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Title thesis: The Environmental Regulation Effect: A Study of IPO Underpricing and Long-Term Performance across different Countries Worldwide
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Abstract: Using a sample of 6,252 initial public offerings (IPOs) from 31 countries between 2000 and 2020, this study examines the effect of environmental rules on IPO underpricing, with a particular emphasis on the energy sector. Strict environmental regulations are analyzed for their effects on IPO underpricing and post-IPO performance using hierarchical linear models and an OLS regression. The findings indicate that IPO underpricing is negatively impacted by a country's stringency of environmental regulation. This means that although these rules promote sustainability and openness, they also put a heavy financial strain on businesses, which makes investors demand larger risk premiums. More precisely, the study discovers that underpricing is higher in energy companies that are directly impacted by these policies than in non-energy industries. Tighter environmental regulations may have unforeseen negative effects on IPO performance even while they are good for advancing sustainability. These results demonstrate the connection between financial market responses and regulatory frameworks. Policymakers, investors, and businesses can learn valuable lessons from this study regarding the financial effects of environmental policies.

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1 Introduction

The green energy sector has attracted significant attention from countries worldwide who want to shift to renewable energy (United Nations Environment Programme, 2024). This shift is possible due to technological advances, the growing environmental consciousness and the policy reforms that aim to reduce fossil fuel dependence and climate change. The International Energy Agency (2014) report predicts that energy-related investments will need to reach $53 trillion by the year 2035 for the aim of the Paris Agreement of capping the temperature rise that is 2 °C to be achieved. The risk of energy security and price fluctuations increases as the current misalignment in energy investments continues. A significant policy-driven increase in investment towards clean energy transitions is recommended to mitigate these risks. In this changing landscape, the IPO market has turned out to be the main route through which green energy companies that are looking for capital and want to grow can access funds. (Mendelsohn and Feldman, 2013) These businesses, however, can encounter some unique challenges and chances while going through the IPO process, such as the valuation of their shares in public markets. Environmental regulation could significantly shape the IPO underpricing dynamics for clean energy companies, influencing investor perceptions, market sentiment, and valuation metrics.

To illustrate, in 2016, Ørsted A/S (previously DONG Energy) went public and experienced an underpricing of 9.8% (Holme and Pehrsson, 2022). At the time of the offering, the company had significantly transformed from a traditional fossil fuel-based energy company to a leading player in the renewable energy sector, supported by the Danish and German government (McKinsey, 2019).

The Initial Public Offering (IPO) underpricing under academic research has been widely studied. Engelen and Van Essen (2010) have investigated the role of institutional traits of a country on the IPO underpricing using hierarchical linear modeling, which has incorporated issue-specific and firm-specific features. Their examination, which spanned 2,920 IPOs in 21 different countries, discovered that variations among countries contribute to 10% of the discrepancies in underpricing levels, demonstrating that a strong legal infrastructure within a country can significantly mitigate underpricing.

The study by Akyol et al. (2014) revealed that enhancing corporate governance standards increases transparency and minimizes information asymmetries impacting IPO valuations. From 1998 to 2021, the effects of adopting corporate governance codes in European Union Member States on the underpricing of IPOs in regulated markets were explored using a regression analysis. The study compared IPOs in member-regulated markets to a baseline of IPOs in exchange-regulated markets.

Zhao et al. (2018) researched the impact of environmental regulations on the share prices of fossil-based energy companies in China. Based on an event study methodology, their research found

that while legislative regulations negatively affect stock prices, the disclosure of environmental information and administrative regulations positively impact them.

Baker et al. (2021) discovered that countries with higher ESG Government Ratings typically experience less IPO underpricing, with consistent observations across different ESG pillars. Their multivariate analysis, which spanned 36 countries from 2008 to 2018, emphasized the crucial relationship between national institutions and the level of IPO underpricing at the firm level, aligning with the findings of (Engelen and Van Essen, 2010).

Anderloni and Tanda (2017) conducted the first analysis of European green energy companies' underpricing and subsequent stock performance at their IPOs. They highlighted the different underpricing and return trends between green and non-green energy firms, with their multivariate analysis revealing that green companies undergo less underpricing and that, over time, the performance trajectories of green and non-green firms converge, with traditional risk factors explaining the dynamics of returns.

Studies indicate that discrepancies in information, such as the diverging interests between a company initiating an IPO and its investment bank, significantly influence how much an IPO is underpriced. Ljungqvist (2007) pointed out this factor as key in determining IPO underpricing levels. Anderloni and Tanda (2017) discovered that, within European markets, companies in the green energy sector experience less underpricing than their non-green counterparts. However, there is a lack of research specifically delving into how environmental regulation impacts IPO underpricing for green energy companies.

Building a green financial system worldwide is important and green IPOs are crucial to this. Green IPOs help environmentally friendly companies get capital and support goals for a sustainable planet (Mumtaz and Smith, 2019). Backing business efforts in sustainability through their IPOs does more than just steer investment away from big polluters; it also boosts the growth of industries that emit less carbon. Furthermore, these actions make it easier for businesses to adopt greener practices. As a fresh and sustainable investment option, green IPOs present a new category of assets for investors around the world (Wang et al., 2022). Analyzing the pricing behavior of green IPOs will provide valuable insights for developing green equity financing in the future. By investigating the impact of environmental regulation on the underpricing of IPOs for energy firms across 31 different countries, this research aims to shed light on a crucial yet under-explored aspect of the energy transition. The research question that this thesis aims to answer is:

To what extent does environmental regulation affect the level of underpricing in initial public offerings for firms across different countries?

Following Anderloni and Tanda (2017), the sample will be based on all IPOs conducted between 2000 and 2020 located in countries with available environmental policy stringency ratings. The sample will be divided into two sub-samples: the energy and the non-energy sector. A 'more fair' sample of IPOs can be created by matching energy with non-energy firms. IPOs are identified using Eikon/Datastream, which also provides initial offering and first-day trading prices. Companies within the energy category are those engaged in producing and distributing fossil and alternative energy. The OECD Environmental Policy Stringency Index will be used to measure environmental regulation, a country-specific tool that offers a comparative measure of the toughness of environmental policy (Botta and Koźluk, 2014). The index's data will be obtained from the OECD.Stat database.

The dataset on IPOs shows that observations within the same country may not be entirely independent, indicating clustering by country. To address this issue, a two-level Hierarchical Linear Model (HLM) will be applied, following previous research and Engelen and Van Essen (2010). At level 1, the dependent variable is the extent of IPO underpricing, while at level 2, country-level predictors, including the Environmental Policy Stringency Index, will be introduced. A dummy variable will be constructed to investigate the different impacts on IPOs to differentiate between energy and non-energy firms. Moreover, the analysis will employ a random intercept model to accommodate variations in the initial intercept at level 1 across different countries. This means that the country acts as a random factor, which leads to correlated errors within countries while maintaining parallel slopes across them. This model's initial intercept representing IPO performance is modeled as a random outcome influenced by country-specific factors at level 2 (Marcato et al., 2018). The study will include a comprehensive set of control variables as advised by Ljungqvist (2007), and firm- and issue-specific data will be obtained from Eikon Refinitiv.

Next to the amount of IPO underpricing, this research also investigates the long-term performance of IPOs and how they are impacted by environmental regulation. Following a similar methodological framework as Gimeno and González (2022), the Fama French 5 Factor Model will be expanded with an additional environmental regulation term.

Aligned with the findings of Baker et al. (2021); Fenili and Raimondo (2021); Ferri et al. (2023), a trend is indicated where the market values environmental conscientiousness, driven by regulation. Based on this empirical evidence, stricter environmental regulations are expected to lead to lower IPO underpricing for firms across different countries, and the underpricing is lower for energy firms than non-energy firms. Also expected is that companies in countries with stricter environmental regulations experience better financial performance and higher stock returns after going public. Lastly, differences in regulatory stringency and market conditions are expected to result in variations in the impact of environmental regulation on underpricing across different countries.

This study investigates the relationship between environmental regulation and IPO underpricing, focusing on companies across 31 different countries. Previous studies have considered IPO underpricing and the influence of environmental policies, but this research integrates these areas to examine the specific impact of environmental regulation on IPO underpricing. A hierarchical linear modeling approach addresses the methodological gap in cross-country comparisons, which accounts for country-specific factors and firm-level variables. Additionally, this study provides insights into the financial dynamics of the energy sector by highlighting the role of environmental policy stringency in relation to regulatory environments and market behaviors within the context of sustainable finance.

The remainder of the paper is organized as follows: section 2 offers a closer look at the underlying theory and develops the hypothesis. Section 3 describes how the data for the different variables is obtained and describes the methodology. The results are presented in section 4. In section 5, robustness an diagnostic checks will be performed. Last, the limitations will be discussed in section 6, and the paper concludes in section 7.

2 Theoretical framework

2.1 IPO underpricing

The underpricing of IPOs has been a research subject for many years, with several important contributions exploring the topic. Studies by Ibbotson (1975) and Beatty and Ritter (1986) were some of the earliest works in the field, highlighting the prevalence of underpricing in IPOs and its implications for capital markets. The literature on IPO underpricing is broad and shows various theoretical perspectives, which can be broadly categorized into four primary themes: asymmetric information, institutional frameworks, issues related to ownership and control, and behavioral factors (Ljungqvist, 2007).

Asymmetric information, where there is an imbalance in the information available to different parties, is one of the primary explanations for IPO underpricing. Baron (1982) suggests that banks have access to more information on market demand than issuers, creating a principal-agent scenario in which underpricing incentivizes optimal sales efforts. In contrast, Welch (1989) suggests that issuers with superior knowledge of the company's true value might underprice shares as a value signal. Rock (1986) considers a scenario where certain investors possess more information than others, allowing them to sidestep overvalued IPOs. This scenario, known as the winner's curse, suggests that uninformed investors are at risk of overpaying unless underpricing is strategically employed. Additionally, Benveniste and Spindt (1989) suggests that underpricing acts as compensation to knowledgeable investors who share their insights before finalizing the issue price, thus minimizing the money left on the table.

The winner's curse theory posits that uninformed investors will typically achieve no abnormal returns on average after adjusting for rationing, which is essential for continued market participation. An early study by Koh and Walter (1989) explored oversubscribed IPOs in Singapore during the 1970s and 1980s, which were distributed through a random ballot. The findings indicated that the chance of receiving an allocation was inversely related to the degree of underpricing. Their research revealed a reduction in average initial returns, dropping from 27% to just 1% when adjusted for rationing, highlighting the impact of investor information heterogeneity.

Ritter (1984) introduced, and Beatty and Ritter (1986) later formalized the notion that IPO underpricing is expected to rise with the pre-offering uncertainty about a firm's value. This hypothesis is supported by extensive empirical evidence, indicating that minimizing the information asymmetry between informed and uninformed investors is key to lower underpricing. Engaging reputable underwriters or auditors can mitigate this issue by effectively "certifying" the offering's quality, thus diminishing the need for investors to generate their information and reducing the winner's curse (Ljungqvist, 2007).

The link between underwriters' reputation and initial returns on IPOs has yielded mixed results, with outcomes differing across various study periods. Research from the 1970s and 1980s by Carter and Manaster (1990) indicated a negative relation, while a study by Beatty and Welch (1996) in the early 1990s found a direct correlation, suggesting that more prestigious underwriters are now linked with greater underpricing. These findings highlight the evolving nature of the relationship between underwriter reputation and initial return.

Institutional frameworks related to IPO underpricing concentrate on litigation risk, price stabilization efforts by banks post-IPO, and tax implications of underpricing. The litigation risk is due to the tendency of American investors to initiate legal action, which leads to the hypothesis that companies may underprice their shares as legal insurance or to avoid potential legal actions from investors dissatisfied with the post-IPO performance of their stocks. This concept was originally presented by Logue (1973) and Ibbotson (1975), who proposed that a lower initial offering price could decrease the likelihood of shareholder lawsuits. Lowry and Shu (2002) discovered that around 6% of U.S. firms that underwent an IPO between 1988 and 1995 faced lawsuits related to their IPO, with lowering averaging 13.3% of the IPO proceeds. Although the threat of litigation does not significantly deter companies in some non-U.S. jurisdictions, where underpricing is also prevalent, avoiding legal challenges may still impact IPO underpricing.

The second institutional theory is the concept of price stabilization by banks after the start of trading. Underwriters may use price stabilization tactics shortly after an IPO to avoid price drops in the secondary market. Such practices are authorized in many jurisdictions, including the U.S., under the 1934 Securities Exchange Act, Rule 10b-7 (currently replaced by Regulation M), and aim to reduce instances of overpricing by adjusting the mean initial return upwards.

Direct evidence of price stabilization is limited, mainly because these operations are reported solely to market regulators and remain opaque to the wider investor community. Indirect evidence, such as the inventory accumulation patterns observed by Michaely and Shaw (1994) where the lead underwriter becomes the predominant market-maker post-IPO, suggests that price support activities are substantial and can extend over significant periods (Ljungqvist, 2007).

Ultimately, the potential tax benefits from IPO underpricing create a trade-off between the advantages of lower taxes and the costs associated with underpricing. From a managerial perspective, the optimal level of underpricing may vary depending on the specific tax circumstances (Ljungqvist, 2007). An examination of Swedish IPOs by Rydqvist (1994) showed that in 1990, the implementation of a policy that required individuals to pay income tax on gains related to underpricing. This policy change eliminated the motivation to distribute underpriced stocks to employees. This policy adjustment led to a noticeable decrease in underpricing, from an average of 4% during 1980-1989 to 8% in the period from 1990-1994, highlighting the influence of tax policy on IPO underpricing strategies.

The theories of ownership and control suggest that when a company underprices its IPO, it may be doing so deliberately to structure the shareholder base to reduce the potential for external investor interference after going public. This shift marks a critical phase toward separating ownership and control, significantly affecting strategic company operations and investment decisions. The alignment, or lack thereof, between ownership and control can lead to conflicts of interest, especially when non-managerial shareholders believe that those in control may pursue personal gains, such as excessive perks, at the expense of overall shareholder value. Such conflicts can potentially harm external shareholders (Jensen and Meckling, 2019).

There are two contrasting viewpoints in the literature regarding the debate on underpricing from the perspective of agency costs. Brennan and Franks (1997) posits that underpricing can help consolidate managerial control and reduce agency costs by diminishing the power of major external shareholders. Conversely, Stoughton and Zechner (1998) contends that underpricing can increase scrutiny and thereby lower agency costs by drawing in a broader base of investors.

Ljungqvist (2007) notes a growing interest in research exploring how variations in the institutional frameworks of different countries can impact IPO underpricing. While most current research in the field focuses on firm-specific and issue-specific factors that contribute to the uncertainty surrounding a firm's valuation, there has been relatively less emphasis on exploring how a country's specific institutional environment, as discussed by North (1991) and Tywoniak (2005), influences IPO underpricing. This perspective suggests that understanding the nuances of a country's business framework can provide deeper insights into the mechanisms of IPO underpricing.

IPO underpricing is frequently explained by the involvement of "irrational" investors who push IPO share prices beyond their intrinsic value or by behavioral biases that prevent issuers

from putting sufficient pressure on underwriters to price the offerings accurately. The IPO market provides an ideal setting to examine the influence of such "irrational" investors, as companies going public often do not have a track record of share prices, are often in their early stages of development, and possess characteristics that make them difficult to evaluate accurately. As a result, there is a wide variety of opinions on their true market value, making the pricing of these firms especially challenging (Ljungqvist, 2007).

More recent research on IPO underpricing has expanded to include many new areas. Studies have investigated how government policies, media coverage, and companies' specific challenges in developing countries can affect IPO prices. Additionally, companies' approach to ESG issues and its impact on IPO underpricing are gaining attention.

As pointed out by Ljungqvist (2007), there is increasing interest in the research examining how variations in different countries' institutional frameworks can affect IPO underpricing. Engelen and Van Essen (2010) carried out a study investigating the influence of a nation's institutional characteristics on IPO underpricing, using hierarchical linear modeling for accounting for characteristics specific to firms and their issues. Their examination, which spanned 2,920 IPOs in 21 different countries, discovered that variations among countries contribute to 10% of the discrepancies in underpricing levels, demonstrating that a strong legal infrastructure within a country can significantly mitigate underpricing.

