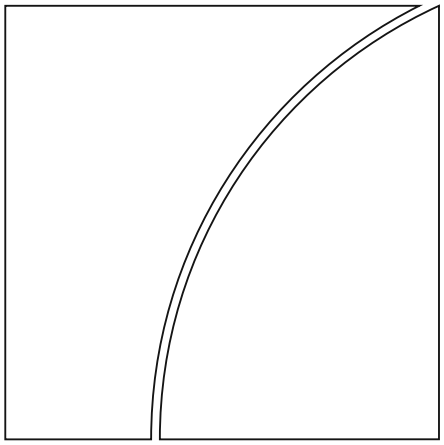

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by Giulio Cornelli, Magdalena Erdem and Egon Zakrajšek

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CEO turnover risk and firm environmental performance*

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Abstract

We investigate the relationship between the probability of a CEO forced-turnover and firm performance on several environmental dimensions. Our findings suggest that a higher risk of being terminated for the CEO is correlated with a lower environmental ranking, particularly on environmental innovation activities. The inclusion of ESG-pay clauses in executives' compensation packages only marginally offsets such deterioration. Looking at data on Greenhouse gas (GHG) emissions, we consistently find that a rise in the probability of being terminated corresponds to an increase in scope 2 and 3 emissions ("carbon leakeage"), whereas scope 1 emissions remain unchanged. We trace the deterioration of firms' overall environmental- and environmental innovation scores to a strategical re-orientation towards short-termism.

JEL Classification: D22 G30 G34 O31 Q55

Keywords: corporate finance, ESG, emissions, environmental innovation, short-termism

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1 Introduction

The 2015 Paris Agreement established a long-term goal of keeping the rise in global average temperatures below 2^oC above pre-industrial levels. Changes in individuals' preferences and consumption behaviours alone will fall short of achieving this high-priority objective. Recent work by Bouckaert et al. (2021) showed that less than 5% of the reduction in CO_2 emissions by 2050 will originate from behavioural changes. On the other hand, they estimate that 55% will come from technology already in commerce in the market, and the residual 45% from innovation. Such a high-order challenge highlights even more prominently the pivotal role that firms' research and development (R&D) activities will play in greening the economy and calls for a shift in firms' culture when setting their strategies. Furthermore, the recent wave of record-high temperatures in the summer of 2023 has highlighted even more prominently the priority of achieving this objective, and given the scale of the challenge any contribution, even if small, shouldn't be left unexplored.

Achieving these results is not only a priority from a "macro-societal" perspective but offers considerable benefits at the micro-firm level too. Indeed, consistently with investors and financial intermediaries internalizing the importance of the green transition (Krueger et al., 2020), greener firms borrow at cheaper rates (Degryse et al., 2023), have a lower overall cost of capital (Chava, 2014), do not have to correspond a premium to investors for their exposure to carbon emission risk (Bolton and Kacperczyk, 2021), and are less financially constrained (Oliviero et al., 2024) relative to browner ones.

Sustainable and long-lasting improvements in firm's environmental results may require a shift of focus towards the long-term, whereas management incentives could at times be tilted in favour of shorter-term returns. This friction, also called *tragedy of the horizon* (see Carney (2015)), can be particularly acute for Chief Executive Officers (CEO) when the risk of a forced turnover becomes higher.

In this paper, we investigate the relationship between the probability of a CEO forced-turnover, a prominent source of risk for CEOs (Peters and Wagner, 2014; Jenter and

Kanaan, 2015; Ellul et al., 2020), and firm performance along several environmental dimensions. In other words, when CEOs face a higher probability of being unwillingly terminated, do they keep pursuing environmental objectives, which are typically more long-term in nature? Or conversely, do they re-focus the strategy toward short-term objectives to consolidate their position?

To answer these questions, we assemble a novel database combining indicators on CEO characteristics and exposure to the risk of a forced turnover, and on firms' financials, expected default frequencies, and ESG and environmental performance. Our methodology to estimate the probability of a CEO forced-turnover builds on the results from Peters and Wagner (2014). Specifically, we obtain the fitted values from a probit regression of *Forced Turnover*, a dummy that takes value of 1 when a CEO is terminated unexpectedly [1], on a set of controls representing industry volatility and market-adjusted returns, firms' financials, stock idiosyncratic returns, and CEO characteristics like age, tenure and duality.

In a second step we investigate how the measure obtained correlates with indicators of firms environmental performance, controlling for regulation, shareholders pressures, board representation, CEO power, as well as firm characteristics, stock returns, and industry volatility. In a third step, we test if our results are affected by so-called ESG-pay caluses –i.e. compensation clauses tied to ESG related objectives –and by the adoption of the Paris Agreement. In a fourth step, we test if our results tell a consistent story when using data on firms' greenhouse gas (GHG) emissions as dependent variable. In other words, we investigate if the effect of a higher risk of an unexpected termination of the contract of a CEO on firm environmental performance is detectable on a directly measurable indicator such as the firm GHG emissions. Finally, we investigate the mechanism by which the effect operates within firms. Specifically, we propose *"short-termism"* as a relevant channel to explain the deterioration in the firm's performance on overall environmental and environmental innovation dimensions. Therefore, we argue that when CEOs face a higher risk of being terminated unwillingly, they re-orient the strategic focus of the firm

[1] For more details see Peters and Wagner (2014).

towards the short-term (i.e. short-termism). Such a shift, leaves less room for efforts aimed at improving the environmental performance of the firm, particularly in areas where benefits will only be reaped in the long-term such as, for example, environmental R&D.

The main results of our study are the following. First, a higher probability of a forced turnover for the CEO corresponds to a worse environmental performance for the firm. We consistently find such effect across all the dimensions of environmental performance and it is particularly strong for the more long-term oriented environmental innovation dimension. Second, the increasingly adopted ESG-Pay clauses don't seem effective at taming this effect. Third, a higher probability of a forced turnover for the CEO corresponds to higher scope 2 & 3 emissions. Contrarily, we don't find any effect on scope 1 emissions which may be more difficult to alter in the short-run. Finally, through a sequential g-estimator approach (Joffe and Greene, 2009; Vansteelandt, 2009; Acharya et al., 2016), we trace the deterioration of firms' performance on the overall environmental and the environmental innovation dimensions to a strategical re-orientation towards short-termism.

Our paper is relevant to several strands of literature. Specifically, our analysis speaks to papers studying the effect of forced turnover risk for CEOs. Peters and Wagner (2014) document how CEOs of companies facing volatile industry conditions are more exposed to turnover risk and consequently adjust their demand for compensation. Contrarily to standard economic theory, suggesting that the board of directors when appraising the performance of the CEO should filter out factors that are beyond her control, Jenter and Kanaan (2015) document how CEOs face a higher risk of being unwillingly terminated after bad industry and market performance. Ellul et al. (2020) establish the presence of a negative and sizeable effect of a forced turnover on top managers of funds liquidated after periods of persistent underperformance. Wang et al. (2024) document the relationship between CEO career concerns and ESG controversies. Our results complement their findings documenting the effect of turnover risk on firms' environmental performance.

Our work complements the literature studying the effectiveness of ESG-Pay clauses in executives compensation packages. Cohen et al. (2023) find a positive effect of ESG-Pay clauses on key ESG metrics in an international context. Michaely et al. (2024) study the effectiveness of environmental and social (ES) pay clauses and find that these clauses are particularly effective when they entail quantitatively defined objectives while the environmental performance of the firm is unaffected when the objectives are defined qualitatively. We find only a marginal effectiveness of ESG-Pay clauses on environmental metrics –i.e. the **E** in ESG –in the context of the United States.

As Bouckaert et al. (2021), we highlight the importance of environmental innovation to achieve crucial improvements on climate goals and the pivotal role of private- and public capital in financing innovative firms active in this field (Cornelli et al., 2023; Oliviero et al., 2024; De Haas and Popov, 2023; Aghion et al., 2024; Acemoglu et al., 2012, 2016).

Our results are consistent with findings by Brochet et al. (2012) who document that firms' short-termism is associated with greater risk at the firm-level. Laverty (1996) provides evidence of how management choices on inter-temporal resource differ depending on whether the objective is to maximize profit in the short-term rather then maximising firm value in the long-run. According to Bolton et al. (2006), the typical structure of executive compensation packages which links a significant part of the remuneration to current performance, incetivizes managers to prioritize short-term outcomes. In our framework, when CEOs face a higher probability of being unwillingly terminated the strategical re-orientation towards short-termism becomes even stronger. The increase in risk at the firm level deriving from a stronger focus on the short-term is consistent with an increase in "reputational" risk originating from more controversies related to ESG matters. Finally, our work echoes work by Hassan et al. (2019, 2024) and Sautner et al. (2023) who show how machine learning techniques effectively build measures of exposure to specific topics at the firm level based on companies earnings call transcripts.

