Green versus Brown Initial Public Offerings: How do green IPOs fare?

Abstract

Using a sample of 284 energy, transport and building material IPOs from Europe between 2001 and 2017, we examine the probability of withdrawal and the post-IPO performance in both renewable (green) and non-renewable (brown) firms. We find that during the sample period, green firms are less likely to withdraw showing a positive market sentiment toward these renewable firms. We find greater PE and VC involvement for green firms and higher levels of retained ownership in the wake of green IPOs. This may be illustrative of a poor outlook for non-renewable firms, leading owners of brown firms to reduce their stakes. Our findings indicate that green firms are at a disadvantage with respect to post-IPO performance. They produce significantly more negative BHARs relative to both, benchmark indices and brown firms, and significantly lower alphas in the four-factor regressions. Overall, whilst post-IPO performance in terms of absolute returns is poor, the probit analyses show an increased positive sentiment toward green firms, and therefore their relative importance in the fight against climate change.

Keywords: Initial Public Offering, Performance, Withdrawal, Green

JEL Codes : G24; G34 ; Q56

1. Introduction

Energy transition and technological change mean that new players are emerging in the energy sector. Some of these new players may be categorised as 'green', while others may be developing technologies and products related to the extraction and burning of fossil fuels ('brown'). The 2015 United Nations Climate Change Conference acted as a key moment in the recognition of and fight against climate change (UNFCCC, 2015). The conference highlighted the great importance of financial systems in fostering the development of renewable industries to replace fossil fuels. Renewable technologies are labelled as replacement technologies, as they have to overcome the role of current technology and ultimately replace it as opposed to creating their own new market (Jackson, 2011). As governments have limited ability to finance new projects, financial markets play a large role in the development of the necessary industries, providing the bulk of the capital required for sustainable growth and development (IPCC, 2008).

Both, green and brown, types of firms need to raise capital and many fund their growth by raising equity capital in the stock market. Thus the initial public offering (IPO) process is a pivotal point in their growth and development. The growing awareness of climate change has provided opportunities both environmentally and financially for green firms. Not only are they required for the transition away from non-renewables, but the sharp focus on the environmental impacts of non-renewables has also created a financial demand for green firms through socially responsible investment (SRI) (Friede et al., 2003, Baker et al., 2018). Rezec and Scholtens (2017) state that renewable energy investments are a critical part of the EU's goal to reduce greenhouse gas emissions in which financial markets must take an accommodating role to transition to a renewable society. Insights into the IPO process, why they withdraw and how green firms perform relative to brown firms, will help the understanding of the renewable industry to take off. This paper therefore aims to provide initial insights into the probability

of IPO withdrawal and post-IPO performance of renewable energy, transport and building material firms in comparison to both non-renewable firms and the market as a whole.

This paper contributes to the existing literature on climate finance and corporate finance research. Energy and transport firms from eight European countries (including the UK, France, Germany, Spain, Italy, Denmark, Sweden, and Norway) are used in the sample across a 17-year period, beginning January 2001. In our withdrawal analysis, we find that green IPOs are less likely to withdraw than brown IPOs. Further, there is significant involvement of both private equity (PE) and venture capital (VC) in green IPOs, which provides another channel of funding to the benefit of green firms. Finally, we observe higher levels of retained ownership in green IPOs, acting as a signal for a bright horizon for renewable industries. Brown firms are more likely to end up inactive post-IPO withdrawal and, on average, about three years earlier than green firms. The latter predominantly remain private or engage in M&A. By comparing the post-IPO shareholder returns of green and brown IPOs in a buy-and-hold abnormal return (BHAR) and four-factor model, we find that green IPOs are subject to more consistent negative returns of greater magnitude than brown firms. While brown IPOs appear to be underpriced to a much greater extent than green IPOs. Therefore, our results show a positive outlook for green firms undertaking an IPO in terms of market support, though they still remain worse off in terms of returns than brown firms. Developing this literature holds great value due to the importance of primary markets and the IPO process for renewable new ventures, as it could provide an understanding into how the growth and development of renewable industries can be further facilitated. This is of significant interest, and is an area worthy of development if we are to meet the climate goals outlined in the Paris Agreement.

2. Green and Brown IPOs: Hypotheses Development

2.1. Determinants of IPO Withdrawal

An initial public offering is often identified as a key moment in a company's life cycle, however not all companies that file for an IPO also list. The issuer can change course at any time and withdraw the IPO before its completion (Busaba, 2006). An IPO withdrawal is universally defined as an event when a company files for an IPO, but does not follow through. Having filed for an IPO the company can actively cancel the IPO filing or passively not list in due time (Helbing, 2019). Can we identify differences in the determinants and probabilities of green versus brown IPOs? The determinants of IPO withdrawal may provide insights into the corporate behaviour of green and brown firms. Existing literature on IPO withdrawals is less documented, focusing largely on the US market and focusing on market conditions in explaining IPO withdrawal (Busaba et al., 2001, Dunbar and Foerster, 2008, Boeh and Dunbar, 2013). Helbing et al. (2019) consider a wide range of market, offer and firm characteristics for the European market and evidence the importance of firm specific characteristics in determining IPO withdrawal (see Table A.1). Markets appear to react positively to renewable projects and/or industry announcements; however, these investments are subject to variable returns and high risk. Investors that have invested in marine renewable energy (MRE) technologies previously are unlikely to do so again, indicating that large and uncertain capital costs and variable revenues create a significant barrier to investment (Leete et al., 2013). Not only does this impact on existing firms' projects, but it could also prove to be meaningful in an IPO situation, leading to withdrawal as a result of market skepticism. Although investors can play a key role in the mobilisation of capital to support these renewables, they are often reluctant to do so. This stems from the fact that investors make investment decisions based on prior investment reliability rather than the perceived effectiveness of existing policies that favour these investments (Masini and Menichetti, 2012). This implies that

