of both the House and the Senate, which made his policies (and resonance) stronger than in the last two years of his administration, during which government was divided between Democrats and Republicans.

The results are in Table 12. In column (1), we consider the top green firm dummy for technological greenness. Consistent with our conjecture, we find that two-year cumulative stock returns were indeed 17.1% higher after 2016 for top green firms (t-stat 3.50), with the exception of U.S.-based firms for which the effect was 21.4% lower than their global counterparts (t-stat -2.92). We find a similar empirical pattern for the ESG dummy in column (2), and for the GHG emissions dummy in column (3). When we introduce all three measures of top greenness simultaneously, in column (4), we find again that the coefficients of the technological greenness dummy and its interactions provide the strongest results in terms of both magnitude and statistical significance.

[Table 12 here]

Overall, the market seems to reward firms that disclose their degree of greenness. Specifically, investors price the disclosure of technological greenness more strongly than the disclosure of ESG ratings or carbon emissions. The results support the idea that a tangible and relative measure of greenness is comparatively more informative about a firm's future fundamentals.

These findings also have important policy implications. Although we find that a reputational mechanism is indeed at play, it does not seem strong enough because only a small fraction of firms decides to disclose green tech data. All the firms that do not disclose are pooled together in the category of non-publishers, independently of their fossil fuel profile. The introduction of better climate-related disclosure regulations would substantially increase transparency, thereby reinforcing the incentives to go green.

7. Conclusion

In this paper, we study the financial and operating performance of green firms in the long-run. Consistent with our theoretical model, we show that technological greenness is associated with positive and large long-run returns, higher valuations, and better operating performance. The results are particularly strong in financially developed countries, where green tech investments are facilitated through easier access to external finance. We also find that the stock market rewards firms that decide to disclose their degree of technological greenness with higher long-run returns.

An emerging literature shows that green stocks trade at higher prices and yield subsequent lower returns. As we show in our theoretical model, this result is specific to the short run. When there is little news about the long-run prospects of green investments, the impact of pro-social preferences on stock prices is dominant. In the long run, however, green stocks earn higher returns due to the arrival of new positive information on their economic prospects. For example, their returns became much more pronounced after the resolution of uncertainty brought about by the Paris Agreement.

Our paper provides some first evidence that investing in green stocks is not only socially responsible, but also quite lucrative in the long run. This is an important result as the financial performance of green assets is still largely debated. This is also food for thought for policymakers, as the transition to a greener economy may entail more economic advantages than previously thought. More generally, our findings suggest that more systematic requirements to disclose technological greenness may be an important step in this process. The importance of this information seems to be already recognized by stock markets around the world, thereby setting the right incentives for firms to go green.

Appendix A

A.1. Model with partial information updating

If uninformed investors engage in partial information updating at time 1, they do not simply neglect Δ and rather estimate it as $\lambda\Delta$, with $\lambda \in (0,1)$. This implies $E_1^B(S_2) = F + \lambda\Delta + g$. Including this alternative expectation in the market clearing condition from Eq. 7, we obtain the following equilibrium price:

$$S_1 = F + \Delta - (1-f)((1-\lambda)\Delta - g), \tag{A.1}$$

and correspondingly the following expected return:

$$E_1(r_2) \equiv E_1(S_2) - S_1 = F + \Delta - (F + \Delta - (1-f)((1-\lambda)\Delta - g)) = (1-f)((1-\lambda)\Delta - g), \tag{A.2}$$

which is positive if $(1-\lambda)\Delta > g$, i.e., if information updating on the part of uninformed investors is slow enough (low λ), or green tech is highly profitable (high Δ).

A.2. Model with generalized green preferences

If all investors exhibit green preferences, arbitrageurs' evaluation of the terminal payoff changes to $E_1^A(S_2) = F + \Delta + g$. Updating the market clearing condition from Eq. 7 accordingly, we obtain the following equilibrium price:

$$S_1 = F + \Delta - ((1 - f)\Delta - g), \tag{A.3}$$

and correspondingly the following expected return:

$$E_1(r_2) \equiv E_1(S_2) - S_1 = F + \Delta - (F + \Delta - ((1 - f)\Delta - g))) = (1 - f)\Delta - g, \tag{A.4}$$

which is positive if $(1 - f)\Delta > g$, i.e., if arbitrage forces are weak enough (low f), or green tech is highly profitable (high Δ).

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Table 1. Summary statistics

Summary statistics for the main variables in our sample. Panel A includes a sample of 1,000 utility firms from 77 countries. Panels B and C include a sample of 165 utility firms located in 31 countries for which we have data on their degree of technological greenness. The sample period is from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

Panel A. Full sample (1000 firms, 77 countries)

Variable	Mean	Std. Deviation	P25	Median	P75
Book-to-Market	1.20	1.29	0.44	0.73	1.35
Market Cap (€billion)	2.31	4.19	0.06	0.38	2.22
Liabilities / Assets	2.05	1.97	0.64	1.49	2.71
Capex / Assets	0.06	0.05	0.02	0.05	0.08
Stock Return (%)	0.05	0.36	-0.20	0.00	0.22
PPE (€billion)	1.79	3.49	0.03	0.23	1.60
Sales Growth (%)	0.08	0.23	-0.03	0.05	0.16
EPS Growth (%)	-0.05	1.32	-0.57	-0.05	0.31
Return on Equity (%)	0.07	0.16	0.02	0.08	0.14
Volatility (%)	0.37	0.21	0.22	0.32	0.47
Beta	0.74	0.47	0.37	0.75	1.01

Panel B. Green technology sample (165 firms, 31 countries)

Variable	Mean	Std. Deviation	P25	Median	P75
Book-to-Market	0.98	0.87	0.52	0.71	1.08
Market Cap (€billion)	7.83	5.84	2.61	5.99	15.63
Liabilities / Assets	2.88	1.86	1.59	2.39	3.62
Capex / Assets	0.06	0.03	0.04	0.06	0.08
Stock Return (%)	0.05	0.29	-0.14	0.02	0.19
PPE (€billion)	5.79	5.06	1.52	3.92	10.50
Sales Growth (%)	0.05	0.15	-0.03	0.04	0.11
EPS Growth (%)	-0.13	1.19	-0.49	-0.04	0.23
Return on Equity (%)	0.06	0.11	0.04	0.08	0.11
Volatility (%)	0.29	0.14	0.19	0.26	0.36
Beta	0.72	0.40	0.39	0.70	0.98