Boulton et al. (2010) studied the effects of national governance frameworks on IPO underpricing and the valuation of firms going public. Their findings indicate that countries with more robust investor protection mechanisms tend to exhibit higher initial returns on IPOs. These findings are confirmed by Hopp and Dreher (2013), who analyzed the factors influencing IPO underpricing in 24 countries between 1988 and 2005 using a panel data analysis. Their findings indicate that nations with stronger investor protection measures tend to witness increased levels of underpricing. This implies that existing managers might use underpricing as a tactic to uphold their private control advantages during public offerings. Moreover, the study reveals that enhanced law enforcement and improved accessibility to accounting information tend to reduce underpricing by decreasing the value of private control benefits.

Within the financial literature, the importance of media has grown notably. Bajo and Raimondo (2017) investigate how news presentation influences retail investors' perceptions, subsequently affecting share demand and initial returns. Analyzing over 2,800 U.S. IPOs and 27,000 newspaper articles, they discover a positive correlation between the optimistic tone of news coverage and IPO underpricing. This relationship intensifies when the news is published nearer to the IPO date and is particularly pronounced when disseminated by more reputable newspapers. Another research performed by Chen et al. (2020) investigated the influence of media attention on IPO pricing globally. They conclude that extensive media coverage before an IPO correlates with reduced

initial returns on the IPO. This phenomenon is less pronounced in countries with superior financial reporting standards, enhanced protection of shareholder rights, and stricter control over media content, as well as for IPOs endorsed by well-regarded intermediaries. Additionally, their results indicate that increased media exposure before an IPO diminishes the information gap between investors, resulting in less underpriced IPOs.

The underpricing of IPOs in developing and emerging markets has garnered worldwide attention due to the unique institutional, regulatory, and market characteristics that differentiate these countries from developed ones. Several studies have attempted to explain the mechanisms behind this underpricing phenomenon in such situations. Mehmood et al. (2021) reviewed global financial markets, divided into emerging and developed markets by FTSE Russell, to determine the extent of IPO underpricing. They conducted an in-depth investigation of the extent of underpricing in both developed, developing, and emerging countries. Their findings show that underpricing is not limited to any particular type of capital market but affects all types of capital markets across the globe. Additionally, the research determined that developing markets are most affected, with considerable underpricing witnessed in countries like Saudi Arabia, Bangladesh, China, and the UAE, and the volatility is also high. The paper suggests that the main cause of underpricing in emerging markets is because of information asymmetry. The study also implies that the spread of fixed-price mechanisms, weak institutional frameworks, and inadequate measures to protect investors lead to this information gap. This, in turn, generates communication obstacles between the participants of the IPO process, such as issuers, underwriters, and investors.

2.2 Environmental regulation, firm performance and IPO underpricing

Environmental rules affect energy businesses differently than companies in sectors outside of energy. On one hand, such regulations can impose additional operational burdens, which could discourage investment and innovation in firms (Dechezleprêtre and Sato, 2017). Alternatively, government policies can encourage innovation in two main ways: by providing direct support for innovative activities through credits and subsidies for research and development and by encouraging firms to shift away from harmful production methods, thereby promoting innovation. Additionally, as noted by Popp et al. (2010), environmental regulations could boost the market for eco-friendly energy solutions, creating a stronger incentive for companies to invest in sustainable technologies, as the expected returns are higher than the costs of green innovation.

Two theories exist about the impact of environmental regulations: the Porter Hypothesis and the Pollution Haven Hypothesis. The latter, rooted in trade theory, proposes that strict environmental regulations raise operating expenses and might prompt industries to move their pollution-heavy operations to areas with lower mitigation costs, resulting in the creation of "pollution havens" and leading to policy-induced pollution leakage (Levinson and Taylor, 2008). In contrast, The Porter Hypothesis proposes that rigorous environmental regulations can actually improve firms'

competitiveness by prompting efficiency gains and cost reductions. These improvements may spur innovation in new technologies, potentially positioning these firms as international leaders in technology and expanding their market share (Porter and Van der Linde, 1995).

Empirical research consistently highlights the transformative power of environmental policies on enhancing green innovation and economic performance across various sectors and regions. Studies such as those by Nesta et al. (2014), Hille et al. (2020), Johnstone et al. (2010), and Wang and Zhang (2022) have demonstrated that renewable energy policies significantly propel technological advancements within environmentally friendly sectors such as wind and solar energy, not just in the US and Europe but also in a broader range of OECD and non-OECD economies. This global impact is further evidenced by data showing a rise in green patents stimulated by strategic non-market policies like RD subsidies and technological support, particularly effective in regions experiencing robust economic growth, stability, and minimal financial stress.

Additionally, the positive effects of these environmental regulations extend beyond immediate innovation to influence long-term economic performance. For example, research within the UK industrial sector by Ramanathan et al. (2010) reveals that while initial adaptation costs and challenges may temper innovation short-term, over time, these regulations drive significant improvements in operational efficiency and technology development, supporting the Porter Hypothesis (Porter and Van der Linde, 1995). This suggests that stringent environmental policies not only foster a sustainable environment but also enhance industrial competitiveness and economic resilience, proving beneficial across both advanced and emerging economies, as shown in studies by Bettarelli et al. (2023) and others. These findings highlight the dual benefits of environmental regulations—spurring green innovation and enhancing economic performance.

Parallel to technological advancements, environmental regulations have profound implications on financial markets, particularly in how companies are valued during IPOs. Studies have identified a clear relationship between stringent environmental regulations and reduced IPO underpricing. For instance, Akyol et al. (2014) and Zhao et al. (2018) explore how governance and transparency induced by environmental standards can mitigate information asymmetries, thus impacting IPO valuations positively. This relationship is emphasized further in the research by Baker et al. (2021), which correlates high ESG government ratings with lesser IPO underpricing across various nations. Moreover, the inclusion of ESG factors in IPO prospectuses, as discussed by Fenili and Raimondo (2021) and Ferri et al. (2023), underscores the importance of environmental disclosures in reducing underpricing by diminishing investor uncertainties and enhancing the market's perception of the firm.

2.3 Environmental regulation and post-IPO performance

Previous research indicates that IPOs usually perform worse than more established stocks over the long-term (Ibbotson and Ritter, 1995). Two semi-rational theories attempt to explain this

phenomenon. One theory suggests that since it's not possible to short sell IPOs and investors have differing expectations about the company's value, the most optimistic buyers drive up the price initially. Over time, as opinions become more normalized, the valuation by the marginal investor adjusts towards the average, leading to a price decline (Miller, 1977). Another theory posits that the amount of IPOs tends to increase following the success of previous ones. As a result, a significant portion of the latest batch of IPOs underperforms, making up a larger share of the sample Schultz (2003).

A review of over 2,200 studies by Friede et al. (2015) investigating the relationship between ESG standards and Corporate Financial Performance (CFP) reveals that almost 90% of the studies find a favorable association between ESG practices and financial performance. This implies that firms with robust ESG commitments typically attain superior financial outcomes.

However, a study by Hsu et al. (2023) also delves into how industrial pollution affects asset pricing, using mandatory emissions data reported to the Environmental Protection Agency (EPA) to measure annual toxic releases by firms. The research reveals that investing in high-emission firms while shorting low-emission counterparts within the same industry yields an average annual excess return of 4.42%. Traditional risk factors cannot explain this positive relationship between emissions intensity and returns and Fama and MacBeth (1973), and even when adjusting for other company characteristics through regression analysis, the findings remain consistent. Moreover, the study observes a decline in future profitability for high-emission companies following stricter environmental regulations.

Studies examining the relationship between corporate social responsibility (CSR) and stock market performance have produced conflicting results. In the 1970s, Alexander and Buchholz (1978) found a positive correlation between CSR initiatives and equity market outcomes in the United States. However, a smaller group of studies, including those conducted by Ingram and Frazier (1980); Preston and O'bannon (1997); Waddock and Graves (1997), have suggested a negative relationship between CSR involvement and corporate performance. The impact of CSR on financial performance is still a debated topic without a clear consensus. Recently, Havlinova and Kukacka (2023) investigated this relationship, focusing on the period after the global financial crisis. They measured CSR using the Environmental, Social, and Governance Combined Score (ESGC Score) developed by Thomson Reuters in 2017. This fresh approach, employing a distinctive indicator for corporate social responsibility actions, offers new insights into the dynamics between CSR and stock market performance post-crisis. By applying fixed effects regression with industry-clustered robust standard errors to estimate the connection, their findings show a statistically and economically significant beneficial impact of CSR on the stock market performance of firms.

Huang et al. (2019) developed indices to evaluate two critical aspects of Corporate Social Responsibility (CSR) information: Corporate Social Performance (CSP) and Corporate Environmental Performance (CEP). Their study focused on the impact of disclosing CSR information in IPO prospectuses within the Chinese market. The key discovery is a significant correlation between CSP disclosure and a firm's performance in the market after its IPO. In detail, firms that provide thorough CSP information but do not report donations or environmental expenses tend to see higher returns in the post-IPO period. However, this correlation does not extend to firms that report making donations and environmental expenditures. Furthermore, institutional investors apparently emphasize a firm's CEP details more than its CSP information.

The effects of environmental regulation on post-IPO performance remain relatively understudied. Zhou et al. (2020) performed a study investigating the effects of environmental policies on both financial and non-financial outcomes of publicly listed companies in China. With the data of 2,839 firms from 2014 to 2018 as their sample, their major discovery was that the financial performance of these companies was negatively associated with environmental regulations. Specifically, they found that environmental policies enacted by the government tend to limit the financial growth of businesses. Moreover, the study highlighted that the influence of these environmental regulations varied significantly across companies, depending on their level of pollution and the nature of their emissions. Firms categorized under heavy pollution sectors experienced significant financial constraints due to governmental environmental regulations, whereas companies in sectors with lesser pollution impacts saw minimal effects on their financial performance.

Another study on the Chinese IPO market is the research conducted by Liu et al. (2021). They investigated how fulfilling environmental responsibilities affects the financial performance of the Chinese IPO market. A study used panel data of listed companies from 2008 to 2017. The results showed that fulfilling environmental responsibilities can help companies convey positive signals to both the government and society. This, in turn, enhances their operational efficiency and competitiveness, significantly improving their financial performance.

The study conducted by Abbas et al. (2023) examines the impact of disclosures related to community and the impact of environmental concerns on the long-term stock price performance of recently listed companies in Malaysia. The study found that disclosing information about community involvement positively affects the performance of IPOs. However, the amount of environmental disclosures negatively impacts IPO performance. The research suggests that companies planning to go public in Malaysia should prioritize disclosing their corporate social responsibility initiatives, especially those that involve community engagement and environmental sustainability. Doing so could significantly improve their chances of success during the IPO process. These findings could help financial institutions and regulatory bodies to encourage firms to adopt more transparent practices around their contributions to community welfare and environmental sustainability.

Gimeno and González (2022) integrates a climate change exposure factor into existing stock return models. They construct a portfolio favoring companies with lower carbon footprints and betting against those with higher emissions. Their analysis reveals that climate change exposure significantly influences stock market returns, comparable to or surpassing the impact of other well-acknowledged factors in explaining expected returns.

2.4 Hypothesis

Based on the insights from existing literature, it becomes evident that the dynamics between environmental regulations and IPO underpricing require a closer examination. For instance, Baker et al. (2021) have highlighted how higher ESG Government Ratings, indicative of stringent environmental regulations, are associated with lower IPO underpricing. This suggests regulatory compliance may improve company valuations during IPOs by signaling investors lower risk and higher governance standards. Additionally, Fenili and Raimondo (2021) have demonstrated that increased ESG disclosure, a consequence of strict environmental regulations, can significantly reduce IPO underpricing by mitigating information asymmetry and enhancing investor confidence. These findings, along with the evidence provided by Ferri et al. (2023), who found that sustainability reporting before IPOs positively influences underpricing, indicate a trend where the market values environmental conscientiousness, driven by regulation. Based on these empirical evidences, the following main hypothesis is formalized:

H_1: *Stricter environmental regulations lead to lower IPO underpricing for firms in European markets*

Energy companies are increasingly influenced by environmental policies, which impact both operational and strategic decisions. Research suggests that strict environmental regulations may reduce IPO underpricing across markets. Given that green patents for renewable energy increase due to CCPs (Bettarelli et al., 2023), it's reasonable to believe that energy companies directly impacted by such policies may experience a favorable shift in investor perception over time. This positive shift would likely be due to the company's alignment with sustainable practices and innovations in green technologies, as signaled by the accumulation of green patents. Consequently, energy companies might witness less underpricing of IPOs, as by actively participating in green innovation, energy companies convey clear information about their future plans and sustainable practices. This could lead to lower uncertainty regarding the firm's value before the offering, leading to lower IPO underpricing (Beatty and Ritter, 1986). Another study by Ramanathan et al. (2010) supports this idea, finding that environmental rules for the energy, gas, and water sectors can make companies perform better financially. This is based on the thought that energy firms make themselves stand out to investors by working to meet environmental standards and innovate.

These efforts are seen as signs of a less risky company and more likely to succeed, leading to more favorable pricing when they first sell their shares to the public. The second hypothesis, therefore, is:

H_2: *Energy firms experience less underpricing compared to non-energy firms*

The research by Friede et al. (2015) showed a clear trend: companies that care about ESG factors often do better financially in the long run. Additionally, Hsu et al. (2023) study on pollution and stock prices indicates that high-emission firms' future profitability is lower after governments impose stricter environmental regulations. Based on these findings, it is possible that companies that adhere to stricter environmental regulations may experience better financial performance and higher stock returns after going public. This idea is the foundation of the third hypothesis:

H_3: *Countries with stricter environmental regulations are associated with better long-term stock performance post-IPO*

3 Data and methodology

3.1 Sample

A dataset comprising IPO events is assembled to evaluate the hypotheses. Data for IPOs conducted between 2000 and 2020, located in countries with available environmental policy stringency ratings, is sourced from Eikon Refinitiv. The top and bottom 1% observations are removed to exclude outliers and possible data mismatches. This process yields a dataset consisting of 6,252 IPOs across 31 countries. Data concerning post-IPO performance metrics is also acquired from Eikon Refinitiv, with any supplementary variables being sourced from Datastream by matching ISIN codes provided by Eikon Refinitiv.

3.2 Variables

3.2.1 Main variables

IPO Underpricing. The process of underpricing an Initial Public Offering (IPO) is typically evaluated by calculating the percentage difference between the offering price and the closing price on the first day of trading in the secondary market. In the United States, there is typically no adjustment made for market returns, while in Europe, such adjustments are becoming less frequent. The offering price is determined just a few days, and often just hours, before the beginning of trading on the stock market, indicating that fluctuations in the market between the setting of the price and the beginning of trading are minimal (Ljungqvist, 2007).

$$Underpricing_i = \frac{P_{i,1} - P_{i,\text{IPO}}}{P_{i,\text{IPO}}} \tag{1}$$

Where $P_{i,1}$ corresponds to the returns of the first day of trading and $P_{i,IPO}$ to the offer price.

Environmental regulation. Environmental regulations significantly impact the economy, but measuring the severity of these policies, also known as "stringency," is a complex task. Measuring this variable consistently across different nations and over time makes cross-country comparisons difficult. A study by Botta and Koźluk (2014) created two Environmental Policy Stringency (EPS) indices to evaluate environmental regulations. The indices combine scores from various policy instruments into comprehensive indices, targeting the energy sector and the wider economy. The study covers most OECD nations from 1990 to 2012 and found that these indices align well with other metrics for assessing policy stringency, environmental performance, and aggregate policy influences.

Kruse et al. (2022) updated the EPS index across 40 countries and 13 policy instruments from 1990 through 2020, offering three decades of data. This revision not only refines the index but also introduces a new sub-index that assesses the strength of technology support policies, thereby enriching the current framework of market and non-market-based indices.

Galeotti et al. (2020) evaluated various methodologies for quantifying environmental policy stringency and examined their influence on corporate innovation and the uptake of energy-efficient technologies. The study provides insight into the strengths and pitfalls of different approaches, including qualitative reviews, composite indices, and econometric analyses. The researchers underline the challenge of achieving consistent findings on policy stringency's impact across different contexts and indicators, pointing out that the diversity in outcomes observed in empirical research may stem from variations in the indicators used to measure policy stringency.

