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High-tech firms: Dividend policy in a context of sustainability and technological change☆

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ABSTRACT

We examine whether the dividend policy of high-tech firms is explained by ESG performance in the triple ESG components (environmental, social, and governance). Using a panel of US-based firms in the technology sector from 2002 to 2021, we find that better ESG scores are linked with a higher likelihood of dividend payments, stability of the amount paid, and implied shareholder returns from the dividend yield. R&D intensity is a constraint of dividend policies, although ESG scores mitigate this adverse effect by helping increase the likelihood of dividend payments. Overall, our findings highlight the role of ESG scores in enabling high-tech firms to implement dividend policies that yield stable returns to investors.

1. Introduction

Technological firms ("high-tech firms") are subject to intense pressure and competition due to several factors. They are subject to more significant technological change (Jafari-Sadeghi et al., 2022), which leads to higher levels of investment that might induce technological change and innovation, including in Small and Medium Enterprises (SMEs) (Alzamora-Ruiz et al., 2021). Innovation is so relevant in high-tech firms that development models of open innovation are explicitly proposed for firms with these characteristics (Adamides and Karacapilidis, 2020). Substantial innovation in high-tech SMEs is a critical success factor in cross-border operations (Jafari-Sadeghi et al., 2022). Such a high level of investment is reflected in both higher research and development (R&D) intensity and the acquisition of technological innovation. These firms face intense competition from other firms and alternative technologies and innovations (Hausman and Johnston, 2014; Vecchiato, 2015; Flor et al., 2018). High-tech firms are becoming more and more regulated (Demirel and Kesidou, 2019), while investment levels (Alzamora-Ruiz et al., 2021) and capital requirements are on the rise (Gharbi et al., 2014; Savrul and Incekara, 2015). Such a competitive and operational environment requires significant levels of investment that have historically been associated with different payout ratios (Fama, 1974; Smirlock and Marshall, 1983; Pruitt and Gitman, 1991; DeAngelo & DeAngelo, 2006; Wang, 2010; Deng et al., 2013). The existing empirical evidence is more consensual towards a negative association between the dividend payout ratio and investment levels, although mixed evidence still exists (Wang, 2010).

Despite all these constraints and context, high-tech firms are also subject to shareholder pressure to pay dividends and have a regular dividend policy, by keeping the dividend payout ratio or the dividends per share constant (Lee and Lee, 2019). The dividend policy is the guideline that firms have in place on the issue of paying dividends, including whether to pay and how much, how frequently, and when they pay (Barros et al., 2021a). Dividend policy is highly relevant to firms' capital requirements, as it signals past and future shareholders' prospects of returning their capital (Barros et al., 2020; Ham et al., 2020). The dividend policy among high-tech firms follows a nonlinear flow, in contrast to other industries. High-tech firms often do not pay dividends and have negative earnings and low cash flows. Despite these features, these firms usually exhibit high market valuations supported by the generalised expectation that a firm's new investments and growth potential will lead to higher future growth rates and positive earnings (Iyer et al., 2020).

Similar to other industries, high-tech ones are increasingly subject to sustainability issues, mainly environmental and governance (Song et al., 2018; Moro-Visconti et al., 2020; Christensen et al., 2022; Zumente and Bistrova, 2021), and according to Ciasullo et al. (2020), the link between technology and sustainability is two-fold. Sustainable management

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practices and technology are also crucial tools in implementing sustainable communities, which contribute to creating a sustainable world. Nevertheless, even without particular sustainability concerns, innovation has long been associated with the development of countries (Porter, 2011; Hsu et al., 2014), such as Taiwan (Hu and Tseng, 2007) and China (Shahzad et al., 2022). The number of firms undertaking sustainable investments and building supply chains with other green and sustainable firms is increasing (Lee et al., 2009). Consequently, this type of investment has attracted the attention of investors (Khan et al., 2016; Unruh et al., 2016; Hartzmark and Sussman, 2019) and academics (Starks, 2021).

Corporate sustainability is a critical concept covering several dimensions: ethical, social, environmental, cultural, and economic fields (Lankoski, 2016). An increasing number of firms assume sustainability to be the vital standard of their management (Hunt et al., 2020; Park and Jang, 2021). Firm sustainability is mainly measured by environmental, social, and governance (ESG) scores (Giese et al., 2019; Widyawati, 2020). However, not all corporate sustainability dimensions are equally relevant to all firms. Research shows that high-tech firms are subject to more sustainability pressures regarding the environmental and governance pillars (Cui et al., 2019; Verdu et al., 2012). The environmental pressure relates to its tendency to consume large quantities of energy and rely on rare materials (Jabbour et al., 2013). Governance pressures include scrutiny regarding media attention, ethical issues concerning new technologies such as AI (Benkler, 2019), and how such firms balance the impact of social media on mental health and profitability (Berryman et al., 2018), among other issues reported in the literature. In summary, high-tech firms face specific challenges regarding the environmental and governance pillars due to the need for high quantities of scarce raw materials, eventual lack of transparency, and potential abuse of customer data.

This study aims to analyse whether sustainability and technological changes influence a high-tech firm's dividend policy. Furthermore, we aim to investigate whether more sustainable firms with a higher level of technological change and investments can still have a robust dividend policy, not only paying dividends regularly but also regarding the stability in the amount and if dividends are low or high. Therefore, this study contributes to a better understanding of the drivers and outcomes of technological change and entrepreneurship, as advocated by Majdouline et al. (2022).

To assess the dividend policy, we used data from Refinitiv Eikon, covering a large panel of high-tech firms in an extensive period from 2002 to 2021. We focus on several of its dimensions to explain each firm's dividend policy. First, to analyse whether the firm pays dividends, we use *Dividend* as a dependent variable, which is a dummy variable taking the value one if firm *i* pays dividends in year *t*. Second, to analyse the determinants of the stability of the dividend policy, our dependent variables are *dividend per share* (DPS), *regular payout ratio*, and *regular dividend yield*. Third, we analyse dividends paid to shareholders using three variables: DPS, *payout*, and *dividend yield*. DPS (EUR) is the cash dividend paid to the holders of each outstanding share. *Payout* (%) is the ratio of the DPS to the firm's earnings per share. *Dividend Yield* (%) is the ratio of dividends paid to the firm's stock price.

To analyse the impact of sustainability on the dividend policy of high-tech firms, we use the ESG score and each of its three pillars: environmental, social, and governance. Data were collected from the Refinitiv Eikon database in a firm-year sample that matched the dividend database. Several studies have examined technological change (e.g., Coccia, 2005; Funk and Owen-Smith, 2017), and its impact is measured using standard industry proxies, such as R&D Intensity and Goodwill. We also control for firm variables, such as size, industry, profitability, and leverage.

Our main findings are as follows. We find evidence of a positive relationship between ESG scores and firms' dividend policies. This fundamental result is robust to various alternative approaches. Disentangling the ESG score into its main pillars–environmental, social, and governance–we find that all share a similar understanding of the firm's dividend policy. We employ an analysis to capture the effects of the life cycle and sustainability level. Our findings reveal that the impact of R&D intensity is more prominent in lowering the likelihood of dividend payments as the firm grows, suggesting that firms' investment in R&D may yield sustainability benefits as long as practices are compliant with score guidelines. Better ESG scores smooth the role of R&D intensity in allowing firms to initiate dividend payment policies. We find no evidence that controversies in sustainability influence our main findings.

The remainder of this paper is organised as follows. Section 2 reviews the literature on dividend policy and firm sustainability, with an emphasis on high-tech firms. Section 3 describes the study's data and research design. Section 4 presents the empirical results. Section 5 presents the discussion and contributions, and Section 6 concludes the paper.

2. Literature review

The high-tech industry is one of the most relevant today, as it supports the advent of a brave new world (Moncada-Paternò-Castello et al., 2010), and its analysis is crucial for understanding the future of societies and informing policymakers (TFAMWG, 2004). Several studies analysing firms in high-tech industries have been conducted in the last decade. Such studies have addressed high-tech firms from many different perspectives, such as the volatility of their stock prices (Gharbi et al., 2014; Jiang et al., 2020); their stock market valuation (Lev and Sougiannis, 1996); their operational (Wang and Wu, 2012), technological (Chen et al., 2017) and financial (Lantz and Sahut, 2005) performance; the relationship between their innovative capacity and survival (Zhang et al., 2018); the cost of their capital (Cowling et al., 2018); their capital structure and governance model (Aaboen et al., 2006; Colombo et al., 2014); and the riskiness of these firms (Chan et al., 2001). In this study, we contribute to this discussion by focusing on the dividend policy of high-tech firms in the context of industry idiosyncrasies.

The first idiosyncrasy is the need for high investment levels to induce stronger innovation and innovation performance (Gharbi et al., 2014; Savrul and Incekara, 2015; Alzamora-Ruiz et al., 2021). Traditionally, firms, including high-tech ones, seek innovation either through internal R&D activities or by appropriating innovation developed externally (Huang et al., 2010).

The relationship between corporate investment and dividend policy is well documented in the literature (see, for example, Fama, 1974; Smirlock and Marshall, 1983; Pruitt and Gitman, 1991; DeAngelo & DeAngelo, 2006; Wang, 2010; Deng et al., 2013). However, the true nature of this relationship in high-tech firms may be more complex than initially thought. For example, Wang (2010) addressed the causal effect between corporate investment, financing and dividend decisions, and firm performance in Taiwanese and Chinese high-tech firms. Using path analysis, Wang found that changes in dividends lead to changes in investments in China, but not in Taiwan. In fact, no relationship between investments and dividends was found in Taiwan. Deng et al. (2013) added that the relationship between investments and dividends is moderated by cash flow uncertainty in China. Such a link, namely, in the context of high economic policy uncertainty, can arguably support the claim that the financial flexibility of enterprise savings can significantly improve enterprises' innovation ability (Hao et al., 2022). Flexibility helps high-tech firms deal better with cash flow uncertainty, reducing their risks of financing constraints. The payment of dividends reduces cash holdings and financial flexibility, eventually leading to a negative impact on innovation investment levels. In line with the previous discussion, most research suggests that high-tech firms not pay dividends, while some research suggests that this is not the case. Consequently, we raise the question of what drives high-tech firms to pay dividends.