better governmental policy to support these industries, more stable returns and lower perceived risk must be realised before markets offer their financial support (Chassot et al., 2014). Further, Hong et al. (2019) examine the efficiency of markets with respect to climate risks. They find evidence to show that markets underreact to this climate risk, meaning they fail to price it into the stock valuations. Combining these findings, it appears that markets have both not effectively considered climate risks when evaluating investments, and also show reluctance to invest in renewables due to the poor performance and uncertainty of existing investments. It seems that markets are yet to meaningfully recognise climate risk.

Hypothesis 1: Green IPOs have a greater likelihood of being withdrawn than brown IPOs.

Previous research on IPO withdrawal (Busaba et al., 2001, Dunbar and Foerster, 2008, Helbing et al., 2019) assert a special role to private equity and venture capital in the IPO process. From an investment point of view, the motive and role of private equity and venture capital appears to differ. PE firms traditionally invest in mature, established firms that may have operating or financial issues that can be resolved by the expertise of private equity investors (Gompers et al., 2016). This differs from the role of VC firms, who invest in relatively young companies in new industries with high growth potential, exposing themselves to high risk, but potentially above average returns in the process. Green VC are defined as a high-risk capital provision for new ventures that contribute to sustainable development (Randjelovic et al., 2003). Moore and Wüstenhagen (2004) highlight the role of VC in the financing of renewable energy due to the relatively recent development of renewable industries and their high growth potential. Bocken (2015) states that although sustainable investment is on the rise, VC has an important role in the further development of these sustainable new ventures. Therefore, it appears that renewable industries provide an

investment opportunity consistent with those desired by VC firms, inferring one would expect to see greater VC involvement in green IPOs as follows:

Hypothesis 2: Green IPOs are likely to have greater VC involvement, whilst brown IPOs are likely to have more PE involvement.

2.2. Post-IPO Performance

Do green IPOs show superior post-IPO performance to brown IPOs, and IPOs in general? By examining the performance differential between green and brown IPOs, an insight into the market sentiment toward renewables can be obtained. If markets are not confident in the sustainability of these firms, then investor skepticism will be reflected in post-IPO returns. Though investors are rewarded with abnormal positive first day returns, there is significant underperformance of offering firms in the long run (Ritter, 1991, Aggarwal et al., 1993, Levis, 1993). Brav and Gompers (1997) suggest that this underperformance is due to an over optimism of investors in relation to the prospects of firms issuing equity for the first time. Therefore, the question remains whether green IPOs fare better or worse in comparison to brown IPOs. Initial hypotheses from Porter (1991) indicate that pollution represents an economic inefficiency, and that improved environmental performance is beneficial to firms. This effect is believed to be stronger in the long run, as firms take time to adjust (Horváthová, 2012). Financial performance responds negatively to environmental performance at a one-year lag, though becomes positive for a two-year lag, showing the hypothesised long-run adjustment effect (Rassier and Earnhart, 2011). Investors respond favourably upon announcement of a green investment in the market (Ba et al., 2013) when managers highlight the societal benefits as opposed to the cost to the firm (Martin and Moser, 2016). An equilibrium model proposed by Heinkel et al. (2001) shows that the presence of socially responsible investors within the market drives the share price of irresponsible firms downward. This creates a price differential that can effectively alter the

environmental behaviour of irresponsible firms, when the differential begins to exceed the costs of reforming.

Existing literature on the performance of green investments provides mixed findings. Rezec and Scholtens (2017) examine renewable energy indices and find comparatively poor performance and higher risk overall than their comparative benchmarks. Studying environmental mutual funds Climent and Soriano (2011) show significant underperformance which decreases in later years, suggesting growing positive sentiment toward green firms as climate issues become more publicised. Consistent with this, Fernández et al. (2019) exhibit underperformance of German green mutual funds relative to conventional and socially responsible investment funds between 2007 and 2018. This could infer that positive externalities associated with these socially responsible firms are not yet priced in. Whilst the green bond literature is comprehensive, comparatively little evidence exists on the equity side of green investments, in particular the post-IPO performance of energy and transport firms. Although increased environmental performance and green investments have tangible benefits for firms, the narrative differs when considering the broad market and the interactions between various factors. Bohl et al. (2013) examine the lucrative German renewable energy stocks during the 2000's and document strong outperformance which, however, completely reversed, as the stocks fell short of investor expectations. Interestingly, there is no evidence to show US alternative energy stocks exhibit comparable price explosiveness during the 2000's (Bohl et al., 2015). Boulatoff and Boyer (2009) examine the performance of environmental stocks relative to the market as a whole and show that these environmental firms performed worse than the Nasdaq. Leete et al. (2013) conclude that until governments deliver a clear, long-term policy vision, this will continue to create financial adversity for these industries to overcome. Eyraud et al. (2013) investigate the effect of macroeconomic variables on green investment, finding that economic growth and high fuel prices increase the rate of investment in green

industries. This shows that when the cost of green investment is lower relative to traditional fossil fuel technologies, green investment becomes more favourable. Financial performance of renewable firms depends greatly on the behaviour of oil prices (Reboredo, 2015, 2018). A positive relationship is documented between rising oil prices and the substitution of green energy sources (Kumar et al., 2012). Whilst the literature suggests that markets react favourably to the idea of green investment, it is clear that the uncertainty of these investments deter investors. Although markets hold green bonds in a positive light, this effect does not spill over into equity markets. Green equity investments are observed to perform poorly when compared to conventional equity investments due to their high associated risk and variable returns. Therefore, the following hypothesis is developed.