Our paper contributes to the literature documenting the effect of the risk of CEO forced turnover on firm's environmental performance, and sheds light on the effectiveness

of ESG-Pay clauses, which are increasingly being included in executives' compensation packages. We show that the effect of interest is negative, it is particularly detrimental for highly-needed, and more long-term oriented, environmental R&D activities, and that ESG-Pay clauses don't seem to be effective at dampening it. We document how the effect of an increase in the probability of a CEO forced turnover is consistent with "carbon leakage" practices aimed at reducing costs and boosting returns in the short-term. Finally, to identify the channel at play, we trace this effect to a strategical re-orientation toward short-termism.

The rest of this paper is organised as follows. Section 2 presents the data. Section 3 describes the key historical trends in the derived measure of risk of forced-turnover, and in selected environmental/ESG indicators, develops our methodology and interprets the results. Section 4 offers some robustness tests. Section 5 draws the policy implications of our results and concludes

2 The data

We source data on firms' executives from ExecuComp, a database collecting executive-firm level data for more than 3,900 US firms in yearly frequency for the period 1992–2022. This data includes information on the name of a CEO, her/his age and any additional role covered at the company, the date when she/he took office, and the date when she/he was terminated. We use this information to derive CEO tenure and the dummy indicating if a CEO is also chairman of the board (i.e. CEO duality). We then match this data with data on CEOs forced turnovers from Peters and Wagner (2014) who collect around 1,400 episodes of CEO forced-turnover for US firms for the period 1993–2019.

Firms' balance sheet data – i.e. assets, Tobin's Q, and sales – come from Compustat North America dataset. The stock idiosyncratic return is calculated based on the methodology by Peters and Wagner (2014) – i.e. individual stock return minus equally weighted industry return in excess of the market – using data from the Center for Research in

Security Prices (CRSP) and following their same timing convention. Specifically, returns are computed over a period that covers the 12 months prior to the announcement date of a CEO forced turnover, or the current fiscal year's performance if the CEO was not fired. Insofar, such a timing convention avoids significant gaps between the CEO's departure date and the performance measurement period that would result instead by using lagged-year performance. Industries are defined according to Fama and French (1997) 48-industry classification.[2]

Data on one-year Expected Default Frequencies (EDF) comes from the Moody's CreditEdge database. EDF measures the probability that a firm will default over the following one-year period.[3]

Data on ESG- and environmental indices, as well as the dummy indicating the presence of ESG-pay clauses in executives' compensation, and the existence of ESG-related controversies are sourced from Refinitiv. *Refinitiv ESG indices* range between 0 and 100, with higher scores associated with a better performance in the specific activity. For our analysis, we divide the indices by 100 to simplify the interpretation of results.[4]

Data on Greenhouse gas (GHG) emissions come from S&P Trucost, a prominent source for data on firms' emissions and climate change risks (Bolton and Kacperczyk, 2021, 2023; Azar et al., 2021).

Finally, the measure of firm-level exposure to short-termism comes from NL Analytics. Specifically, this data provider leverages earnings call transcripts and proprietary machine learning algorithms to discover keywords related to a certain topic, and to build time-varying measures of firms' exposure to the topic.[5]

Our final sample is constrained by the availability of the firm-level ESG/environmental data. For this reason, our sample of analysis consists of 957 firms with at least six years of data, of which 221 had at least one forced CEO turnover episode, and 2,090 executives,

[2]For more details see Ken French's Data Library.
[3]For more details see Moody's EDF Overview.
[4]For more details on the indices see Environmental, social and governance scores from Refinitiv
[5]We we manually vet the keywords proposed by the machine learning algorithm to minimize the possibility of including false positives. See Table A3 for a list of the resulting keywords.

for the period 2002–2019. The average year includes about 683 firms, with a minimum of 338 firms in 2004. Overall, the number of firms increases steadily, consistently with a gradual rise in industry-awareness, and reassuringly, we do not observe any sudden jump in the number of reporting firms. Finally, we winsorise controls at the 0.25th and 99.75th percentiles.

Table 1 shows the descriptive statistics.

3 Methodology and empirical analysis

3.1 Estimating a measure of the probability of forced turnover

To estimate the probability of a CEO forced-turnover, we rely on the well established approach by Peters and Wagner (2014) who document that episodes of forced turnover are predicted by industry volatility and market-adjusted returns, firms' assets, Tobin's Q, stock idiosyncratic returns, and CEO characteristics like age, tenure and duality. Based on this methodology, we compute our measure of probability of a CEO turnover as the fitted values from a probit regression with the following specification

$$\Pr\left(\textit{Forced Turnover}_{i,t}^{c}\right) = \Phi\left(\beta_1 X_{i,t-1} + \beta_2 W_{i,t}^{c} + \gamma_t + \varepsilon_{i,t}\right) \tag{1}$$

where Forced Turnover$_{i,t}^{c}$ is an indicator variable taking value one if CEO c of firm i was unexpectedly terminated in year t, $X_{i,t-1}$ is a vector of firm characteristics, $W_{i,t}^{c}$ is a vector of characteristics of the CEO c of firm i, and γ_t corresponds to year fixed effects. One should note that our panel-dataset is two-dimensional. In other words, c is nested with i. Table 2 reports the results of this regression.

Column 1 of Table 2 uses the same set of variables as in column 1, table 3 from Peters and Wagner (2014). Our results are very similar to theirs. The coefficient for industry volatility (Industry Volatility$_{t-1}$) is positive and statistically significant at the five percent

TABLE 1: Descriptive statistics

	No observations	Mean	St dev	Min	Max
Forced Turnover (0/1 indicator)	11,610	0.02	0.15	...	...
Environmental Score	11,610	0.34	0.28	0.00	0.98
Emissions Score	11,610	0.35	0.33	0.00	1.00
Resource Use Score	11,610	0.37	0.34	0.00	1.00
Environmental Innovation Score	11,610	0.21	0.30	0.00	0.99
Scope 1 GHG Emissions to Sales, tCO2e/$\$mn$	11,047	296.99	1186.97	0.00	22,972.64
Scope 2 & 3 GHG Emissions to Sales, tCO2e/$\$mn$	11,047	489.63	3875.24	7.69	202,163.20
Total GHG Emissions to Sales, tCO2e/$\$mn$	11,047	786.62	4098.74.24	8.10	202,365.60
short-termism	10,337	0.003	0.002	0.00	0.03
$\widehat{\text{Forced Turnover}}$	11,610	0.02	0.03	0.00	0.43
Industry Volatility	11,610	0.07	0.02	0.03	0.14
Ind-Adj Volatility	11,609	0.02	0.04	−0.06	0.25
Idiosyncratic Return, Dec, t–1:Dec, t	11,610	0.15	0.40	−0.88	2.90
Mkt-adj Industry Return	11,610	0.01	0.17	−0.78	0.74
Assets, in $ bn	11,609	41.53	164.69	0.15	3,221.97
Tobin's Q	11,608	1.92	1.23	0.62	10.12
CEO Age > 60 (0/1 indicator)	11,610	0.26	0.44	...	...
CEO Tenure, years	11,610	7.78	6.84	0.00	52.00
CEO duality (0/1 indicator)	11,610	0.55	0.50	...	...
Governance, Management Score	11,610	0.56	0.28	0.00	1.00
Governance, Shareholder Score	11,610	0.53	0.28	0.00	1.00
One-Year EDF, last	11,610	0.01	0.03	0.00	0.37
ESG-Pay Clauses (0/1 indicator)	11,610	0.31	0.46	...	...

NOTE: The sample includes 952 firms with at least six years of data, of which 220 had at least one forced CEO turnover episode, and 2,085 executives, for the period 2002–2019.

level. In terms of economic effect, a one standard deviation increase (about 2%) in industry volatility is associated with an increase in the likelihood of a forced turnover of about 0.33 percentage point, which is a very similar magnitude compared to the about 0.20 percentage point found by Peters and Wagner (2014). The effects for idiosyncratic returns (Idiosyncratic Return) and market-adjusted returns (Market-Adjusted Industry Return) are negative and strongly statistically significant. These results are consistent with negative returns increasing the probability of a forced turnover in the subsequent year.