The second industry specificity is related to information asymmetry and transparency (Eden and Jovanovic, 1994; Hall, 2002). Information asymmetry refers to different levels of information between managers

and shareholders (Ross, 1977), as the latter are engaged in the firm's daily activities and, therefore, are more knowledgeable of the firms than owners. Since these firms operate in a more competitive, unstable, and flexible context (Wu, 2007), several authors associate them with more significant information asymmetry and higher stock price volatility (Eden and Jovanovic, 1994; Attanasio, 1990). The asymmetry of information between management and shareholders/investors is a common feature of listed firms, since the former has direct, detailed, and daily contact with the firm (assets, productivity, etc.) and is responsible for preparing the information given to investors to evaluate performance (of firms and the management team itself) (Mallin, 2018; Shleifer and Vishny, 1997; Tricker, 2019). However, several authors (Aboody and Lev, 2000; Alam and Walton, 1995; Hall, 2002) point out that this asymmetry is even greater in firms with significant R&D activities, particularly in high-tech industries, because of the greater complexity of their innovations (Liu, 2006) and the need to maintain some secrecy to limit competition (Gu and Li, 2007). This more significant information asymmetry may highlight the dividend policy as a corporate governance instrument that limits it and has consequences in its cost of capital (Armstrong et al., 2011).

The ability of the dividend policy to reduce the information asymmetry issue and promote transparency has long been pointed out by dividend signalling theory (Ross, 1977). Actually, the payout policy is a credible vehicle to convey reliable information about the firm's health to the financial markets (Ham et al., 2020). Unexpected increases in dividend payouts are understood by the markets as signalling higher future cash flows, while unexpected decreases signal concerns about future cash flows.

The discussion on the transparency issue cannot be separated from the agency cost problem. The relationship between agency costs, liquidity, and dividends is well-documented in the literature (e.g., Smith and Pennathur, 2017; Hu et al., 2020). However, high-tech firms usually have high levels of cash holdings because of their vital need for cash to fund R&D activities and smooth R&D investment in times of crisis (Brown & Peterson, 2011; Levitas and Mcfadyen, 2009). However, high levels of liquidity may lead managers to make suboptimal decisions that benefit themselves while destroying value, leading to non-negligible agency costs (Jensen, 1986). As higher levels of dividends decrease available cash, dividend policy is an effective way to control agency costs (Smith and Pennathur, 2017; Hu et al., 2020).

Therefore, the dividend payout policy is a valuable tool that induces managers to make better decisions, leads to better performance, and controls information asymmetry. Consistent with this line of argument, Lee and Lee (2019) reported that high-tech firms also suffer pressure from shareholders to pay regular dividends.

This quest for transparency is not the only reason for dividend payments. In recent decades, various explanations have been proposed in the literature. For example, Shefrin and Statman (1984) hypothesised that people with some aversion to regret would prefer to consume out of dividends rather than out of capital. Taxation (Ahmad et al., 2018; Barros et al., 2021b) and shareholders' desire to obtain a fast and significant return on their investment also helps explain such preferences. This is especially true for activist shareholders (Barros et al., 2021a). On the other hand, paying cash dividends also depends on firms' will and ability to pay them. Life-cycle theory suggests that larger firms in more mature phases tend to pay more dividends because they can free higher amounts of free cash, requiring lower retention levels (Fama and French, 2001; DeAngelo & DeAngelo, 2006; DeAngelo et al., 2006).

Third industry specificity concerns sustainability (Song et al., 2018; Moro-Visconti et al., 2020; Shahzad et al., 2022). Dividend policy, one of the fundamental decisions made by the board and shareholders (Barros et al., 2020, 2021a, 2021b), is closely related to sustainability. Sustainability is reportedly related to meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, page 24). This definition associates sustainability with balancing current and future earnings while considering all stakeholders (Reiser and Tucker, 2019). Following a holistic perspective, Bansal and Desjardine (2014, page 71) define business sustainability as "the ability of firms to respond to their short-term financial needs without compromising their (or others') ability to meet their future needs".

Considering the increasing attention on sustainability, fuelled by the growth of alternative ESG metrics, it is no surprise that Nirino et al. (2021) reported that sustainability has become increasingly relevant to stakeholders and firms over the last few years. Critical policies, such as investment, financing, and dividends, are incorporating more and more sustainability concerns. On the other hand, investors, including large investment funds (e.g. BlackRock), are diverting their interests towards more sustainable firms (Gillan et al., 2021; Khan et al., 2016; McKinsey, 2017). Remarkably, sustainable funds consistently achieve higher performance than traditional funds (Reiser and Tucker, 2019).

Since Elkington (1994), sustainability has been understood as a multidimensional variable within the environmental and social dimensions of sustainability. More recently, sustainability has evolved into the dimensions of ESG: environmental (E), social (S), and governance (G). The advent of these ESG criteria was followed by the development of a global sustainability rating (Porter et al., 2019), which has led to a more substantial scrutiny of firms' behaviour towards sustainability. Over the last two decades, global ESG scores and performance in each of these dimensions have become a growing concern for stakeholders. From an investor's perspective, this concern is justified as the literature reports that firms with higher ESG scores are achieving higher financial performance due to the decreasing impact of corporate controversies (Alshehhi et al., 2018; Ameer and Othman, 2012, Hussain et al., 2018; Nirino et al., 2021; Martínez-Ferrero and Frías-Aceituno, 2015). However, financial concerns are just one reason for the role of sustainability (Club of Rome, 2022). Amel-Zadeh and Serafeim (2018) reported the relevance of ESG scores in assessing investment performance and appraisal, clientele demand, fund strategy, and ethical considerations.

To measure corporate actions towards environmental, social, and economic/governance objectives, several agencies specialise in developing ESG scores (e.g. RobecoSAM Corporate Sustainability Assessment, Sustainalytics' ESG Risk Ratings, MSCI ESG Ratings, Bloomberg ESG Disclosure Scores, FTSE Russell's ESG Ratings, and Thomson Reuters ESG Scores). These ESG ratings are also widely used in academic research (e.g., Del Giudice and Rigamonti, 2020; Drempetic et al., 2019; Duque-Grisales and Aguilera-Caracuel, 2019; Rajesh, 2020), even if they present several limitations, such as the lack of reporting standards, which compromise comparability among different rating agencies (Amel-Zadeh and Serafeim, 2018; Berg et al., 2019).

3. Data and research design

3.1. Data

Data were collected from the Refinitiv Eikon database (formerly Thomson Reuters Eikon). The initial sample consisted of all publicly listed firms in the technology sector that have been active since 2000. We restricted the headquarters of these firms and the country of the stock exchange to the US, which yielded 1491 publicly listed US-based firms in the technology sector. The initial sample of 1491 active firms was narrowed down because critical data on dividends, R&D expenses, ESG metrics, and control variables were unavailable. The main restriction in data selection is on ESG metrics, which have only been available for most firms since 2005. This restriction on ESG data alone renders 4730 observations of 341 unique firms, which would otherwise make the analysis more comprehensive. The final sample comprised 2567 observations related to 385 unique publicly listed US-based technology sector firms from 2002 to 2021.

Table 1
Variables definitions.

Variable	Description
Dividend policy	
Dividend	Dummy: 1 if firms pay dividends in year t, and 0 otherwise
DPS regular	Dummy: 1 if the DPS in year t is the same as in year t-1, and 0 otherwise
Payout range 2 %	Dummy: 1 if the Payout in year t is in the 2 % range from year t-1, and 0 otherwise[b]
DY range 2 %	Dummy: 1 if the Dividend Yield – DY (DPS/stock price) in the 2 % range from the previous year, and 0 otherwise[b]
Payout <0 %	Dummy: 1 if the Payout in year t is <0 %, and 0 otherwise
Payout >100 %	Dummy: 1 if the Payout in year t is >0 %, and 0 otherwise
Sustainability	
ESG	ESG score from Refinitiv Eikon, which includes the 3 pillars
Environmental	Environmental score, composed of 68 metrics, from Refinitiv Eikon
Social	Social score, composed of 62 metrics, from Refinitiv Eikon
Governance	Governance score, composed of 56 metrics, from Refinitiv Eikon
Controversies score	Controversies score from 0 to 100 (absent), defining whether firms are involved in news controversies that materially impact corporations
Controversies (absent)	Dummy: 1 if the firm is not involved in controversies, and 0 otherwise
Industry-specific	
R&D intensity	R&D expense/Revenue[a]
Goodwill	Goodwill/Total Assets[a]
Controls	
N. Analysts	Number of sell-side Analysts listed as covering each firm
Market/Book	Market Value/Book Value of Equity[a]
Size	Log (Total Assets)
EBT margin	EBT/Revenue[a]
ROE	Net Income/Equity[a]
Leverage	Debt/Equity[a]
PP&E	Property, Plant & Equipment (PP&E)/Total Assets[a]
Book ETR	Income Tax Expense/EBT[a]
ΔMarket cap	Log (Maket Value$_t$ / Maket Value$_{t-1}$)

[a] Variables are winsorized at the 1.0 % level to control for outliers.
[b] A range of 2 % allows a deviation from −2 % to +2 % from the central point.

3.2. Dependent variable measures

Similar to recent literature on dividend policy (Barros et al., 2020, 2021a, 2021b), we employ measures that capture the decision to pay dividends and its stability. The variable *Dividend* is central as a dummy, taking the value of one for firms paying dividends and zero otherwise. The descriptive statistics in Table 2 indicate that about 29.2 % of firms in the sample pay dividends, and the average dividend yield for these firms is 2.1 %. The average payout is 11.5 % (38.5 % for dividend-paying firms), although there is relevant variability. The *Payout range* (2 %) aims to precisely look at stability, considering small deviations from a payout policy. Only 5.0 % of the observations lie in the proxy's four percentage point allowed deviations.

Proponents of the 'clientele effect' (Graham and Kumar, 2006) are less likely to find ground in the technology sector, as the dividend payment fluctuation is below average compared to non-technological firms. The dividend per share (*DPS*) *regular* is only 7.3 % (or 25.1 % for dividend-paying firms exclusively), which emphasises the growth nature of these firms. A classic example is Apple's dividend policy initiation in August 2012, with a quarterly $0.0946 DPS that has ever since risen to $0.22 in November 2021. Nevertheless, the dividend yield (DY) has decreased to about 0.6 % since the high of 2.4 % in September 2013, reflecting faster stock price growth. Only 25.6 % of the sample had a DY within a deviation of 2 %. These figures are explained by the volatility embedded in this sector. However, a narrow absolute range of 1 %, allowing a deviation of two percentage points, yields an average of 23.1 %, which is close to the broader approach. Data on the technology sector also indicate that firms steadily enhance dividend payments to follow stock price evolutions, although at a slower pace.

3.3. Methodology

The main objective of our analysis is to examine firms' choice of dividend policy exclusively for the technology sector, that is, to investigate whether firms pay dividends and its stability. Considering that our dependent variable *Y* is one of the binary variables described in the previous section, as in other studies on dividend policy (Barros et al., 2021b), we opted to use a logistic regression model. This approach has

Table 2
Summary statistics.