Hypothesis 3: Green firms have a worse post-IPO performance than brown firms.

3. Data and Methods

The initial dataset of Western European IPOs (including the UK, France, Germany, Spain, Italy, Scandinavia) covers 2,808 IPOs from 2001 – 2017, of which 2,474 were successfully completed, and 334 withdrawn (Helbing et al., 2019). Consistent with usual practice in IPO literature (Ritter, 1987), the sample is restricted to common stock IPOs. Bloomberg industry classifications are used to filter firms into different broad industries based on their business operations such as energy, transport and building materials sectors (310 IPO filings) with the majority categorised as energy companies (see Table A.1). Each IPO is classified as green, brown or ambiguous using information from a combination of the IPO prospectus, Capital IQ, Bloomberg, or other public sources at the time of the IPO filing. Therefore, using the prospectus to classify firms and the proceeding three-years of returns facilitates a direct comparison. Classification as green, brown or ambiguous is done through manual coding and subsequently cross-checked.

Undertaking this manual coding requires individual judgement, and so the following definition of a green firm is developed.[1]

A firm with a majority (over 50%) of their operations (as measured by revenues) focused on renewable, GHG neutral or reducing methods, technologies and associate enabling 'green' services and technologies. This includes renewable energies, carbon-neutral buildings, building materials, electrification of transport and enabling technologies such as Smart Grid and Smart Grid Edge Technologies.

Based on these data, the sample size of 284 companies covers all IPO filings categorised as green (90) or brown (194) of which 36 were withdrawn. Due to ambiguity in classification or incorrect specification, we exclude 26 of the 310 IPOs that do not meet the above definition. In Figure 1 the majority (172) of the offerings are from the UK. Germany, Norway and Italy contribute to the bulk of the sample, with 31, 29, and 26 IPOs each, respectively. It is illustrated that the UK is responsible for a large majority of brown IPOs mainly at the Alternative Investment Market. Proportionally, Germany has the highest amount of green IPOs, indicating their role in the transition to renewables. Figure 2 shows the evolution of green and brown IPOs across the sample period, highlighting periods of high IPO activity. IPO activity peaks in the years leading up to the 2008 global financial crisis (GFC), with the greatest total number of IPOs occurring in 2005. Whilst 2005 has the greatest number of brown IPOs, with 41 occurring during the year, the peak number of green IPOs is lagged by one year, with 14 occurring in 2006. Although the number of IPOs for both groups declines in wake of the GFC, the proportion of green IPOs relative to brown IPOs increases, indicating a deceleration of brown offerings. An interesting observation is

[1]We exclude nuclear-based firms from the analysis due to the conflicting opinions on the nature of nuclear energy. It is debated that nuclear energy has zero greenhouse gas emissions, but the materials used in producing this energy are not renewable.

the fact that brown IPOs peak in numbers in 2005, declining significantly from there on out. One explanation for this may be the ratification of the Kyoto Protocol in 2005, acting as a major step in a commitment to reducing emissions, of which brown firms in the energy sector are a major contributor. The lack of brown IPO activity post-GFC also supports this explanation over an economic cycle explanation.

Insert Figures 1 and 2 about here

3.1. Probit Model for IPO Withdrawal Analysis

Following the methodology of Busaba et al. (2001), a probit model is used identifying a binary dependent variable, y, which represents the withdrawal of an IPO by any given firm. This variable will take the value 1 if the IPO is withdrawn, and 0 otherwise. This gives the basic model for withdrawals as follows:

$$Pr(y_j \neq 0|x_j) = \Psi(x_j\beta) \tag{1}$$

Whereby x_j represents the dependent variables outlined in the table below with their corresponding coefficient, β, and Ψ represents the cumulative standard normal function. For interpretation, the marginal impact of each independent variable on the dependent variable (decision to withdraw) is developed, creating a linear function for continuous and dummy variables, respectively, as follows:

$$ME = \frac{\partial Pr(y \neq 1|x)}{\partial x} = \Psi(x_j\beta)\beta \tag{2}$$

$$ME = \Big[\Psi(x_j\beta|x^k = 1) - \Psi(x_j\beta|x^k = 0)\Big] \tag{3}$$

3.1.1. Survival Setting for Withdrawn IPOs

In order to analyse the afterlife of a withdrawn IPO filing, we identify different post-IPO withdrawal outcomes: private, inactive, M&A, second

time IPO. The advantage of survival analysis is the connection of the outcome characteristics and the timing of a particular event. We apply the semi-parametric Cox proportional hazards model (Kartsonaki, 2016):

$$h(t; x_1, ..., x_p) = h_0(t)e^{\beta_1 x_{i1} + ... + \beta_k x_{ik}} \tag{4}$$

where $h(t)_0$ is the hazard function and represents the instantaneous rate of change from survival to the defined event at time t, given survival until time t. The second component is the exponential of a linear function of k fixed covariates, $x_{i1}...x_{ik}$ and their coefficients, $\beta_1, ..., \beta_k$, representing the effect of the covariates on the outcome; for each unit increase in x_k the hazard is multiplied by $e^{\beta k}$, ceteris paribus.