Scrieciu (2015) evaluates the body of research on quantifying environmental policy stringency and its interplay with economic growth. Their examination sheds light on the methodological and conceptual hurdles in measuring policy stringency, emphasizing the importance of both de facto enforcement metrics and de jure explicit measures. Although no single methodology emerges as superior for assessing the stringency of environmental policies, the authors advocate for a comprehensive approach that leans on direct, explicit measures. They also highlight the necessity for ongoing data collection and the refinement of indicators, supplemented by additional proxies to represent environmental policy stringency accurately.

Environmental regulations will be evaluated using the OECD Environmental Policy Stringency Index (EPS), a country-specific measure for comparing environmental policy stringency. This data will be obtained from OECD.stat. The index compiles and scores a range of policies on their stringency from zero to six based on the foundational work of Botta and Koźluk (2014). The index focuses on climate change and air pollution policies, where data availability is most robust. However, due to the lack of comprehensive cross-country data, it excludes other significant areas, such as water management, biodiversity, and waste management. The index has three

sub-indices: Market-Based Instruments (MBI), Non-Market Based Instruments (NMBI), and Technology Support (TS) policies, as detailed by Kruse et al. (2022). The MBI sub-index groups policies designed to monetize pollution, including various pricing mechanisms and consist of the following:

- *CO_2 Trading Schemes*: The intensity of CO_2 Trading Schemes is evaluated by the average price of emission permits per year, with higher prices indicating stricter regulations.
- *Renewable Energy Trading Schemes*: The stringency of Renewable Energy Trading Schemes is determined by the required proportion of electricity generated from renewable sources, with a higher mandated percentage reflecting greater stringency.
- *CO_2 Taxes*: The severity of CO_2 taxes is quantified by the rate applied to CO_2 emissions.
- *Nitrogen Oxides (NO_x) Tax*: The level of strictness for NO_x taxes is measured by the tax rate imposed on emissions.
- *Sulphur Oxides (SO_x) Tax*: The degree of strictness for SO_x taxes is assessed by the emission tax rate.
- *Fuel Tax (Diesel)*: The strictness is evaluated by the proportion of tax on a liter of diesel fuel relative to the pre-tax price utilized in the transport sector.

The Non-Market Based Instruments (NMBI) sub-index centers on regulations that prescribe specific emission caps and standards:

- *Emission Limit Value (ELV) for nitrogen oxides (NOx_x)*: This measure specifies the highest allowable nitrogen dioxide emission levels for newly established large coal-fired power plants, serving as a benchmark for regulatory standards in power generation. Stricter policies are indicated by lower permissible concentrations.
- *Emission Limit Value (ELV) for sulfur oxides (SO_x)*: This measure sets the upper limit for sulfur dioxide emissions from newly constructed large coal-fired power plants, reflecting regulatory norms in the sector. Policies are considered more stringent with reduced allowable concentrations.
- *EV for Particulate Matter (PM)*: This measure is defined as the maximal allowed particulate matter (PM) emission levels for new, sizable coal-fired power stations, acting as an emissions standards marker in power production. Lower thresholds signify tighter regulations.
- *Sulphur content limit for Diesel*: This standard dictates the maximal sulfur content allowed in diesel fuel for vehicles, with lower concentrations indicating higher regulatory strictness.

The Technology Support (TS) sub-index includes policies to promote clean technology innovation and adoption, featuring:

– *Public research and development expenditures*: This metric quantifies governmental spending on research and development for low-carbon energy solutions as a proportion of the nation's nominal GDP.

– *Renewable energy support for Solar and Wind*: This indicates the financial incentives provided for solar and wind technologies through mechanisms like feed-in tariffs (FIT) and renewable energy auctions, compared to the global average cost of producing electricity (LCOE).

The Environmental Policy Stringency Index (EPS) used to have two sub-indices: market-based and non-market-based policy measures. Nevertheless, the latest version of the EPS now comprises a third sub-index that concentrates on policies that support technological conditions. In addition to the existing sub-index, this particular sub-index includes policies that include government funding for research and development of low-carbon energy technologies and financial incentives for solar and wind energy, such as feed-in tariffs and renewable energy auctions. The amended framework has three sub-indices, each with equal weight, and is divided into market-based, non-market, and technology support policies. Technology support policies are further classified into two categories: upstream, which includes measures like public RD funding to foster innovation in emerging clean technologies, and downstream, which targets the deployment of specific technologies through renewable energy support schemes (Kruse et al., 2022).

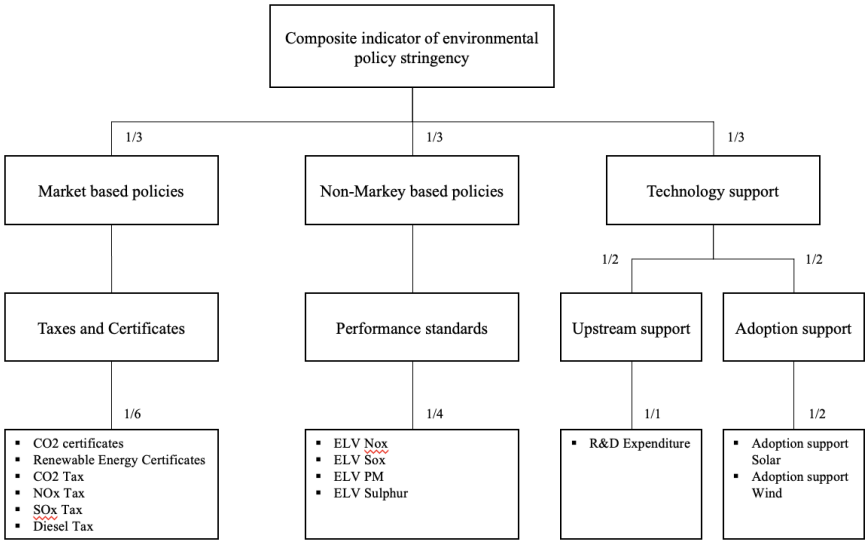


Figure 1: The aggregation structure of the revised EPS index. *Source: OECD*

3.2.2 *Firm- and issue-specific characteristics*

Research on IPOs has identified several factors that significantly affect underpricing levels. These factors are important to consider when analyzing underpricing dynamics. One factor is the *offer size*, which indicates the firm's size. Generally, larger firms are more transparent, reducing the informational gap between buyers and sellers. To analyze this variable, it is adjusted for inflation and presented in millions of euros. In the hierarchical linear modeling, this variable undergoes a logarithmic transformation to mitigate skewness (Baker et al., 2021).

Firm age is a metric that quantifies the disparity from a firm's foundation to its IPO. IPO underpricing tends to increase with greater pre-offering uncertainty regarding the firm's valuation (Ritter, 1984). With longer operational histories and publicly available financial records, mature firms tend to be scrutinized more by financial intermediaries and the media, thus diminishing valuation uncertainty and, consequently, underpricing. This inverse relation between firm age and underpricing has been validated by Su and Fleisher (1999), Loughran and Ritter (2004), and Chahine (2008).

High-tech companies usually encounter greater uncertainty before going public compared to their non-high-tech counterparts, leading to a tendency towards higher underpricing in their IPOs (Ritter, 1984). Technology-specific dummy variables or industry-specific dummies are used in the model to adjust for this effect (Roosenboom and Schramade, 2006; Benveniste et al., 2003).

Venture capital backing is important in reducing investor uncertainty about a firm's valuation. Venture capitalists contribute capital, expertise, and oversight, often engaging directly in the firm's governance. While venture capital backing traditionally correlates with reduced underpricing (Megginson and Weiss, 2022), other studies on this relationship have yielded mixed outcomes (Arthurs et al., 2008; Dolvin and Jordan, 2008; Guo et al., 2006).

The *price-earnings ratio (P/E ratio)* is another factor that acts as a firm-specific control variable. Firms with many growth opportunities often exhibit higher P/E ratios, introducing more risk and ambiguity about the firm's actual value to investors (Chen et al., 2004). Consequently, firms with elevated P/E ratios are typically associated with higher underpricing levels (Engelen, 2003; Hauser et al., 2006).

In *Privatizations*, governmental discretion in setting IPO prices allows for aligning pricing with broader political and economic goals, such as promoting retail investor participation through underpricing. This strategy commonly results in short-term underpricing, with governmental aims predominantly guiding pricing decisions Akyol et al. (2014).

Equity carve-outs (ECOs) involve the public offering of shares from a parent company's subsidiary to the public or qualified institutional investors. Due to the parent company's size, more information tends to be available to potential investors, influencing IPO underpricing. According to Akyol et al. (2014), ECOs negatively affect the degree of IPO underpricing.

Table 1
Description and overview of firm- and issue-specific variables

Variable	Description	Source	Obs.	Mean	SD
Ln(Firm age)	The natural logarithm of the duration from the company's inception to its IPO	Refinitiv Eikon	6,293	11.55	15.90
High-tech firm	An indicator variable set to one for firms operating within high-tech industries, and zero otherwise	Refinitiv Eikon	6,293	0.34	0.47
Venture capital backed	An indicator variable set to one for IPOs that received venture capital funding, and zero otherwise	Refinitiv Eikon	6,293	0.25	0.43
Privatizations	A binary variable that equals one if the IPO represents the privatization of a state-owned enterprise, and zero otherwise	Refinitiv Eikon	6,293	0.01	0.07
Equity carve-outs	A binary variable, assigned one if the IPO involves a subsidiary of a public company issuing shares to external investors, representing a minority interest, and zero otherwise	Refinitiv Eikon	6,293	0.14	0.34

Five of the seven firm- and issue-specific variables will be included in the model, as the offer size and price-earnings ratio are excluded due to limited data availability.

3.2.3 Country-specific characteristics

Researchers in the fields of law and finance have examined how variations in legal systems affect corporate finance decisions. A study by La Porta et al. (1997) was the pioneering work in this area. Researchers have conducted numerous studies on the relationship between legal infrastructure and corporate finance decisions, using various methods to evaluate the effectiveness of a nation's legal framework. One such study by Engelen and Van Essen (2010) found that the quality of a country's legal framework, which includes investor protection, overall integrity of the legal system, and enforcement levels, tends to reduce underpricing. This study aims to evaluate the impact of environmental policy stringency, which is a country-specific characteristic, on corporate finance decisions. The study also incorporates various firm-specific and issue-specific variables as controls in the analysis.

IPO activity also exerts a significant influence on IPOs. Underpricing increases with increased IPO volume and favorable stock market returns (Ritter, 1984). IPO activity is measured by the ratio of IPOs to total listed equities at the national level, as documented by the World Bank (Baker et al., 2021).

Djankov et al. (2008) introduced the *anti-self dealing index* as a measure of a country's efficacy in contract enforcement. This index evaluates the protection level against the misappropriation of assets by corporate insiders from minority shareholders. It uses a scale from zero to one, where zero indicates minimal legal protection and one indicates maximal legal protection. The index remains constant for a country throughout the study period and can be accessed via Professor Rafael

La Porta's website. Engelen and Van Essen (2010) and Banerjee et al. (2011) found a significant negative relationship between the anti-self-dealing index and IPO underpricing.

The *Rule of Law* factor measures the public's trust in societal regulations and their adherence. It is an initial measure for assessing legal institutions' quality across different regions (Kaufmann, 2004). This data is procured from the Our World in Data (OWID) database.

The *Corruption Perception Index* was defined as 'the use of public office for private gain' in 2002, and this index covers several dimensions, such as bribery and its influence on the business environment (Kaufmann, 2004). This study applies the Corruption Perceptions Index (CPI) by Transparency International to demonstrate this.

The *Public Enforcement Index* evaluates the effectiveness and quality of legal enforcement, concentrating on multiple facets of public enforcement Engelen and Van Essen (2010) also observed a strong negative correlation between the public enforcement index and IPO underpricing. The index's data can also be found on Professor Rafael La Porta's website.

Based on Baker et al. (2021) ESG framework, the *market integration* factor is represented by the Economic Globalization Index, which the KOF Swiss Economic Institute reports.

3.3 Analysis

3.3.1 Environmental regulation's impact on IPO underpricing

The Ordinary Least Squares (OLS) method is frequently used to analyze IPOs. However, the presence of similar patterns among IPOs within the same country suggests that Hierarchical Linear Modeling (HLM) offers a more suitable framework for examining the effects of country-level institutions while accommodating country-specific effects without breaching the independence assumption of residuals, as noted by Raudenbush and Bryk (2002). Engelen and Van Essen (2010) and Marcato et al. (2018) have applied this approach in examining cross-country IPO underpricing phenomena. Garson et al. (2013) highlights that OLS regression may underestimate the standard errors of predicted parameters when data within the same cluster are correlated, potentially leading to inaccurate or imprecise conclusions. For effective HLM analysis, a minimum of 20 observations per grouping level is recommended, a criterion satisfied by the dataset comprising 31 countries.

The dataset is structured into two levels, each with its own regression equation. The level 1 model incorporates predictors specific to the firm and issue, as outlined in Table 1. Conversely, the level 2 model involves predictors specific to the country and pertains to the environmental policy stringency index discussed in Table. 2. Unlike standard linear regression, the level 1 model permits variations in slopes and intercepts across different countries, highlighting the nuanced differences between them (Engelen and Van Essen, 2010). This enables the level 1 intercept to vary from country to country, introducing a random element through the country variable and generating correlated errors while maintaining parallel slope lines across different countries. In this model, the

Table 2
Description and overview of country-specific variables

Variable	Description	Source	Obs.	Mean	SD
Environmental regulation	A country-specific measure for comparing environmental policy stringency	OECD.stat	6,293	2.51	0.88
IPO-activity	The proportion of IPOs relative to the total number of listed equities at the national level	The World Bank	6,293	2.78	1.99
Anti self-dealing index	This index evaluates the degree of protection provided to minority shareholders from misappropriation by corporate insiders, with a scale from zero to one where one signifies maximum and zero minimum protection	Djankov et al. (2008)	6,293	0.64	0.17
Rule of Law	This metric assesses the government's adherence to legal norms, the independence of courts, clarity of laws, accessibility of justice, absence of corruption, and the neutrality of bureaucracy	Our World in Data	6,293	0.87	0.23
Corruption Perception Index	The Corruption Perceptions Index (CPI) evaluates countries based on the perceived levels of corruption within the public sector, derived from expert assessments and opinion poll	Transparency International	6,293	68.87	18.06
Public enforcement index	This index quantifies the effectiveness of a country's enforcement mechanisms	Djankov et al. (2008)	6,293	0.30	0.38
Market integration	The Economic Globalization Index	KOF Swiss Economic Institute	6,293	72.85	15.28

intercept of IPO performance at level 1 is considered a random effect, influenced by the particular country characteristics at level 2 (Marcato et al., 2018).

In a more detailed econometric expression, the Level-1 model can be described as follows:

$$U_{ijt} = \beta_{0j} + \beta_{1j} X_{ijt} + \epsilon_{ijt} \tag{2}$$

Where U_{ijt} represents the underpricing level for IPO i in country j in year t; X_{ijt} represents a vector of the control variables; ϵ_{ijt} is the overall error term at level 1, capturing unmeasured factors affecting IPO underpricing at the IPO level.

The Level-2 model can be outlined as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(EnvReg)_j + \gamma_{02} Z_j + u_{0j} \tag{3}$$

Where β_{0j} represents the intercept for country j, which is influenced by country-specific characteristics; $EnvReg_j$ is the primary independent variable at the country level, capturing the stringency of environmental policies in country j; Z_j is a vector of the control variables at the country level; γ_{00} is the average intercept across all countries, representing the baseline level of IPO underpricing when the environmental policy stringency index and other country-level controls are at their reference levels; γ_{01} and γ_{02} represent the effects of the environmental policy stringency index and country-level control variables on the baseline level of IPO underpricing; u_{0j} is the random effect for country j, capturing unexplained variation in the intercept across countries due to unobserved country-specific factors.

Following the methodology outlined by Pástor and Veronesi (2005) in their discussion on "Rational IPO Waves, time-fixed effects are integrated into various models. This approach uses a dummy variable for each year to account for annual variations. By doing so, it helps to separate the particular impacts of environmental regulation on IPO underpricing over different time frames.

An OLS analysis will be performed as a robustness check. If both models yield similar results for the key variables, the confidence of the findings will be strengthened.