	N	Mean	Std. Dev.	1st Quartile	Median	3rd Quartile
Dividend policy						
Dividend	2567	0.292	0.455	0	0	1
DPS regular	2567	0.073	0.261	0	0	0
Payout range 2 %	2567	0.050	0.219	0	0	0
DY range 2 %	2567	0.256	0.437	0	0	1
Payout <0 %	2567	0.024	0.154	0	0	0
Payout >100 %	2567	0.026	0.158	0	0	0
Sustainability						
ESG	2567	40.258	19.247	24.963	37.145	53.564
Environmental	2567	24.498	27.772	0.000	12.835	44.747
Social	2567	43.704	21.080	28.363	41.558	58.047
Governance	2567	45.647	22.359	27.674	45.629	63.606
Controversies score	2567	89.163	25.096	100.00	100.00	100.00
Controversies (absent)	2567	0.205	0.404	0.000	0.000	0.000
Industry specific						
R&D intensity	2567	0.213	1.109	0.072	0.140	0.207
Goodwill	2567	0.191	0.171	0.040	0.150	0.306
Controls						
Analysts	2567	14.304	12.419	4.000	11.000	23.000
Market/Book	2567	5.265	15.359	2.084	3.541	6.695
Size	2567	21.551	1.816	20.395	21.539	22.595
EBT margin	2567	−0.180	4.850	−0.029	0.077	0.185
ROE	2567	0.054	1.329	−0.061	0.079	0.180
Leverage	2567	0.379	1.687	0.000	0.216	0.699
PP&E	2567	0.121	0.111	0.052	0.088	0.148
Book ETR	2567	0.100	0.612	−0.004	0.142	0.265
Δ Market cap	2567	0.141	0.506	−0.101	0.142	0.392

Table 3
Correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1) Dividend	1.00																				
(2) DPS regular	0.44*	1.00																			
(3) Payout range 2 %	0.36*	0.19*	1.00																		
(4) DY range 2 %	0.91*	0.42*	0.38*	1.00																	
(5) R&D intensity	−0.06*	−0.03	−0.02	−0.05*	1.00																
(6) Goodwill	0.08*	0.06*	0.12*	0.08*	−0.06*	1.00															
(7) ESG	0.41*	0.07*	0.13*	0.40*	−0.07*	0.16*	1.00														
(8) Environment	0.40*	0.04*	0.11*	0.38*	−0.06*	0.09*	0.83*	1.00													
(9) Social	0.32*	0.04*	0.11*	0.31*	−0.05*	0.14*	0.87*	0.73*	1.00												
(10) Governance	0.34*	0.10*	0.11*	0.33*	−0.08*	0.11*	0.76*	0.47*	0.42*	1.00											
(11) Controversies score	−0.17*	−0.01	−0.04*	−0.15*	0.03	0.03	−0.30*	−0.32*	−0.29*	−0.17*	1.00										
(12) Controversies (absent)	0.19*	0.01	0.06*	0.17*	−0.03	0.02	0.34*	0.36*	0.32*	0.19*	−0.85*	1.00									
(13) Analysts	0.19*	−0.07*	0.05*	0.17*	−0.05*	0.00	0.43*	0.46*	0.41*	0.23*	−0.42*	0.44*	1.00								
(14) Market/Book	−0.04*	−0.02	−0.01	−0.05*	0.04*	−0.06*	−0.02	−0.02	0.04*	−0.07*	0.00	0.00	0.09*	1.00							
(15) Size	0.42*	0.04*	0.17*	0.40*	−0.16*	0.19*	0.62*	0.64*	0.57*	0.38*	−0.47*	0.49*	0.68*	−0.01	1.00						
(16) EBT margin	0.05*	0.02	0.02	0.04*	−0.85*	0.05*	0.07*	0.06*	0.05*	0.06*	−0.03	0.03	0.06*	−0.04*	0.14*	1.00					
(17) ROE	0.05*	0.03	0.03	0.04*	−0.09*	0.02	0.04*	0.04*	0.03	0.03	−0.02	0.03	0.02	−0.20*	0.04*	0.08*	1.00				
(18) Leverage	0.06*	0.05*	0.02	0.04*	−0.01	0.09*	0.05*	0.07*	0.09*	−0.02	−0.04*	0.03	0.04*	0.65*	0.12*	0.01	−0.17*	1.00			
(19) PP&E	0.00	−0.03	−0.03*	0.01	−0.03	−0.35*	0.01	0.10*	−0.02	0.04*	−0.07*	0.05*	0.02	−0.06*	0.10*	0.03	0.01	−0.01	1.00		
(20) Book ETR	0.10*	0.04*	0.04*	0.09*	−0.02	0.04*	0.05*	0.05*	0.04*	0.04*	0.01	0.00	0.03	−0.01	0.06*	0.01	−0.01	0.03	−0.02	1.00	
(21) Δ Market cap	−0.08*	−0.04*	−0.03	−0.06*	0.00	−0.01	−0.04*	−0.07*	−0.01	−0.04*	0.06*	−0.06*	−0.02	0.15*	−0.09*	0.00	0.04*	−0.02	−0.07*	0.00	1.00

* Represents significance level at 10 %.

the advantage of predicting the probability of a particular level of the dependent variable, whereas a linear probability model predicts values at the mean of the dependent variable. We employ the following logit model:

$$Y_{it} = ESG_{it} + R\&D\ intensity_{it} + Controls_{it}\beta + \delta_t + \varepsilon_{it} \quad (1)$$

where the subscripts refer to firm *i* at time *t*. The coefficients are estimated based on unbiased standard errors under heteroscedasticity. δ_t is the year fixed effect specification. *R&D intensity* is our central industry-specific control computed as the allocation of revenue to R&D activities (Huang et al., 2010). In a robustness section, the relevance of Goodwill on firms' total assets is introduced to capture acquisitive R&D.

ESG is the global sustainability score computed by Refinitiv Eikon, although subsequent analyses examine its pillars individually namely, environmental, social, and governance.

Each pillar has a score ranging from 0 to 100, and together, creates the ESG score with the following weights: environmental (28.7 %), social (45.1 %), and governance (26.1 %). Furthermore, ESG controversies are added to set the combined ESG score. The ESG controversy score comprises 23 controversial topics (e.g. product quality, tax fraud, child labour, strikes) and mitigates the potential weakness of scores computed yearly by capturing controversies and adverse events reflected in global media on the ESG pillars. Therefore, it allows adjustment of the base scores for recent adverse effects. Overall, the ESG combined score covers over 400 data points on a firm's ESG pillars.

Control variables are obtained from more recent literature on dividend policy (Barros et al., 2020, 2021a, 2021b), as follows:

- *Book ETR* is introduced to accommodate the influence of tax avoidance strategies on dividend policy (Jacob and Jacob, 2013; Berzins et al., 2019);
- *N. Analysts* is a proxy for analyst coverage. The rationale for using this proxy relates to the information asymmetry issue (DeAngelo et al., 2000; Ham et al., 2020; Naqvi et al., 2021). Analysts play a role in firms' external oversight by helping fit the information asymmetry gap between managers and shareholders. Simultaneously, analysts play the role of pressuring managers to act diligently on providing cash returns to shareholders (Barros and Neves, 2020);
- *Market/Book* considers the relationship between market pricing and historical performance embedded in a firm's book equity. For technological firms, high market valuations are expected (Iyer et al., 2020). In fact, our sample presents an average valuation ratio of 5.27, above the samples in extant literature focused on a broader spectrum of non-financial firms (Chen and Zhao, 2006);
- *Size* is the firms' decimal logarithm of total assets to account for the life cycle stage that inevitably influences dividend decisions (Redding, 1997). This measure overcomes the valuation size bias of growing firms measured by market capitalization. However, the literature is not consensual as extant studies exist to support both a positive (Farinha, 2003; Ahmad et al., 2018) and a negative (Botoc and Pirtea, 2014; Chang et al., 2016) association with dividends;
- *EBT margin* and *ROE* are added to capture operational profitability (Botoc and Pirtea, 2014) and return yielded to equity holders (Barros et al., 2021a);
- *Leverage* is expected to constrain dividend payments (Jacob and Jacob, 2013; Henry, 2011), especially for highly levered firms (Al-Yahyaee et al., 2010);
- *PP&E* is a measure of the intensity of fixed assets on firms' total assets (Barros et al., 2021a). Despite being particularly relevant in the manufacturing industry to disentangle the higher operating assets required to run activities, this variable is included to capture diverging investment levels depending on the industry within the technology sector.

All controls were winsorised at the top and bottom 1.0 % percentiles

Table 4
Results: ESG score.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dividend	Dividend	DPS regular	DPS regular	Payout range 2 %	Payout range 2 %	DY range 2 %	DY range 2 %
ESG		0.029***		0.017***		0.009		0.029***
		(0.004)		(0.005)		(0.006)		(0.004)
R&D intensity	−1.866***	−2.294***	−2.997***	−3.010***	−7.137***	−7.332***	−1.536**	−1.913***
	(0.645)	(0.680)	(1.011)	(1.024)	(1.512)	(1.493)	(0.667)	(0.702)
Analysts	−0.043***	−0.045***	−0.046***	−0.047***	−0.043***	−0.043***	−0.043***	−0.046***
	(0.006)	(0.006)	(0.008)	(0.008)	(0.010)	(0.010)	(0.006)	(0.006)
Market/Book	−0.011**	−0.012**	−0.012*	−0.012**	0.006	0.006	−0.006	−0.007
	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)	(0.008)	(0.005)	(0.005)
Size	0.702***	0.506***	0.171***	0.044	0.460***	0.393***	0.688***	0.494***
	(0.052)	(0.057)	(0.057)	(0.069)	(0.072)	(0.088)	(0.051)	(0.057)
EBT margin	4.971***	4.818***	1.560***	1.434***	6.145***	6.155***	4.835***	4.698***
	(0.425)	(0.439)	(0.480)	(0.501)	(0.577)	(0.584)	(0.422)	(0.439)
ROE	0.075	0.074	0.083*	0.081*	0.040	0.034	0.033	0.029
	(0.050)	(0.049)	(0.046)	(0.045)	(0.061)	(0.063)	(0.054)	(0.058)
Leverage	0.085*	0.110**	0.127**	0.143***	−0.025	−0.018	0.019	0.042
	(0.046)	(0.047)	(0.051)	(0.051)	(0.055)	(0.056)	(0.044)	(0.045)
PP&E	−0.970**	−0.808*	−1.895**	−1.740**	−2.865***	−2.794**	−0.820*	−0.635
	(0.476)	(0.488)	(0.742)	(0.788)	(1.049)	(1.086)	(0.483)	(0.499)
Book ETR	0.303***	0.294***	0.225	0.216	0.242**	0.229**	0.292***	0.281**
	(0.106)	(0.113)	(0.174)	(0.178)	(0.104)	(0.106)	(0.109)	(0.118)
Δ Market cap	−0.456***	−0.412***	−0.414**	−0.393**	−0.303	−0.283	−0.436***	−0.393***
	(0.138)	(0.143)	(0.165)	(0.170)	(0.233)	(0.235)	(0.141)	(0.146)
Constant	−16.577***	−13.008***	−4.410***	−2.116	−11.526***	−10.282***	−16.255***	−12.725***
	(1.205)	(1.281)	(1.336)	(1.524)	(1.695)	(1.932)	(1.189)	(1.270)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567	2567	2567	2567	2567
Pseudo R^2	0.268	0.291	0.089	0.097	0.198	0.200	0.248	0.270
Wald test	507.649	571.339	134.969	153.958	220.668	229.876	482.343	541.765

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

to control for extreme outliers. Table 1 provides detailed definitions of all the variables in this study. Table 2 provides descriptive statistics for all the variables, while Table 3 presents a univariate analysis relevant to the first inspection of the forces within our sample. When assessing the sustainability metrics, the score with the lowest performance is the environmental, averaging (median) at 24.5 (12.84) on a 0 to 100 scale. The variability is also denoted as higher for the environmental score and sheds light on the role of this thematic across the technological sector. Firms forming the sector in our sample are indeed diverse, ranging from Apple Inc. ($274.5 billion 2020 revenue) or Intel Corp ($77.9 billion) to Vuzix Corp ($11.6 million) or Anterix Inc. ($1.6 million).