Panel C. Firm-level energy sources (% firm capacity)

Variable	Mean	Std. Deviation	P25	Median	P75
Solar (%)	6.71	18.43	0.14	0.91	3.83
Waste (%)	4.75	9.46	0.08	0.74	4.65
Wind (%)	16.32	25.20	1.92	6.34	16.96
Hydro (%)	28.49	30.44	5.07	15.71	48.18
Nuclear (%)	23.23	21.88	8.57	18.49	27.75
Gas (%)	35.61	24.05	16.26	32.75	51.70
Coal (%)	36.71	26.47	13.51	33.23	52.71

Table 2. Tech greenness and future stock returns

Panel regressions of annual firm-level stock returns measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Return t+1	(2) Return t+2	(3) Return t+3	(4) Return t+4	(5) Return t+5
Tech Greenness	0.0220***	0.0231***	0.0360***	0.0468***	0.0269**
	2.77	3.19	4.31	4.18	2.20
Book-to-Market Ratio	0.0143	0.0084	0.0115	0.0162	0.0063
	0.92	0.57	0.66	0.83	0.33
Market Cap	-0.0270***	-0.0191*	-0.0228*	-0.0377***	-0.0331**
	-2.59	-1.68	-1.89	-2.78	-2.19
Liabilities / Assets	0.0106*	0.0069	-0.0019	0.0033	0.0061
	1.78	1.22	-0.34	0.46	0.68
Capex / Assets	-0.1142	-0.5043*	-0.9512***	-0.8709***	-0.1234
	-0.41	-1.88	-3.04	-2.58	-0.36
Stock Return	-0.0345	-0.0563	0.0205	-0.1192***	-0.0750
	-0.86	-1.36	0.51	-2.62	-1.35
PPE	-0.0011	-0.0003	0.0058	0.0111	0.0186**
	-0.23	-0.05	0.99	1.29	2.18
Sales Growth	-0.0424	0.0569	-0.0262	0.0488	0.0056
	-0.68	0.90	-0.43	0.63	0.05
EPS Growth	0.0173**	0.0143*	-0.0097	-0.0047	-0.0053
	2.06	1.69	-0.95	-0.50	-0.43
Return on Equity	-0.0015	-0.0188	-0.1337	-0.0518	0.0746
	-0.02	-0.20	-1.62	-0.50	0.46
Return Volatility	-0.0007	-0.0008	-0.0013	-0.0037***	-0.0000
	-0.81	-0.81	-1.10	-4.24	-0.04
Year FE	Y	Y	Y	Y	Y
Observations	1095	942	793	652	524
R-squared	0.1074	0.1060	0.1289	0.1222	0.0844

Table 3. Tech greenness and future cumulative stock returns

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0522***	0.0883***	0.1335***	0.1511***
	3.60	4.51	4.94	4.19
Book-to-Market Ratio	0.0111	0.0196	0.0724	0.0954
	0.46	0.55	1.37	1.54
Market Cap	-0.0464**	-0.0478*	-0.0562	-0.0778
	-2.61	-1.80	-1.49	-1.56
Liabilities / Assets	0.0173	0.0150	0.0240	0.0316
	1.65	1.03	1.24	1.36
Capex / Assets	-0.9502**	-2.2411***	-3.0112***	-3.0363***
	-2.07	-3.66	-3.47	-2.86
Stock Return	-0.1038**	-0.0934	-0.1715***	-0.2984***
	-1.98	-1.42	-2.81	-3.80
PPE	-0.0048	-0.0170	-0.0284	-0.0304
	-0.46	-0.97	-1.05	-0.88
Sales Growth	-0.0372	-0.0335	0.0106	0.0547
	-0.44	-0.31	0.08	0.38
EPS Growth	0.0270***	0.0127	0.0227	0.0271
	2.68	0.87	1.19	1.15
Return on Equity	0.1158	0.0268	0.0938	0.1678
	0.72	0.14	0.40	0.55
Return Volatility	-0.0008	-0.0025	-0.0073***	-0.0076**
	-0.51	-1.16	-2.60	-2.34
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.1059	0.1396	0.1940	0.2068

Table 4. Tech greenness and future valuations

Panel regressions of the annual firm-level market-to-book ratio measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the current market-to-book ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1)	(2)	(3)	(4)	(5)
	MB t+1	MB t+2	MB t+3	MB t+4	MB t+5
Tech Greenness	0.0321*	0.0601*	0.0943**	0.1311**	0.1799***
	1.83	1.83	2.26	2.47	2.79
Market Cap	0.0041	0.0119	0.0444	0.0623	0.0748
	0.17	0.32	1.06	1.18	1.15
Liabilities / Assets	0.0199	0.0354	0.0368	0.0390	0.0471
	1.14	1.42	1.23	1.04	1.13
Capex / Assets	0.7211	0.2214	-1.2889	-2.8560*	-3.7095*
	1.05	0.20	-0.95	-1.71	-1.85
Market-to-Book	0.8225***	0.7609***	0.7582***	0.6644***	0.6289***
	21.39	12.98	10.55	7.13	5.53
Stock Return	0.2134**	0.1429	0.1454	0.0247	-0.2466*
	2.43	0.99	1.04	0.21	-1.92
PPE	-0.0074	-0.0093	-0.0161	-0.0137	-0.0195
	-0.77	-0.54	-0.67	-0.43	-0.47
Sales Growth	-0.0015	-0.1427	-0.0249	0.0276	0.0790
	-0.01	-0.74	-0.10	0.08	0.29
EPS Growth	-0.0348	-0.0279	-0.0379	-0.0493	-0.0234
	-1.56	-1.31	-1.43	-1.31	-0.65
Return on Equity	0.2786	0.5856**	0.0397	-0.0312	-0.4078
	0.99	2.16	0.10	-0.07	-0.97
Return Volatility	-0.0045***	-0.0045*	-0.0070**	-0.0114***	-0.0149***
	-2.76	-1.86	-2.17	-2.74	-3.44
Year FE	Y	Y	Y	Y	Y
Observations	1095	942	793	652	524
R-squared	0.6858	0.5331	0.4707	0.3983	0.3848