3.3.2 Sector influence on IPO underpricing: energy vs non-energy firms

The HLM framework will be expanded to examine the second hypothesis and explore whether environmental regulation exerts a distinct influence on IPO underpricing for energy companies compared to non-energy companies. This will provide a more comprehensive understanding of how regulatory contexts interact with industry characteristics at various levels. The first step in this expansion is to distinguish firms based on their industry classification at the company level and classify them as either energy or non-energy firms. Again, different models with and without time fixed effects will be tested.

At the firm level, IPO underpricing is modeled as a function of environmental regulation, firm/issue characteristics, and interaction between firm type (energy vs. non-energy) and environmental regulation:

$$U_{ijt} = \beta_{0j} + \beta_{1j}(\text{EnvReg})_{ijt} + \beta_{2j}(\text{EnergyFirm})_{ijt} + \beta_{3j}(\text{EnvReg} \times \text{EnergyFirm})_{ijt} + \beta_X X_{ijt} + \epsilon_{ijt} \tag{4}$$

Where U_{ijt} represents IPO underpricing for firm i in country j in year t; $(\text{EnvReg})_{ijt}$ is the environmental regulation index in country j in year t; $(\text{EnergyFirm})_{ijt}$ is a binary indicator for energy firms; $(\text{EnvReg} \times \text{EnergyFirm})_{ijt}$ shows interaction term between environmental regulation

and the energy firm indicator; $\beta_X X_{ijt}$ is a vector of firm-specific control variables; ϵ_{ijt}: is the error term.

At the country level, we model how the intercepts and slopes from the Level-1 model vary with country-specific characteristics:

$$\beta_{0j} = \gamma_{00} + \gamma_Z Z_j + u_{0j} \tag{5}$$

Where: γ_{00} shows the average IPO underpricing across all firms and countries when environmental regulation and other predictors are at their reference levels; $\gamma_Z Z_j$ is the vector of country-specific characteristics affecting IPO underpricing; u_{0j} is a random effect capturing unexplained variation in IPO underpricing across countries.

To assess the differential impact, the coefficient of the interaction term β_{3j} in the Level-1 model is particularly interesting for testing the second hypothesis. A significant β_{3j} suggests that the effect of environmental regulation on IPO underpricing varies significantly between energy firms and non-energy firms.

As an additional robustness check to compare the impact of environmental regulation on IPO underpricing between energy and non-energy firms, a propensity score estimation using a logit model is performed.

3.3.3 Environmental regulation and post-IPO performance

Two important metrics are frequently used to assess the long-term performance of IPOs: Cumulative Abnormal Returns (CARs) and Buy-and-Hold Returns (BHRs). However, researchers have no agreement on the most efficient approach for assessing long-term stock returns. Similarly, Barber and Lyon (1997) find CARs to be an inaccurate predictor of long-term results and suggest using BHRs instead. On the other hand, Fama (1998); Gompers and Lerner (2003); Mitchell and Stafford (2000) insist that CARs are a better measure than BHRs both theoretically and statistically. One disadvantage of using CARs is that it assumes investments in IPOs need rebalancing regularly to ensure an even distribution of wealth across different IPOs.

Monthly benchmark-adjusted returns are calculated by deducting the monthly benchmark return from the monthly raw stock return over the same 21-trading-day period (Ritter, 1991). The abnormal return ($AR_{i,t}$) for a company i at a given time t is described as follows:

$$AR_{i,t} = r_{i,t} - r_{b,t} \tag{6}$$

where $AR_{i,t}$ is the monthly abnormal return of IPO i and $r_{b,t}$ is the benchmark return over period t.

Previous studies have adopted various benchmarks to assess the performance of IPO firms, emphasizing that these benchmarks should mirror the fundamental risk profiles of the IPO companies to reflect the expected return determinants accurately. One approach is to pair each IPO

firm with a publicly traded company sharing similar firm-specific attributes. However, using market indices as benchmarks proves to be more efficient for assessing investment strategies involving IPOs, according to Bergström et al. (2006) in their examination of underpricing and the subsequent long-term performance of IPOs.

The mean benchmark-adjusted return for a collection of n stocks over the course of month t is determined by the simple arithmetic mean of all the benchmark-adjusted returns:

$$AR_{p,t} = \frac{1}{n_p} \sum_{i=1}^{n_p} AR_{i,t} \tag{7}$$

where $AR_{p,t}$ is the equally weighted abnormal return of portfolio p in month t

The cumulative abnormal return (CAR_{t-T}) for the period from t to T is calculated as the aggregation of average abnormal returns:

$$CAR_{t-T} = \sum_{t=1}^{T} AR_t \tag{8}$$

For a portfolio p, if a company is delisted, the return for the subsequent month is computed as the equally weighted average return of the firms that continue to be part of the portfolio (Ritter, 1991).

The buy and hold return ($R_{p,T}$) for a portfolio p over a period T is the product of one plus the period returns:

$$R_{p,T} = \prod_{t=1}^{T} (1 + r_{p,t}) \tag{9}$$

where $R_{p,T}$ represents the portfolio's Buy-and-Hold Return (BHR) from the initial trading day in the year following the IPO year through the specified time period T. This calculation reflects the aggregate return from a buy-and-hold investment strategy, wherein an investor buys shares at the first closing market price after the IPO and holds onto them until either (i) the completion of a 3-year holding period, or (ii) the point of delisting. To assess this 3-year comprehensive return, a measure relative to wealth is employed to compare the portfolio's performance against various benchmarks by using the following formula:

$$WR_{p,T} = \frac{R_{p,T}}{R_{b,T}} \tag{10}$$

where $R_{p,T}$ is the daily compounded return of the portfolio over time T, and $WR_{p,T}$ is the resulting wealth relative for portfolio p over the same period. A wealth relative greater than 1.00 suggests that IPOs have outperformed a portfolio of comparable firms, while a wealth relative less than 1.00 indicates underperformance (Ritter, 1991).

Expanding the Fama-French five-factor model to include the Environmental Policy Stringency Index and its interaction with energy sector classification offers a nuanced analysis of how sustainable practices and regulatory pressures uniquely impact financial performance. A weighted average Environmental Policy Stringency is constructed per month to better estimate the policy stringency for the total sample. This is done as the dependent variable is the average monthly returns of the IPO firms across different countries. This study is consistent with Friede et al. (2015) findings that ESG factors impact firm value and stock returns, highlighting the financial relevance of sustainability measures. The Fama-French five-factor model, expanded to include environmental regulation, is specified as:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_m(R_{m,t} - R_{f,t}) + \beta_s SMB_t + \beta_h HML_t + \beta_r RMW_t + \beta_c CMA_t + \beta_e EPS_{i,t} + \epsilon_{i,t} \tag{11}$$

where $R_{i,t}$ is the return on stock i at time t; $R_{f,t}$ is the risk-free rate at time t; $R_{m,t}$ is the return on the market portfolio at time t; SMB_t is the size premium at time t; HML_t is the value premium at time t; RMW_t is the profitability premium at time t; CMA_t is the investment premium at time t; $EPS_{i,t}$ is the environmental policy stringency index for the country of stock i at time t; α_i is the intercept; and $\epsilon_{i,t}$ is the error term. The inclusion of the EPS Index aims to capture the impact of environmental regulation on the stock performance of firms post-IPO.

Two separate regressions will be conducted to investigate the distinct impacts of environmental regulations on the stock performance of energy versus non-energy companies. The average monthly returns of the energy and non-energy sectors will be the dependent variables. The other variables in the regression for the full sample remain unchanged. The weighted average of the Environmental Policy Stringency Index for both subsamples is calculated to improve the estimator.

$$R_{Energy,t} - R_{f,t} = \alpha_i + \beta_m(R_{m,t} - R_{f,t}) + \beta_s SMB_t + \beta_h HML_t + \beta_r RMW_t + \beta_c CMA_t + \beta_e EPS_{i,t} + \epsilon_{i,t} \tag{12}$$

$$R_{Non-Energy,t} - R_{f,t} = \alpha_i + \beta_m(R_{m,t} - R_{f,t}) + \beta_s SMB_t + \beta_h HML_t + \beta_r RMW_t + \beta_c CMA_t + \beta_e EPS_{i,t} + \epsilon_{i,t} \tag{13}$$

4 Empirical results

4.1 Environmental regulation's impact on IPO underpricing

To determine whether to use HLM over standard regression models, a random-effects ANOVA is used to evaluate significant variation among countries in the sample. The ANOVA helps to

determine whether differences between countries are significant. This analysis reveals that the overall average underpricing is 11.00% and statistically significant at the 1% level. The next step is calculating the intraclass correlation (ICC), representing the proportion of total variance attributed to between-group variation, specifically among countries. The ICC is computed at 11.12% and reflects a substantial variance in IPO underpricing attributable to differences among countries, underscoring the importance of considering country-specific characteristics when analyzing IPOs. The results from the one-way ANOVA with random effects are also shown in table 3 below.

Table 3
Results from the one-way ANOVA with random effects. This table details the outcomes of an analysis assessing the average underpricing of IPOs, represented by the fixed effect. The model quantifies variability at two levels: the country level (Level 2) and the IPO-specific level (Level 1), with their respective random effects parameters shown. Intraclass correlation indicates the proportion of variance explained by differences across countries. The fixed effect coefficient, its standard error, and the 95% confidence interval are provided.

	Coefficient	Std. err.	95% conf. interval
Fixed effect			
Average underpricing, γ_{00}	11.002***	1.666	[7.737, 14.266]
Random Effects Parameters			
Level 2 effect, u_{0j}	67.700	19.682	[38.293, 119.687]
Level 1 effect, e_{ij}	541.343	9.670	[522.718, 560.632]
Intraclass Correlation			
Country	0.111	0.029	[0.066, 0.181]

The results obtained from the hierarchical linear model are presented in table 4 and 5 on page 4 and 5, providing significant insights into the factors determining the degree of IPO underpricing from 2000 to 2020. The model includes level 2 variables representing country-specific characteristics, which are treated as fixed effects to evaluate their direct impact on IPO underpricing.

First, in model 1 of table 4, a baseline model is constructed that only includes firm and issue-specific characteristics. *Firm age* has a coefficient of 0.699 and a p-value of 0.014, indicating that older firms could slightly increase IPO underpricing. This relationship is in line with prior studies by Su and Fleisher (1999), Loughran and Ritter (2004) and Chahine (2008).

If a company is in the high-tech industry, represented by *dummy high-tech*, it shows a significant and substantial coefficient of 3.893 with a p-value of less than 0.001, suggesting a strong positive correlation between being a high-tech firm and the level of IPO underpricing, which confirms the findings of Ritter (1984).

The coefficient for *privatizations* is 0.404, but with a p-value of 0.929, it is not statistically significant. This means that privatizations do not influence IPO underpricing in a distinct pattern in this analysis.

The variable *equity carve-outs* has a negative coefficient of -1.144 with a p-value of 0.181, which means that equity carve-outs are associated with a decrease in IPO underpricing. However, this result is not statistically significant.

Table 4
HLM analysis of the impact of environmental regulation on IPO underpricing, 2000-2020 without time fixed effects. This table shows the outcomes from models 1-4, examining how environmental regulation affects the underpricing of IPOs. Key variables across two levels are presented: level 1 includes firm-specific characteristics, while level 2 captures broader economic indicators and regulatory conditions. The table showcases variations in the model specifications by progressively incorporating additional variables to assess their influence on IPO underpricing. Statistical significance is indicated with asterisks, reflecting varying levels of confidence (***p<0.01, **p<0.05, *p<0.1). The random effects at both firm and country levels highlight unobserved heterogeneity that could influence IPO pricing discrepancies.

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Firm age	0.700**	0.284	0.722**	0.285	0.915***	0.285	0.948***	0.285
Dummy high tech	3.893***	0.715	3.898***	0.715	3.892***	0.712	3.906***	0.712
Dummy privatizations	0.404	4.530	0.468	4.530	0.680	4.514	0.826	4.512
Dummy equity carve-outs	−1.144	0.856	−1.346	0.878	−1.420		−1.430	0.875
Dummy VC-backed	2.687***	0.867	2.625***	0.869	2.788***	0.866	2.813***	0.865
Level 2								
Environmental regulation			0.484	0.469	0.991**	0.473	1.001***	0.471
IPO Activity					1.140***	0.172	1.127***	1.172
Anti-self dealing index							20.542***	7.609
Rule of law								
CPI index								
Public enforcement index								
Market integration								
Constant	7.795***		6.508***	2.167	2.038	2.274	−7.925*	4.367
Time fixed effects	No		No		No		No	
Random effect								
Level 2 effect, u_{0j}	64.710		66.549		67.671		52.815	
Level 1 effect, e_{ij}	534.751		534.603		530.854		530.806	
Model fit								
Likelihood Ratio Test	651.25***		593.70***		593.27***		561.27***	

Venture capital backing, represented by *dummy VC-backed*, has a positive and significant impact on IPO underpricing with a coefficient of 2.686 and a p-value of 0.002. This suggests that venture capital-backed IPOs tend to be more underpriced, aligning with previous research by Megginson and Weiss (2022).

To establish the baseline for the study, we started with model 1. Then the country-specific variables are added to the subsequent models individually and the results are shown in table 5. The first variable that is added was *environmental regulation*, which is included in model 2. The estimated coefficient for environmental regulation was 0.483, with a standard error of 0.469. However, the result was not statistically significant, as indicated by a p-value of 0.303. When additional country-specific variables are controlled for in models 3 through 8, the influence of environmental regulation becomes significant. This suggests that in countries with more stringent environmental policies, there is a tendency toward greater underpricing of IPOs.

Table 5
HLM analysis of the impact of environmental regulation on IPO underpricing, 2000-2020 without time fixed effects. This table shows the outcomes from models 5-8, examining how environmental regulation affects the underpricing of IPOs. Key variables across two levels are presented: level 1 includes firm-specific characteristics, while level 2 captures broader economic indicators and regulatory conditions. The table showcases variations in the model specifications by progressively incorporating additional variables to assess their influence on IPO underpricing. Statistical significance is indicated with asterisks, reflecting varying levels of confidence (***p<0.01, **p<0.05, *p<0.1). The random effects at both firm and country levels highlight unobserved heterogeneity that could influence IPO pricing discrepancies.

	Model (5)		Model (6)		Model (7)		Model (8)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Firm age	0.934***	0.285	0.938***	0.285	0.968***	0.287	0.963***	0.287
Dummy high tech	3.935***	0.712	3.930***	0.712	3.951***	0.715	3.976***	0.715
Dummy privatizations	0.537	4.510	0.493	4.511	0.617	4.700	0.647	4.498
Dummy equity carve-outs	−1.538*	0.875	−1.565*	0.877	−1.602**	0.882	−1.561*	0.883
Dummy VC-backed	2.882***	0.863	2.900***	0.864	2.845***	0.867	2.851***	0.867
Level 2								
Environmental regulation	1.045**	0.468	1.076**	0.473	1.081**	0.476	1.341***	0.507
IPO activity	1.119***	1.171	1.122***	0.171	1.114***	0.172	1.167***	0.176
Anti-self dealing index	17.796***	6.698	18.113***	6.704	16.005**	7.727	15.739**	7.285
Rule of law	−15.991 ***	5.350	−14.474 **	6.550	−16.407 **	7.566	−14.114 *	7.484
CPI index			−0.025	0.062	−0.012	0.065	0.009	0.065
Public enforcement index					−1.760	3.703	−1.472	3.499
Market integration							−0.100	0.070
Constant	7.165	6.331	7.261	6.302	9.913	7.685	13.286*	7.549
Time fixed effects	No		No		No		No	
Random effect								
Level 2 effect, u_{0j}	37.576		37.033		37.581		32.119	
Level 1 effect, e_{ij}	530.826		9.483		532.117		532.245	
Model fit								
Likelihood Ratio Test	253.55***		253.61***		238.08***		172.44***	

The variable *IPO activity* displays a significant positive effect on the underpricing of IPOs with a coefficient of 1.140. This implies that a rise in IPO activity correlates with an increase in IPO underpricing. This confirms the results of Ritter (1984), who discovered that IPO underpricing is higher when overall stock market returns and IPO volume are high.