3.2. Buy-and-hold Abnormal Returns

Post-IPO returns are obtained from Bloomberg for the three-year period following the IPO, or the period from the initial offering up until the date the firm is delisted, whichever is earlier. This return series takes the first listed Bloomberg trading day as the beginning of the three-year period. A time-series of oil prices, carbon prices and market indices (used as benchmarks) is also obtained for analysis, all of which are obtained from Bloomberg as both daily and monthly series.[2] Consistent with the IPO literature, post-IPO performance is measured using the stock returns for the three-years directly after the IPO, following the two stock-performance measures implemented by Gao and Jain (2011). We follow Ritter (1991) three-year period for performance due to data limitations for the most recent IPOs. In order to calculate these buy-and-hold returns, a traditional event study framework is

[2]Due to the collapse of carbon allowance (spot EUA) prices around 2008, we merge the original price series with a carbon futures price series when the two price series begin to diverge significantly on the 12/04/2006, and continue it up until expiration on the 15/12/2008. Not performing this adjustment would artificially deflate the true value of spot carbon allowances, which saw prices drop as low as 0.015 due to the no banking rule (Daskalakis et al., 2011).

utilised for firms engaging in an IPO. The results are reported with respect to multiple market index benchmarks, including the FTSE100, the DAX, the N100 (Euronext 100), DAXAE (DAX alternative energy), NEX (WilderHill New Energy Global Innovation), and CAC40. For each IPO in the sample, similar to both Gao and Jain (2011) and Ritter (1991), the first listed trading day on Bloomberg is defined as day zero in the event framework. Firms are followed from this initial listing date until the earlier date out of delisting or the three-year anniversary after the IPO listing, meaning the return period will be truncated if the firm is delisted before this three-year anniversary. Consistent with Ritter (1991) and Loughran and Ritter (1995), one year is defined as 12 consecutive 21-day trading day intervals (251 days). This means that month 1 contains trading days 1-21; month 2 contains trading days 22-42 and so on. Buy-and-hold returns are calculated as the difference between the product of buy-and-hold returns of the sample firm and the benchmark. This is represented by the following formula:

$$BHAR(t_1, t_2) = \Pi_{t=t_1}^{t_2}[(1 + R_{it})] - \Pi_{t=t_1}^{t_2}[(1 + R_{mt})] \tag{5}$$

R_{it} is the return for the firm i undertaking an IPO on date t, and R_{mt} is the return on the benchmark on the same day, t. The dates t_1 and t_2 represent the first trading day after the IPO and the earlier out of the delisting date or three-year anniversary after the IPO listing respectively. To facilitate comparison of the differences in BHARs for green and brown firms, average BHARs are computed for portfolios of green and brown firms during each of the 36 months post-IPO. As IPOs do not occur at standardised times each month, the portfolios are formed based on month 1 to 36. Brav and Gompers (2000) note that if small stocks are more likely to be mispriced than larger stocks, then power considerations in themselves would favour equal weighting. Therefore, as this may hold true in our context, stocks are equally weighted when computing the average returns for the portfolios of stocks.

3.3. Calendar Time Approach – Factor Regression Model

Gao and Jain (2011) state that there are multiple methods for detecting abnormal performance, each with their own benefits and downfalls, however no consensus exists as to which method is preferred. Therefore, using both a buy-and-hold abnormal return method and a calendar time methodology allows for mitigation of potential issues associated with each model, providing evidence to confirm the robustness of results. This approach involves developing a time-series of monthly portfolio returns and estimating the Carhart (1997) four-factor model. Consistent with the existing literature, the dependent variable is constructed as the excess return of a portfolio of green (brown) firms relative to the risk-free rate. Further, this model contains factors controlling for market risk, size, book to market ratios, and momentum as follows:

$$\begin{aligned} r_{it} - r_{ft} =& \alpha_{iT}^{4F} + b_{iT} MktRF_t + s_{iT} SMB + h_{iT} HML_t \\ &+ p_{iT} WML_t + e_{it} \end{aligned} \tag{6}$$

Where r_{it} is the monthly return for either green or brown firms in month t, and r_{ft} the monthly return on three-month Treasury bills in month t. The factor-mimicking portfolios $MktRF_t$, SMB_t, HML_t and WML_t capture return spreads between high- and low-beta stocks, small- and large-cap stocks, high and low book to market ratios, and past winner and loser stocks respectively in month t. The use of this model has further relevance, as Bohl et al. (2013) and Bohl et al. (2015) attribute a large proportion of the performance of German alternative energy stocks and European and international alternative energy indices to price momentum. Therefore, in the context of European alternative energy equities, controlling for this price momentum appears to be a key consideration in the analysis of returns. Further, Brav and Gompers (1997) show empirically that when factors such as size or book-to-market are controlled for, the underperformance of IPOs is significantly reduced. The key focus of the model is, α_{iT}^{4F}, the Carhart four-factor