Table 5. Tech greenness and future operating performance

Panel regressions of the annual firm-level return on equity measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) ROE t+1	(2) ROE t+2	(3) ROE t+3	(4) ROE t+4	(5) ROE t+5
Tech Greenness	0.0103***	0.0132***	0.0180***	0.0174***	0.0164**
	2.81	2.83	3.33	3.04	2.60
Market Cap	-0.0138**	-0.0141**	-0.0134*	-0.0124	-0.0073
	-2.35	-2.26	-1.70	-1.26	-0.70
Liabilities / Assets	0.0107*	0.0128**	0.0140**	0.0151**	0.0112
	1.87	2.16	2.01	2.13	1.37
Capex / Assets	-0.0004	0.0009	-0.0006	0.0005	0.0054*
	-0.16	0.32	-0.19	0.18	1.73
Market-to-Book	0.1011	0.0693	0.0564	0.0429	-0.2319
	0.96	0.53	0.36	0.21	-1.14
Stock Return	0.0064	0.0171	0.0247*	-0.0108	-0.0061
	0.55	1.52	1.73	-0.67	-0.42
PPE	-0.0039	-0.0039	-0.0059	-0.0057	-0.0039
	-1.59	-1.46	-1.64	-1.35	-0.93
Sales Growth	-0.0181	-0.0092	-0.0796**	-0.0938**	-0.0491
	-0.64	-0.30	-2.59	-2.04	-1.34
EPS Growth	0.0110***	0.0043	0.0061	0.0053	-0.0011
	3.21	1.38	1.48	1.17	-0.21
Return on Equity	0.2876***	0.1586**	0.0925	0.1367**	0.2187***
	5.18	2.08	1.55	2.25	3.09
Return Volatility	-0.0002	-0.0001	0.0001	0.0004	0.0003
	-0.69	-0.31	0.23	0.94	0.63
Year FE	Y	Y	Y	Y	Y
Observations	1095	942	793	652	524
R-squared	0.2160	0.1255	0.1189	0.1094	0.1146

Table 6. Tech greenness and future cumulative operating performance

Panel regressions of annual firm-level cumulative return on equity measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. ROE 1-2	(2) Cum. ROE 1-3	(3) Cum. ROE 1-4	(4) Cum. ROE 1-5
Tech Greenness	0.0220***	0.0372***	0.0589***	0.0760***
	2.70	2.79	2.99	2.95
Book-to-Market Ratio	-0.0303***	-0.0446**	-0.0516*	-0.0508
	-2.73	-2.27	-1.73	-1.25
Market Cap	0.0202**	0.0341*	0.0547**	0.0659*
	1.97	1.85	1.96	1.71
Liabilities / Assets	-0.0005	-0.0023	-0.0007	0.0008
	-0.12	-0.29	-0.06	0.05
Capex / Assets	0.1922	0.2769	0.3551	-0.0536
	0.84	0.79	0.69	-0.07
Stock Return	0.0364*	0.0689**	0.0403	0.0797
	1.95	2.40	1.05	1.46
PPE	-0.0046	-0.0095	-0.0145	-0.0147
	-0.97	-1.11	-1.07	-0.80
Sales Growth	-0.0398	-0.1361*	-0.2460**	-0.3176**
	-0.80	-1.92	-2.13	-1.97
EPS Growth	0.0168***	0.0216***	0.0308***	0.0241
	3.39	2.86	3.13	1.63
Return on Equity	0.4532***	0.5462***	0.6570***	0.7397***
	3.74	3.03	3.21	2.79
Return Volatility	-0.0006	-0.0007	-0.0005	-0.0009
	-0.87	-0.63	-0.35	-0.49
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.2619	0.2734	0.2791	0.2556

Table 7. Tech greenness and future operating performance volatility

Panel regressions of the three-year moving standard deviation of firm-level return on equity measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year *t*, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) SD ROE t+1	(2) SD ROE t+2	(3) SD ROE t+3	(4) SD ROE t+4	(5) SD ROE t+5
Tech Greenness	-0.0077***	-0.0059**	-0.0068**	-0.0073**	-0.0066
	-2.61	-1.99	-2.10	-2.00	-1.65
Book-to-Market Ratio	-0.0036	-0.0020	0.0008	0.0026	0.0025
	-0.76	-0.43	0.15	0.43	0.41
Market Cap	-0.0038	0.0004	-0.0019	-0.0031	-0.0043
	-0.90	0.10	-0.46	-0.61	-0.72
Liabilities / Assets	0.0103***	0.0106***	0.0094***	0.0078**	0.0071*
	4.00	4.12	3.30	2.18	1.80
Capex / Assets	-0.1557	-0.1577	-0.2017	-0.1787	-0.1783
	-1.58	-1.43	-1.55	-1.32	-1.31
Stock Return	0.0080	0.0048	-0.0111	-0.0155	-0.0141
	0.82	0.50	-1.30	-1.61	-1.62
PPE	0.0022	0.0032	0.0060**	0.0075**	0.0086**
	0.86	1.26	2.15	2.23	2.39
Sales Growth	-0.0305*	-0.0434***	-0.0220	-0.0098	0.0164
	-1.89	-2.74	-1.28	-0.55	0.81
EPS Growth	-0.0089***	-0.0021	-0.0053*	-0.0077***	-0.0126***
	-3.69	-0.89	-1.93	-2.98	-4.21
Return on Equity	-0.0797***	-0.1933***	-0.0973***	-0.0551	-0.0155
	-2.96	-6.30	-3.83	-1.39	-0.34
Return Volatility	0.0011***	0.0010***	0.0010***	0.0006**	0.0002
	4.44	3.84	3.72	2.07	0.69
Year FE	Y	Y	Y	Y	Y
Observations	1095	942	793	652	524
R-squared	0.2544	0.3353	0.2364	0.1784	0.1658