TABLE 2: Probability of a CEO forced-turnover

	Dependent Variable: Forced Turnover$^{c}_{i,t}$	
Explanatory variables	(1)	(2)
Industry Volatility$_{i,t-1}$	0.164**	0.171**
	(0.069)	(0.067)
Ind-Adj Volatility$_{i,t-1}$	0.113***	0.085**
	(0.037)	(0.036)
Idiosyncratic Return	−0.067***	−0.059***
	(0.010)	(0.009)
Mkt-adj Industry Return	−0.048***	−0.040***
	(0.011)	(0.010)
ln(Assets)$_{i,t-1}$	0.002*	0.003**
	(0.001)	(0.001)
Tobin's Q$_{i,t-1}$	−0.004**	−0.003**
	(0.002)	(0.002)
$\mathbb{1}$ [CEO Age $>$ 60]$^{c}_{i,t}$		−0.006
		(0.004)
CEO Tenure; in years$^{c}_{i,t}$		−0.000*
		(0.000)
$\mathbb{1}$ [CEO Duality]$^{c}_{i,t}$		−0.014***
		(0.003)
No.of firms	965	961
No.of CEOs	2,151	2,098
Observations	12,025	11,689
McKelvey and Zavoina's R^2	0.160	0.189

NOTE: Annual data from 2002 to 2019. The dependent variable is *Forced Turnover*$^{c}_{i,t}$, a 0/1-indicator that equals 1 if CEO c of firm i was unwillingly terminated during year t. The entries denote the marginal effects (evaluated at the mean) of the parameters associated with the specified explanatory variable (see the text for details). In case of a forced turnover in year t, returns are calculated on the 12-months before the termination date; otherwise, returns are calculate on the period from December of year $t-1$ to December of year t. Industry volatility is calculated from monthly returns over the previous 120 months. Industry-adjusted volatility is calculated as the difference between the firm's idiosyncratic volatility and industry volatility, where the former is calculated from monthly stock returns over the previous 48 months. All probit specifications include year fixed effects and are estimated by quasi-maximum likelihood. Asymptotic standard errors in parentheses are clustered by CEO: * $p < .10$; ** $p < .05$; and *** $p < .01$.

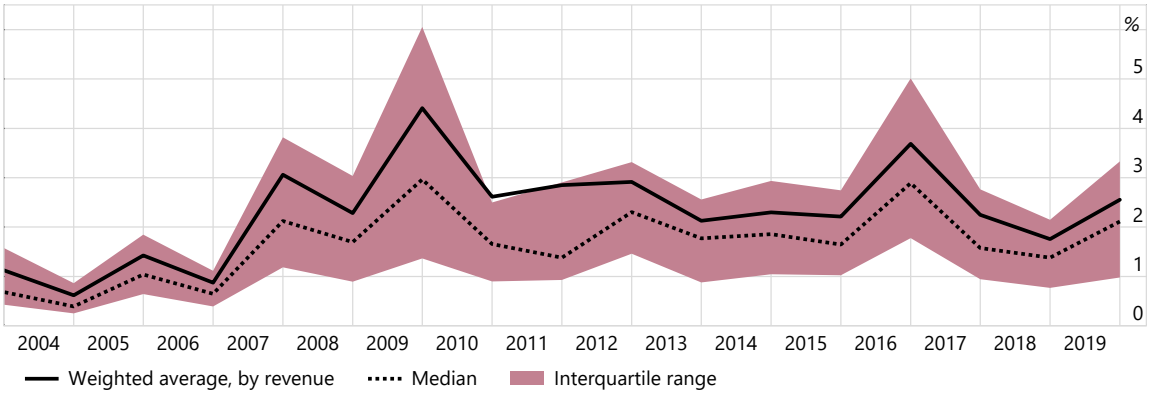
Column 2 adds CEO characteristics like age, tenure, and duality, which Peters and Wagner (2014) have identified to be relevant predictors of the risk of a forced turnover. The marginal effect for industry volatility remains positive and statistically significant, and it is somewhat bigger. An increase of one standard deviation in industry volatility is associated with a 0.34 percentage point increase in the probability of a forced

turnover over the subsequent year. Results for industry-adjusted volatility Industry-Adjusted Volatility) are similar, but sizeably smaller. Finally, CEO characteristics seem to play a minor role. Higher CEO power in terms of stronger entrenchment (i.e. Age $>$ 60, and Tenure) and firmer influence on the Board (i.e. Duality) are all associated with a lower probability of incurring a forced turnover. The marginal effects for the first two indicators, CEO Age $>$ 60 and CEO Tenure, are small and only marginally- or non statistically significant. Specifically, a CEO who is older than 60 is associated with a 0.6 percentage point lower probability of a forced turnover; a one standard deviation increase (almost 7 years) in the Tenure of the CEO is associated with a 0.27 percentage point lower probability of a forced turnover. The marginal effect for the latter, CEO Duality, is negative, and significant from both a statistical and an economic perspective. CEO Duality is associated with a 1.4 percentage point lower probability of a forced turnover which corresponds to more than 60% of the mean of the dependent variable (about 2%).

Overall, the specification in column 2 has a better measure of goodness of fit, and for this reason we estimate our fitted measure of the probability of a forced turnover based on this specification.

Figure 1 shows the distribution of our measure of probability of a CEO forced turnover over time. The probability ranges between 0.25% and 6%, suggesting the presence of cross-sectional variation, and interestingly, peaks around the Global Financial crisis (GFC).

FIGURE 1: **Probability of a CEO forced-turnover**

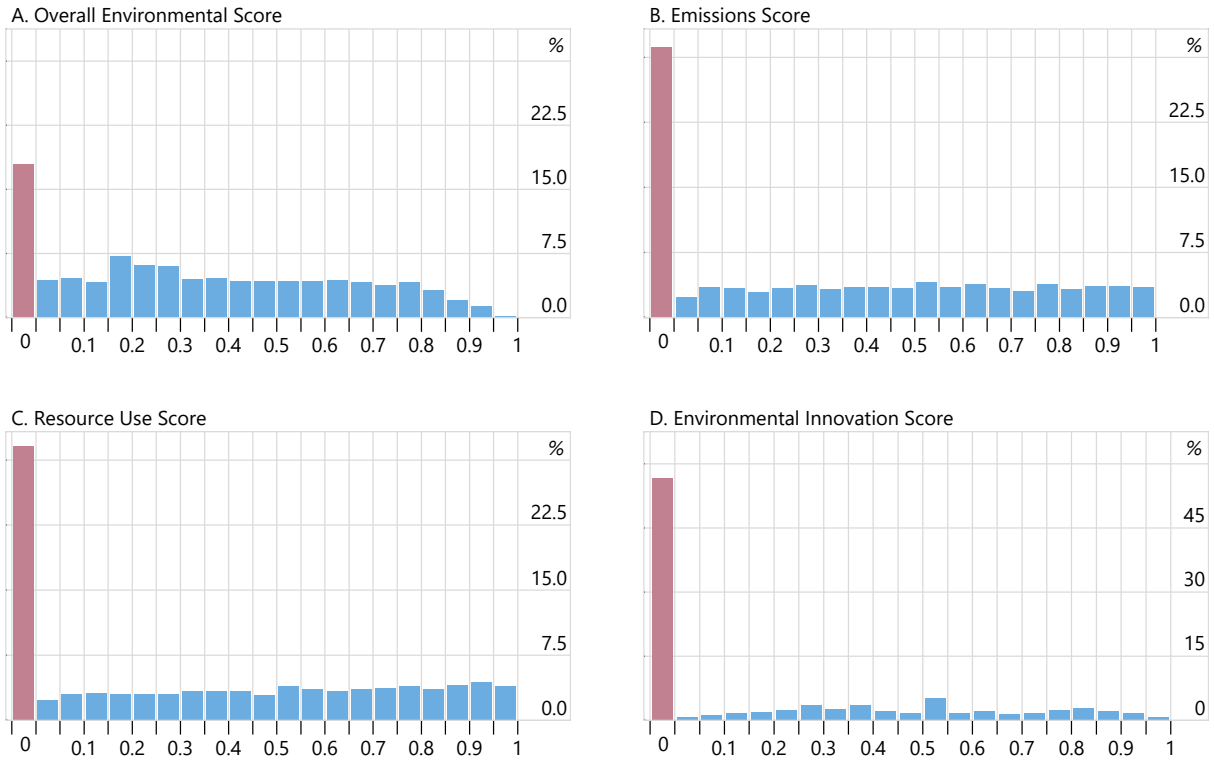


NOTE: The graph shows the average weighted by revenues, median, and 25th and 75th percentiles of the derived probability of a CEO forced-turnover.

3.2 The nexus between turnover risk and firm environmental performance

Following a growing literature (Liang and Renneboog, 2017; Albuquerque et al., 2019; Pedersen et al., 2021) we measure a firm environmental performance along several dimensions through the environmental scores. Figure 2 shows the distribution of these environmental indicators and reveals that the data is bunched heavily around the minimum. Specifically, 18%, 31%, 32%, and 57% of the observations for overall environmental score (panel A), emissions score (panel B), resource use score (panel C), and innovation score (panel D), respectively, are exactly at zero.