alpha, which is a measure of outperformance of the stock with respect to the market after controlling for sensitivities to the four aforementioned factors. Therefore, by comparing the four-factor alphas for green and brown firms, we develop an idea as to the level of outperformance exhibited by both green and brown firms. The four-factors required for the model are downloaded from Kenneth R. French's website, which are developed under the methodology of Fama and French (1993) for the size and book to market equity factors, and the methodology of Carhart (1997) for the momentum factor. The size and book to market equity factors are created each year at the end of June, with a subsequent 12-month holding period, having returns to these portfolios calculated each month. The momentum factor is calculated as the equal-weight average of firms with the top 30% eleven-month returns lagged one month minus the bottom 30% eleven-month returns lagged one month, and is re-formed monthly. Therefore, the size and book-to-market equity factor-mimicking portfolios should be re-formed once a year, whilst the momentum factor-mimicking portfolio should be re-formed once a month. Further, time-series of European oil and carbon prices will be added into the model to assess the effect of these on returns to both green and brown firms as follows:

$$\begin{aligned} r_{it} - r_{ft} =& \alpha_{iT}^{4F} + b_{iT} MktRF_t + s_{iT} SMB + h_{iT} HML_t + p_{iT} WML_t \\ &+ o_{it} EUCRBRDT_t + c_{it} EUETS_t + e_{it} \end{aligned} \tag{7}$$

In the above model, $EUCRBRDT_t$ represents the European Brent Crude oil price series taken from Bloomberg, and $EUETS_t$ represents the European Emissions Trading Scheme carbon price series.

4. Green vs Brown IPOs

Consistent with the literature on IPOs in Europe, we focus on firm-specific control variables as economic variables are found to be of little

significance in a withdrawal setting (Helbing et al., 2019). Therefore, the control variables we include focus on offer, firm-specific and corporate governance characteristics (see Table A.1). Some interesting findings emerge from the descriptive analysis in Table 1. There is a positive and significant difference between the frequency of IPO withdrawal for green and brown IPO filings. This positive difference indicates that green firms are more likely to withdraw, aligning with Hypothesis 1. It appears that significantly more brown IPO companies file for an IPO at the AIM. The AIM is an exchange-regulated stock market with looser regulation and listing standards (Vismara et al., 2012), formally, these second markets are not officially regulated by the European Financial Services Directives (Espenlaub et al., 2012). Although the difference in offer size is not statistically significant, the economic differences in firm size and age of green and brown firms are substantial, consistent with expectations. Brown firms are on average larger and older than green firms. The recent growth of renewable industries supports this finding, as firms in these industries have had less time to both grow and develop, resulting in smaller and younger firms (Jackson, 2011). Consistent with this outcome, is the fact that green firms are observed to utilise higher levels of debt than brown firms. Green firms are younger, subject to more uncertainty, and require more external funds to make up for a deficit of internal cash flows, thus making debt a more viable source of capital. The finding that VC backing is more likely in green IPOs supports Hypothesis 2, however the greater involvement of PE in green IPOs is surprising. This is because the characteristics of green firms misalign with the traditional characteristics desired by PE firms. Regardless, it appears that green IPOs have greater PE and VC involvement than brown IPOs. Though not statistical significant, there is an economic difference in means of higher levels of retained ownership for green firms. Indicating that green firms hold onto more ownership in the wake of an IPO compared to brown firms. This may further tie into the longer lockup period that brown firms

have, indicating that those insiders that do not sell out are forced to retain their ownership for longer periods of time than green firms. By selling down their ownership stakes, brown firms are taking action to reduce their exposure to what they think may be a 'sunset' industry impacted by the Kyoto Protocol 2005 and the Paris Agreement 2015, sending negative signals to the market about the future of their investment.

Insert Table 1 about here

In Table 2 identify variables that determine a green IPO company. Both, the PE and VC dummy variables, exhibit significance. We see that the VC dummy has a positive marginal effect of about 30% across the three models, indicating that the presence of VC in an IPO makes the issuing firm more likely to be green, consistent with Hypothesis 2. This result is economically significant, whilst also being consistent with the emphasis Moore and Wüstenhagen (2004) place on the role of VC in providing financial support to green firms. Surprisingly, we also see a positive marginal effect (20-25%) suggesting that PE plays a similar role to VC in supporting green issuing firms; despite PE firms traditionally tending toward mature and developed industries (Gompers et al., 2016). Comparing the magnitude of the marginal effects, we can see that whilst the presence of both PE and VC significantly increase the probability of a firm being green, the presence of VC has a larger impact. An explanation for the PE involvement with green IPOs could be due to a shift of investor priority toward incorporating ESG standards into investments. Friede et al. (2003) and Baker et al. (2018) observe this empirically by documenting an increased demand for SRI. As PE firms must satisfy client demand, this shift in investor preference for ESG may be represented in the increased involvement of PE in green IPOs, having a positive outlook for the future. Therefore, whilst at present the involvement of PE in green firms appears to be lower in magnitude, we may see increased PE involvement moving forward as investors become more informed of ESG-style investing. The disclosure of intellectual capital or the companies competitive