4. Results

4.1. Results on ESG performance

We begin by analysing the impact of R&D intensity and ESG scores on firms' dividend policy. In all estimations in Table 4, R&D intensity is a constraint of dividend policies, looking at both the decision to pay dividends and its stability. For ESG, the positive coefficient is in line with the legitimacy argument. Investment in these activities showcases the firm to the market, allowing more sustainable technological firms to share value with shareholders through cash dividends and to have a more stable policy. Columns (4) and (8) report that stability is found within metrics that are easily observable by shareholders, either through the predictability of the amount received in cash or on a market-to-market basis using the dividend yield. The extant literature has suggested that stability in the DPS should not be found in more volatile stocks (Lee and Mauck, 2016), and our conclusions are not different. The market/book ratio as a measure of growth potential and the change in market capitalisation support this conclusion. Controls align with the existing literature, pointing out that analyst coverage may be related to the asymmetric information issue, allowing a more timid payout policy (Basiddiq and Hussainey, 2012). The policy of whether and how much to return to shareholders is intrinsically connected with the firms' life-cycle, proxied using different angles to contain unobserved effects that drive our findings. As maturity approaches, the intensity of R&D is expected to decrease (Fan and Wang, 2021) and the growth potential is lower (Coad et al., 2016). The fast market capitalisation accumulation yielded by better outlooks, especially in the early stages, drives away the life-cycle curve. However, total book assets are not especially sensitive to market fashions and momentum, thus better capturing the maturity of operations (Kieschnick and Moussawi, 2018). All proxies that indirectly point to firms' life-cycle position suggest that an attractive dividend policy is put on hold while growth is shining.

Table 5 reports the analysis for crossing effects with the life cycle and the sustainability level. The analysis is conceptually relevant to account for crossing effects that sustainability performance may be along with the requirements to invest in R&D. Regarding the interactions involving R&D intensity, we aim to test if it is constrained by firm-specific variables such as growth in value, size, ESG scores, and EBT margin. Looking specifically at Size (column 11), a negative coefficient means that the constraint on the dividend policy driven by the need to gather higher R&D intensity is more prominent for larger firms. Taking the additional step by including the influence of ESG scores (column 13), a positive coefficient would mean that, collectively, a better ESG score hampers the size constraint in the dividend policy under more R&D intensity.

Results in Table 5 are revealing. The ESG score is, in fact, dependent on firm size in explaining the decision to pay dividends. The analysis of the change in market capitalisation is included in column (9) to dissipate the role of recent stock price movements in management decisions. Such volatility does not explain the dividend policies. Surprisingly, the effect of R&D intensity is more relevant in lowering the likelihood of dividend payments as the firm grows (see column 11). That is, for larger firms, the need to invest in R&D further decreases the likelihood of dividend payment.

High-tech firms are mostly service providers by nature, although the technology sector has a broader scope and includes both services and

Table 5
Results: ESG score and spillover effects.

	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Dividend	Dividend	Dividend	Dividend	Dividend	Dividend	Dividend
ESG × Size	0.007***						
	(0.002)						
R&D intensity × Δ Market cap		0.280					
		(1.331)					
R&D intensity × Size			−0.737**				
			(0.368)				
R&D intensity × ESG				0.063*			
				(0.036)			
R&D intensity × ESG × Size					0.003*		
					(0.001)		
R&D intensity × EBT margin						8.345	
						(5.504)	
R&D intensity × ESG × EBT margin							0.158*
							(0.082)
R&D intensity	−2.157***	−2.330***	13.790*	−5.111***	−4.795***	−3.164***	−3.117***
	(0.669)	(0.701)	(7.950)	(1.805)	(1.651)	(0.933)	(0.806)
ESG	−0.120***	0.029***	0.029***	0.021***	0.022***	0.028***	0.025***
	(0.041)	(0.004)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)
Δ Market cap	−0.417***	−0.443**	−0.410***	−0.427***	−0.425***	−0.012**	−0.013**
	(0.139)	(0.202)	(0.144)	(0.142)	(0.142)	(0.006)	(0.006)
Size	0.225**	0.506***	0.583***	0.515***	0.504***	0.504***	0.507***
	(0.096)	(0.057)	(0.068)	(0.057)	(0.057)	(0.058)	(0.057)
Analysts	−0.049***	−0.045***	−0.044***	−0.046***	−0.046***	−0.044***	−0.045***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Market/Book	−0.012**	−0.012**	−0.012**	−0.012**	−0.012**	−0.012**	−0.013**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)
EBT margin	4.820***	4.822***	4.929***	4.754***	4.742***	3.642***	3.857***
	(0.427)	(0.439)	(0.447)	(0.443)	(0.443)	(0.894)	(0.676)
ROE	0.075	0.074	0.075	0.073	0.073	0.074	0.073
	(0.048)	(0.049)	(0.048)	(0.049)	(0.049)	(0.049)	(0.049)
Leverage	0.112**	0.110**	0.110**	0.107**	0.107**	0.108**	0.111**
	(0.047)	(0.047)	(0.047)	(0.046)	(0.046)	(0.047)	(0.047)
PP&E	−0.850*	−0.808*	−0.807	−0.911*	−0.906*	−0.810*	−0.880*
	(0.498)	(0.488)	(0.491)	(0.496)	(0.496)	(0.483)	(0.488)
Book ETR	0.287***	0.294***	0.295***	0.304***	0.302***	0.297***	0.296***
	(0.111)	(0.113)	(0.114)	(0.113)	(0.113)	(0.114)	(0.114)
Constant	−6.692***	−12.991***	−14.756***	−12.844***	−12.613***	−12.802***	−12.726***
	(2.121)	(1.284)	(1.524)	(1.283)	(1.296)	(1.289)	(1.280)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567	2567	2567	2567
Pseudo R^2	0.295	0.291	0.291	0.292	0.292	0.292	0.292
Wald test	589.195	571.689	582.032	553.934	555.490	549.061	565.029

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

hardware providers. Firms' investment in R&D may therefore yield sustainability benefits as long as practices comply with score guidelines. Across all estimations, R&D intensity is not favourable towards the likelihood of dividend payments, while ESG scores appear to explain dividend payments positively. The results in column 12 suggest that better ESG scores smooth the adverse role of R&D intensity in allowing firms to initiate dividend payment policies, yet such an effect is verified whether firms are larger (column 13).

Collectively, the results indicate that R&D expenses decrease the availability of resources to trigger dividend payments, given the growth nature of such expenses, although ESG scores mitigate this adverse effect by helping increase the likelihood of dividend payments. Two opposing channels may have driven our results. One relates to the resource view, whereas the other accounts for the legitimacy of these policies. The first encompasses sourcing of capital to fund the investments required for growth and innovation. The literature has suggested that sustainability reporting, which is based on what ESG metrics are primarily based on, effectively reduces the cost of capital (Shad et al., 2020), especially concerning social- and environmental-related disclosures (Martínez-Ferrero and García-Sánchez, 2017). The second channel is the legitimisation of initiating dividend payments without hampering the information asymmetry issue. Acting more aligned with the values of society by disclosing a socially and environmentally responsible image may legitimise corporate actions (Lanis and Richardson, 2013).

4.2. Results on the sustainability pillars: environmental, social, and governance

Next, we focused on each component of the ESG pillars. These pillars may be conflicting because optimisation may yield spillover effects in the components. For instance, investing in the social component adds costs to the firm, indirectly influencing profitability. Lower value generation may lead to the distribution of lower dividends to shareholders. Especially for larger firms, the shareholder structure comprises many investors, including investment and pension funds. The lower availability of dividends has a spillover effect on the future value of pensions for contributors to these funds. Nevertheless, these spillover effects may not be perceived in the short term. Tables 6 to 8 stress the influence of the three pillars on dividend policy, following the order of each acronym. Overall, the environmental and social scores present similar results, considering the correlation between these components. The performance of the governance component also appears to drive stability in the payout ratio, in the range of 2 %. The magnitude of the coefficients suggests that the governance score is more influential in explaining dividend policy decisions, yet this component is, on average, below all others. Marginal effects, not reported here for parsimony, do not show a clear superior explanatory role of the governance component. The findings previously mentioned for the ESG score are collectively maintained with the narrowing of the pillars.

Table 6
Results: environmental score.

	(14)	(15)	(16)	(17)
	Dividend	DPS regular	Payout range 2 %	DY range 2 %
Environmental	0.018***	0.009***	0.001	0.018***
	(0.002)	(0.004)	(0.005)	(0.002)
R&D intensity	−2.494***	−3.169***	−7.170***	−2.156***
	(0.677)	(1.026)	(1.476)	(0.702)
Analysts	−0.046***	−0.047***	−0.043***	−0.046***
	(0.006)	(0.008)	(0.010)	(0.006)
Market/Book	−0.012**	−0.012*	0.006	−0.007
	(0.005)	(0.006)	(0.007)	(0.005)
Size	0.524***	0.070	0.454***	0.508***
	(0.057)	(0.066)	(0.091)	(0.058)
EBT margin	4.811***	1.470***	6.146***	4.686***
	(0.428)	(0.488)	(0.577)	(0.425)
ROE	0.066	0.081*	0.039	0.022
	(0.047)	(0.045)	(0.061)	(0.055)
Leverage	0.091*	0.131**	−0.025	0.025
	(0.047)	(0.052)	(0.055)	(0.045)
PP&E	−1.372***	−2.103***	−2.881***	−1.198**
	(0.489)	(0.774)	(1.036)	(0.496)
Book ETR	0.293***	0.220	0.242**	0.282**
	(0.110)	(0.174)	(0.104)	(0.114)
Δ Market cap	−0.396***	−0.389**	−0.301	−0.377***
	(0.140)	(0.167)	(0.233)	(0.144)
Constant	−12.431***	−2.131	−11.381***	−12.089***
	(1.326)	(1.544)	(2.087)	(1.328)
Year FE	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567
Pseudo R^2	0.285	0.094	0.198	0.265
Wald test	571.795	153.860	224.234	552.290

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

Table 7
Results: social score.