The *anti-self dealing index* measures how well minority shareholders are protected from being taken advantage of by company insiders. The variable has a positive coefficient of 20.542, which means that stronger protections against self-dealing (as reflected by higher index values) are linked to a higher level of IPO underpricing. This contradicts the findings of Engelen and Van Essen (2010), who found a negative relation between the anti-self dealing index and IPO underpricing. Companies may increase investor confidence by implementing stronger protections against self-dealing, which could raise expectations for future performance. When investors are more confident, it might lead to more interest and demand for the IPO. As a result, underwriters could price the IPO

higher relative to its market debut. However, if these expectations are not fully met immediately after the IPO, the relative increase in initial pricing could still result in higher underpricing. This measurement spans from the offering price to the closing price on the first day.

The *Rule of law* significantly negatively impacts IPO underpricing, as shown by a coefficient of -15.991, which is consistent with the findings of Engelen and Van Essen (2010) regarding underpricing. This implies that in regions where the legal system is more advanced and consistently implemented, IPOs may face less underpricing. This could be due to increased investor trust and reduced ambiguity.

The *CPI index* shows a negative coefficient of -0.025 with a p-value of 0.684; however, this coefficient is not statistically significant. Therefore, nothing can be said about the relationship between the CPI index and IPO underpricing.

Similarly, the *public enforcement index* has a negative coefficient but is also insignificant at the 10% level. Hence, no conclusions about the correlation between the index and IPO underpricing cannot be drawn.

Lastly, the *market integration* variable has a coefficient of -0.100, but, it is not statistically significant. Therefore, it cannot be determined if there is a meaningful relationship between market integration and IPO underpricing.

An OLS analysis with clustered standard errors to account for clustering within countries is performed as a robustness check, and the results are shown in table 6 above. The OLS analysis supports the findings, increasing confidence in the results from the HLM analysis. The coefficient of environmental regulation is 2.699 and statistically significant at the 1% level. The R^2 of models 1 and 2 increases from 2.22% to 10.31%. This means that in the second model, 10.31% variance can be explained by the variables included. A model excluding all country-specific variables yielded a R^2 of 2.22%. This means that stricter environmental regulations in a country lead to higher IPO underpricing. The main difference between the HLM and OLS analysis is that public enforcement has a negative sign in the HLM and a positive sign in the OLS regression. For privatizations it is the other way around, the sign is positive in the HLM and negative in the OLS regression.

The Likelihood Ratio Test results across models 1 to 8 in table 4 and 5 on page 28 and 29 show a consistent pattern of significant improvement ($p < 0.001$) as additional variables are incorporated into the hierarchical linear models. In particular, while each successive model remains statistically significant, indicating a better fit compared to simpler nested models, the decreasing chi-square values suggest diminishing returns in terms of model fit improvement. This pattern may indicate an approach towards an optimal set of explanatory variables, where further additions contribute less explanatory power and could risk model overfitting.

A noteworthy observation from table 4 and 5 is the decrease in Level 2 variance (between-group variability) from model 1 to model 4, indicating an improved explanation of the differences

Table 6
OLS regression analysis of the impact of environmental regulation on IPO underpricing for the period 2000-2020. This table presents two models analyzing the relationship between various firm-specific and country-specific factors and IPO underpricing. Model 1 focuses on firm- and issue-specific characteristics, while model 2 integrates additional country-specific variables to observe their impact on IPO pricing. Coefficients and standard errors are reported, with significance levels indicated (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)	
	Coefficient	se	Coefficient	se
Firm- and issue specific				
Firm age	0.983	1.021	0.767	0.952
Dummy high tech	1.479	1.159	3.354***	0.893
Dummy privatizations	−0.925	3.537	−3.164	3.535
Dummy Equity Carve-outs	−2.211*	1.189	−2.163**	0.916
Dummy venture capital-backed	6.491***	1.554	5.032**	2.022
Country-specific				
Environmental regulation			2.699**	1.047
Anti-self-dealing index			15.912**	7.386
Rule of Law			−14.826 **	10.247
CPI index			0.043	0.148
Public enforcement index			3.321	4.105
Market integration			−0.331**	0.130
IPO Activity			1.169**	0.468
Constant	11.419***	0.549	24.450***	2.503
Time fixed-effects	No		No	
R^2	2.22%		10.31%	
Number of observations	6293		6293	

between groups as more variables are introduced. This suggests that the added predictors are effectively capturing group-specific characteristics that influence IPO underpricing. However, the Level 1 variance (within-group variability) remains relatively stable across the models, implying that individual differences within groups are not significantly explained by the models.

Following the approach suggested by Pástor and Veronesi (2005), who discuss the phenomenon of "Rational IPO Waves," time-fixed effects are incorporated in the different models. This method involves including a dummy variable for each year in the analysis to control for annual fluctuations, thereby isolating the specific effects of environmental regulation on IPO underpricing across different periods. The results of the HLM analysis with fixed time effects are shown in table 7 and 8 on page 32 and 33.

When looking at the full model in table 8 on page 33 and comparing the results with the findings from the HLM analysis without fixed time effects in table 5 on page 29, the most important difference is that the proxy for measuring environmental regulation becomes insignificant. Also, an OLS regression with fixed time effects is performed and the results are shown in table 9 on page 34. When controlling for time-fixed effects, firm age becomes significant, but the variable for dummy equity carve-outs becomes insignificant. The other variables are in line with the OLS regression

Table 7
HLM analysis of the impact of environmental regulation on IPO underpricing, 2000-2020 with time fixed effects. This table presents the results from models 1-4, each incorporating time-fixed effects to control for period-specific variations that might influence IPO underpricing. Level 1 variables include firm-specific characteristics such as firm age and sector involvement, while level 2 variables cover broader economic and regulatory factors, including environmental regulation. Each model progressively adds more variables to explore their distinct impacts on IPO underpricing. The results are displayed with asterisks to show statistical significance (***p<0.01, **p<0.05, *p<0.1), and the inclusion of random effects accounts for unobserved heterogeneity at both the firm and country levels.

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Firm age	0.649**	0.284	0.643**	0.284	0.802***	0.285	0.864***	0.285
Dummy high tech	3.849***	0.714	3.841***	0.715	3.854***	0.712	3.837***	0.711
Dummy privatizations	−0.183	4.505	−0.277	4.508	−0.146	4.494	0.014	4.492
Dummy equity carve-outs	−1.481	0.905	−1.475	0.906	−1.353	0.903	−1.361	0.902
Dummy VC-backed	2.616***	0.867	2.666***	0.867	2.814***	0.867	2.838***	0.865
Level 2								
Environmental regulation			−0.524	0.870	0.241	0.876	0.305	0.857
IPO Activity					1.247***	0.198	1.229***	0.198
Anti-self dealing index							20.849***	7.549
Rule of law								
CPI index								
Public enforcement index								
Market integration								
Constant	−4.786	6.434	−4.495	6.445	−5.728	6.431	−15.807 **	7.412
Time fixed effects	Yes		Yes		Yes		Yes	
Random effect								
Level 2 effect, u_{0j}	67.314		65.942		66.562		51.550	
Level 1 effect, e_{ij}	527.799		527.814		524.491		524.432	
Model fit								
Likelihood Ratio Test	610.85***		538.61***		529.40***		499.79***	

without time-fixed effects from table 6. When examining the full model presented in Table 8, a notable difference appears compared to the HLM analysis without fixed time effects shown in Table 5: the significance of the environmental regulation proxy diminishes. Furthermore, the implementation of an OLS regression incorporating fixed time effects, as detailed in Table 9, reveals that while firm age is statistically significant, the dummy variable for equity carve-outs loses its significance. The results for other variables remain consistent with those from the OLS regression without fixed time effects described in Table 6. The results from the HLM and OLS analyses show that almost none of the year dummies are statistically significant, with only a few exceptions in different models. This suggests that temporal factors might not have a strong consistent impact on IPO underpricing during the period studied. However, the sporadic significance in certain years could indicate isolated temporal effects or anomalies rather than a consistent trend. Therefore, while time-specific variations exist, they do not appear to systematically influence the underpricing of IPOs across the studied period.

Table 8
HLM analysis of the impact of environmental regulation on IPO underpricing, 2000-2020 with time fixed effects. This table presents the results from models 5-8, each incorporating time-fixed effects to control for period-specific variations that might influence IPO underpricing. Level 1 variables include firm-specific characteristics such as firm age and sector involvement, while level 2 variables cover broader economic and regulatory factors, including environmental regulation. Each model progressively adds more variables to explore their distinct impacts on IPO underpricing. The results are displayed with asterisks to show statistical significance (***p<0.01, **p<0.05, *p<0.1), and the inclusion of random effects accounts for unobserved heterogeneity at both the firm and country levels.

	Model (5)		Model (6)		Model (7)		Model (8)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Firm age	0.835***	0.285	0.835***	0.285	0.864***	0.286	0.837***	0.286
Dummy high tech	3.850***	0.712	3.850***	0.712	3.862***	0.715	3.932***	0.715
Dummy privatizations	−1.132	4.491	−0.132	4.491	0.122	4.676	0.200	4.672
Dummy equity carve-outs	−1.357	0.902	−1.357	0.902	−1.430	0.907	−1.394	0.907
Dummy VC-backed	2.869***	0.865	2.870***	0.864	2.831***	0.867	2.850***	0.866
Level 2								
Environmental regulation	1.061	0.954	1.061	0.953	0.988	0.964	0.662	0.952
IPO activity	1.244***	0.198	1.244***	0.198	1.233***	0.199	1.290***	0.199
Anti-self dealing index	19.985***	6.856	19.985***	6.855	18.639***	7.941	17.501***	7.172
Rule of law	−7.923	6.752	−7.926	6.752	−8.560	7.883	−1.722	7.813
CPI index			−0.053	0.071	−0.063	0.068	0.033	0.074
Public enforcement index					−1.365	3.801	−0.897	3.432
Market integration							−0.250***	0.080
Constant	−4.981	9.008	2.316	9.671	−3.901	10.145	2.316	9.671
Time fixed effects	Yes		Yes		Yes		Yes	
Random effect								
Level 2 effect, u_{0j}	38.983		38.983		40.095		30.512	
Level 1 effect, e_{ij}	524.681		524.681		525.867		525.615	
Model fit								
Likelihood Ratio Test	241.58***		241.58***		230.11***		156.73***	

The results of hierarchical linear models without fixed time effects initially indicate that environmental regulation has no significant impact on IPO underpricing. However, as the models incorporate country-specific variables, the effect of environmental regulation becomes significant. This indicates that countries with more stringent environmental policies have higher IPO underpricing. It emphasizes the importance of considering institutional factors at the country level and firm-specific attributes when evaluating IPO underpricing.

The OLS analysis with and without fixed time effects confirms the relationship between stricter environmental regulations and increased IPO underpricing. However, the direction of the effect may differ between the HLM and OLS models for some control variables. These discrepancies suggest that while OLS provides valuable insights, it may not fully capture the complexity of the hierarchical data structure that HLM accommodates.

Based on the available evidence, it can be concluded that environmental regulation does increase IPO underpricing. The first hypothesis states that stricter environmental regulations lead to lower

Table 9
OLS regression analysis of the impact of environmental regulation on IPO underpricing, 2000-2020 with time fixed effects. This table displays results from two models assessing how environmental regulation influences IPO underpricing while controlling for time-specific variations. Model 1 focuses on firm- and issue-specific variables, whereas model 2 includes additional country-specific variables. The inclusion of time-fixed effects ensures that period-specific factors are accounted for, isolating the effects of the variables of interest. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)	
	Coefficient	se	Coefficient	se
Firm- and issue specific				
Firm age	0.788***	0.243	0.598***	0.249
Dummy high tech	1.717**	0.764	3.408***	0.737
Dummy privatizations	−1.322	2.867	−3.053	3.398
Dummy Equity Carve-outs	−1.242	0.883	−1.196	0.872
Dummy venture capital-backed	6.487***	0.867	4.722***	0.858
Country-specific				
Environmental regulation			3.582***	0.559
Anti-self-dealing index			17.289***	2.196
Rule of Law			−12.128 ***	3.396
CPI index			0.034	0.046
Public enforcement index			2.984	1.077
Market integration			−0.374***	0.044
IPO Activity			1.246***	0.196
Constant	4.138	5.878	21.990***	7.253
Time fixed-effects	Yes		Yes	
R^2	4.09%		11.66%	
Number of observations	6293		6293	

IPO underpricing for the firms in the sample. This is because regulatory compliance may improve company valuations during IPOs by signaling investors lower risk and higher governance standards (Baker et al., 2021). Additionally, Fenili and Raimondo (2021) have demonstrated that increased ESG disclosure, a consequence of strict environmental regulations, can significantly reduce IPO underpricing by mitigating information asymmetry and enhancing investor confidence, which is supported by Ferri et al. (2023) who found that sustainability reporting before IPOs positively influences underpricing. Therefore, the first hypothesis is rejected.

The relationship between strict environmental regulations and the higher underpricing of IPOs can be explained using Information Asymmetry Theory, which Rock (1986) discusses. According to the theory, companies tend to underprice their shares when there is a significant difference between what insiders and outside investors know. Although stricter regulations and more transparency can help reduce this information gap, they also make investors uncertain about the company's future costs and financial health. This uncertainty leads to higher underpricing because investors need a higher return to cover these risks, which aligns with Beatty and Ritter (1986) view on how market conditions affect IPO pricing. Recently, Baker et al. (2021) and Fenili

and Raimondo (2021) have discussed the role of ESG factors in enhancing transparency and reducing information asymmetry.

Companies operating in heavily regulated industries may incur higher operational costs due to the need to invest in advanced technologies and implement stringent emission controls, which makes them appear riskier to investors (Beatty and Ritter, 1986). These costs may include investing in advanced technologies, implementing enhanced waste management systems, and adhering to more stringent emissions controls. This perceived risk and the potential for future regulatory changes may lead investors to demand a higher return on investment, reflected in a lower initial offering price.

Additionally, the dynamics of the investor base itself may shift due to stringent environmental regulations. Investors focusing on sustainability may prefer firms that adhere to high environmental standards, potentially altering demand dynamics during the IPO and affecting the pricing strategy (Baker et al., 2021).

4.2 Sector influence on IPO underpricing; energy vs non-energy firms

For measuring the differential impact, a dummy variable is created within the dataset to distinguish energy firms from non-energy firms. It is assigned a value of one for companies within the energy sector and zero for all others. Subsequently, an interaction term is generated by multiplying this energy sector dummy variable by the environmental regulation measure. This interaction term is used to investigate the potential differential influence of environmental regulations on IPO underpricing between the two groups of firms.

In model 1 in table 10 on page 36, the significant negative coefficient for the *energy sector dummy* implies that, on average, energy sector firms experience lower IPO underpricing than non-energy sector firms. This could indicate that market participants view energy firms as potentially less risky or more attractive investments. This is reflected in a smaller variance between the offering and closing prices on the first trading day. Meanwhile, the interaction term between *environmental regulation* and the *energy sector dummy* shows a positive but statistically insignificant coefficient, suggesting that the differential impact of environmental regulation on underpricing across sectors is not substantial enough to be statistically verified from the data available.

In model 2, when *environmental regulation* is introduced, the negative coefficient for the *energy sector dummy* remains significant, reinforcing the notion that energy firms typically experience less underpricing. However, despite the increase, the interaction term coefficient remains statistically insignificant, indicating that the influence of environmental regulation does not significantly differ between energy and non-energy sectors. These findings are consistent in model 3, which also incorporates country-specific variables, suggesting that the observed patterns are robust across different model specifications. This result supports the argument that energy companies are inherently underpriced at IPOs, regardless of the impact of environmental regulations.