advantage in the IPO prospectus appears to have a negative effect on a firm being classified as green. The marginal effects range from -12.07% in Model One to -18.44% in Model Three, this may be explained by brown IPOs requiring more help to get moving, whether it be through providing corporate wash in their prospectus, specifically, by stating their intellectual capital or competitive advantages. Also, consistent with the descriptive statistics, the results show that firm size has a negative effect on the classification of a firm as green (3%). As the number of IPO filings in the prior 180 days increase (Hotness Dummy), the probability that a firm is green decreases. This is evident within Figure 2, which shows a large peak in brown IPOs leading up to the GFC and then a significant drop off. Filing for an IPO at the AIM reduces the likelihood that a firm is green by about 30%. It shows that brown firms are more likely to take advantage of looser regulation on the AIM, therefore indicating that they may be trying to circumvent some of the regulations at official stock exchanges. Interestingly, IPOs with higher levels of ownership retention are more likely to be green. The marginal effects range from 22.50% in Model One to 35.58% in Model Three, suggesting statistical and economic significance. Thus insiders in green firms retain more ownership than insiders of brown firms. We attribute this to two explanations. The first states that greater earnings uncertainty in green firms leads insiders to use ownership retention as a low-cost signal (Fan, 2007). The second looks at this from a climate policy and investment quality perspective. Insiders of green firms may retain more ownership to signal quality, by 'investing in their own projects'. This ties into the insiders motive for the IPO, in particular, whether insiders are selling down their position and reducing their exposure, or whether they are retaining shares. This is especially relevant for this study, as momentum on climate action through policy and other means has grown significantly throughout the 2000's, particularly through events such as the ratification of the Kyoto Protocol in 2005, and signing of the Paris Agreement in 2015. We conclude that in light of this

growing pressure to comply, green firms hold a significantly more positive outlook than brown firms, leading to higher ownership retention. By selling down their ownership stakes, brown firms are taking action to reduce their exposure to what they think may be a 'sunset' industry, sending negative signals to the market about the future of their investment.

Insert Table 2 about here

4.1. Determinants of IPO Withdrawal

Three models are run in Table 3 ; one with only the variables of interest, a stepwise model at the 10% level of significance, and a third model containing all variables of interest and control variables.[3] For each regression, we report the regression coefficient, as well as the corresponding marginal effect. The negative marginal effect of the Green Firm Dummy indicates that these firms are less likely to withdraw from the IPO process reducing the probability of withdrawal by 7.67%. We interpret this finding as a positive sentiment towards these firms. Interestingly, the significance of the Pre-2011 Green Interaction Dummy captures green IPO filings prior to 2011 with a positive marginal effect of over 22%. When viewing withdrawal as a lack of market interest, this points to a changing sentiment towards green firms. Of further interest is the European Oil Price Dummy, which shows that higher oil prices decrease the probability of withdrawal by 10.5%. This may be driven by the greater proportion of brown firms in the sample, who are likely to succeed in times of high oil prices given more attractive cash inflows, revenue forecasts and correspondingly more productive assets. The use of the Green Oil Price Interaction variable, representing green IPO firms during high oil prices, provides support for this idea, as green firms are 19% more likely to withdraw in times of high oil prices. This variable

[3]We run the full regression (model three) without the carbon price dummy, as the variable has no significant effect when included. Also, the variable reduces the sample size by 98 observations as a result of an incomplete carbon price series.

holds its significance in all settings. We attribute this to green firms holding a competitive disadvantage in terms of financial attractiveness. Consistent with the findings of Eyraud et al. (2013), Leete et al. (2013) and Reboredo (2015), there is greater investment in these green industries when oil prices rise, though it may come from private sources such as private equity or venture capital. The Negative News Dummy, which shows the association of the companies name with negative news in the year prior to the IPO, leads to increased probability of withdrawal of 15.90%. In contrast, the percentage of primary shares in our sample reduces the chance of withdrawal significantly by 5.37%, whilst showing no significant effect in the broad market. Other variables such as firm size, debt, and board independence reduce the probability of IPO withdrawal. Compared to the general results of Helbing et al. (2019), there appears some overlap in the drivers of IPO withdrawal, though the magnitude of the effect in our sample appears to be amplified. In summary, we identify that overall green firms are less likely to withdraw from the IPO process across the sample, which contradicts Hypothesis 1; leading us to believe that a sentiment shift has already occurred to favour green firms in an IPO setting.

Insert Table 3 about here

4.1.1. Survival Analysis of post-IPO Withdrawal Outcomes

In the green and brown sample, an absolute of 38 IPO withdrawals of 284 IPO filings are documented constituting a withdrawal rate of about 13%. Table 4, shows the distribution and average time in months of post-IPO withdrawal outcomes according to classification. Companies that withdraw from the IPO predominantly are merged or acquired (M&A) with about 40% or remain private (34%). One in almost five companies that withdraws from the IPO is terminated (inactive, 18%) and only 8% are trading after a second time IPO. Interestingly, on average brown IPO withdrawals become inactive much faster (56 months) than green firms (88 months) - a difference of almost three years. This timing difference suggests that green firms are

of better quality compared to brown ones. While brown firms are more frequently filing for a second time IPO (14%), green firms more often remain private or are merged and acquired (both 42%). Consistent with findings from the probit analysis, these results indicate that green IPOs simply stay private and the existing shareholders retain their ownership. Overall, the subsample of green and brown IPO withdrawals are more frequently engaged in M&A compared with the total European sample while being less likely to end up inactive. Within the first two years after an IPO filing, almost all of the brown IPO withdrawals are likely to be merged or acquired according to Figure 3. It appears that the owners of the brown withdrawn IPO companies are exiting quickly. While for green IPO withdrawals it seems that, either the company is engaged in M&A within the first two years of the IPO filing or after five years. We get the idea that insiders of green IPOs do not seem to be in a rush to exit per se.