	(18)	(19)	(20)	(21)
	Dividend	DPS regular	Payout range 2 %	DY range 2 %
Social	0.013***	0.008*	0.004	0.012***
	(0.003)	(0.005)	(0.006)	(0.003)
R&D intensity	−2.056***	−3.072***	−7.227***	−1.697**
	(0.667)	(1.040)	(1.489)	(0.689)
Analysts	−0.044***	−0.047***	−0.043***	−0.044***
	(0.006)	(0.008)	(0.010)	(0.006)
Market/Book	−0.012**	−0.012*	0.006	−0.007
	(0.005)	(0.006)	(0.007)	(0.005)
Size	0.602***	0.104	0.430***	0.593***
	(0.057)	(0.068)	(0.087)	(0.057)
EBT margin	4.941***	1.553***	6.161***	4.815***
	(0.430)	(0.490)	(0.578)	(0.428)
ROE	0.076	0.080*	0.039	0.032
	(0.050)	(0.044)	(0.061)	(0.056)
Leverage	0.091**	0.129***	−0.025	0.025
	(0.046)	(0.050)	(0.055)	(0.045)
PP&E	−0.824*	−1.779**	−2.810***	−0.667
	(0.482)	(0.760)	(1.076)	(0.491)
Book ETR	0.299***	0.219	0.238**	0.287**
	(0.110)	(0.177)	(0.104)	(0.113)
Δ Market cap	−0.429***	−0.402**	−0.294	−0.410***
	(0.140)	(0.168)	(0.234)	(0.143)
Constant	−14.714***	−3.156**	−10.961***	−14.492***
	(1.284)	(1.528)	(1.917)	(1.278)
Year FE	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567
Pseudo R^2	0.274	0.091	0.199	0.253
Wald test	523.919	141.078	227.088	501.216

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

Table 8
Results: governance score.

	(22)	(23)	(24)	(25)
	Dividend	DPS regular	Payout range 2 %	DY range 2 %
Governance	0.025***	0.017***	0.010**	0.025***
	(0.003)	(0.004)	(0.004)	(0.003)
R&D intensity	−1.748***	−2.628***	−7.076***	−1.380**
	(0.648)	(0.960)	(1.519)	(0.666)
Analysts	−0.046***	−0.047***	−0.045***	−0.047***
	(0.006)	(0.009)	(0.010)	(0.006)
Market/Book	−0.012**	−0.013*	0.006	−0.006
	(0.006)	(0.007)	(0.008)	(0.006)
Size	0.632***	0.110*	0.422***	0.621***
	(0.052)	(0.062)	(0.077)	(0.051)
EBT margin	4.913***	1.356***	6.200***	4.791***
	(0.438)	(0.501)	(0.594)	(0.443)
ROE	0.074	0.085*	0.030	0.028
	(0.051)	(0.047)	(0.064)	(0.060)
Leverage	0.115**	0.150***	−0.010	0.046
	(0.048)	(0.053)	(0.057)	(0.047)
PP&E	−0.974**	−1.827**	−2.751**	−0.784
	(0.475)	(0.790)	(1.087)	(0.484)
Book ETR	0.303***	0.221	0.230**	0.291**
	(0.111)	(0.176)	(0.108)	(0.115)
Δ Market cap	−0.459***	−0.402**	−0.290	−0.439***
	(0.143)	(0.171)	(0.236)	(0.149)
Constant	−16.123***	−3.838***	−11.115***	−15.861***
	(1.193)	(1.385)	(1.752)	(1.179)
Year FE	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567
Pseudo R^2	0.298	0.103	0.203	0.278
Wald test	546.445	156.649	222.479	516.084

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

Table 9
Results: controversies score.

	(26)	(27)	(28)	(29)
	Dividend	DPS regular	Payout range 2 %	DY range 2 %
Controversies score	0.004	−0.002	0.010**	0.006**
	(0.002)	(0.004)	(0.004)	(0.002)
R&D intensity	−1.850***	−3.003***	−7.162***	−1.510**
	(0.647)	(1.008)	(1.540)	(0.672)
Analysts	−0.041***	−0.047***	−0.038***	−0.041***
	(0.006)	(0.008)	(0.010)	(0.006)
Market/Book	−0.011**	−0.012*	0.005	−0.006
	(0.006)	(0.006)	(0.008)	(0.005)
Size	0.727***	0.159***	0.531***	0.730***
	(0.056)	(0.059)	(0.076)	(0.057)
EBT margin	4.974***	1.562***	6.233***	4.846***
	(0.427)	(0.478)	(0.588)	(0.426)
ROE	0.077	0.080*	0.067	0.038
	(0.051)	(0.046)	(0.060)	(0.057)
Leverage	0.083*	0.128**	−0.033	0.016
	(0.047)	(0.050)	(0.056)	(0.045)
PP&E	−0.971**	−1.901**	−2.795***	−0.821*
	(0.478)	(0.748)	(1.005)	(0.485)
Book ETR	0.304***	0.224	0.275***	0.296***
	(0.107)	(0.174)	(0.105)	(0.111)
Δ Market cap	−0.472***	−0.403**	−0.317	−0.463***
	(0.139)	(0.164)	(0.242)	(0.143)
Constant	−17.459***	−3.957***	−13.982***	−17.727***
	(1.380)	(1.502)	(1.937)	(1.398)
Year FE	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567
Pseudo R^2	0.269	0.090	0.204	0.250
Wald test	504.206	136.349	213.464	474.157

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

Table 10
Results: absent from controversies.

	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)
	Dividend	Dividend	DPS regular	DPS regular	Payout range 2 %	Payout range 2 %	DY range 2 %	DY range 2 %
ESG	0.029***	0.028***	0.018***	0.016***	0.010*	0.010*	0.028***	0.029***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)
ESG × Controversies (absent)		0.001		0.004		−0.001		−0.001
		(0.003)		(0.004)		(0.005)		(0.003)
Goodwill	−0.983***	−0.976***	0.483	0.535	2.604***	2.594***	−0.589	−0.601
	(0.356)	(0.358)	(0.507)	(0.516)	(0.643)	(0.649)	(0.367)	(0.369)
R&D intensity	−2.219***	−2.221***	−2.978***	−2.985***	−7.290***	−7.270***	−1.869***	−1.865***
	(0.679)	(0.678)	(1.030)	(1.029)	(1.546)	(1.533)	(0.702)	(0.703)
Analysts	−0.048***	−0.048***	−0.046***	−0.047***	−0.038***	−0.038***	−0.047***	−0.047***
	(0.006)	(0.006)	(0.008)	(0.009)	(0.010)	(0.011)	(0.006)	(0.006)
Market/Book	−0.014**	−0.014**	−0.012*	−0.012*	0.010	0.010	−0.008	−0.008
	(0.006)	(0.006)	(0.006)	(0.006)	(0.009)	(0.009)	(0.005)	(0.005)
Size	0.548***	0.544***	0.026	0.009	0.353***	0.360***	0.516***	0.523***
	(0.059)	(0.062)	(0.068)	(0.070)	(0.093)	(0.099)	(0.059)	(0.062)
EBT margin	4.772***	4.774***	1.453***	1.474***	6.535***	6.533***	4.665***	4.662***
	(0.434)	(0.434)	(0.511)	(0.508)	(0.653)	(0.654)	(0.436)	(0.437)
ROE	0.076	0.075	0.083*	0.081*	0.034	0.036	0.030	0.031
	(0.049)	(0.048)	(0.045)	(0.045)	(0.069)	(0.069)	(0.057)	(0.057)
Leverage	0.124***	0.125***	0.138***	0.141***	−0.059	−0.060	0.051	0.050
	(0.048)	(0.048)	(0.052)	(0.051)	(0.063)	(0.063)	(0.046)	(0.046)
PP&E	−1.475***	−1.468***	−1.389*	−1.344	−0.994	−1.001	−1.024*	−1.036*
	(0.539)	(0.540)	(0.825)	(0.824)	(1.099)	(1.100)	(0.547)	(0.549)
Book ETR	0.300***	0.300***	0.216	0.215	0.223**	0.224**	0.284**	0.285**
	(0.114)	(0.114)	(0.178)	(0.178)	(0.109)	(0.109)	(0.118)	(0.118)
Δ Market cap	−0.403***	−0.401***	−0.399**	−0.385**	−0.349	−0.352	−0.387***	−0.391***
	(0.143)	(0.142)	(0.170)	(0.169)	(0.249)	(0.251)	(0.146)	(0.146)
Constant	−13.706***	−13.625***	−1.848	−1.470	−10.095***	−10.240***	−13.093***	−13.235***
	(1.312)	(1.366)	(1.514)	(1.563)	(2.053)	(2.185)	(1.292)	(1.367)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2567	2567	2567	2567	2567	2567	2567	2567
Pseudo R^2	0.293	0.293	0.098	0.098	0.219	0.219	0.271	0.271
Wald test	576.521	580.373	156.253	157.444	201.045	200.434	543.805	545.270

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

4.3. Robustness

We check the robustness of our key findings of a positive relationship between ESG scores and dividend policy, looking at whether controversies affect ESG scores. To further control for sustainability score composition, we employ an analysis that includes the controversy scores in Table 9. To further control for these controversies, we run a crossover analysis, as shown in Table 10. The controversies score is computed on a scale of 0 to 100 and measures whether news was disclosed that put firms' ESG scores at risk. A score of 100 is attained for firms that lack controversies. The binary variable Controversies (absent) precisely captures whether firms are free from news that jeopardises our primary variable of interest regarding sustainability. These analyses show that the absence of controversy alone is a driver of stability in firms' payout rate and dividend yield. The payout rate results align with the governance score findings.

We employ an analysis that focuses on special cases to address the concern that firms may employ a dividend policy that jeopardises long-term sustainability. First, we consider firm-year observations with negative payout rates. The second special case includes dividend payments that exceed firms' year-by-year profits (Table 11). The coefficient estimate for ESG is not relevant for explaining dividend policies. This reinforces the fact that special dividend policy cases do not drive the main findings.