Table 10
HLM analysis results of the differential impact of environmental regulation on IPO between energy and non-energy firms, 2000-2020 without time fixed effects. This table details results from three models that assess the varying influences of environmental regulation on IPO underpricing across energy and non-energy sectors. The analysis is structured across two levels: Level 1 includes firm-specific variables and level 2 incorporates broader economic and regulatory variables. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)	
	Coefficient	se	Coefficient	se	Coefficient	se
Level 1						
Dummy energy sector	−11.234***	3.324	−11.030***	3.314	−10.540***	3.312
EnvReg * Energy Sector	3.049**	1.331	2.972**	1.355	2.884**	1.356
Firm age	0.606**	0.284	0.613**	0.2	0.856***	0.287
Dummy high tech	3.631***	0.718	3.634****	0.718	3.732***	0.718
Dummy privatizations	0.718	4.525	0.730	4.525	0.974	4.693
Dummy equity carve-outs	−1.360***	0.856	−1.417	0.877	−1.618**	0.882
Dummy VC-backed	2.742***	0.866	2.722***	0.868	2.927***	0.866
Level 2						
Environmental regulation			0.145	0.479	0.968**	0.518
IPO activity					1.145***	0.176
Anti-self dealing index					15.211**	7.352
Rule of law					−15.069**	7.526
CPI index					0.020	0.066
Public enforcement index					−1.651	3.531
Market integration					−0.089	0.070
Constant	8.376***	1.780	7.988***	2.189	14.484*	7.622
Time fixed effects	Yes		Yes		Yes	
Level 2 effect, u_{0j}	65.477		65.996		32.929	
Level 1 effect, e_{ij}	533.103		533.079		530.832	
Model fit						
Likelihood Ratio Test	652.30***		586.80***		173.05***	

The HLM results across models 1 and 3 show that environmental regulation's impact on IPO underpricing is distinct between the energy and non-energy sectors. Specifically, the consistently negative and significant coefficient for the *energy sector dummy* suggests that holding other factors constant, companies within the energy sector are associated with less IPO underpricing than their non-energy counterparts. Moreover, the interaction term between *environmental regulation* and *energy sector dummy* is positively signed and significant across all models, indicating that the effect of environmental regulation on IPO underpricing is stronger for firms in the energy sector. This implies that as environmental regulatory stringency increases, energy firms, possibly due to their heightened sensitivity to such regulations, experience greater IPO underpricing. This pattern persists even when controlling for additional firm- and issue-specific variables and country-specific characteristics, reinforcing the relationship's robustness.

As demonstrated in the previous section, time-fixed effects have been incorporated into both the HLM and OLS analyses. The results of the HLM model incorporating time-fixed effects are

Table 11
OLS regression analysis results of the differential impact of environmental regulation on IPO underpricing between energy and non-energy firms, 2000-2020 without time fixed effects. This table presents outcomes from three models examining the varied effects of environmental regulation on IPO underpricing across different sectors. Models incorporate firm- and issue-specific variables, with additional country-specific variables included in subsequent models. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)	
	Coefficient	se	Coefficient	se	Coefficient	se
Firm- and issue specific						
Dummy energy sector	−3.3494	3.320	−10.788***	3.483	−8.518**	3.466
EnvReg * Energy Sector	−0.712	1.342	2.191	1.401	1.821	1.397
Firm age	0.868***	0.241	0.669***	0.239	0.672***	0.245
Dummy high tech	1.154***	0.768	1.287*	0.762	3.082***	0.739
Dummy privatizations	−0.944	3.007	−1.537	3.307	−2.920	3.608
Dummy equity carve-outs	−2.334	0.843	−1.214	0.850	−2.239***	0.844
Dummy VC-backed	6.421***	0.872	6.861***	0.865	5.061***	0.853
Country-specific						
Environmental regulation			−2.974***	0.408	2.419***	0.425
IPO activity					1.153***	0.177
Anti-self dealing index					15.596***	2.177
Rule of law					−15.234***	3.344
CPI index					0.050	0.044
Public enforcement index					3.262***	1.058
Market integration					−0.326***	0.043
Constant	12.147***	0.572	19.715***	1.211	25.523***	2.531
Time fixed effects	No		No		No	
R^2	2.50%		3.51%		10.53%	
Number of observations	6.252		6.252		6.252	

presented in Table 10. In this model, both the effect and significance of the dummy variable for the energy sector, as well as the interaction between environmental regulation and the energy sector dummy, remain consistent with previous findings. Although the significance of some control variables has changed — some becoming significant and others losing significance — the overall results from the HLM model with time-fixed effects align with those reported in Table 10. Additionally, the OLS results with time-fixed effects, detailed in Table 12, also align closely with those from the OLS model without time-fixed effects, underscoring the consistency across different analytical approaches.

4.3 Environmental regulation and post-IPO performance

To evaluate the performance of IPOs in the long run, Buy and Hold Returns (BHR) and Cumulative Abnormal Returns (CAR) are calculated for intervals of 6 months, 3 years, and 5 years after the IPO. The results are presented in table 14 on page 40. The analysis indicates that the energy sector consistently outperforms the non-energy sector in terms of both BHR and CAR across most time frames, except for the 5-year BHR, where the non-energy sector shows higher returns. Only the

Table 12
OLS regression analysis results of the differential impact of environmental regulation on IPO underpricing between energy and non-energy firms with time fixed-effects, covering the period 2000-2020. This table presents findings from three models, each incorporating an increasing level of detail regarding firm-specific and country-specific variables. The models assess the influence of environmental regulation on IPO underpricing, with the inclusion of time-fixed effects to account for period-specific variations. The presence of time-fixed effects aims to isolate the effects of regulatory and economic variables more accurately. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)	
	Coefficient	se	Coefficient	se	Coefficient	se
Firm- and issue specific						
Dummy energy sector	−4.386	3.339	−11.084***	3.455	−9.541***	3.442
EnvRegxEnergyFirm	−0.329	1.348	2.473*	1.397	2.241	1.392
Firm age	0.671***	0.244	0.462	0.241	0.494*	0.251
Dummy high tech	1.418	0.769	1.602*	0.762	3.149***	0.742
Dummy privatizations	−1.299	2.967	−2.499	3.258	−2.743	3.537
Dummy equity carve-outs	−1.217	0.883	−1.084	0.878	−1.194	0.873
Dummy VC-backed	6.412***	0.867	6.833***	0.860	4.737***	0.856
Country-specific						
Environmental regulation			−3.756***	0.482	3.328***	0.567
Anti-self dealing index					16.973***	2.197
Rule of law					−12.507***	3.394
CPI index					0.038	0.046
Public enforcement index					2.874***	1.075
Market integration					−0.368***	0.045
IPO activity					1.245***	0.196
Constant	4.866	5.769	9.130	5.878	23.091***	6.828
Time fixed-effects	Yes		Yes		Yes	
R^2	0.36%		5.54%		11.90%	
Number of observations	6,252		6,252		6,252	

returns of the energy sector are statistically different from the non-energy sector at the 10% level. These results are consistent with the findings of Hsu et al. (2023), who discovered that investing in high-emission firms while shorting low-emission counterparts produces a positive excess return.

This study uses the Fama and French 5-factor model to assess the influence of environmental regulation on stock returns across different sectors in the full sample and the energy and non-energy sectors. The results are shown in table 15 on 41.

For the full sample, *environmental regulation* has a positive but statistically insignificant impact on the stock returns (coefficient = -0.005), suggesting that environmental regulation might not broadly affect the firms in this study. Similarly, the market factor coefficient is negative and insignificant (coefficient = -0.023), indicating that general market movements had a minimal influence on the stock returns across all sectors. The R^2 of the model is 13.18%, and this means that 13.18% of the variance can be explained by the Fama and French 5 factors and the proxy for environmental regulation.

Table 13
HLM analysis results of the differential impact of environmental regulation on IPO underpricing between energy and non-energy firms with time-fixed effects, covering the period 2000-2020. This table shows results from three models, each integrating both firm-specific factors and broader economic indicators across two levels of analysis. Each model is progressively adjusted to incorporate additional variables, revealing the effects on IPO underpricing. The inclusion of time-fixed effects helps control for period-specific fluctuations, thereby focusing on the variable effects. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)	
	Coefficient	se	Coefficient	se	Coefficient	se
Level 1						
Dummy energy sector	−11.542***	3.286	−11.835***	3.304	−11.108***	3.302
EnvReg * Energy Sector	3.259**	1.343	3.387**	1.352	3.188**	1.352
Firm age	0.541*	0.285	0.53*1	0.285	0.732**	0.287
Dummy high tech	3.616***	0.717	3.605***	0.717	3.710***	0.717
Dummy privatizations	0.159	4.501	0.035	4.503	0.566	4.668
Dummy equity carve-outs	−1.489*	0.904	−1.487*	0.904	−1.406	0.906
Dummy VC-backed	2.669***	0.867	2.735***	0.867	2.912***	0.865
Level 2						
Environmental regulation			−0.763	0.874	0.411	0.957
Anti-self dealing index					17.120***	7.208
Rule of Law					−2.830	7.840
CPI index					0.037	0.074
Public enforcement index					−1.071	3.450
Market integration					−0.234***	0.080
IPO activity					1.273***	0.199
Constant	3.572	6.433	−3.131*	6.445	3.597	9.698
Time fixed-effects	Yes		Yes		Yes	
Level 2 effect, u_{0j}	68.182		66.012		30.950	
Level 1 effect, e_{ij}	526.238		526.242		524.213	
Model fit						
Likelihood Ratio Test	241.58***		534.13***		156.26***	

The study found significant results for the size and value factors. The *size factor (SMB)*, which measures the performance difference between small and large companies, had a strongly positive and statistically significant effect on returns (Coefficient = 0.821). This suggests that smaller companies tended to outperform larger ones. during the period of the study. The *value factor (HML)* also had a positive and significant relationship with returns (Coefficient = 0.604), implying that companies with higher book-to-market ratios had better stock performance (Fama and MacBeth, 1973).

The *investment factor (CMA)*, showing a significant negative coefficient (Coefficient = -0.733), indicates that firms with lower capital asset investments yielded higher returns, which could reflect a market preference for less capital-intensive business models. The *profitability factor (RMW)* was insignificant, suggesting that this variable did not distinctly influence the stock returns during the analyzed period.

Table 14
Post-IPO Performance for the Period 2000-2020. This table summarizes the post-IPO performance across different time frames and sectors. Performance is measured using both Buy and Hold Returns (BHR) and Cumulative Abnormal Returns (CAR). The table shows the performance for the full sample, the energy sector, and non-energy sectors, along with their differential impact. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

Performance	Full Sample	Energy Sector	Non-Energy Sector	Difference
6M BHR	1.74%	7.27%	1.31%	5.96%*
3Y BHR	4.78%	8.44%	4.50%	3.94%*
5Y BHR	12.06%	-0.38%	12.85%	-13.22%
6M CAR	5.37%	3.66%	0.41%	3.25%
3Y CAR	8.92%	11.47%	8.61%	2.86%
5Y CAR	22.14%	36.05%	21.28%	14.77%

When breaking down the sample into energy and non-energy sectors, the analysis reveals sector-specific dynamics. When looking at the Energy sector, the coefficient for the *environmental regulation* proxy was found to be slightly negative (-0.010) but not significant. This indicates that environmental policies have no clear impact on stock returns within this sector. However, the *SMB factor*, which represents the size of the companies, was highly significant and strongly positive (coefficient = 1.677). This reinforces the idea that smaller energy companies have outperformed larger ones. Additionally, the *CMA factor*, representing investment intensity, negatively correlated with stock returns (coefficient = -1.315). This suggests that less investment-intensive energy companies performed better. For the energy sector, the R^2 is slightly higher at 17.29%.

Results for the non-energy sector are similar to those of the overall sample. Environmental regulation has a positive but insignificant effect (Coefficient = 0.006). The R^2 of the model is 12.78%. The size (SMB) and value (HML) factors positively and significantly affect stock returns. This aligns with the overall findings and shows that smaller and higher book-to-market firms consistently generate higher stock returns.

The data does not support the hypothesis that stricter environmental regulations lead to better long-term stock performance after IPO, as the results from the proxy for environmental regulation were not statistically significant. Although the impact of environmental regulation on stock returns did not show a significant result in this analysis, the directionality of its effects across different sectors needs to be investigated more closely. The coefficient was slightly positive within the full sample and the non-energy sector, suggesting that environmental regulations may potentially benefit stock returns. This could indicate that the broader market is neutral or mildly positive towards environmental compliance, possibly reflecting investor confidence in firms that exceed regulatory standards. This is supported by the positive correlation found in broader ESG studies (Friede et al., 2015).

Conversely, in the energy sector, the environmental regulation proxy shows a negative coefficient, which may reflect sector-specific challenges or costs associated with adhering to stringent

Table 15
OLS regression analysis results for the Fama and French 5-factor Model with the proxy for environmental regulation. This table presents the impact of environmental regulation on stock performance across the full sample, energy sector, and non-energy sector. It includes coefficients for the market, SMB (Small Minus Big), HML (High Minus Low), RMW (Robust Minus Weak), and CMA (Conservative Minus Aggressive) factors, alongside the constant. Results indicate the sector-specific influences of environmental regulation within the framework of the Fama and French model. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Full Sample		Energy Sector		Non-Energy Sector	
	Coefficient	se	Coefficient	se	Coefficient	se
Environmental regulation	0.005	0.008	−0.010	0.015	0.006	0.008
Market	−0.023	0.090	−0.095	0.167	−0.021	0.895
SMB	0.821***	0.217	1.677***	0.512	0.791***	0.216
HML	0.604***	0.218	0.089	0.583	0.621***	0.213
RMW	0.103	0.276	−0.771	0.634	0.133	0.276
CMA	−0.733***	0.021	−1.315**	0.602	−0.711*	0.378
Constant	−0.012	0.021	0.030	0.041	−0.013	0.021
R^2	13.18%		17.29%		12.78%	
Number of observations	252		252		252	

environmental regulations. Energy companies, particularly those involved in the oil and gas industry, often face greater expenses related to compliance and need to modify their operations in response to environmental policies. These changes may be viewed negatively by investors. These conclusions align with the research conducted by Zhou et al. (2020)), which demonstrated a negative association between environmental regulations and both financial and non-financial results. Specifically, they found that environmental policies tend to limit companies' financial growth and that firms categorized under heavy pollution sectors experienced significant financial constraints. In contrast, companies in sectors with lesser pollution impacts saw minimal effects on their performance.

The difference in the direction of the impact between sectors underscores the complex interplay between environmental regulation and sector-specific dynamics. It suggests that while environmental regulations might impose costs that could deter investor enthusiasm in more heavily regulated industries like energy, in other sectors, compliance could be associated with enhanced corporate governance and sustainability practices that appeal to investors.

5 Robustness and diagnostic checks

5.1 Robustness and diagnostic checks on the hierarchical linear modeling analyses

The first robustness test is to validate the impact of environmental regulations on IPO underpricing, an OLS analysis with clustered standard errors was conducted, accounting for clustering within countries. This analysis aligns with the results from the HLM model, and the findings are presented again in the table 6 on page 31.

In an additional robustness check, two extra control variables were incorporated at the firm level, but the sample size is significantly smaller compared to the main analysis. The Price-to-Earnings ratio, also used in Engelen and Van Essen (2010), and a dummy variable indicating the use of the bookbuilding method, as discussed in Baker et al. (2021), were included to enhance the model's specificity. The privatization variable was omitted due to uniformity across the sample, rendering it ineffective for differential analysis. The results of the HLM and OLS analysis are shown in table 17 and 18 in the appendix. The HLM model without fixed effects revealed that both the P/E ratio and the bookbuilding dummy were not statistically significant. However, the proxy for environmental regulation demonstrated significance, suggesting its impactful role in IPO underpricing. Upon integrating fixed effects into the HLM, environmental regulation maintained its significance. Also, an OLS regression was performed with two new control variables. The analysis revealed that the P/E ratio was consistently significant across all models, with a negative coefficient, suggesting that a higher P/E ratio reduces IPO underpricing. The dummy variable for the book-building method showed significance only in the first model, also with a negative coefficient, indicating its impact on reducing underpricing in this context. The results align with previous OLS analyses using the initial set of control variables. However, a notable shift was observed in the environmental regulation coefficient in models 1 and 3, which turned negative, contrasting with its previous positive influence. The negative sign in models 1 and 3 might be due to omitted variable bias. When country-level variables are excluded, the model may not fully account for broader regulatory or economic factors that influence IPO underpricing. Overall, the findings from both the HLM and OLS analyses, incorporating the P/E ratio and the bookbuilt dummy, reinforce the impact of environmental regulation on IPO underpricing.