Insert Table 4 and Figure 3 about here

4.2. Post-IPO Performance

In Table 5 we report the BHARs for three samples; all relevant IPO firms, all brown IPO firms, and all green IPO firms, in panels A, B and C respectively. In panel D, we report the difference in BHARs between green and brown firms. Consistent with Ritter (1991) and Loughran and Ritter (1995), we can identify underperformance of IPOs relative to the market indices consistent across all groups and all BHAR periods. The only exception to this is a slight, insignificant outperformance of brown firms relative to the FTSE100, N100 and CAC40 indices in the first 12 months post-IPO. This may be driven by the abnormally high returns from underpricing displayed by brown firms in the first month compared to the green filings. The underperformance relative to all indices becomes more pronounced whereby returns become more negative as the BHAR period increases from 12 to 36 months, indicating that issuing firms experience continually negative stock

returns across the 36 months post-IPO. These positive initial returns in the first month, followed by subsequent underperformance in the following one to three years post-IPO aligns with existing literature (Aggarwal et al., 1993). In panels B and C both green and brown firms exhibit underperformance post-IPO. At the 12-month mark there is no significant performance differential between green or brown firms and their respective benchmarks. However, this performance differential is amplified and becomes highly significant by the end of the second and third year post-IPO. Brown IPOs appear to experience a range of abnormal returns relative to their benchmarks between -23.81% and -73.77% by the end of the third year post-IPO. The greatest underperformance of brown firms is against the DAXAE (DAX alternative energy) index, which could partially be a function of the aforementioned bubble observed by Bohl et al. (2013) in German renewable energy stocks during the early to mid 2000's. The underperformance of green firms after 36 months post-IPO relative to the DAXAE is only -62.28%, providing evidence to support this notion. Green firms appear to underperform to a similar or greater extent at the end of the second year post-IPO than brown firms do by the end of their third year post-IPO, contradicting the positive correlation between ESG and financial performance documented by Friede et al. (2015). After 36 months, green firms experience BHARs that are all significantly worse than those experienced by brown firms, except for the aforementioned performance relative to the DAXAE. This underperformance ranges from -40.04% to -62.95%. In the case of the FTSE100, green firms underperform by almost twice as much as brown firms. Therefore it appears that in general, green firms experience significantly lower returns relative to the majority of indices in Europe in comparison to brown firms. This may be a result of a lack of return framework that includes ESG components compensating for non-pecuniary factors (Eccles et al., 2015). Panel D shows the difference in BHARs experienced by green and brown firms across the 12-, 24- and 36-month periods post-IPO. This provides a direct

comparison of the returns to equally weighted green and brown portfolios assuming shares are held for every IPO from the date of issue until 36 months post-IPO, or delisting, whichever comes first. The results indicate no significant difference at the 12-month mark but significance at 24 (-31.91%) and 36 months (-32.61%) post-IPO.

Insert Table 5 about here

Figures 4 and 5 display the performance differential, showing significantly more negative returns to green firms as well as increased volatility (movement) of green firm returns post-IPO. Green IPOs seem to be subject to larger fluctuations and more consistent negative returns of greater magnitude than brown firms. It appears that brown IPOs are underpriced to a much greater extent than green IPOs, represented by the initial first month return of 11.31% in Figure 4, compared to that of green IPOs of 4.38% in Figure in Figure 5. This finding leads us to believe that the greater underpricing of brown IPOs contributes to their better performance, especially at the end of the first 12 months post-IPO. Overall, the results of the BHAR analysis provide evidence to support Hypothesis 3, showing that green IPOs do in fact perform worse on average in comparison to both their benchmarks and brown firms.

Insert Figures 4 and 5 about here

In Table 6, we report the results of the Carhart (1997) four-factor model and its variants, including the oil and carbon price series. The results are reported for the whole sample, as well as for two separate sub-samples for only green and only brown firms, respectively. Across all regressions, the dependent variable is taken as the monthly excess return of each firm above the risk-free rate. Consistently negative and significant intercepts are present across all models and all samples, indicating underperformance of both, green and brown, IPO firms. As alpha is a measure of return performance

(Fama and French, 1993), the negative alpha indicates that monthly returns in the 36 months post-IPO of all issuing firms, regardless of classification, are expected to be negative. The alphas for brown firms show consistent values of approximately -2% across all four models. This indicates that brown firms have a baseline return that underperforms by approximately 2% each month in the 36 months post-IPO, after controlling for relevant factors. Of further importance are the highly significant beta (RMRF) and size (SMB) factors for brown firms. The beta values are clustered and indicate that returns to brown firms fluctuate less than the market. The size of brown firms also significantly explains the excess returns to a firm, indicated by the highly significant SMB coefficients across all regressions. Consistent with theory, smaller firms are seen to earn a significant return premium over larger firms (Brav and Gompers, 1997), shown through the positive coefficients of approximately 0.356 across all models. When considering the oil and carbon price series, we find that, surprisingly, they do not contribute significantly to the returns observed by brown firms. When considering green firms, the alpha values in the models show underperformance each month ranging from 2.78% to 3.37%, evidencing a performance differential between green and brown firms. The results suggest that green firms are subject to greater underperformance than brown firms. As shown in the descriptive statistics, green firms are significantly smaller, which usually indicates a return premium. However, after controlling for firm size green firms are still identified to underperform brown firms. The beta coefficients are significant and smaller in magnitude compared with the brown firm sample. Also, the beta coefficients indicate that green firms are subject to less return fluctuation relative to the market. Overall, we can see that after controlling for the Carhart (1997) four-factors, as well as oil and carbon prices, the underperformance of green firms relative to brown firms still exists.