5. Discussion and contribution

The results reported in the previous section are aligned with the literature, yet not focused exclusively on the technology sector. Regarding sustainability, our findings illustrate that dividend policy can be a tool to control agency costs, lead managers to better decisions, and achieve higher ESG scores. These results are consistent with the complex mechanism explained in the literature review, which links agency costs, liquidity, dividends, information asymmetry, and sustainability. Similar to the findings of Wang (2010), we also report that R&D intensity constrains firms' will to pay dividends or even higher dividends, as these firms are more demanding in terms of cash flow needs to fund new investments. Bringing sustainability and R&D intensity together yields findings that add to the literature and the high-tech industry. Overall, our results suggest that dividend policy is complex and must be examined at the industry level, not from a general perspective.

Our contributions to the literature are twofold. First, we add to the reputational issue of managers when setting firms' strategic decisions. Arguably, managers desire to pay higher dividends, as this is a sign of greater transparency and increased trustability, and in turn, they may also benefit from higher ESG ratings. The positive impact on stock prices is also non-negligible. The increase in transparency with dividend distribution has been well documented in the literature (Koo et al., 2017; Smith et al., 2017), because fewer cash holdings from dividend distributions inhibit managers from rent extraction and self-discipline managers. The benefits for managers in getting higher ESG ratings are diverse, from better access to capital (Kotsantonis et al., 2016) to executive compensation (Maas, 2018). Nevertheless, there is a level above which the marginal gain in terms of ESG tends to be zero. However, there is also a minimum level below which firms should avoid penalisation. In addition, paying too many dividends may compromise future growth, negatively impacting stock prices, and destroying value. This puzzle for the reputation of managers in the technology sector persists, especially considering the need for R&D investment that is critical for firms' growth prospects. Yet, our findings detail that a better performance in ESG scores mitigates this adverse effect by helping increase the likelihood of dividend payments, thus allowing high-tech firms to

Table 11
Results: special cases of dividend payments.

	(35)	(39)	(40)	(41)	(42)	(43)
	Payout < 0 %	Payout < 0 %	Payout < 0 %	Payout > 100 %	Payout > 100 %	Payout > 100 %
ESG	0.010	0.010	0.007	−0.002	−0.001	−0.001
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
ESG × Controversies (absent)			0.008			−0.000
			(0.007)			(0.006)
Goodwill		−0.223	−0.125		−0.925	−0.928
		(0.719)	(0.748)		(0.707)	(0.713)
R&D intensity	−0.949	−0.949	−0.957	−0.585	−0.612	−0.610
	(0.842)	(0.833)	(0.828)	(1.267)	(1.255)	(1.265)
Analysts	−0.044***	−0.044***	−0.047***	−0.018	−0.021*	−0.021*
	(0.013)	(0.013)	(0.014)	(0.012)	(0.012)	(0.012)
Market/Book	−0.005	−0.006	−0.006	−0.005	−0.006	−0.006
	(0.013)	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)
Size	0.336***	0.343***	0.302***	0.102	0.141	0.142
	(0.113)	(0.109)	(0.111)	(0.146)	(0.139)	(0.145)
EBT margin	−0.156	−0.155	−0.155	2.772***	2.690***	2.691***
	(0.130)	(0.128)	(0.126)	(0.845)	(0.787)	(0.787)
ROE	−0.022	−0.023	−0.022	0.104*	0.102	0.102*
	(0.101)	(0.102)	(0.094)	(0.060)	(0.062)	(0.062)
Leverage	0.080	0.083	0.088	0.036	0.045	0.045
	(0.094)	(0.095)	(0.090)	(0.078)	(0.077)	(0.076)
PP&E	−0.132	−0.272	−0.222	−0.057	−0.622	−0.623
	(0.987)	(1.079)	(1.083)	(1.120)	(1.247)	(1.250)
Book ETR	0.671**	0.672**	0.673**	0.226	0.228	0.229
	(0.339)	(0.339)	(0.342)	(0.216)	(0.214)	(0.214)
Δ Market cap	−0.745***	−0.744***	−0.697***	−0.813***	−0.795***	−0.796***
	(0.234)	(0.234)	(0.227)	(0.236)	(0.230)	(0.228)
Constant	−10.243***	−10.339***	−9.398***	−4.854	−5.396*	−5.422*
	(2.455)	(2.381)	(2.421)	(3.023)	(2.880)	(3.023)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2338	2338	2338	2338	2338	2338
Pseudo R^2	0.096	0.096	0.099	0.053	0.055	0.055
Wal test	85.390	89.141	94.186	48.820	51.253	51.507

Robust standard errors are in brackets, and the symbols *, **, and *** represent significant levels of 10 %, 5 %, and 1 %, respectively.

implement dividend policies that yield stable returns to investors.

Our second contribution relates to the antagonistic relationship between size and dividends paid. Overall, size is positively associated with dividend payments. However, analyses of spillover effects imply that more mature firms that need to engage in R&D intensity pay lower dividends, which is a puzzling result. The first attempt to explain this result leads us in two directions. First, larger and more mature high-tech firms eventually need more funds to invest because size opens the door to new investment opportunities that are highly demanding in terms of cash flows. Firms such as Amazon or Virgin Group head to space because they are big enough to do so. In addition, room for relative growth marginally decreases with size. The second direction is related to Dividend Signaling Theory (Ross, 1977), Agency Theory (Jensen, 1986), and the well-documented entrenchment behaviour of managers (Baysinger and Butler, 1985; Novaes, 2003; Hu and Kumar, 2004; Gymah and Gyapong, 2021). Because high-tech firms are expected to invest a large amount of cash and have larger expected growth rates, paying more dividends under the need to engage in R&D intensity might be perceived by the market as a decrease in the portfolio of investment opportunities, leading analysts to lower expected cash flows and, consequently, lowering stock prices. Such bearish performance of the stock could lead to the replacement of the management team through a hostile takeover, which entrenched managers try to avoid at all costs.

The COVID-19 pandemic has highlighted the importance of technological firms in innovation, the search for solutions to social problems, and the importance of models for analysing technological evolution (TFAMWG, 2004). New challenges and solutions (e.g., Marinakis and White, 2022; Nanath et al., 2022; Nedjah et al., 2022) make it essential to further research on technology firms and technological entrepreneurship (Modgil et al., 2022; Shahzad et al., 2022) in different geographic and institutional contexts.

6. Conclusion, limitations, and future research

Using a sample composed exclusively of US firms in the technology sector, we examine the impact of ESG scores and R&D intensity on high-tech firms' dividend policy. The technology sector provides an interesting setting for this issue because these firms rely heavily on the allocation of resources to R&D expenditures for growth and pay dividends to compromise growth. Our key conclusion is that we find evidence of a positive relationship between ESG scores and firms' dividend policies. This result is robust to various alternative approaches, including disentangling the ESG score into its main environmental, social, and governance pillars. In addition, we find that the effect of R&D intensity is more prominent in lowering the likelihood of dividend payments as the firm grows, suggesting that firms' investment in R&D may yield sustainability benefits, as long as practices are compliant with score guidelines. Our results are consistent with the better ESG scores, smoothing the role of R&D intensity in allowing firms to initiate dividend payment policies.

Despite the contributions of our study, it is not exempt from caveats. Our focus on one country, the US, limits cross-country variability in our analysis, driven by different institutional features that may drive conclusions. One of the key characteristics is the accounting treatment of R&D expenses, which is more easily captured under US GAAP than in other markets such as Europe. However, a limitation of this approach is that we may not capture the dissimilarities that are likely in other markets, such as in China and Taiwan (Wang, 2010). Future research could build on this limitation and extend the geographical scope of the analysis. Additional avenues may be explored in future research. Identifying the range of optimal payout ratios will help practitioners in the technology sector better craft a dividend policy.

Another avenue of future research, which we could not cover in our

work, relates to further exploration of dividend policies in the technology sector. Two questions with potential contribution can be addressed. First, what is the optimal balance between the positive impact of higher ESG scores on dividends paid and the negative impact of higher R&D intensity in the dividends paid. Second, what is the optimal amount of dividends high-tech firms should pay. Answering these questions would be valuable to academics and practitioners, as this is one of the strategic financial decisions that firms must undertake.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