FIGURE 2: **Distribution of environmental indicators**



NOTE: The figure shows the distribution of the Refinitiv Overall Environmental-, Emissions-, Resource Use and Environmental Innovation Score. All measures are divided by 100 to range between 0-1. The red bars indicate the percentage of observations that take value zero.

To account for this distributional characteristics of the dependent variables, for our analysis we adopt fractional response regressions (Papke and Wooldridge (1996, 2008)). Thus, we estimate regressions with the following specification

$$\mathbb{E}\left(y_{i,t}|x_{i,t}\right) = \mathbf{G}\left(x_{i,t}\beta\right) \tag{2}$$

where $\mathbf{G}$ corresponds to $\Phi\left(\cdot\right)$ –the standard normal distribution.

Certain industries, or even specific firms, may be characterized by a higher probability of forced turnover. It is important to note that these characteristics may, on average, correlate with firms' environmental performance. Therefore, to control for such firm- or industry-level factors, we include either firm or industry fixed effects in our baseline regression specification. This approach allows us to capture the within-industry (or within-firm) variation between a firm's environmental performance and the risk of forced

turnover. One should note that, due to the incidental parameter problem (Papke and Wooldridge, 2008), we cannot estimate fractional response regressions when the model includes firm fixed effects. Therefore, in our baseline specification we control for industry and time fixed effects. Furthermore, given that $\widehat{Forced\ Turnover}^{c}_{i,t}$ is a *"generated regressor"*, we use a bootstrap procedure to estimate standard errors.[6]

We assume that a firm environmental strategy is determined by four forces: regulation, shareholders pressures, board decisions, and CEO power. We account for regulation through time fixed effects. We account for the shareholders pressure factor by controlling for the lagged score assigned to the shareholders dimension. This variable captures shareholders rights and takeover defenses. We account for the board decisions factor by controlling for the lagged score assigned to the management dimension.[7] This variable captures the organizational structure of management, e.g. independence, diversity and the presence of committees, and compensation. As for the CEO decisions factor, we control for the "level of influence" that the CEO can exercise on the board through CEO entrenchment (proxied with tenure) and a dummy that takes value one when the CEO is also the chairman of the board (i.e. CEO duality).

Table 3 reports the results in the form of marginal effects for our baseline specification. Looking at the key variable of interest –the probability of a forced turnover –we find a statistically significant negative effect suggesting that an increase in the probability of a forced CEO turnover is associated with a lower environmental performance. Specifically, an increase in the probability of a forced turnover of one standard deviation (about 3%) is associated with a drop of almost 1.1 percentage point in the overall environmental score (column 1) and of 1.5 percentage point in the environmental innovation score. These effects are not large from an economic perspective–but are also non-negligible –correspond-

[6]Our bootstrap procedure is based on 5,000 repetitions. We start by randomly drawing 5,000 combinations of GVKEYs –the firm-level identifier in our dataset –allowing for replacement. Then, in each repetition we estimate the pseudo-first-stage regression to derive the fitted measure of probability of a forced turnover, and each of the relevant subsequent regressions storing the resulting coefficients/marginal effects. We then calculate the 2.5th and 97.5th percentiles from the distribution of the boostrapped estimates obtained from the previous steps which we report as the 95% confidence interval.

[7]The management- and the shareholders scores together with the CSR strategy score are the three sub-components of the governance pillar score – i.e. the G in the overall ESG score.

TABLE 3: CEO forced turnover risk and firm ESG performance

	Dependent Variable: Environmental Score$_{i,t}$			
	Overall	Emissions	Resource Use	Innovation
Explanatory variables	(1)	(2)	(3)	(4)
Forced $\widehat{\text{Turnover}}^{c}_{i,t}$	−0.358	−0.348	−0.363	−0.475
	[−0.629, −0.085]	[−0.66, −0.028]	[−0.672, −0.05]	[−0.849, −0.124]
Idio. Return$_{i,t-1:t}$	−0.022	−0.019	−0.024	−0.020
	[−0.035, −0.006]	[−0.036, 0]	[−0.04, −0.004]	[−0.038, 0.003]
ln(Assets)$_{i,t-1}$	0.109	0.127	0.125	0.068
	[0.101, 0.118]	[0.117, 0.138]	[0.115, 0.135]	[0.058, 0.078]
Tobin's Q$_{i,t-1}$	0.017	0.021	0.020	0.009
	[0.008, 0.026]	[0.011, 0.03]	[0.01, 0.031]	[−0.002, 0.019]
$\mathbb{1}$ [CEO Age $>$ 60]$^{c}_{i,t}$	−0.010	−0.013	−0.014	−0.006
	[−0.028, 0.008]	[−0.034, 0.008]	[−0.035, 0.008]	[−0.024, 0.016]
CEO Tenure$^{c}_{i,t}$	−0.001	−0.001	−0.002	−0.001
	[−0.003, 0.001]	[−0.003, 0.001]	[−0.004, 0]	[−0.002, 0.001]
$\mathbb{1}$ [CEO Duality]$^{c}_{i,t}$	0.011	0.008	0.019	0.013
	[−0.01, 0.031]	[−0.017, 0.031]	[−0.006, 0.042]	[−0.01, 0.035]
Management Score$_{i,t-1}$	0.107	0.127	0.131	0.083
	[0.076, 0.135]	[0.092, 0.16]	[0.093, 0.163]	[0.049, 0.116]
Shareholders Score$_{i,t-1}$	0.070	0.079	0.077	0.026
	[0.04, 0.101]	[0.043, 0.118]	[0.039, 0.116]	[−0.009, 0.063]
One-Year EDF$_{i,t-1}$	−0.010	−0.069	0.069	−0.268
	[−0.335, 0.251]	[−0.420, 0.224]	[−0.300, 0.369]	[−0.721, 031]
Pseudo R^2	0.141	0.189	0.198	0.188

NOTE: Annual data from 2002 to 2019. No. of firms = 957; No. of CEOs = 2,090; Observations = 11,622. The dependent variables are the Refinitiv environmental score index and its sub-indices; higher scores corresponds to an improvement. The entries denote the marginal effects (evaluated at the mean) of the parameters associated with the specified explanatory variable (see the text for details). All specifications include industry- and year fixed effects. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

ing to about 3% and 7% of the mean of the respective dependent variable. Interestingly, the effect is larger for environmental innovation, suggesting that this dimension is more affected by increases in the risk of a CEO being unwillingly terminated. The marginal effects for returns are negative and statistically significant at the 5% level in most of the specifications. Assets and Tobin's Q are positively and significantly associated with firms' environmental performance across the different definitions of the outcome variable. CEO characteristics turn out to be broadly statistically insignificant. CEO age above 60 and tenure are negatively associated with each definition of environmental score. Conversely, duality is positively associated with firms' environmental performance. The marginal effects of the management- and shareholders scores –indicators of management structure (eg independence, diversity) and compensation, and of shareholders' rights and takeover defenses –are positive and statistically significant at the 5% level.[8] Finally, the one-year EDF is negatively associated with firms environmental scores, but the relationship is statistically insignificant at the 5% level. Interestingly, when comparing the absolute value of the size of the marginal effects we find that the ones corresponding to the likelihood of a forced turnover are the largest.[9]

In the baseline specification we interpret $\widehat{\text{Forced Turnover}}_{i,t}^{c}$ as $\mathbb{E}\left[Pr(\text{Forced Turnover})_t|\Omega_t\right]$, where Ω_t denotes the information set at time t. Intuitively, as the risk of a forced turnover materializes, CEOs may take immediate action as they might not have a chance to act at a later stage if such a risk becomes a realization. However, one may reasonably wonder if the increase in the probability of a forced turnover for the CEO could affect the environmental performance with some delay. Therefore, to address this concern, we re-run the analysis in Table 3 using as dependent variables the environmental performance indicators in years $t+1$ to $t+4$. The results from Table 4 show that the marginal effects of interest remain similar and consistent over the periods

[8]For more details on the Refinitiv Management- and Shareholders see Environmental, Social an Governance Scores from Refinitiv.

[9]We use Refinitiv ESG scores data as of February 2023. As pointed out by Berg et al. (2021), these data are subject to revisions, which are positively correlated with firms' stock market performance. To account for this feature, our baseline regression specification includes firms' idiosyncratic stock returns.

considered.[10] The magnitudes of the marginal effects remain stable over the different horizons with the exception of the Innovation Score for which it monotonically decreases, becoming statistically insignificant after three years. This suggests that the risk of a forced turnover has a persistent effect on firms' environmental performance.