Table 8. Tech greenness and future cumulative stock returns: Financial development

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, a country's degree of financial development, defined as the ratio between total banking credit and real GDP and calculated over the period 1975-1990, an interaction term between the two, and a vector of controls. Both technological greenness and financial development are standardized by subtracting their mean and dividing by their standard deviation to ease the economic interpretation of the results. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0264*	0.0545**	0.0971***	0.1095**
	1.85	2.45	2.90	2.52
Tech Greenness × Banking FD	0.0654***	0.0859***	0.0995**	0.1195**
	3.59	3.21	2.53	2.36
Banking FD	0.0060	-0.0063	-0.0267	-0.0431
	0.30	-0.22	-0.68	-0.87
Book-to-Market Ratio	0.0085	0.0183	0.0704	0.0955
	0.36	0.52	1.34	1.56
Market Cap	-0.0440**	-0.0429*	-0.0467	-0.0637
	-2.56	-1.67	-1.29	-1.34
Liabilities / Assets	0.0167*	0.0162	0.0269	0.0380*
	1.68	1.17	1.48	1.78
Capex / Assets	-1.1368**	-2.5868***	-3.5310***	-3.7326***
	-2.31	-3.80	-3.53	-3.03
Stock Return	-0.1144**	-0.1061	-0.1962***	-0.3044***
	-2.16	-1.61	-3.23	-3.93
PPE	-0.0130	-0.0267	-0.0388	-0.0417
	-1.11	-1.41	-1.37	-1.19
Sales Growth	-0.0526	-0.0609	-0.0365	0.0045
	-0.63	-0.57	-0.28	0.03
EPS Growth	0.0301***	0.0169	0.0270	0.0317
	2.92	1.14	1.40	1.34
Return on Equity	0.1494	0.0805	0.1684	0.3002
	0.94	0.43	0.74	1.01
Return Volatility	0.0000	-0.0016	-0.0062**	-0.0061*
	0.02	-0.76	-2.28	-1.93
Year FE	Y	Y	Y	Y
Observations	937	789	649	522
R-squared	0.1169	0.1524	0.2098	0.2283

Table 9. Tech greenness and future cumulative stock returns: Financial development in OECD countries
Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, a country's degree of financial development, defined as the ratio between total banking credit and real GDP and calculated over the period 1975-1990, an interaction term between the two, and a vector of controls. Both technological greenness and financial development are standardized by subtracting their mean and dividing by their standard deviation to ease the economic interpretation of the results. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample only includes OECD countries. The sample period is from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0355**	0.0481*	0.0517	0.0692
	2.06	1.91	1.54	1.44
Tech Greenness × Banking FD	0.0969***	0.1401***	0.1924***	0.2299***
	4.16	4.50	4.90	4.45
Banking FD	-0.0096	-0.0081	-0.0046	-0.0297
	-0.40	-0.24	-0.10	-0.48
Book-to-Market Ratio	-0.0129	-0.0193	-0.0040	0.0182
	-0.62	-0.57	-0.09	0.32
Market Cap	-0.0037	-0.0171	-0.0338	-0.0481
	-0.24	-0.72	-1.08	-1.11
Liabilities / Assets	0.0113	0.0134	0.0224	0.0360
	1.01	0.83	1.07	1.39
Capex / Assets	-1.6679***	-3.1383***	-4.2786***	-4.7204***
	-2.96	-3.74	-3.45	-3.08
Stock Return	-0.0364	-0.0546	-0.0961	-0.0788
	-0.57	-0.63	-1.05	-0.63
PPE	-0.0112	-0.0112	-0.0035	0.0039
	-0.95	-0.66	-0.15	0.12
Sales Growth	-0.1373	-0.2568*	-0.2840*	-0.2744
	-1.24	-1.81	-1.68	-1.62
EPS Growth	0.0138	-0.0023	0.0147	0.0190
	1.27	-0.15	0.66	0.68
Return on Equity	-0.1137	-0.1806	-0.1815	-0.0998
	-0.77	-1.10	-0.97	-0.31
Return Volatility	-0.0015	-0.0054**	-0.0111***	-0.0109**
	-0.80	-2.02	-3.55	-2.60
Year FE	Y	Y	Y	Y
Observations	650	554	460	372
R-squared	0.1525	0.1805	0.2338	0.2261

Table 10. Tech greenness disclosure and future cumulative stock returns

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on a dummy variable that captures a firm's disclosure of its degree of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and a set of firm-level controls. In Panel A, the dummy variable takes on value one if a firm's disclosed degree of technological greenness is among the top 30% in a given year, and zero otherwise. In Panel B, the dummy variable takes on value one if a firm's disclosed degree of technological greenness is among the bottom 30% in a given year, and zero otherwise. In Panel C, the dummy variable takes on value one if a firm discloses its degree of technological greenness independently of the score. The controls are the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 1,000 utility firms located in 77 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

Panel A. Top publishers

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Top 30% Tech Greenness	0.1461***	0.2615***	0.3784***	0.4289***
	4.49	5.14	5.17	4.49
Year FE	Y	Y	Y	Y
Observations	4410	3767	3155	2580
R-squared	0.0670	0.0617	0.0617	0.0692

Panel B. Bottom publishers

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Bottom 30% Tech Greenness	0.0542*	0.0840*	0.1056*	0.1197
	1.93	1.90	1.77	1.60
Year FE	Y	Y	Y	Y
Observations	4417	3785	3177	2605
R-squared	0.0675	0.0605	0.0549	0.0603

Panel C. All publishers

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Publisher	0.0699***	0.1182***	0.1620***	0.1810***
	3.01	3.31	3.29	2.94
Year FE	Y	Y	Y	Y
Observations	5082	4340	3631	2965
R-squared	0.0617	0.0565	0.0542	0.0611

Table 11. Greenness disclosure and future cumulative stock returns: Alternative measures