The same robustness test is performed to measure the sector influence of environmental regulation on IPO underpricing between the energy and non-energy sectors. The HLM analysis in table 19 in the appendix shows that environmental regulation was only significant in the full model 2, which includes firm, issue, and country variables without time-fixed effects. Across all HLM models, the dummy variable indicating energy firms was consistently negative and significant, suggesting that energy sector firms experience less IPO underpricing compared to non-energy firms. This finding supports previous results presented in this paper. However, both the bookbuilt dummy and the price-to-earnings ratio were not significant in the HLM analysis. In the OLS regression in table 20 in the appendix, environmental regulation was significant in all models, but it displayed a negative coefficient in models 1 and 3, which focus solely on firm and issue-specific variables, both with and without fixed effects. The results for the energy sector dummy were consistent with earlier OLS analyses using the initial set of control variables. Unlike in the HLM, the interaction term was not significant in any OLS models. These results underline the complexity of factors influencing IPO underpricing and the specific impact of sector distinctions.

Overall, the findings from both the HLM and OLS analyses, which included the P/E ratio and the bookbuilding dummy, confirm the earlier results obtained using the initial set of control variables. These consistent outcomes across different models reinforce the robustness of the previous findings.

For measuring the sector influence on IPO underpricing, an interaction term between environmental regulation and a dummy for the energy sector is created. The introduction of this interaction term raises concerns about potential increases in multicollinearity, which could compromise the precision of the analysis. To assess the effects of this enhanced collinearity on the estimates, a similar methodology as Aiken et al. (1991) and Jaccard and Turrisi (2003) will be followed by mean-centering the two variables involved before creating the interaction term.

$$Interaction = (\text{EnvReg} - \text{Mean EnvReg}) * \text{Dummy Energy} \tag{14}$$

Even though the coefficient estimates for the centered variables differ, their impact and significance remain unchanged, indicating that the findings are not influenced by potential increased multicollinearity resulting from the interaction term. Again, when computing the VIF for the variables, they remain low, which supports the reliability of the results.

As an extra robustness check on the differential impact of environmental regulation on IPO underpricing between energy and non-energy firms, the propensity score estimation using a logit model is performed. Propensity Score Matching helps estimate treatment effects from observational data by addressing the challenge of missing potential outcomes for each subject. It does this by using the outcomes of similar subjects who have received a different treatment level. This similarity is determined based on estimated treatment probabilities, known as propensity scores. The Average Treatment Effect (ATE) is then calculated by averaging the differences between the observed outcomes and the imputed potential outcomes across all subjects. The analysis across the three different models suggests that there is no statistically significant (ATE) of being an energy firm on IPO underpricing. In model (1), which controls for firm-specific variables, the ATE of -1.278 with a standard error of 1.803 implies that energy firms do not significantly differ from non-energy firms in terms of IPO underpricing. When environmental regulation is introduced in model (2), the ATE becomes more negative -3.412 but with a larger standard error of 4.113, suggesting increased uncertainty around the estimate. This trend is consistent in model (3), which incorporates firm- and country-specific variables, yielding an ATE of -2.508 with a standard error of 1.855. Despite the lack of statistical significance, the consistent negative direction of the ATE across models may hint at a potential pattern where energy firms could be experiencing lower IPO underpricing compared to non-energy firms. However, this cannot be confirmed without statistical significance.

The first diagnostic check on the hierarchical linear model is to verify if the residuals from the model are normally distributed. The histogram in figure 2a shows a distribution close to the normal curve. This implies that the robustness of the findings justifies using parametric tests in the analysis.

Table 16
Results from Propensity Score Estimation using a Logit Model. This table presents the estimated Average Treatment Effects (ATE) from three different models. The coefficients are derived from the propensity score-matched samples to assess the impact of a specific treatment. Each model is calibrated to capture the underlying conditional probability of receiving treatment, factoring in observed covariates. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)	
	Coefficient	se	Coefficient	se	Coefficient	se
ATE	−1.278	1.803	−3.412	4.133	−2.508	1.855

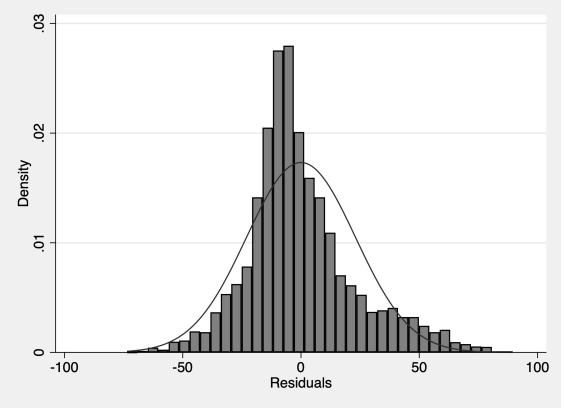
In addition, the residuals from the hierarchical linear model were evaluated using the Shapiro-Wilk test and quantile-quantile (QQ) plots, as the Shapiro-Wilk test returned a W statistic of 0.956 with a p-value of 0.000. Suggesting that the residuals do not follow a normal distribution. The QQ plot, which is displayed in figure 2b of the appendix, shows the presence of a thin tail, which is not too strong even as it shows some deviations. This narrow tail shows some minor misfits in the residual distribution, which may not significantly affect the reliability of the regression coefficients and all sample estimates. Despite these mild constraints, the main results of the Shapiro-Wilk test indicate that the assumption of normality is validly violated.

In the analysis of the variance inflation factor (VIF) for the variables used in the full model, all firm- and issue-specific, and country-specific variables demonstrated VIF scores that were comfortably low, indicating that there is no concerning level of multicollinearity among them. Multicollinearity can inflate the variance of an estimated regression coefficient, which may make it difficult to assess the true effect of each variable. This supports the reliability of the regression results, as it confirms that the individual predictors provide unique, non-redundant information to the model.

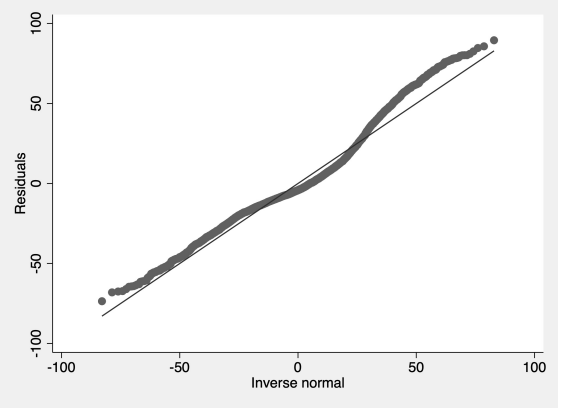
To determine the impact of firm-specific, issue-specific, and country-specific variables on IPO underpricing, models 7 and 8 stand out significantly. The results are again shown in table 4 and 5 on page 28 and 29. Both models exhibit the lowest AIC and BIC values compared to the earlier models. This indicates that they provide a better fit to the data and maintain a balance between model complexity and explanatory power. Given these findings, models 7 and 8 are identified as the most robust in our tested model suite. Their performance supports the inclusion of the specific country-level variables introduced in these iterations, demonstrating that these factors significantly enhance the model's explanatory capacity statistically. This reinforces the importance of considering both firm and issue-specific country-specific factors in the analysis, aligning with Engelen and Van Essen (2010).

The residuals versus fitted values from two hierarchical linear models, with all the firm- and issue-specific and country-specific variables incorporated - one with standard errors and the other with robust standard errors - reveal important insights into heteroscedasticity. Both figures 2c and

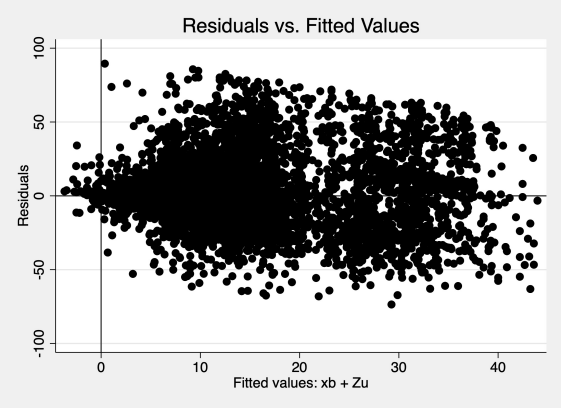
2d show a pattern indicative of heteroscedasticity, where the variance of residuals increases with the fitted values. This pattern remains consistent across both figures, suggesting that heteroscedasticity is a persistent issue in the data. Despite applying robust standard errors in the second model 2d, which does not correct the heteroscedasticity itself, there is an essential benefit. The use of robust standard errors helps to ensure that the estimated standard errors are reliable, supporting more robust statistics under heteroscedasticity. This is crucial for maintaining the validity of the model's conclusions.



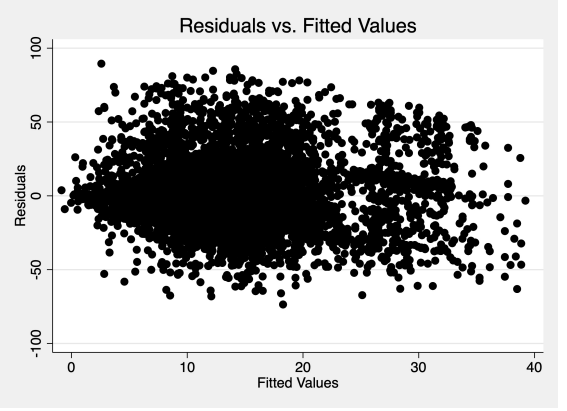
(a) Histogram of residuals HLM



(b) Quantile-quantile plot HLM



(c) Residuals vs. fitted values



(d) Residuals vs. fitted values (robust)

Figure 2: Diagnostic checks for HLM model

5.2 Diagnostic checks on the expanded Fama & French 5 factor model

To check if the residuals from the OLS model are normally distributed, a histogram was created and displayed in Figure 3a. The histogram shows an approximately normal distribution, indicating the robustness of the findings. In addition, the normality of the residuals was tested using the Shapiro-Wilk test and the QQ plot. The Shapiro-Wilk test yielded a W statistic of 0.961 and a p-value of 0.000, indicating that the null hypothesis that the residuals were normally distributed

should be rejected. The QQ plot, which is shown in figure 3b also supports this conclusion since significant exhibits a distinct path from the two-tailed line. However, evidence of non-normality in the residuals suggesting possible skewness or kurtosis indicates that the assumptions underlying the linear regression model may be violated. This violation might potentially impact the validity of inferential statistics derived from the model.

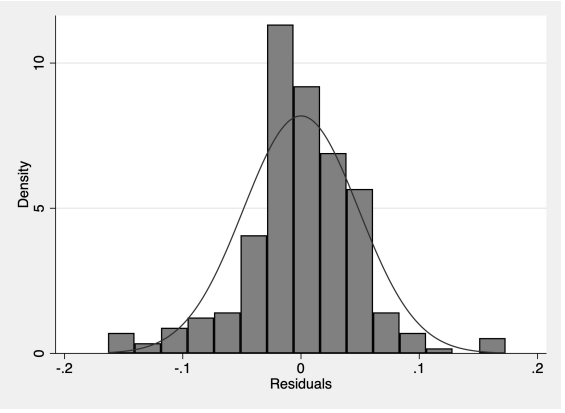
In the regression analysis, all Variance Inflation Factor (VIF) scores were found to be sufficiently low, indicating an absence of significant multicollinearity among the independent variables. Consequently, the model's stability and reliability were enhanced, allowing for more confident interpretations of the results.

Figure 3c shows that the residuals versus fitted values do not reveal any visible pattern that would indicate heteroscedasticity. The residuals are distributed uniformly across different levels of fitted values, suggesting that the variance of the residuals is constant. Therefore, it can be concluded that this model's assumption of homoscedasticity is satisfied, supporting the reliability of the standard errors and statistical tests used in the regression analysis.

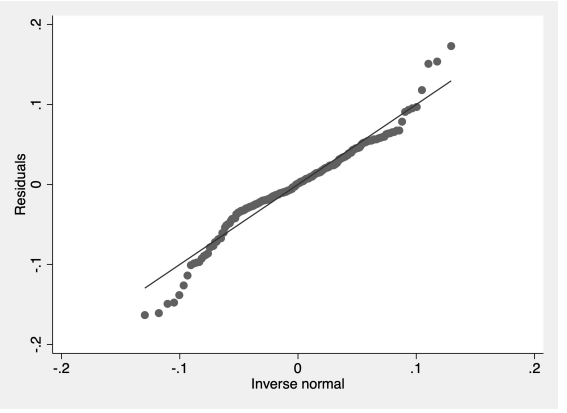
Also, following the execution of a Breusch-Pagan Test for heteroscedasticity, the resulting p-value falls slightly above the conventional threshold of 0.05. Consequently, the null hypothesis is retained, suggesting insufficient statistical evidence at the 5% significance level to assert the presence of heteroscedasticity within the residuals. This indicates a consistent variance across the range of fitted values. Thus, under a 5% significance level, the assumption of homoscedasticity for the model is accepted, which confirms the observations from figure 3c.

6 Discussion

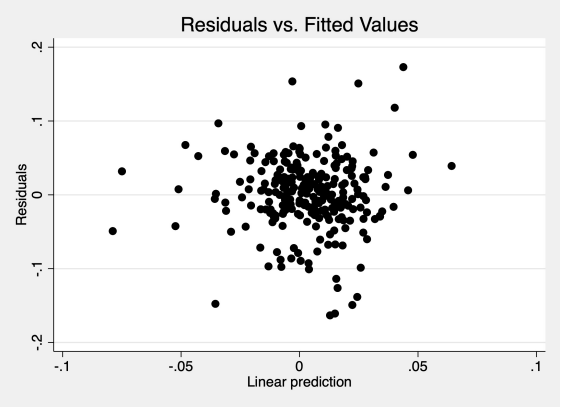
The study uses hierarchical linear modeling to examine the effects of country-level institutions on IPO underpricing while considering country-specific factors without breaking the independence assumption of residuals following the study by Raudenbush and Bryk (2002). This methodological choice is justified as it allows for a more nuanced analysis that considers the influence of macro-level factors on micro-level outcomes. The initial results of hierarchical linear models with and without time-fixed effects showed no significant impact of environmental regulations on IPO underpricing. However, as the models incorporated country-specific variables, the effect of environmental regulation became significant in the model without time-fixed effects. This means that countries with more stringent environmental policies have higher IPO underpricing. The study highlights the importance of considering institutional factors at the country level and firm-specific attributes when evaluating IPO underpricing, which is in line with the theoretical frameworks outlined by Engelen and Van Essen (2010) and Ljungqvist (2007). To ensure the robustness of the findings, the study conducted an OLS regression with and without fixed-time effects, along with clustered standard errors. The results were consistent with the HLM analyses. This supports the conclusion



(a) Histogram of residuals expanded FF5 model



(b) QQ plot of residuals expanded FF5 model



(c) Scatter plot of residuals expanded FF5 model

Figure 3: Diagnostic checks for expanded Fama & French 5 factor model

that environmental regulation indeed leads to an increase in IPO underpricing, contradicting the initial hypothesis, which suggested that stricter environmental regulations would result in lower IPO underpricing because regulatory compliance and higher ESG disclosure may improve company valuations during IPOs by signaling investors lower risk and higher governance standards (Baker et al., 2021). Conversely, more stringent environmental regulations might result in increased IPO underpricing because this makes investors more uncertain about the company's future costs and financial health. This uncertainty leads to higher underpricing because investors need a higher return to cover these risks, which aligns with Beatty and Ritter (1986)'s view on how market conditions affect IPO pricing

The empirical analysis through various models consistently indicates that energy firms are associated with less IPO underpricing than non-energy firms. This is supported by the significant negative coefficients for the energy sector dummy variable in both OLS and HLM frameworks. This aligns with the second hypothesis that energy firms experience less underpricing than

non-energy firms. A possible explanation is that energy companies, especially those in utilities or established energy production, tend to have more predictable and steady cash flows due to long-term contracts and regulated pricing. This predictability reduces uncertainty about future earnings, making it easier for investors to value the company accurately and effectively, reducing underpricing (Ritter, 1984; Beatty and Ritter, 1986). Over time, the perception of investors toward energy companies has improved, largely due to the rise in green patents and innovations driven by climate change policies (Bettarelli et al., 2023). As energy companies actively pursue green technologies, they not only commit to sustainable practices but also clearly convey their strategic intentions and lowered operational risks to the market. This commitment to environmental regulation is perceived as reducing the risks associated with their operations, leading to reduced IPO underpricing according to Beatty and Ritter (1986). Moreover, Ramanathan et al. (2010) observes that stringent adherence to environmental standards in the energy sector correlates with better financial performance, strengthening investor confidence. Perceived as lower-risk and more likely to succeed, these companies improve their market position and achieve more favorable pricing at IPO. This scenario aligns with the established theoretical understanding that reduced uncertainty and enhanced transparency regarding a firm's environmental compliance are associated with lower IPO underpricing (Beatty and Ritter, 1986). Environmental regulations could create a stronger incentive for companies to invest in sustainable technologies, as the expected returns are higher than the costs of green innovation, as noted by Popp et al. (2010). However, while environmental regulation may affect underpricing differently for energy firms due to regulatory sensitivity, the interaction effect in the OLS models was not statistically significant, making it difficult to confirm the differential impact posited in the hypothesis. On the other hand, the HLM results suggest a stronger impact of environmental regulation on underpricing within the energy sector. Although the propensity score analysis did not yield significant results, the directionality of the ATE across models suggests a pattern consistent with the hypothesis. These findings of the HLM analyses align with the theoretical expectations discussed in the literature review, particularly the theories regarding institutional frameworks and asymmetric information. According to Ljungqvist (2007), the regulatory framework within which firms operate significantly influences their market behavior and investor perceptions. This research underscores that energy firms, often at the forefront of regulatory scrutiny due to their environmental impact, might react more sensitively to changes in regulatory regimes. This aligns with the asymmetric information theory proposed by Rock (1986), where the presence of stringent regulations can exacerbate information asymmetries between informed and uninformed market participants, leading to higher underpricing.