TABLE 4: CEO forced turnover risk and firm ESG performance: dynamic evolution of the effect

	Year of the Dependent Variable			
	$t+1$	$t+2$	$t+3$	$t+4$
	(1)	(2)	(3)	(4)
A. Dep. Variable: Overall Environmental Score				
$\widehat{\text{Forced Turnover}}^{c}_{i,t}$	−0.368	−0.327	−0.268	−0.319
	[−0.653, −0.058]	[−0.627, −0.010]	[−0.576, 0.035]	[−0.657, 0.017]
Observations	10,649	9,709	8,777	7,854
Pseudo R^2	0.131	0.122	0.113	0.104
B. Dep. Variable: Emissions Score				
$\widehat{\text{Forced Turnover}}^{c}_{i,t}$	−0.309	−0.345	−0.314	−0.402
	[−0.643, 0.066]	[−0.701, 0.056]	[−0.692, 0.060]	[−0.833, 0.022]
Observations	10,649	9,709	8,777	7,854
Pseudo R^2	0.177	0.164	0.152	0.139
C. Dep. Variable: Resource Use Score				
$\widehat{\text{Forced Turnover}}^{c}_{i,t}$	−0.384	−0.409	−0.414	−0.587
	[−0.719, −0.036]	[−0.766, −0.042]	[−0.820, −0.021]	[−1.052, −0.144]
Observations	10,649	9,709	8,777	7,854
Pseudo R^2	0.184	0.171	0.160	0.148
D. Dep. Variable: Innovation Score				
$\widehat{\text{Forced Turnover}}^{c}_{i,t}$	−0.480	−0.395	−0.318	−0.129
	[−0.859, −0.097]	[−0.768, −0.017]	[−0.704, 0.064]	[−0.539, 0.266]
Observations	10,649	9,709	8,777	7,854
Pseudo R^2	0.176	0.164	0.154	0.142

NOTE: Annual data from 2002 to 2019. No. of firms = 957; No. of CEOs = 2,090. The dependent variables are the Refinitiv environmental score index and its sub-indices at different leads (i.e. from $t+1$ to $t+4$); higher scores corresponds to an improvement. The entries denote the marginal effects (evaluated at the mean) of the parameters associated with the specified explanatory variable (see the text for details). All specifications include industry- and year fixed effects, and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

[10] The marginal effects of $\widehat{\text{Forced Turnover}}^{c}_{i,t}$ evaluated at the mean on the Emissions Score at horizons $t+2$ and $t+4$ are statistically significant at the 10% level. The 90% bootstrapped confidence intervals based on 5,000 replications are $[-0.628, -0.011]$ and $[-0.733, -0.045]$, respectively.

An important concern with our results is that these may be driven by unobservable time-invariant factors that vary at the firm-level. Due to the incidental parameter problem, we cannot include firm fixed effects in our baseline fractional response regressions. Therefore, to address this concern, we run a panel OLS regression model controlling for firm and time fixed effects, instead of the industry and time fixed effects included in the baseline specification. Results from Table 5 are consistent and similar to the ones reported in Table 3. For example, a one standard deviation increase in the probability of a forced turnover is associated with a 1 percentage point drop in the firm overall environmental performance. As a measure of the goodness of fit we estimate the percentage of observations for the fitted values that lie outside the support of the dependent variables —i.e. below zero or above one. For the specification from Table 5, these figures drop to zero for both the share of observations below zero and above one. Overall, this evidence confirms the robustness of our findings.

TABLE 5: CEO forced turnover risk and firm ESG performance: linear model and firm fixed effects

	Dependent Variable: Environmental Score			
	Overall	Emissions	Resource Use	Innovation
Explanatory variables	(1)	(2)	(3)	(4)
Forced $\widehat{\text{Turnover}}^{c}_{i,t}$	−0.214	−0.206	−0.190	−0.319
	[−0.384, −0.047]	[−0.405, −0.016]	[−0.389, 0.011]	[−0.556, −0.112]
Within R^2	0.032	0.031	0.027	0.007

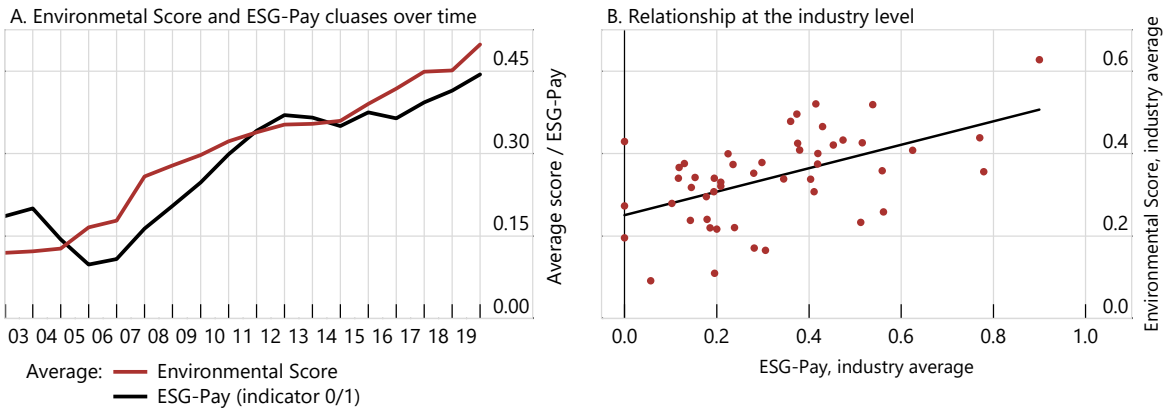
NOTE: Annual data from 2002 to 2019. No. of firms = 952; No. of CEOs = 2,085; Observations = 11,617. The dependent variables are the Refinitiv environmental score index and its sub-indices; higher scores corresponds to an improvement. The entries denote the panel-OLS coefficients of the parameters associated with the specified explanatory variable (see the text for details). All specifications include firm- and year fixed effects and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

3.3 The impact of ESG-Pay clauses

Over time, the compensation packages of a growing share of executives started to include clauses, often dubbed ESG-Pay clauses, related to ESG targets. For example, such clauses could make the payment of bonuses conditional on the achievement, or the non-breech,

of specific environmental objectives. Figure 3 depicts a positive association between the overall company environmental performance and the adoption of ESG-Pay clauses, unconditionally. Panel A shows that since 2006, firm environmental performance and adoption of ESG-Pay clauses have grown in tandem. Consistently, panel B shows the existence of a positive relationship between these two measures at the industry level.

FIGURE 3: **Environmental performance and ESG-Pay clauses**



NOTE: The left-hand panel shows the temporal evolution of the average environmental score and the average number of firms including ESG-Pay clauses in their executives' compensation packages. The right-hand panel is a scatter plot of industry-level averages of the variables indicated on the axes.

Based on this evidence, it would be reasonable to expect that ESG-Pay clauses play a significant role in curbing the effect of a higher probability of a CEO-forced turnover on firms' environmental performance. In other words, ESG-Pay clauses may make CEOs unwilling to cut on their environmental commitments due to the personal compensation losses —e.g. missed bonus payments —they would incur when falling short on the relevant environmental objectives. To test this hypothesis, we augment the baseline specification including $\text{ESG-Pay}_{i,t}$, an indicator variable that takes value one when firm i adopts ESG-Pay clauses in year t and zero elsewhere, and its interaction with variable $\widehat{\text{Forced Turnover}}^{c}_{i,t}$.

Results from Table 6 show that the marginal effects of ESG-Pay clauses (evaluated at the mean) are positive and statistically significant at the 5% level for the Overall Environmental, Emissions and Resource Use Score, suggesting that these clauses indeed contribute to improve firms' environmental performance. Notwithstanding, such effect is

relatively small in terms of magnitude. Conversely, the marginal effect for the Innovation Score is statistically insignificant, indicating that ESG-Pay clauses don't have an effect on the more long-term oriented R&D activities.

Interestingly, the marginal effects of Forced $\widehat{\text{Turnover}}_{i,t}^{c}$ indicate that when the risk of a forced turnover increases, ESG-Pay clauses don't seem capable of preventing CEO's short-terministic behaviours. Specifically, the size of the negative effect of the risk of a forced turnover on the Overall Environmental, Emissions and Resource Use Score for firms that don't adopt ESG-Pay clauses is very similar to the one for firms that conversely do (ESG-Pay$_{i,t} = 0$ vs ESG-Pay$_{i,t} = 1$).[11] For example, a one standard deviation increase in the estimated probability of a forced turnover is associated with a 1.1 percentage point decrease in the firm Overall Environmental Score for the former and a 1.2 percentage point decrease for the latter. Interestingly, the size of the negative effects on the Innovation Score is twice as large for firms that adopt ESG-Pay clauses relative to the ones that don't. While the effect is statistically significant at the 5% level for the former, it is statistically insignificant for the latter; nonetheless, both effects are statistically significant at the 10% level.[12] This result may seem surprising at first, however, it may consistently reflect two features about ESG-Pay clauses: first, compensation contracts more often include targets specified on governance and social metrics relative to the environmental ones; second, clauses on the environmental dimension typically target GHG emissions or wastewater, thus neglecting investment in environmental R&D and innovation (see Cohen et al. (2023)). Overall, this result suggests that ESG-Pay clauses don't seem to have a grip on the crucial and long-term oriented R&D activities and, in other words, are not effective where they are greatly needed.