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on a dummy variable that captures a firm's disclosure of its degree of greenness, and a vector of firm-level controls. In Panels A and B, we include a dummy that takes on value one if a firm's disclosed degree of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, is among the top 30% in a given year, and zero otherwise, a dummy variable that takes on value one if a firm's ESG score (Panel A) or E score (Panel B) is among the top 30% in a given year, and zero otherwise, and a dummy variable that takes on value one if a firm's level of GHG emissions is among the bottom 30% in a given year, and zero otherwise. In Panel C, we include an alternative set of dummy variables that respectively take on value one if a firm discloses its degree of technological greenness, ESG score, or GHG emissions, independently of the score. The controls are the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 1,000 utility firms located in 77 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

Panel A.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Top 30% Tech Greenness	0.1170***	0.2079***	0.3131***	0.3572***
	3.92	4.38	4.49	3.85
Top 30% ESG	0.0363	0.0771**	0.0963*	0.1239*
	1.56	2.14	1.90	1.83
Bottom 30% GHG	0.0749**	0.1273***	0.1962***	0.2180**
	2.29	2.59	3.03	2.54
Year FE	Y	Y	Y	Y
Observations	5082	4340	3631	2965
R-squared	0.0644	0.0629	0.0654	0.0731

Panel B.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Top 30% Tech Greenness	0.1174***	0.2107***	0.3115***	0.3577***
	3.95	4.45	4.47	3.83
Top 30% E-score	0.0335	0.0634	0.0980*	0.1091
	1.35	1.62	1.83	1.56
Bottom 30% GHG	0.0789**	0.1379***	0.2071***	0.2384***
	2.45	2.88	3.31	2.91
Year FE	Y	Y	Y	Y
Observations	5082	4340	3631	2965
R-squared	0.0644	0.0626	0.0655	0.0728

Panel C.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness Publisher	0.0534**	0.0829**	0.1106**	0.1237*
	2.26	2.25	2.16	1.89
ESG Publisher	0.0171	0.0392	0.0650	0.0620
	0.58	0.86	1.10	0.83
GHG Publisher	0.0356	0.0737*	0.1030**	0.1285**
	1.34	1.85	2.04	2.08
Year FE	Y	Y	Y	Y
Observations	5082	4340	3631	2965
R-squared	0.0624	0.0587	0.0580	0.0650

Table 12. Tech greenness and future cumulative stock returns: 2016 effect

Panel regressions of annual firm-level cumulative two-year stock returns on a dummy variable that takes on value one if a firm's disclosed degree of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, is among the top 30% in a given year, and zero otherwise, a dummy variable that takes on value one if a firm's ESG score is among the top 30% in a given year, and zero otherwise, and a dummy variable that takes on value one if a firm's level of GHG emissions is among the bottom 30% in a given year, and zero otherwise, a dummy variable that takes on one if a firm's headquarters is located in the United States, and zero otherwise, a dummy variable that takes on value one for year 2016, and zero otherwise, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications are estimated through panel OLS with standard errors clustered by firm and year. The sample includes 1,000 utility firms located in 77 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-2	(3) Cum. Returns 1-2	(4) Cum. Returns 1-2
Top 30% Tech Greenness	0.1263**			0.1233***
	2.46			3.15
Top 30% Tech Greenness × US	-0.0101			-0.0317
	-0.16			-0.50
Top 30% Tech Greenness × 2016	0.1709***			0.0763**
	3.50			2.06
Top 30% Tech Greenness × 2016 × US	-0.2138***			-0.2246***
	-2.92			-3.07
Top 30% ESG		0.0281		-0.0286
		0.44		-0.46
Top 30% ESG × US		0.0496		0.0976**
		0.99		2.21
Top 30% ESG × 2016		0.3114***		0.2561***
		4.16		4.32
Top 30% ESG × 2016 × US		-0.2054***		-0.1158**
		-2.75		-2.13
Bottom 30% GHG			0.1135**	0.1132**
			2.02	2.50
Bottom 30% GHG × US			-0.1087***	-0.1180***
			-2.93	-2.90
Bottom 30% GHG × 2016			0.2046***	0.0695
			2.93	1.56
Bottom 30% GHG × 2016 × US			-0.2302***	-0.0880*
			-3.61	-1.93
Controls	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Observations	5082	5082	5082	5082
R-squared	0.0372	0.0364	0.0364	0.0415

Appendix B. Additional tables

Table A1. Tech greenness and future stock returns: Controlling for market beta

Panel regressions of annual firm-level stock returns measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the three-year rolling market beta of the stock, the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Return t+1	(2) Return t+2	(3) Return t+3	(4) Return t+4	(5) Return t+5
Tech Greenness	0.0346***	0.0323***	0.0270**	0.0344**	0.0252
	4.04	3.65	2.14	2.06	1.04
Market Beta	-0.0487	-0.0562*	-0.0750*	0.0320	0.0424
	-1.63	-1.71	-1.83	0.60	0.62
Book-to-Market Ratio	0.0273	0.0066	0.0006	0.0037	0.0068
	1.29	0.35	0.02	0.10	0.18
Market Cap	-0.0290**	-0.0327**	-0.0357**	-0.0651***	-0.0318
	-2.20	-2.17	-2.21	-3.17	-1.06
Liabilities / Assets	0.0077	0.0078	0.0039	0.0096	0.0108
	1.06	1.09	0.51	0.91	0.78
Capex / Assets	-0.1652	-0.2662	-0.9383**	-0.7217	1.1640*
	-0.41	-0.67	-2.05	-1.18	1.71
Stock Return	-0.0123	-0.0615	0.1243**	-0.0758	-0.1015
	-0.28	-1.13	2.16	-1.06	-1.22
PPE	0.0004	0.0154**	0.0270***	0.0249**	0.0467**
	0.07	2.34	3.09	2.41	2.46
Sales Growth	0.0589	-0.0664	0.0364	0.0505	0.0010
	0.81	-0.85	0.38	0.41	0.00
EPS Growth	0.0196*	-0.0055	-0.0015	-0.0005	0.0094
	1.89	-0.56	-0.12	-0.03	0.44
Return on Equity	-0.1946	-0.0526	-0.1184	-0.1760	-0.0524
	-1.57	-0.42	-0.91	-1.22	-0.20
Return Volatility	-0.0005	0.0003	0.0007	-0.0032**	0.0004
	-0.42	0.24	0.44	-1.96	0.20
Year FE	Y	Y	Y	Y	Y
Observations	783	631	483	342	215
R-squared	0.1122	0.1195	0.1119	0.1475	0.1253