The performance of Initial Public Offerings (IPOs) is assessed using two measures, Buy and Hold Returns (BHR) and Cumulative Abnormal Returns (CAR), over intervals of 6 months, 3 years, and 5 years after the IPO. The analysis shows that the energy sector consistently outperforms the

non-energy sector in terms of both BHR and CAR across most time frames. These findings align with Hsu et al. (2023), who found that investing in high-emission firms while shorting low-emission counterparts yields a positive excess return.

In the next step, the Fama French 5-factor framework is used to evaluate the influence of environmental regulation on stock returns (Fama, 1998). According to research conducted by Friede et al. (2015), companies that comply with stricter environmental regulations may experience better financial performance and higher stock returns after going public. The hypothesis that stricter environmental regulations are linked to better long-term stock performance post-IPO cannot be confirmed based on this analysis, because the proxy used for environmental regulation did not yield statistically significant results. Although the analysis did not show a significant result regarding the influence of environmental regulation on stock returns, the difference in the direction of the impact between sectors highlights the complex interplay between environmental regulation and sector-specific dynamics. This suggests that while environmental regulations may impose costs that could deter investor enthusiasm in more heavily regulated industries like energy, in other sectors, compliance could be associated with enhanced corporate governance and sustainability practices that appeal to investors.

The main research question focuses on investigating how environmental regulations impact the level of IPO underpricing in different countries. Environmental regulations have a significant impact on IPO underpricing. Stricter regulations usually lead to higher underpricing, as investors consider potential future compliance costs and financial uncertainties (Beatty and Ritter, 1986). However, this effect varies depending on the sector. Energy companies, for example, often experience lower underpricing due to their predictable cash flows and regulatory adherence, which boosts investor confidence and reduces perceived risks (Bettarelli et al., 2023; Ramanathan et al., 2010). The relationship between environmental regulation and sector dynamics is complex, and the impact of regulations on underpricing depends on various factors, such as operational characteristics and the stringency of regulatory environments (Ljungqvist, 2007; Engelen and Van Essen, 2010). Therefore, environmental regulations are crucial in shaping IPO underpricing, reflecting broader institutional and market dynamics.

7 Conclusion

This paper investigates the relationship between environmental regulation and IPO underpricing and the long-run performance post-IPO. Previous studies have considered IPO underpricing and the influence of environmental policies, but this research integrates these areas to examine the specific impact of environmental regulation on IPO underpricing and post-IPO performance. A hierarchical linear modeling approach addresses the methodological gap in cross-country comparisons, which accounts for country-specific factors and firm-level variables. Additionally, this study specifically

looks into the financial dynamics of the energy sector by highlighting the role of environmental policy stringency in relation to regulatory environments and the IPO pricing dynamics. Therefore, this paper aims to answer the main research question: To what extent does environmental regulation affect the level of underpricing in initial public offerings for firms across different countries?

A dataset of 6,252 IPOs across 31 different countries between 2000 and 2020 is used to answer this research question. In the first part of the analysis, the hierarchical linear modeling approach is used because it offers a more suitable framework for examining the effects of country-level institutions while accommodating country-specific effects without breaking the independence assumption of residuals. The first hypothesis states that implementing stricter environmental regulations would result in a lower level of IPO underpricing. The reasoning behind this theory was that these regulations would enhance the reputation of a company which in turn reduces information assy, entry and increases investor confidence (Baker et al., 2021; Fenili and Raimondo, 2021; Ferri et al., 2023). However, the opposite was found in this study. Instead, the results suggest that more stringent environmental regulations would lead to higher IPO underpricing. This implies that while environmental regulations may promote sustainable practices and improve transparency, they also introduce significant costs and uncertainties for companies, leading investors to compensate for these risks with higher risk premiums.

Moreover, a sector-specific analysis showed that environmental regulations impact the energy sector differently than non-energy sectors. Energy firms that are directly affected by these regulations show higher IPO underpricing relative to their non-energy counterparts, aligning with Anderloni and Tanda (2017) findings of sector-specific impacts of environmental regulation. This sector-specific behavior highlights the varying degrees to which different industries react to regulatory changes.

Finally, to assess the long-term performance of the IPOs in the sample, an expanded Fama French 5-factor model is used Fama (1998). This model includes a proxy for environmental regulation to determine the impact of environmental regulation on stock returns for the entire sample and the energy and non-energy sectors. The analysis showed non-statistically significant coefficients for environmental regulation across the full and sub-samples. Therefore, nothing can be said anything about the impact of environmental regulation on post-IPO performance.

This study provides new empirical evidence showing that IPO underpricing is negatively impacted by a country's stringency of environmental regulation, which is more pronounced for the energy sector. It shows that these policies can have complex consequences on financial markets and offers valuable insights for policymakers, investors, and firms to understand the potential economic implications of regulatory decisions. By considering these dynamics, stakeholders can make better decisions about balancing regulatory compliance and financial performance.

The study provides valuable insights, but there are some limitations to consider. One limitation is the possibility of omitted variable bias, as the models used may not consider all relevant factors that affect IPO underpricing and post-IPO performance, such as market sentiment or unobserved firm characteristics. Furthermore, the use of environmental regulation as a composite index may oversimplify the complexities of individual policies and their specific impacts on firms, as discussed by Baker et al. (2021) and Ljungqvist (2007). Finally, it is worth noting that there could be endogeneity issues within the models when interpreting the causal relationships between the underpricing of IPOs and environmental regulation. This is because companies may strategically time their decision to initiate an IPO to take advantage of favorable regulatory environments, suggesting a possible reverse causality where both the independent and dependent variables influence each other.

It's important to conduct further research on how other sectors with different levels of exposure to environmental regulation affect IPO underpricing and long-run performance. This would help to understand the effects of environmental regulations across various industries. Although the study analyzed the effect of environmental regulations on post-IPO performance, the results were insignificant. Future research is needed to explore longer time frames or to include additional variables that might capture the effects of environmental regulation. Lastly, the presence of heteroscedasticity suggests that further work could refine the model specifications. These methods could improve the accuracy and predictive performance of the models used to analyze the post-IPO performance.

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Appendix

Table 17
HLM analysis of the impact of environmental regulation on IPO underpricing for the period 2000-2020 with extra control variables on firm level. Level 1 variables include firm-specific characteristics such as firm age and sector involvement, while level 2 variables cover broader economic and regulatory factors, including environmental regulation. Models 1 and 2 show the firm and-issue specific variables and the proxy for environmental regulation. Models 2 and 4 also include the country-specific variables. The results are displayed with asterisks to show statistical significance (***p<0.01, **p<0.05, *p<0.1), and the inclusion of random effects accounts for unobserved heterogeneity at both the firm and country levels.

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Firm age	0.644	0.393	0.894**	0.369	0.635	0.393	0.866**	0.396
Dummy high tech	2.298**	1.001	2.198**	1.004	2.187**	1.004	2.169**	1.007
Dummy equity carve-outs	−3.118***	1.194	−3.644***	1.205	−3.170***	1.226	−3.450***	1.237
Dummy VC-backed	3.196***	1.207	3.452***	1.202	3.442***	1.206	3.642***	1.201
Dummy Bookbuilt	−1.343	6.271	−1.317	6.272	−1.121	6.283	−1.540	6.292
Price earnings ratio	−0.005	0.005	−0.005	0.005	−0.005	0.005	−0.005	0.005
Level 2								
Environmental regulation	0.981	0.644	2.249***	0.703	−0.054	1.096	1.977*	1.192
IPO Activity			1.226***	0.234			1.349***	0.275
Anti-self dealing index			19.961***	7.499			21.306***	7.398
Rule of law			−10.774	8.606			−5.066	8.813
CPI index			−0.034	0.086			−0.004	0.096
Public enforcement index			−0.737	3.602			−0.482	3.538
Market integration			−0.079	0.088			−0.169*	0.097
Constant	6.642**	2.541	7.720	7.781	1.322	9.683	6.038	12.305
Time fixed effects	No		No		Yes		Yes	
Random effect								
Level 2 effect, u_{0j}	57.347		25.536		56.717		23.953	
Level 1 effect, e_{ij}	534.268		532.597		527.785		526.857	
Model fit								
Likelihood Ratio Test	231.45***		49.33***		208.79***		45.46***	

Table 18

OLS regression analysis of the impact of environmental regulation on IPO underpricing, 2000-2020. This table displays results from four models assessing how environmental regulation influences IPO underpricing while controlling for time-specific variations. Model 1 focuses on firm- and issue-specific variables and environmental regulation, whereas model 2 includes additional country-specific variables. The inclusion of time-fixed effects ensures that period-specific factors are accounted for, isolating the effects of the variables of interest. Statistically significant results are marked with asterisks (***p<0.01, **p<0.05, *p<0.1).

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Firm- and issue specific								
Firm age	0.784**	0.332	0.645*	0.349	0.582*	0.335	0.613*	0.349
Dummy high tech	0.254	1.048	1.624	1.011	0.306	1.051	1.686*	1.019
Dummy equity carve-outs	−3.825***	0.988	−4.173***	1.035	−3.895***	1.077	−3.359***	1.104
Dummy VC-backed	7.326***	1.192	5.427***	1.190	7.606***	1.185	5.563***	1.193
Dummy Bookbuilt	−5.626**	2.747	−2.296	3.087	−4.863	3.193	−3.280	3.467
Price earnings ratio	−0.007**	0.003	−0.004*	0.002	−0.005**	0.002	−0.005**	0.002
Country- specific								
Environmental regulation	−1.665***	0.548	3.311***	0.576	−2.413***	0.649	3.814***	0.757
IPO Activity			1.325***	0.257			1.389***	0.280
Anti-self dealing index			15.020***	3.009			16.344***	3.057
Rule of law			−13.485***	4.616			−11.051**	0.067
CPI index			0.065	0.062			0.071	0.067
Public enforcement index			1.162	1.463			0.992	1.481
Market integration			−0.320*	0.002			−0.357***	0.061
Constant	16.638***	1.638	21.201***	3.393	12.308	11.778	28.011**	12.639
Time fixed effects	No		No		Yes		Yes	
R2	3.11%		9.68%		4.96%		10.79%	
Number of observations	3187		3187		3187		3187	

Table 19
HLM analysis results of the differential impact of environmental regulation on IPO underpricing between energy and non-energy firms with time-fixed effects, covering the period 2000-2020. Models 1 and 2 show the firm and-issue specific variables and the proxy for environmental regulation. Models 2 and 4 also include the country-specific variables. The results are displayed with asterisks to show statistical significance (***p<0.01, **p<0.05, *p<0.1), and the inclusion of random effects accounts for unobserved heterogeneity at both the firm and country levels.

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Level 1								
Dummy energy sector	−9.173*	4.869	−8.500*	4.867	−10.137**	4.885	−9.806**	4.885
EnvReg * energy sector	2.433	1.978	2.303	1.978	2.871	1.981	2.766	1.982
Firm age	0.563	0.394	0.818**	0.397	0.551	0.394	0.787**	0.397
Dummy high tech	2.068**	1.007	1.199**	1.010	1.967*	1.008	1.964*	1.011
Dummy equity carve-outs	−3.161***	1.193	−3.678***	1.203	−3.165***	1.225	−3.451***	1.235
Dummy VC-backed	3.253***	1.206	3.490***	1.201	3.479***	1.205	3.669***	1.201
Dummy Bookbuilt	−1.640	6.266	−1.637	6.270	−1.375	6.277	−1.821	6.287
Price earnings ratio	−0.005	0.005	−0.004	0.005	−0.005	0.005	−0.005	0.005
Level 2								
Environmental regulation	0.682	0.660	1.939***	0.721	−0.262	1.103	1.741	1.200
IPO Activity			1.209***	0.244			1.334***	0.275
Anti-self dealing index			19.415***	7.520			20.901***	7.409
Rule of law			−11.403	8.623			−5.788	8.822
CPI index			−0.023	0.086			0.001	0.096
Public enforcement index			−0.945	3.612			−0.667	3.543
Market integration			−0.075	0.088			−0.161*	0.275
Constant	7.705***	2.258	8.912	7.820	3.246	9.703	7.961	12.332
Time fixed effects	No		No		Yes		Yes	
Random effect								
Level 2 effect, u_{0j}	56.779		25.748		56.606		24.067	
Level 1 effect, e_{ij}	533.274		531.724		526.632		525.821	
Model fit								
Likelihood Ratio Test	228.47***		49.34***		207.06***		45.17***	

Table 20

OLS regression analysis of the impact of environmental regulation on IPO underpricing, 2000-2020. This table displays results from four models assessing how environmental regulation influences IPO underpricing while controlling for time-specific variations. Model 1 focuses on firm- and issue-specific variables and environmental regulation, whereas model 2 includes additional country-specific variables. The inclusion of time-fixed effects ensures that period-specific factors are accounted for, isolating the effects of the variables of interest.

	Model (1)		Model (2)		Model (3)		Model (4)	
	Coefficient	se	Coefficient	se	Coefficient	se	Coefficient	se
Firm- and issue specific								
Dummy energy sector	−8.764*	5.205	−7.271	5.121	−9.014*	5.293	−8.196*	5.278
EnvReg * energy sector	−1.628	2.135	1.638	2.103	1.798	2.169	2.194	2.159
Firm age	0.661**	0.333	0.568	0.351	0.468	0.336	0.525	0.351
Dummy high tech	−0.073	1.053	1.393	1.019	0.013	1.056	1.450	1.025
Dummy equity carve-outs	−3.910***	1.001	4.226***	1.037	−3.876***	1.079	−3.356***	1.107
Dummy VC-backed	7.320***	1.910	5.439***	1.189	7.589***	1.184	5.564***	1.191
Dummy Bookbuilt	−5.937**	2.755	−2.586	3.080	5.187	3.194	−3.581	3.464
Price earnings ratio	−0.007**	0.003	−0.004*	0.002	−0.006**	0.002	−0.005**	0.002
Country- specific								
Environmental regulation	−1.884***	0.569	3.066***	0.595	−2.574***	0.662	3.586***	0.763
IPO Activity			1.308***	0.257			1.371***	0.280
Anti-self dealing index			14.716	3.016			16.066***	3.061
Rule of law			−13.791 ***	4.622			−11.362 **	4.762
CPI index			0.071	0.063			0.076	0.067
Public enforcement index			1.101	1.464			0.903	1.483
Market integration			−0.317***	0.059			−0.353	0.061
Constant	17.919***	1.722	22.199***	3.441	14.021	11.258	29.664	11.754
Time fixed effects	No		No		Yes		Yes	
R2	3.38%		9.82%		5.22%		10.97%	
Number of observations	3187		3187		3187		3187	