References

Aaboen, L., Lindelöf, P.Von, Koch, C., Löfsten, H., 2006. Corporate governance and performance of small high-tech firms in Sweden. Technovation 26 (8), 955–968.
Aboody, D., Lev, B., 2000. Information asymmetry, R&D, and insider gains. J. Financ. 55 (6), 2747–2766.
Adamides, E., Karacapilidis, N., 2020. Information technology for supporting the development and maintenance of open innovation capabilities. J. Innov. Knowl. 5 (1), 29–38.
Ahmad, N.G., Barros, V., Sarmento, J.M., 2018. The determinants of dividend policy in Euronext 100. Corp. Ownersh. Control. 15 (4), 8–17.
Alam, P., Walton, K.S., 1995. Information asymmetry and valuation effects of debt financing. Financ. Rev. 30 (2), 289–311.
Alshehhi, A., Nobanee, H., Khare, N., 2018. The impact of sustainability practices on corporate financial performance: literature trends and future research potential. Sustainability (Switzerland) 10 (2).
Al-Yahyaee, K.H., Pham, T., Walter, T., 2010. Dividend stability in a unique environment. Manag. Financ. 36 (10), 903–916.
Alzamora-Ruiz, J., Fuentes-Fuentes, M.D., Martinez-Fiestas, M., 2021. Together or separately? Direct and synergistic effects of effectuation and causation on innovation in technology-based SMEs. Int. Entrep. Manag. J. 17 (4), 1917–1943.
Ameer, R., Othman, R., 2012. Sustainability practices and corporate financial performance: a study based on the top global corporations. J. Bus. Ethics 108 (1), 61–79.
Amel-Zadeh, A., Serafeim, G., 2018. Why and how investors use ESG information: evidence from a global survey. Financ. Anal. J. 74 (3), 87–103.
Armstrong, C.S., Core, J.E., Taylor, D.J., Verrecchia, R.E., 2011. When does information asymmetry affect the cost of capital? J. Account. Res. 49 (1), 1–40.
Attanasio, O., 1990. Asset price volatility and information structures. Econ. Lett. 33 (2), 159–164.
Bansal, P., DesJardine, M.R., 2014. Business sustainability: it is about time. Strateg. Organ. 12 (1), 70–78.
Barros, V., Neves, J.C.D., 2020. Do managers increase tax disclosure when corporate tax avoidance is high? Int. J. Account. Audit. Perform. Eval. 16 (4), 354–392.
Barros, V., Matos, P.V., Sarmento, J.M., 2020. What firm's characteristics drive the dividend policy? A mixed-method study on the Euronext stock exchange. J. Bus. Res. 115, 365–377.
Barros, V., Guedes, M.J., Santos, P., Sarmento, J.M., 2021b. Does CEO turnover influence dividend policy? Financ. Res. Lett. 44, 102085.
Barros, V., Matos, P.V., Sarmento, J.M., Vieira, P.R., 2021a. Do activist shareholders influence a manager's decisions on a firm's dividend policy: a mixed-method study. J. Bus. Res. 122, 387–397.
Basiddiq, H., Hussainey, K., 2012. Does asymmetric information drive UK dividends propensity? J. Appl. Acc. Res. 13 (3), 284–297.
Baysinger, B.D., Butler, H.N., 1985. Antitakeover amendments, managerial entrenchment, and the contractual theory of the corporation. Va. Law Rev. 71 (8), 1257–1303.
Benkler, Y., 2019. Don't let industry write the rules for AI. Nature 569 (7754), 161–162.
Berg, F., Koelbel, J.F., Rigobon, R., 2019. Aggregate confusion: the divergence of ESG Ratings. In: MIT Sloan School of Management Working Paper.
Berryman, C., Ferguson, C.J., Negy, C., 2018. Social media use and mental health among young adults. Psychiatry Q. 89, 307–314.
Berzins, J., Bøhren, Ø., Stacescu, B., 2019. Dividends and taxes: the moderating role of agency conflicts. J. Corp. Finan. 58, 583–604.
Botoc, C., Pirtea, M., 2014. Dividend payout-policy drivers: evidence from emerging countries. Emerg. Mark. Financ. Trade 50 (sup4), 95–112.
Brown, J.R., Petersen, B.C., 2011. Cash holdings and R&D smoothing. J. Corp. Finan. 17 (3), 694–709.
Chan, L.K.C., Lakonishok, J., Theodore Sougiannis, T., 2001. The stock market valuation of research and development expenditures. J. Financ. 56 (6), 2431–2456.
Chang, K., Kang, E., Li, Y., 2016. Effect of institutional ownership on dividends: an agency-theory-based analysis. J. Bus. Res. 69 (7), 2551–2559.
Chen, L., Zhao, X., 2006. On the relation between the market-to-book ratio, growth opportunity, and leverage ratio. Financ. Res. Lett. 3 (4), 253–266.
Chen, Z., Lee, S.H., Xu, W., 2017. R&D performance in high-tech firms in China. Asian Econ.Pap. 16 (3), 193–208.
Christensen, D.M., Serafeim, G., Sikochi, S., 2022. Why is corporate virtue in the eye of the beholder? The case of ESG ratings. Account. Rev. 97 (1), 147–175.
Ciasullo, M.V., Troisi, O., Grimaldi, M., Leone, D., 2020. Multi-level governance for sustainable innovation in smart communities: an ecosystems approach. Int. Entrep. Manag. J. 16 (4), 1167–1195.
Club of Rome, 2022. Earth for All: A Survival Guide for Humanity. New Society Publishers.
Coad, A., Segarra, A., Teruel, M., 2016. Innovation and firm growth: does firm age play a role? Res. Policy 45 (2), 387–400.
Coccia, M., 2005. Measuring intensity of technological change: the seismic approach. Technol. Forecast. Soc. Chang. 72 (2), 117–144.
Colombo, M.G., Croce, A., Murtinu, S., 2014. Ownership structure, horizontal agency costs and the performance of high-tech entrepreneurial firms. Small Bus. Econ. 42, 265–282.
Cowling, M., Ughetto, E., Lee, N., 2018. The innovation debt penalty: cost of debt, loan default, and the effects of a public loan guarantee on high-tech firms. Technol. Forecast. Soc. Chang. 127, 166–176.
Cui, L., Zhai, M., Dai, J., Liu, Y., Zhang, P., 2019. Assessing sustainability performance of high-tech firms through a hybrid approach. Ind. Manag. Data Syst. 119 (8), 1581–1607.
DeAngelo, H., DeAngelo, L., 2006. The irrelevance of the MM dividend irrelevance theorem. J. Financ. Econ. 79 (2), 293–315.
DeAngelo, H., DeAngelo, L., Skinner, D.J., 2000. Special dividends and the evolution of dividend signaling. J. Financ. Econ. 57 (3), 309–354.
DeAngelo, H., DeAngelo, L., Stulz, R., 2006. Dividend policy and the earned/contributed capital mix: a test of the life-cycle theory. J. Financ. Econ. 81, 227–254.
Del Giudice, A., Rigamonti, S., 2020. Does audit improve the quality of ESG scores? Evidence from corporate misconduct. Sustainability 12 (14), 5670.
Demirel, P., Kesidou, E., 2019. Sustainability-oriented capabilities for eco-innovation: meeting the regulatory, technology, and market demands. Bus. Strateg. Environ. 28 (5), 847–857.
Deng, L., Li, S., Liao, M., Wu, W., 2013. Dividends, investment and cash flow uncertainty: evidence from China. Int. Rev. Econ. Financ. 24, 112–124.
Drempetic, S., Klein, C., Zwergel, B., 2019. The influence of firm size on the ESG score: corporate sustainability ratings under review. J. Bus. Ethics 167, 333–360.
Duque-Grisales, E., Aguilera-Caracuel, J., 2019. Environmental, social and governance (ESG) scores and financial performance of multilatinas: moderating effects of geographic international diversification and financial slack. J. Bus. Ethics 168, 315–334.
Eden, B., Jovanovic, B., 1994. Asymmetric information and the excess volatility of stock prices. Econ. Inq. 32 (2), 228–235.
Elkington, J., 1994. Towards the sustainable corporation: win-win-win business strategies for sustainable development. Calif. Manag. Rev. 36 (2), 90–100.
Fama, E., 1974. The empirical relationships between the dividend and investment decisions of firms. Am. Econ. Rev. 64, 304–318.
Fama, E., French, K., 2001. Disappearing dividends: changing firm characteristics or lower propensity to pay? J. Financ. Econ. 60, 3–43.
Fan, S., Wang, C., 2021. Firm age, ultimate ownership, and R&D investments. Int. Rev. Econ. Financ. 76, 1245–1264.
Farinha, J., 2003. Dividend policy, corporate governance and the managerial entrenchment hypothesis: an empirical analysis. J. Bus. Financ. Acc. 30 (9–10), 1173–1209.
Flor, M.L., Cooper, S.Y., Oltra, M.J., 2018. External knowledge search, absorptive capacity and radical innovation in high-technology firms. Eur. Manag. J. 36 (2), 183–194.
Funk, R.J., Owen-Smith, J., 2017. A dynamic network measure of technological change. Manag. Sci. 63 (3), 791–817.
Gharbi, S., Sahut, J.M., Teulon, F., 2014. R&D investments and high-tech firms'stock return volatility. Technol. Forecast. Soc. Chang. 88, 306–312.
Giese, G., Lee, L.E., Melas, D., Nagy, Z., Nishikawa, L., 2019. Foundations of ESG investing: how ESG affects equity valuation, risk, and performance. J. Portf. Manag. 45 (5), 69–83.
Gillan, S.L., Koch, A., Starks, L.T., 2021. Firms and social responsibility: a review of ESG and CSR research in corporate finance. J. Corp. Financ. 66, 101889.
Graham, J.R., Kumar, A., 2006. Do dividend clienteles exist? Evidence on dividend preferences of retail investors. J. Financ. 61 (3), 1305–1336.
Gu, F., Li, John Q., 2007. The credibility of voluntary disclosure and insider stock transactions. J. Account. Res. 45 (4), 771–810.
Gymah, D., Gyapong, E., 2021. Managerial entrenchment and payout policy: a catering effect. Int. Rev. Financ. Anal. 73, 101600.
Hall, B.H., 2002. The financing of research and development. Oxf. Rev. Econ. Policy 18 (1), 35–51.
Ham, C.G., Kaplan, Z.R., Leary, M.T., 2020. Do dividends convey information about future earnings? J. Financ. Econ. 136 (2), 547–570.
Hao, Z., Zhang, X., Wei, J., 2022. Research on the effect of enterprise financial flexibility on sustainable innovation. J. Innov. Knowl. 7 (2), 100184.
Hartzmark, S.M., Sussman, A.B., 2019. Do investors value sustainability? A natural experiment examining ranking and fund flows. J. Financ. 74 (6), 2789–2837.
Hausman, A., Johnston, W.J., 2014. The role of innovation in driving the economy: lessons from the global financial crisis. J. Bus. Res. 67 (1), 2720–2726.
Henry, D., 2011. Ownership structure and tax-friendly dividends. J. Bank. Financ. 35 (10), 2747–2760.