Table A2. Tech greenness and future cumulative stock returns: Controlling for market beta

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the three-year rolling market beta of the stock, the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0785***	0.1114***	0.1547***	0.1794***
	4.66	4.88	5.19	4.56
Market Beta	-0.1452***	-0.2919***	-0.2812***	-0.3009**
	-2.81	-3.84	-2.63	-2.10
Book-to-Market Ratio	0.0203	0.0121	0.0822	0.1432
	0.62	0.23	1.00	1.47
Market Cap	-0.0675***	-0.0858**	-0.1101**	-0.1357**
	-2.75	-2.47	-2.45	-2.24
Liabilities / Assets	0.0130	0.0144	0.0400	0.0613*
	0.99	0.78	1.57	1.89
Capex / Assets	-0.9669	-2.6167***	-3.3039***	-2.2743
	-1.42	-2.84	-2.64	-1.51
Stock Return	-0.0887	0.0222	0.0645	-0.0100
	-1.26	0.20	0.59	-0.06
PPE	0.0154	0.0249	0.0224	0.0436
	1.23	1.27	0.78	1.46
Sales Growth	-0.0758	-0.0666	-0.0443	0.0051
	-0.76	-0.48	-0.22	0.02
EPS Growth	0.0082	-0.0078	0.0118	0.0360
	0.68	-0.47	0.45	1.06
Return on Equity	-0.0633	-0.1478	-0.1147	-0.1965
	-0.32	-0.56	-0.34	-0.42
Return Volatility	0.0012	0.0025	-0.0032	-0.0032
	0.58	0.82	-0.82	-0.76
Year FE	Y	Y	Y	Y
Observations	631	483	342	215
R-squared	0.1380	0.1963	0.2529	0.3100

Table A3. Tech greenness and future cumulative stock returns: Alternative definitions of greenness

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level controls. Green sources include solar, waste, and wind in all specifications, with the addition of hydro in Panel A, nuclear in Panel B, and both hydro and nuclear in Panel C. Brown sources include gas an coal in all specifications. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

Panel A. Adding hydro

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0450***	0.0868***	0.1406***	0.1610***
	2.90	4.08	4.61	4.00
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.1017	0.1382	0.2007	0.2164

Panel B. Adding nuclear

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0441***	0.0749***	0.1118***	0.1218***
	3.08	3.87	4.20	3.44
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.1017	0.1316	0.1794	0.1905

Panel C. Adding hydro and nuclear

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0393**	0.0773***	0.1253***	0.1407***
	2.56	3.63	4.11	3.51
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.0992	0.1327	0.1898	0.2037

Table A4. Tech greenness and future cumulative stock returns: Alternative specifications

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. In each panel, we include firm fixed effects and clustering by year in column (1), pooled OLS with double clustering by firm and year in column (2), firm and year fixed effects in column (3), and Fama-MacBeth regressions in column (4). The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

Panel A. Two years ahead

	(1)	(2)	(3)	(4)
Tech Greenness	0.0875**	0.0560***	0.0347	0.0415
	2.55	2.61	1.05	1.41
Year FE	N	N	Y	N
Country FE	Y	N	Y	N
Clustering	Year	Country / Year	None	None
Fama-MacBeth	N	N	N	Y
Observations	942	942	942	942
R-squared	0.4142	0.0723	0.2662	0.2439

Panel B. Three years ahead

	(1)	(2)	(3)	(4)
Tech Greenness	0.1586***	0.0935***	0.1001***	0.0755***
	2.87	3.62	2.38	2.64
Year FE	N	N	Y	N
Country FE	Y	N	Y	N
Clustering	Year	Country / Year	None	None
Fama-MacBeth	N	N	N	Y
Observations	793	793	793	793
R-squared	0.5371	0.1077	0.2979	0.2833

Panel C. Four years ahead

	(1)	(2)	(3)	(4)
Tech Greenness	0.1670***	0.1362***	0.1369***	0.1164***
	2.66	4.13	3.07	4.70
Year FE	N	N	Y	N
Country FE	Y	N	Y	N
Clustering	Year	Country / Year	None	None
Fama-MacBeth	N	N	N	Y
Observations	652	652	652	652
R-squared	0.6967	0.1662	0.3965	0.2980

Panel D. Five years ahead

	(1)	(2)	(3)	(4)
Tech Greenness	0.1771***	0.1562***	0.1353***	0.1337***
	2.66	3.71	2.60	4.11
Year FE	N	N	Y	N
Country FE	Y	N	Y	N
Clustering	Year	Country / Year	None	None
Fama-MacBeth	N	N	N	Y
Observations	524	524	524	524
R-squared	0.7882	0.1931	0.4555	0.2996

Table A5. Tech greenness and future cumulative stock returns: Three-year moving average

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, calculated over a three-year moving window, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0510***	0.0741***	0.0850***	0.1056***
	3.45	3.50	3.13	3.05
Book-to-Market Ratio	0.0173	0.0271	0.0704	0.0983
	0.61	0.61	1.15	1.36
Market Cap	-0.0445**	-0.0497	-0.0662	-0.0786
	-2.15	-1.59	-1.58	-1.45
Liabilities / Assets	0.0093	0.0043	0.0140	0.0192
	0.81	0.26	0.64	0.70
Capex / Assets	-0.7631	-2.0302***	-3.0113***	-2.8354**
	-1.43	-2.85	-3.02	-2.28
Stock Return	-0.1188**	-0.0978	-0.1617**	-0.3053***
	-2.07	-1.31	-2.34	-3.42
PPE	-0.0086	-0.0211	-0.0271	-0.0342
	-0.75	-1.03	-0.87	-0.90
Sales Growth	-0.0245	0.0164	0.1317	0.1924
	-0.27	0.14	0.93	1.20
EPS Growth	0.0115	-0.0081	0.0090	0.0151
	1.04	-0.52	0.38	0.49
Return on Equity	0.1445	0.1463	0.2332	0.2666
	0.83	0.70	0.86	0.76
Return Volatility	0.0001	-0.0015	-0.0054*	-0.0047
	0.07	-0.63	-1.68	-1.29
Year FE	Y	Y	Y	Y
Observations	856	707	566	438
R-squared	0.1107	0.1280	0.1623	0.1841