[11] The marginal effects of Forced $\widehat{\text{Turnover}}_{i,t}^{c}$ evaluated at ESG-Pay$_{i,t} \in \{0, 1\}$ on the Emissions Score are statistically significant at the 10% level. The 90% bootstrapped confidence intervals based on 5,000 replications are $[-0.702, -0.032]$ and $[-0.714, -0.030]$, respectively. The same holds for the marginal effect of Forced $\widehat{\text{Turnover}}_{i,t}^{c}$ evaluated at ESG-Pay$_{i,t} = 0$ on the Resource Use Score; the 90% bootstrapped confidence interval is $[-0.689, -0.025]$.

[12] The 90% bootstrapped confidence interval based on 5,000 replications for the marginal effect of Forced $\widehat{\text{Turnover}}_{i,t}^{c}$ evaluated at ESG-Pay$_{i,t} = 0$ is $[-0.682, -0.039]$.

TABLE 6: CEO forced turnover risk and ESG-pay clauses

	Dependent Variable: Environmental Score$_{i,t}$			
	Overall	Emissions	Resource Use	Innovation
Explanatory variables	(1)	(2)	(3)	(4)
ESG-Pay$_{i,t}$	0.041	0.047	0.040	0.019
	[0.020, 0.062]	[0.023, 0.070]	[0.014, 0.065]	[−0.003, 0.043]
$\widehat{\text{Forced Turnover}}_{i,t}^{c}$				
ESG-Pay$_{i,t} = 0$	−0.371	−0.371	−0.366	−0.347
	[−0.727, −0.024]	[−0.790, 0.030]	[−0.782, 0.034]	[−0.780, 0.002]
ESG-Pay$_{i,t} = 1$	−0.395	−0.381	−0.417	−0.728
	[−0.741, −0.054]	[−0.790, 0.034]	[−0.799, −0.010]	[−1.212, −0.193]
Pseudo R^2	0.142	0.191	0.199	0.188

NOTE: Annual data from 2002 to 2019. No. of firms = 957; No. of CEOs = 2,090; Observations = 11,615. The dependent variables are the Refinitiv environmental score index and its sub-indices; higher scores corresponds to an improvement. The entries denote the marginal effects of ESG-Pay$_{i,t}$ (evaluated at the mean), and of $\widehat{\text{Forced Turnover}}_{i,t}^{c}$ (evaluated at ESG-Pay$_{i,t} \in \{0, 1\}$). All specifications include industry- and year fixed effects, and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

3.4 The impact of the Paris Agreement

In December 2015, at the United Nations Climate Change Conference (COP21), nearly 200 countries adopted an international treaty aimed at addressing global warming and climate change. This treaty, known as the Paris Agreement, established several key goals: first, to limit global temperature rise to below 2^oC; second, to improve countries' abilities to adapt to climate impacts through knowledge-sharing; third, to mobilize financial support for the energy transition in developing countries; and finally, to encourage countries to work toward achieving carbon neutrality by mid-century.

While the Paris Agreement didn't specify individual action plans for each country, it established a framework for collective action and accountability. It requires participating countries to submit Nationally Determined Contributions (NDCs), which outline specific actions to curb emissions, and it mandates a global stocktake every five years to assess collective progress toward the agreement's long-term goals.

It is reasonable to expect that the adoption of the Paris Agreement influenced how

the probability of CEO-forced turnover impacts firms' environmental performance. In other words, after the adoption of the Agreement, shareholders and investors may have heightened their awareness and scrutiny of firm's environmental performance, thereby reducing the room for manouvre in environmental practices for CEOs facing a higher probability of turnover. To test this hypothesis, we augment the baseline specification including Post-PA$_t$, an indicator variable that takes value one after 2015 (i.e. when the Paris Agreement was adopted) and zero elsewhere, and its interaction with variable $\widehat{\text{Forced Turnover}}^{c}_{i,t}$.

Table 7 reports the marginal effects of the probability of forced turnover evaluated before and after the adoption of the Paris Agreement. Interestingly, the results suggest that the effect of turnover risk on overall environmental performance, emissions, and resource use remains unaltered by the adoption of the Paris Agreement. Conversely, the marginal effect on environmental innovation doubles (column 4). While this result may initially seem surprising, it likely reflects the Paris Agreement's primary focus on reducing GHG emissions and the lack of a quantifiable target for R&D initiatives. In other words, CEOs facing a higher risk of termination may have had an incentive to deprioritize long-term R&D activities in favor of boosting short-term profitability.

TABLE 7: CEO forced turnover risk and the Paris Agreement

	Dependent Variable: Environmental Score			
	Overall	Emissions	Resource Use	Innovation
Explanatory variables	(1)	(2)	(3)	(4)
$\widehat{\text{Forced Turnover}}^{c}_{i,t}$				
Post-PA$_{i,t}=0$	−0.324	−0.332	−0.373	−0.350
	[−0.623, −0.037]	[−0.685, 0.013]	[−0.738, −0.0150]	[−0.753, 0.012]
Post-PA$_{i,t}=1$	−0.411	−0.370	−0.348	−0.699
	[−0.758, −0.059]	[−0.768, 0.039]	[−0.724, 0.027]	[−1.183, −0.265]
Pseudo R^2	0.141	0.189	0.198	0.188

NOTE: Annual data from 2002 to 2019. No. of firms = 952; No. of CEOs = 2,085; Observations = 11,622. The dependent variables are the Refinitiv environmental score index and its sub-indices; higher scores corresponds to an improvement. The entries denote the marginal effects of $\widehat{\text{Forced Turnover}}^{c}_{i,t}$ evaluated at Post-PA$_{i,t} \in \{0,1\}$). Post-PA is an indicator variable that takes value one from 2015, the year of the adoption of the Paris Agreement. All specifications include industry- and time fixed effects and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

3.5 The effect of turnover risk on firm GHG emissions

In the previous step of our analysis, consistently with the literature (Liang and Renneboog, 2017; Albuquerque et al., 2019; Cao et al., 2019; Ding et al., 2021; Pedersen et al., 2021), we have measured firms' environmental performance through indices. One could reasonably wonder if the patterns identified hold when repeating the analysis using data on emissions. Table 8 columns 1 and 2 show the results of a panel-OLS regression with firm- and year fixed effects and confirm that our results hold when using greenhouse gas (GHG) emissions to sales as dependent variable.[13] [14] Specifically, scope 1 emissions —those directly controlled by a firm (see Table A2) —don't seem to be affected by an increase in the probability of a forced turnover (column 1). On the other hand, scope 2 and 3 emissions —those only indirectly controlled by the firm such as emissions along the value chain (Table A2) —and overall GHG emissions show a positive relationship with the probability of a forced turnover (columns 2 and 3). A one standard deviation increase in the probability of a forced turnover is associated with an increase in the Scope 2 & 3 GHG emission to sales ratio of 4 percentage point and to an increase in the total GHG emissions to sales ratio of about 3 percentage point, respectively. These results together with the result for the overall environmental score (i.e. Table 6, column 1) suggest a tendency towards "outsourcing" emissions or "carbon leaking"[15], consistent with the objective of reducing costs (Bartram et al., 2022; Ben-David et al., 2021; Benincasa et al., 2021, 2024). These results confirm the presence of a negative effect of turnover risk on the environmental performance of the firm.

[13] As the distribution of the dependent variable is not polarized around the minimum and/or the maximum value, we can use a panel-OLS regression specification instead of the fractional response regression specification.

[14] For a discussion on the relevance of scaling emissions data see Aswani et al. (2024).

[15] Carbon leakeage is a practice in which firms operating in a jurisdictions subject to emission regulation move production in less regulated countries. For more details see eg What Is Carbon Leakage?