Hsu, P.H., Tian, X., Xu, Y., 2014. Financial development and innovation: cross-country evidence. J. Financ. Econ. 112 (1), 116–135.
Hu, A., Kumar, P., 2004. Managerial entrenchment and payout policy. J. Financ. Quant. Anal. 39 (4), 759–790.
Hu, M.C., Tseng, C.Y., 2007. Technological interdependence and knowledge diffusion in the building of national innovative capacity: the role of Taiwan's chemical industry. Technol. Forecast. Soc. Chang. 74 (3), 298–312.
Hu, Y., Huang, W., Chen, Z., 2020. Stock liquidity, agency cost, and dividend payouts. Appl. Econ. Lett. 27 (4), 335–339.
Huang, C., Arundel, A., Hollanders, H., 2010. How Firms Innovate: R&D, Non-R&D, and Technology Adoption. UNU-MERIT.
Hunt, V., Simpson, B., Yamada, Y., 2020. The Case for Stakeholder Capitalism, 8. McKinsey & Company.
Hussain, N., Rigoni, U., Cavezzali, E., 2018. Does it pay to be sustainable? Looking inside the black box of the relationship between sustainability performance and financial performance. Corp. Soc. Responsib. Environ. Manag. 25 (6), 1198–1211.
Iyer, S.R., Sankaran, H., Walsh, S.T., 2020. Influence of director expertise on capital structure and cash holdings in high-tech firms. Technol. Forecast. Soc. Chang. 158, 120060.
Jabbour, A.B.L., Azevedo, F., Arantes, A.F., Jabbour, C.J.C., 2013. Green supply chain management in local and multinational high-tech companies located in Brazil. Int. J. Adv. Manuf. Technol. 68 (1), 807–815.
Jacob, M., Jacob, M., 2013. Taxation, dividends, and share repurchases: taking evidence global. J. Financ. Quant. Anal. 48 (4), 1241–1269.
Jafari-Sadeghi, V., Mahdiraji, H.A., Busso, D., Yahiaoui, D., 2022. Towards agility in international high-tech SMEs: exploring key drivers and main outcomes of dynamic capabilities. Technol. Forecast. Soc. Chang. 174, 121272.
Jensen, M.C., 1986. Agency costs of free cash flow, corporate finance, and takeovers. Am. Econ. Rev. 76 (2), 323–329.
Jiang, C., John, K., Larsen, D., 2020. R&D investment intensity and jump volatility of stock price. Rev. Quant. Finan. Acc. 2020, 1–43.
Khan, M., Serafeim, G., Yoon, A., 2016. Corporate sustainability: first evidence on materiality. Account. Rev. 91 (6), 1697–1724.
Kieschnick, R., Moussawi, R., 2018. Firm age, corporate governance, and capital structure choices. J. Corp. Finan. 48, 597–614.
Koo, D.S., Ramalingegowda, S., Yu, Y., 2017. The effect of financial reporting quality on corporate dividend policy. Rev. Acc. Stud. 22 (2), 753–790.
Kotsantonis, S., Pinney, C., Serafeim, G., 2016. ESG integration in investment management: myths and realities. J.Appl.Corp.Financ. 28 (2), 10–16.
Lanis, R., Richardson, G., 2013. Corporate social responsibility and tax aggressiveness: a test of legitimacy theory. Account. Audit. Account. J. 26 (1), 75–100.
Lankoski, L., 2016. Alternative conceptions of sustainability in a business context. J. Clean. Prod. 139, 847–857.
Lantz, J.S., Sahut, J.M., 2005. R&D investment and the financial performance of technological firms. Int. J. Bus. 10 (3), 251.
Lee, N., Lee, J., 2019. R & D intensity and dividend policy: evidence from South Korea's biotech firms. Sustainability 11 (18), 4837.
Lee, B.S., Mauck, N., 2016. Dividend initiations, increases and idiosyncratic volatility. J. Corp. Finan. 40, 47–60.
Lee, A.H., Kang, H.Y., Hsu, C.F., Hung, H.C., 2009. A green supplier selection model for high-tech industry. Expert Syst. Appl. 36 (4), 7917–7927.
Lev, B., Sougiannis, T., 1996. The capitalization, amortization, and value-relevance of R&D. J. Account. Econ. 21 (1), 107–138.
Levitas, E., Mcfadyen, M., 2009. Managing liquidity in research-intensive firms: signaling and cash flow effects of patents and alliance activities. Strateg. Manag. J. 30, 659–678.
Liu, Qiao, 2006. How good is good news? Technology depth, book-to-market ratio, and innovative events. J. Acc. Audit. Financ. 21 (3), 293–321.
Maas, K., 2018. Do corporate social performance targets in executive compensation contribute to corporate social performance? J. Bus. Ethics 148 (3), 573–585.
Majdouline, I., El Baz, J., Jebli, F., 2022. Revisiting technological entrepreneurship research: an updated bibliometric analysis of the state of art. Technol. Forecast. Soc. Chang. 121589.
Mallin, C.A., 2018. Corporate Governance, 6th edition. Oxford University Press.
Marinakis, Y.D., White, R., 2022. Hyperinflation potential in commodity-currency trading systems: implications for sustainable development. Sustain.Technol.Entrep. 1 (1), 100003.
Martínez-Ferrero, J., Frías-Aceituno, J.V., 2015. Relationship between sustainable development and financial performance: international empirical research. Bus. Strateg. Environ. 24 (1), 20–39.
Martínez-Ferrero, J., García-Sánchez, I.M., 2017. Sustainability assurance and cost of capital: Does assurance impact on credibility of corporate social responsibility information? Business Ethics: A European Review 26 (3), 223–239.
McKinsey, 2017. Why" to "Why Not. Sustainable Investing as the New Normal. Private Equity & Principal Investors Practice. McKinsey & Company, New York, NY.
Modgil, S., Dwivedi, Y.K., Rana, N.P., Gupta, S., Kamble, S., 2022. Has Covid-19 accelerated opportunities for digital entrepreneurship? An indian perspective. Technol. Forecast. Soc. Chang. 175, 121415.
Moncada-Paternò-Castello, P., Constantin, C., Smith, K., Tübke, A., Tubbs, M., 2010. Does Europe perform too little corporate R&D? A comparison of EU and non-EU corporate R&D performance. Res. Policy 39 (4), 523–536.
Moro-Visconti, R., Cruz Rambaud, S., López Pascual, J., 2020. Sustainability in fintechs: an explanation through business model scalability and market valuation. Sustainability 12 (24), 10316.
Nanath, K., Balasubramanian, S., Shukla, V., Islam, N., Kaitheri, S., 2022. Developing a mental health index using a machine learning approach: assessing the impact of mobility and lockdown during the COVID-19 pandemic. Technol. Forecast. Soc. Chang. 178, 121560.
Naqvi, S.K., Shahzad, F., Rehman, I.U., Qureshi, F., Laique, U., 2021. Corporate social responsibility performance and information asymmetry: the moderating role of analyst coverage. Corp. Soc. Responsib. Environ. Manag. 28 (6), 1549–1563.
Nedjah, N., de Macedo Mourelle, L., dos Santos, R.A., dos Santos, L.T.B., 2022. Sustainable maintenance of power transformers using computational intelligence. Sustain.Technol.Entrep. 1 (1), 100001.
Nirino, N., Santoro, G., Miglietta, N., Quaglia, R., 2021. Corporate controversies and company's financial performance: exploring the moderating role of ESG practices. Technol. Forecast. Soc. Change 162, 120341.
Novaes, W., 2003. Capital structure choice when managers are in control: entrenchment versus efficiency. J. Bus. 76 (1), 49–82.
Park, S.R., Jang, J.Y., 2021. The impact of ESG management on investment decision: institutional investors'perceptions of country-specific ESG criteria. Int. J. Financ. Stud. 9 (3), 48.
Porter, M.E., 2011. Competitive Advantage of Nations: Creating and Sustaining Superior Performance. Simon and Schuster.
Porter, M., Serafeim, G., Kramer, M., 2019. Where ESG Fails, 16. Institutional Investor.
Pruitt, S., Gitman, L., 1991. The interactions between the investment, financing, and dividend decisions of major US firms. Financ. Rev. 26 (33), 409–430.
Rajesh, R., 2020. Exploring the sustainability performances of firms using environmental, social, and governance scores. J. Clean. Prod. 247, 119600.
Redding, L.S., 1997. Firm size and dividend payouts. J. Financ. Intermed. 6 (3), 224–248.
Reiser, D.B., Tucker, A., 2019. Buyer beware: variation and opacity in ESG and ESG index funds. Cardozo Law Rev. 41, 1921–2018.
Ross, S., 1977. The determination of financial structure: the incentive signaling approach. Bell J. Econ. 8 (1), 23–40.
Savrul, M., Incekara, A., 2015. The effect of R&D intensity on innovation performance: a country level evaluation. Procedia. Soc. Behav. Sci. 210, 388–396.
Shad, M.K., Lai, F.W., Shamim, A., McShane, M., 2020. The efficacy of sustainability reporting towards cost of debt and equity reduction. Environ. Sci. Pollut. Res. 27 (18), 22511–22522.
Shahzad, U., Ferraz, D., Nguyen, H.H., Cui, L., 2022. Investigating the spill overs and connectedness between financial globalization, high-tech industries and environmental footprints: fresh evidence in context of China. Technol. Forecast. Soc. Chang. 174, 121205.
Shefrin, H., Statman, M., 1984. Explaining investor preference for cash dividends. J. Financ. Econ. 13, 253–282.
Shleifer, A.ndrei, Vishny, R.W., 1997. A survey of corporate governance. J. Financ. 52 (2), 737–783.
Smirlock, M., Marshall, W., 1983. Monopoly power and expense-preference behavior: theory and evidence to the contrary. Bell J. Econ. 14 (1), 166–178.
Smith, D., Pennathur, A., 2017. Signaling versus free cash flow theory: what does earnings management reveal about dividend initiation? J.Account.Audit.Financ. 1–25.
Smith, D.D., Pennathur, A.K., Marciniak, M.R., 2017. Why do CEOs agree to the discipline of dividends? Int. Rev. Financ. Anal. 52, 38–48.
Song, M., Wang, S., Sun, J., 2018. Environmental regulations, staff quality, green technology, R&D efficiency, and profit in manufacturing. Technol. Forecast. Soc. Chang. 133, 1–14.
Starks, L.T., 2021. Environmental, social, and governance issues and the financial analysts journal. Financ. Anal. J. 77 (4), 1–17.
Technology Futures Analysis Methods Working Group, 2004. Technology futures analysis: toward integration of the field and new methods. Technol. Forecast. Soc. Chang. 71 (3), 287–303.
Tricker, B., 2019. Corporate Governance: Principles, Policies, and Practices, 4nd edition. Oxford University Press, USA.
Unruh, G., Kiron, D., Kruschwitz, N., Reeves, M., Rubel, H., Zum Felde, A.M., 2016. Investing for a sustainable future: investors care more about sustainability than many executives believe. MIT Sloan Manag. Rev. 57 (4).
Vecchiato, R., 2015. Creating value through foresight: first mover advantages and strategic agility. Technol. Forecast. Soc. Chang. 101, 25–36.
Verdu, A.J., Tamayo, I., Ruiz-Moreno, A., 2012. The moderating effect of environmental uncertainty on the relationship between real options and technological innovation in high-tech firms. Technovation 32 (9–10), 579–590.
Wang, D., 2010. Corporate investment, financing, and dividend policies in the high-tech industry. J. Bus. Res. 63, 486–489.
Wang, H.W., Wu, M.C., 2012. Business type, industry value chain, and R&D performance: evidence from high-tech firms in an emerging market. Technol. Forecast. Soc. Chang. 79 (2), 326–340.
Widyawati, L., 2020. A systematic literature review of socially responsible investment and environmental social governance metrics. Bus. Strateg. Environ. 29 (2), 619–637.
World Commission on Environment and Development (WCED), 1987. Our Common Future: 374. Report to the UN General Assembly no. A/42/427. United Nations.
Wu, Lei-Yu, 2007. Entrepreneurial resources, dynamic capabilities and start-up performance of Taiwan's high-tech firms. J. Bus. Res. 60 (5), 549–555.
Zhang, D., Zheng, W., Ning, L., 2018. Does innovation facilitate firm survival? Evidence from Chinese high-tech firms. Econ. Model. 75, 458–468.
Zumente, I., Bistrova, J., 2021. ESG importance for long-term shareholder value creation: literature vs.practice. J. Open Innov. Technol. Mark. Complex. 7 (2), 127.

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