Table A6. Tech greenness and future cumulative sales growth

Panel regressions of annual firm-level cumulative sales growth measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Sales Gr. 1-2	(2) Cum. Sales Gr. 1-3	(3) Cum. Sales Gr. 1-4	(4) Cum. Sales Gr. 1-5
Tech Greenness	0.0252**	0.0405***	0.0510***	0.0661**
	2.56	2.81	2.66	2.57
Book-to-Market Ratio	-0.0444***	-0.0709***	-0.1023***	-0.1511***
	-2.63	-2.87	-2.92	-3.59
Market Cap	-0.0507***	-0.0696***	-0.0978***	-0.1174***
	-4.38	-4.17	-4.05	-4.12
Liabilities / Assets	-0.0053	-0.0140**	-0.0224***	-0.0330***
	-1.04	-2.05	-3.06	-3.45
Capex / Assets	1.7087***	2.2910***	2.8231***	2.7515***
	5.97	5.99	5.95	4.71
Stock Return	0.0208	0.0076	0.0065	-0.0227
	0.73	0.20	0.17	-0.56
PPE	0.0001	0.0003	0.0030	0.0048
	0.02	0.03	0.22	0.30
Sales Growth	0.0430	0.0810	0.0799	0.1189
	0.84	1.45	1.04	1.25
EPS Growth	0.0047	-0.0027	-0.0085	0.0039
	0.85	-0.46	-0.95	0.36
Return on Equity	-0.1031	-0.1464	-0.1034	-0.3372**
	-1.18	-1.28	-0.76	-2.13
Return Volatility	0.0024***	0.0042***	0.0052***	0.0062***
	2.95	3.83	3.55	3.71
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.2126	0.2813	0.3459	0.3840

Table A7. Tech greenness and future market beta

Panel regressions of the three-year moving market beta of a stock measured one, two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, and standardized by subtracting its mean and dividing by its standard deviation to ease the economic interpretation of the results, and a set of firm-level variables including the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Beta t+1	(2) Beta t+2	(3) Beta t+3	(4) Beta t+4	(5) Beta t+5
Tech Greenness	-0.0436***	-0.0450***	-0.0458***	-0.0423**	-0.0359*
	-2.75	-2.68	-2.62	-2.18	-1.66
Book-to-Market Ratio	-0.0250	-0.0216	-0.0339	-0.0368	-0.0399
	-0.71	-0.64	-1.01	-0.98	-0.93
Market Cap	-0.0900***	-0.0636**	-0.0617**	-0.0713***	-0.0751**
	-3.62	-2.50	-2.43	-2.68	-2.44
Liabilities / Assets	-0.0017	-0.0000	-0.0042	-0.0056	-0.0128
	-0.14	-0.00	-0.34	-0.43	-0.90
Capex / Assets	-1.2052**	-1.2053**	-0.6348	-0.1516	0.1029
	-2.25	-2.29	-1.25	-0.27	0.16
Stock Return	-0.0826**	-0.0635*	-0.0592	-0.0312	-0.0324
	-2.33	-1.67	-1.39	-0.63	-0.57
PPE	0.0621***	0.0505***	0.0518***	0.0542***	0.0584***
	4.27	3.63	3.58	3.50	3.36
Sales Growth	-0.2083**	-0.0942	-0.0272	-0.0240	-0.0339
	-2.17	-1.08	-0.30	-0.26	-0.32
EPS Growth	0.0058	-0.0089	-0.0103	-0.0005	-0.0017
	0.58	-0.74	-0.84	-0.04	-0.13
Return on Equity	0.0171	-0.0429	-0.0656	-0.1266	-0.1571
	0.15	-0.33	-0.49	-0.80	-1.11
Return Volatility	0.0176***	0.0186***	0.0196***	0.0192***	0.0162***
	9.98	8.81	9.86	9.24	7.50
Year FE	Y	Y	Y	Y	Y
Observations	892	837	774	648	521
R-squared	0.4550	0.4427	0.4636	0.4552	0.3917

Table A8. Tech greenness and future cumulative stock returns: Financial development dummy

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, a dummy that takes on value one if a country's degree of financial development, defined as the ratio between total banking credit and real GDP and calculated over the period 1975-1990, is above its median value, and zero otherwise, an interaction term between the two, and a vector of controls. Both technological greenness and financial development are standardized by subtracting their mean and dividing by their standard deviation to ease the economic interpretation of the results. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	-0.0125	0.0075	0.0463	0.0422
	-0.68	0.25	0.98	0.68
Tech Greenness × High FD	0.1119***	0.1369***	0.1479**	0.1868**
	4.26	3.55	2.55	2.41
High FD	-0.0389	-0.0827*	-0.1374**	-0.1744**
	-1.31	-1.90	-2.22	-2.21
Book-to-Market Ratio	0.0120	0.0207	0.0683	0.0896
	0.51	0.60	1.35	1.49
Market Cap	-0.0450**	-0.0488*	-0.0609	-0.0851*
	-2.43	-1.77	-1.58	-1.70
Liabilities / Assets	0.0169*	0.0159	0.0256	0.0359
	1.66	1.13	1.36	1.62
Capex / Assets	-1.2702***	-2.7399***	-3.6976***	-3.9596***
	-2.66	-4.18	-3.87	-3.32
Stock Return	-0.1177**	-0.1099*	-0.1943***	-0.3109***
	-2.27	-1.71	-3.27	-4.09
PPE	-0.0072	-0.0158	-0.0208	-0.0203
	-0.63	-0.87	-0.77	-0.61
Sales Growth	-0.0326	-0.0342	-0.0087	0.0129
	-0.38	-0.31	-0.06	0.09
EPS Growth	0.0281***	0.0133	0.0205	0.0251
	2.74	0.91	1.08	1.08
Return on Equity	0.1485	0.0850	0.1753	0.3134
	0.92	0.44	0.76	1.07
Return Volatility	0.0000	-0.0015	-0.0058**	-0.0054*
	0.00	-0.73	-2.17	-1.74
Year FE	Y	Y	Y	Y
Observations	942	793	652	524
R-squared	0.1262	0.1668	0.2282	0.2500