TABLE 8: CEO forced turnover risk and GHG emissions

	Dependent Variable: ln(GHG Emissions to Sales$_{i,t}$)		
	Scope 1	Scope 2 & 3	Total
Explanatory variables	(1)	(2)	(3)
Forced $\widehat{\text{Turnover}}^{c}_{i,t}$	0.052	1.333	0.958
	[−0.791, 1.244]	[0.277, 2.822]	[0.092, 2.195]
Within R^2	0.013	0.011	0.010
No. of firms	923	923	923
No. of CEOs	2,009	2,011	2,011
Observations	11,043	11,052	11,052

NOTE: Annual data from 2002 to 2019. The dependent variables are the natural logarithm of the ratio of GHG scope 1 emissions to sales (in tCO2e/$\$mn$) (column 1), the natural logarithm of the ratio of GHG scope 2 and 3 emissions to sales (in tCO2e/$\$mn$) (column 2), and the natural logarithm of the ratio of total GHG to sales (in tCO2e/$\$mn$) (column 3). The entries denote panel-OLS coefficients estimates. All specifications include firm- and year fixed effects and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

3.6 The role of short-termism

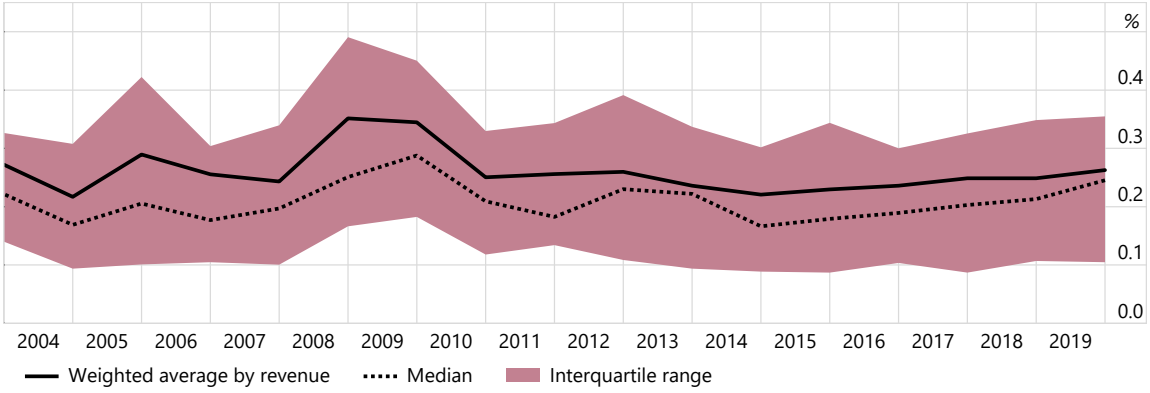
In the last step of our analysis, we explore a plausible channel to explain how the probability of a forced turnover for the CEO could impact a firm environmental performance. Specifically, the channel that we put forward is "short-termism". In other words, once facing a higher probability of being forced out, a CEO shifts the focus toward short-term activities that could achieve an immediate positive performance and away from long-term activities that would reap the benefits only after several years. If short-termism is the channel at play, it is reasonable to expect that such a shift away from long-term activities (e.g. environmental objectives) leads to a decrease in the overall environmental and the environmental innovation performance. Therefore, in the remainder of the analysis we will focus on these two dimensions of a firm environmental performance.

To test our proposed channel we construct a time-varying, firm-level measure of exposure to short-termism from NL Analytics following the methodology from Hassan et al. (2019, 2024). The aim of such a measure is to capture how much management focuses the conversation and catalyses the attention on the *short-term* —and consequently distracts it from the *long-term* perspective, a dimension more closely associated with environ-

mental R&D, and innovation. Specifically, the measure of exposure to short-termism is based on the share of sentences including references to the short-term in the transcripts of companies' earnings calls.[16] Notably, in our setting, having a measure of firms' exposure to short-termism that is based on the transcripts of earning calls is particularly good since the content of these documents is heavily influenced by management decision power. Contrarily, the same cannot be said for forms such as the 10-K or the 10-Q which are subject to precise regulatory reporting requirements.

Figure 4 shows the temporal development and the distributional characteristics of short-termism within our sample of analysis. Overall, the figure shows that there is a significant amount of cross-sectional variation in our derived measure.

FIGURE 4: **Exposure to short-termism**



NOTE: The graph shows the average weighted by revenues, median, and 25th and 75th percentiles of the exposure to short-termism. Exposure is defined according to Hassan et al. (2019, 2024) as the number of sentences containing at least one of the search phrases, divided by the document's total number of sentences.

To assess whether short-termism accounts, at least to some extent, for our findings, we follow Acharya et al. (2016) approach to test how much of our baseline findings can be explained by this mechanism. First, we include an indicator for the mechanism (i.e. the "mediator", here short-termism as measured by our indicator) as a covariate in the baseline specification, along with the probability of forced turnover ("the treatment of interest"). This analysis is shown in Table 9, columns 1 and 3. The coefficients on turnover risk remain similar in magnitude to those from Table 5. At first glance, these

[16] To construct our measure we include both Management presentation and Q&A. See Table A3 for further details.

results suggest that the direct effect does not operate through short-termism. However, these estimates could suffer from post-treatment bias (Rosenbaum, 1984). After all, in the event of a forced turnover a firm environmental performance could be directly influenced by the new CEO, who may be more attentive to environmental issues relative to his/her predecessor. Furthermore, including short-termism as a mediator in a mediation approach would violate the key assumption of no intermediate confounders (Imai et al., 2011; Acharya et al., 2016). We address these twin concerns by using the sequential g-estimator method (Vansteelandt, 2009; Acharya et al., 2016). This method allows to calculate the controlled direct effect of turnover risk, which is the effect of the probability of forced turnover on our outcomes if we were to fix the exposure to short-termism at a particular level. To implement the sequential g-estimator, we first split our set of covariates into pre- and post-treatment (or intermediate confounders). The former set of covariates includes variables that are unlikely affected by the treatment, such as the one period lag of firm assets, Tobin's Q, one-year EDF and management- and shareholders scores. The latter set of covariates includes variables that are likely impacted by a forced turnover such as CEO characteristics and the firm idiosyncratic performance over the 12 calendar months. Second, we estimate the effect of short-termism on firm environmental performance, controlling for all of our covariates and including the additional intermediate covariates. We then adjust each of the outcome variables by subtracting the effect of short-termism to create counterfactual estimates. Finally, we estimate the effect of the turnover risk on this transformed variable, which gives us the controlled direct effect of the probability of forced turnover on our measures of firm environmental performance.

Columns 2 and 4 in Table 9 report the results. Relative to the baseline estimates of Table 5 and the potentially biased estimates in columns 1 and 3, these estimates consistently show that short-termism has a significant impact on the effect of turnover risk on both the outcome variables. The direct effects of turnover risk are sizeably smaller relative to those in Table 5 and in columns 1 and 3 of Table 9. Specifically, the size of the coefficient of the probability of forced turnover on the overall environmental- and the environmental innovation score (columns 2 and 4 in Table 9) drop by about 90%

and 40% respectively. In addition, the coefficient in column 2 becomes not statistically significant at the 5% level, highlighting even more strongly the relevance of short-termism in driving the effect of turnover risk on firm overall environmental performance. Thus, our results suggest that the deterioration in firm overall environmental- and environmental innovation performance is at least partly driven by short-termism.

TABLE 9: The role of short-terminism

	Dependent Variable: Environmental Score			
	Overall	Overall, adj	Innovation	Innovation, adj
Explanatory variables	(1)	(2)	(3)	(4)
Forced $\widehat{\text{Turnover}}^{c}_{i,t}$	−0.226	−0.025	−0.328	−0.185
	[−0.398, −0.047]	[−0.144, 0.099]	[−0.570, −0.091]	[−0.352, −0.027]
Short-terminism$_{i,t}$	0.257		−0.372	
	[−1.636, 2.175]		[−2.717, 1.966]	
Model	OLS	Seq. g-est	OLS	Seq. g-est
Full set of controls	✓		✓	
Pre-treatment controls		✓		✓
Within R^2	0.035	0.032	0.007	0.004

NOTE: Annual data from 2002 to 2019. No. of firms = 952; No. of CEOs = 2,085; Observations = 11,617. The dependent variables in columns 1 and 3 are the Refinitiv environmental score index and the Refinitiv Environmental innovation score index; higher scores corresponds to an improvement. The dependent variables in columns 2 and 4 are the Refinitiv environmental score index and the Refinitiv Environmental innovation score index adjusted according to the sequential g-estimator approach. The entries denote the panel-OLS coefficients of the parameters associated with the specified explanatory variable (see the text for details). Specifications include firm- and year fixed effects. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

4 Sensitivity analysis

As a first robustness test we check if our finding on the persistence of the effect of an increase in the probability of a forced turnover on firms' environmental performance (Table 4) holds in the alternative linear model specification with firm and time fixed effects, instead of the industry and time fixed effects included in the baseline specification. Therefore, to perform this test, we re-run the analysis in Table 5 using as dependent variables the environmental performance indicators in years $t+1$ to $t+4$. The results from Table 10 are consistent and similar to the ones reported in Table 4. Interestingly, the marginal effects for the Overall Environmental and the Innovation Score become

statistically insignificant one period earlier relative to the specification in Table 4, i.e. at $t+2$ instead of $t+3$.