Table A9. Tech greenness and future cumulative stock returns: Financial development and beta

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, a country's degree of financial development, defined as the ratio between total banking credit and real GDP and calculated over the period 1975-1990, an interaction term between the two, a stock's market beta, calculated over a three-year moving window, an interaction term between beta and financial development, and a vector of controls. Both technological greenness and financial development are standardized by subtracting their mean and dividing by their standard deviation to ease the economic interpretation of the results. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include year fixed effects and standard errors clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0534***	0.0793***	0.1139***	0.1055**
	3.15	3.18	3.35	2.56
Tech Greenness × Banking FD	0.0670***	0.0873***	0.1195***	0.1932***
	3.11	2.81	2.67	3.56
Beta	-0.1504***	-0.2996***	-0.2862**	-0.2556*
	-2.72	-3.64	-2.52	-1.80
Beta × Banking FD	0.0465	0.0713	0.0629	-0.0872
	0.86	0.94	0.58	-0.58
Banking FD	-0.0429	-0.0766	-0.0790	0.0495
	-0.84	-1.06	-0.78	0.39
Book-to-Market Ratio	0.0140	0.0046	0.0689	0.1396
	0.42	0.09	0.82	1.42
Market Cap	-0.0685***	-0.0878**	-0.1100**	-0.1169*
	-2.64	-2.33	-2.19	-1.81
Liabilities / Assets	0.0104	0.0118	0.0350	0.0606*
	0.77	0.63	1.28	1.81
Capex / Assets	-1.3356*	-3.2648***	-4.1428***	-3.0917*
	-1.76	-3.02	-2.68	-1.71
Stock Return	-0.1050	0.0023	0.0067	-0.0497
	-1.45	0.02	0.06	-0.33
PPE	0.0105	0.0213	0.0161	0.0210
	0.84	1.07	0.52	0.64
Sales Growth	-0.0893	-0.0820	-0.0889	-0.0080
	-0.90	-0.59	-0.45	-0.04
EPS Growth	0.0087	-0.0074	0.0108	0.0330
	0.71	-0.44	0.40	0.94
Return on Equity	-0.0436	-0.1058	-0.0516	0.0045
	-0.22	-0.42	-0.16	0.01
Return Volatility	0.0018	0.0028	-0.0023	-0.0008
	0.82	0.96	-0.59	-0.20
Year FE	Y	Y	Y	Y
Observations	626	479	339	213
R-squared	0.1494	0.2079	0.2665	0.3464

Table A10. Tech greenness and financial development: Country, year, and country-year fixed-effects

Panel regressions of annual firm-level cumulative stock returns measured over windows of two, three, four, or five years ahead on an index of technological greenness, defined as the total percentage green capacity minus total percentage brown capacity in year t, a country's degree of financial development, defined as the ratio between total banking credit and real GDP and calculated over the period 1975-1990, an interaction term between the two, a stock's market beta, calculated over a three-year moving window, an interaction term between beta and financial development, and a vector of controls. Both technological greenness and financial development are standardized by subtracting their mean and dividing by their standard deviation to ease the economic interpretation of the results. The controls include the book-to-market ratio, the natural logarithm of market capitalization, leverage, the ratio between capital expenditures and total assets, the current stock return, the natural logarithm of the total value of property, plant, and equipment, sales growth, earnings-per-share growth, return on equity, and the annualized volatility of daily stock returns. All specifications include country, year, and country-year fixed effects, and standard errors are clustered by firm. The sample includes 165 utility firms located in 31 countries over the period from 2011 to 2021. The data on technological greenness is from Bloomberg. Firm-level accounting and financial market data is from Refinitiv.

	(1) Cum. Returns 1-2	(2) Cum. Returns 1-3	(3) Cum. Returns 1-4	(4) Cum. Returns 1-5
Tech Greenness	0.0022	0.0038	0.0002	-0.0003
	0.19	0.21	0.01	-0.01
Tech Greenness × Banking FD	0.0530***	0.0766***	0.1078***	0.1274***
	3.36	3.26	3.58	3.09
Book-to-Market Ratio	0.0026	0.0004	0.0289	0.0438
	0.08	0.01	0.47	0.60
Market Cap	-0.0736***	-0.0873***	-0.0893**	-0.1127**
	-3.49	-2.71	-2.05	-2.00
Liabilities / Assets	0.0130*	0.0157	0.0230	0.0317*
	1.77	1.41	1.53	1.84
Capex / Assets	-0.1823	-0.5197	-0.4676	0.3124
	-0.42	-0.83	-0.50	0.28
Stock Return	-0.1197*	-0.1400*	-0.1231*	-0.1727**
	-1.89	-1.76	-1.66	-2.10
PPE	0.0097	0.0061	-0.0020	0.0014
	1.34	0.56	-0.12	0.06
Sales Growth	-0.1015	-0.1600*	-0.1047	-0.0316
	-1.07	-1.72	-0.95	-0.24
EPS Growth	0.0119	0.0084	0.0289*	0.0245
	1.60	0.71	1.76	1.37
Return on Equity	0.1303	0.0443	0.0980	0.2800
	1.10	0.29	0.49	1.32
Return Volatility	0.0036	0.0039	0.0057	0.0092*
	1.61	1.35	1.61	1.79
Country FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Country-Year FE	Y	Y	Y	Y
Observations	937	789	649	522
R-squared	0.1138	0.1301	0.1700	0.2114