TABLE 10: CEO forced turnover risk and firm ESG performance: dynamic evolution of the effect; linear model and firm fixed effects

	Year of the Dependent Variable			
	$t+1$	$t+2$	$t+3$	$t+4$
	(1)	(2)	(3)	(4)
A. Dep. Variable: Overall Environmental Score				
Forced $\widehat{\text{Turnover}}^c_{i,t}$	−0.207	−0.171	−0.173	−0.194
	[−0.386, −0.031]	[−0.364, 0.019]	[−0.382, 0.0220]	[−0.418, 0.009]
Observations	10,647	9,703	8,767	7,800
Within R^2	0.031	0.029	0.028	0.024
B. Dep. Variable: Emissions Score				
Forced $\widehat{\text{Turnover}}^c_{i,t}$	−0.144	−0.178	−0.195	−0.234
	[−0.351, 0.070]	[−0.398, 0.057]	[−0.437, 0.040]	[−0.489, 0.003]
Observations	10,647	9,703	8,767	7,800
Within R^2	0.030	0.027	0.023	0.018
C. Dep. Variable: Resource Use Score				
Forced $\widehat{\text{Turnover}}^c_{i,t}$	−0.145	−0.189	−0.250	−0.363
	[−0.358, 0.051]	[−0.405, 0.014]	[−0.495, −0.020]	[−0.641, −0.114]
Observations	10,647	9,703	8,767	7,800
Within R^2	0.028	0.029	0.030	0.029
D. Dep. Variable: Innovation Score				
Forced $\widehat{\text{Turnover}}^c_{i,t}$	−0.305	−0.207	−0.143	0.030
	[−0.554, −0.081]	[−0.425, 0.009]	[−0.364, 0.079]	[−0.214, 0.275]
Observations	10,647	9,703	8,767	7,800
Within R^2	0.005	0.004	0.003	0.004

NOTE: Annual data from 2002 to 2019. No. of firms = 952; No. of CEOs = 2,085. The dependent variables are the Refinitiv environmental score index and its sub-indices at different leads (i.e. from $t+1$ to $t+4$); higher scores corresponds to an improvement. The entries denote the panel-OLS coefficients of the parameters associated with the specified explanatory variable (see the text for details). All specifications include firm- and year fixed effects, and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

Finally, as a second robustness test we check if our findings on the impact of the adoption of the Paris Agreement hold in the alternative linear model specification. The results from Table 11 are consistent with the findings from Table 7. The non statistically

significant coefficient for the interaction term Forced $\widehat{\text{Turnover}}^{c}_{i,t} \times$ Post-PA supports the lack of differential effects of turnover risk on overall environmental performance, emissions and resource use. In contrast, the negative and statistically significant coefficient for the interaction term on environmental innovation suggests that the detrimental effect of turnover risk has become more pronounced.

TABLE 11: CEO forced turnover risk and the Paris Agreement

	Dependent Variable: Environmental Score			
	Overall	Emissions	Resource Use	Innovation
Explanatory variables	(1)	(2)	(3)	(4)
Forced $\widehat{\text{Turnover}}^{c}_{i,t}$	−0.185	−0.197	−0.150	−0.215
	[−0.366, −0.003]	[−0.413, 0.018]	[−0.373, 0.076]	[−0.475, 0.0118]
Forced $\widehat{\text{Turnover}}^{c}_{i,t} \times$ Post-PA	−0.078	−0.022	−0.105	−0.276
	[−0.343, 0.157]	[−0.333, 0.251]	[−0.439, 0.204]	[−0.553, −0.020]
Total effect$^{c}_{i,t}$	−0.263	−0.219	−0.255	−0.491
	[−0.524, −0.034]	[−0.507, 0.053]	[−0.556, 0.032]	[−0.785, −0.232]
Within R^2	0.032	0.031	0.027	0.007

NOTE: Annual data from 2002 to 2019. No. of firms = 952; No. of CEOs = 2,085; Observations = 11,617. The dependent variables are the Refinitiv environmental score index and its sub-indices; higher scores corresponds to an improvement. The entries denote the panel-OLS coefficients of the parameters associated with the specified explanatory variable (see the text for details). Post-PA is an indicator variable that takes value one from 2015, the year of the adoption of the Paris Agreement. All specifications include firm- and year fixed effects and the same set of controls from Table 3. 95% bootstrapped confidence intervals based on 5,000 replications are reported in squared brackets.

Overall, the evidence from these checks confirms the robustness of our findings.

5 Conclusions

Reigning in the increase in global average temperatures requires a significant effort and transformation in the society as a whole. Changes in individuals' preferences and consumption behaviours alone are unlikely to achieve such a high-priority objective. Technological progress will be crucial to secure a (more sustainable) future. In this context, firms' research and development activities will play a pivotal role in greening the economy. Therefore, companies are called to adjust their objectives when setting strategies, emphasising the importance of long-term benefits originating from environmental innovation

activities.

Our results document a specific channel through which such a high-priority commitment may be derailed. Specifically, we shed light on the effect of a higher risk of being unwillingly terminated for the CEO of a firm and the company environmental performance, focusing on the environmental innovation dimension in particular. Indeed, we find that a higher risk of being terminated is associated with a worse environmental performance across several indicators. We trace this effect to short-terministic behaviours. When facing a higher risk of losing their job, CEOs strategically reorient towards activities targeting a short-term return and away from endeavours with a long-term focus.

Our findings show that CEOs facing higher turnover risk forego crucial environmental innovation activities, thereby increasing the likelihood of missing the CO_2 emission reduction objectives. Therefore, these results are relevant from the perspective of a policy maker and call for further thinking on the desirability/need of internalizing the environmental dimension in the design of CEOs' compensation packages.

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Appendix A

TABLE A1: CEO forced turnover by industry

	No observations	Mean	No of episodes
Aero	103	0.029	3
Agric	18	0.000	0
Autos	193	0.016	3
Banks	525	0.023	12
Beer	51	0.000	0
BldMt	237	0.000	0
Books	72	0.014	1
Boxes	52	0.019	1
BusSv	934	0.025	23
Chems	251	0.008	2
Chips	589	0.032	19
Clths	102	0.029	3
Cnstr	151	0.007	1
Coal	43	0.000	0
Comps	296	0.054	16
Drugs	284	0.032	9
ElcEq	54	0.000	0
FabPr	37	0.000	0
Fin	928	0.024	22
Food	200	0.040	8
Fun	73	0.014	1
Gold	35	0.086	3
Guns	24	0.000	0
Hlth	135	0.015	2
Hshld	248	0.032	8
Insur	728	0.018	13
LabEq	191	0.000	0
Mach	375	0.019	7
Meals	191	0.031	6
MedEq	262	0.031	8
Mines	79	0.025	2
Oil	597	0.017	10
Other	114	0.000	0
Paper	170	0.006	1
PerSv	99	0.061	6
RlEst	89	0.000	0
Rtail	819	0.045	37
Rubbr	37	0.054	2
Ships	29	0.000	0
Smoke	42	0.024	1
Soda	78	0.013	1
Steel	96	0.021	2

	No Observations	Mean	No of Episodes
Telcm	297	0.030	9
Toys	34	0.059	2
Trans	282	0.021	6
Txtls	12	0.000	0
Util	625	0.011	7
Whlsl	270	0.015	4
Total	11,151	0.023	261

NOTE: The table shows the breakdown of the forced turnover episodes by industry. The industry classification corresponds to the one proposed by Fama and French. For more details see Ken French's Data Library.

TABLE A2: Emissions classification

Emissions	Description
Scope 1	Direct greenhouse gas (GHG) emissions caused by sources controlled or owned by a firm
Scope 2	Indirect greenhouse gas (GHG) emissions associated with acquisition of electricity, steam, heat or cooling. Emissions resulting from the firm's energy use
Scope 3	All indirect emissions (not included in scope 2) occurring in the firm's value chain

SOURCES: United States Environmental Protection Agency; Greenhouse gas protocol (2011).

TABLE A3: Keywords releated to short-termism

Keywords	
more short-term	short-term growth
near term	short-term impact
near-term earnings	short-term margin
near-term performance	short-term margins
near-term profitability	short-term numbers
near-term results	short-term performance
nearer term	short-term perspective
short run	short-term profit
short term	short-term profitability
short-term	short-term profits
short-term basis	short-term results
short-term decision	short-term returns
short-term decisions	shorter term
short-term earnings	very short-term
short-term gains	

NOTE: The table shows the list of keywords idenfied through the NL Analytics keyword tool. The tool is based on a proprietary machine learning algorithms that discovers keywords related to a user-defined topic. We have manually vetted each keyword to minimize false positives. For further details see Hassan et al. (2019, 2024). SOURCE: NL Analytics.

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