Insert Table 6 about here

5. Robustness

6. Discussion

Are green and brown IPOs any different? Using a dataset of 284 IPOs from Europe between 2001 and 2017, we analyse the determinants of withdrawal and the post-IPO performance differential between green and brown firms. We employ three main analyses to test our hypotheses, a series of probit regressions, a BHAR and time-series (factor) regressions. We find that a green IPO company is more likely to have involvement of VC or PE. Although the positive involvement of PE with green firms contradicts Hypothesis 2, we attribute this to a shift in investor sentiment toward more ESG-conscious investment. We observe a significantly higher proportion of ownership retained, thus insiders in green firms keep more ownership compared with insiders in brown firms. We attribute this to a signal of investment quality, by 'investing in their own projects'. With respect to withdrawal rates, our findings contradict Hypothesis 1 showing that the classification of a firm as green has a negative effect on the probability of withdrawal from the IPO process. Green IPOs are less likely to withdraw from the IPO. Taking withdrawal to be a lack of market interest, this would align with the idea that the market sentiment towards green firms is positive when considering the sample as a whole; likely to be impacted by policy changes such as the Kyoto Protocol 2005 and the Paris Agreement 2015. Having withdrawn, brown firms are more likely to become inactive and take substantial less time to merge or be acquired compared to green IPO withdrawals. We furthermore find evidence consistent with an underperformance of both green and brown firms relative to market indices, and more significantly, underperformance of green firms relative to brown firms. Whilst the latter appears to be underprices to a much greater extent than green IPOs. Therefore, we obtain strong evidence to support Hypothesis 1 that green firms underperform brown firms in the 36 months post-IPO. It shows that although green firms underperform significantly, there may be a non-

pecuniary component of returns related to SRI or ESG that is not included in the absolute returns. Therefore, if we interpret the lower chance of withdrawal as showing increased demand for green investments and changing market sentiment, utilising a return framework that incorporates ESG components may see the post-IPO return differential between green and brown firms disappear.

In conclusion, ongoing and ever-strengthening policy to reduce emissions creates a positive outlook and investment horizon for green firms. On the other hand, brown firms face a bleak and uncertain future as a result of this, and therefore insiders may be incentivized to sell down their stakes and reduce their exposure, as we find evidence for. Overall, despite poor return performance across the sample period, it appears that the sentiment toward green firms is changing for the better. However, to realise an improvement on the return side, stronger regulation supporting renewables, more numerous responsible investors to price in externalities, and utilisation of return frameworks that better incorporate non-pecuniary ESG concepts may need to be realised.

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Table 1: Descriptive Statistics

Difference in means and associated t-statistics and p-values. Difference is taken as the mean of the green firm sample less the mean of the brown firm sample. Therefore, positive differences (and associated t-statistics) represent a larger mean value for the brown IPO sample, whereas a negative difference (and associated t-statistic) represents a larger mean value for the green sample. Included in the sample are 90 green firms, and 194 brown firms. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	Green IPO filings		Brown IPO filings			
Variable	Mean	St. Dev	Mean	St. Dev	t-stat	p-value
Market Characteristics						
IPO Withdrawal	0.19	0.39	0.11	0.31	-1.86	0.0636*
AIM	0.29	0.46	0.57	0.50	4.50	0.0000***
Market Hotness	0.56	0.50	0.70	0.46	2.42	0.0163**
Trading Volume	0.46	0.50	0.52	0.50	0.94	0.3492
Negative News	0.09	0.29	0.09	0.29	0.11	0.9160
Firm and Offer Characteristics						
Offer Size (abs)	149.84	538.36	852.30	8943.69	0.74	0.4576
Primary Shares	0.82	0.31	0.82	0.32	-0.02	0.9874
Secondary Shares	0.18	0.31	0.18	0.32	0.02	0.9874
Greenshoe Option	0.05	0.07	0.04	0.07	-1.77	0.0781*
Debt Retirement	0.24	0.43	0.15	0.36	-1.95	0.0527*
Private Equity	0.18	0.38	0.08	0.28	-2.38	0.0181**
Venture Capital	0.12	0.33	0.05	0.21	-2.34	0.0201**
Intellectual Capital	0.34	0.48	0.45	0.50	1.74	0.0833*
Underwriter	0.22	0.27	0.20	0.24	-0.63	0.5283
Firm Size (abs)	462.34	2731.66	2720.82	19655.25	1.08	0.2792
Age (abs)	8.18	15.27	11.85	23.75	1.34	0.1815
CapEx	0.10	0.13	0.35	3.64	0.64	0.5199
Return on Assets	-0.28	0.69	-0.26	0.76	0.12	0.9013
Debt	0.75	1.44	0.53	0.65	-1.78	0.0770*
High-Tech	0.19	0.39	0.29	0.46	1.88	0.0612*
Multinationality	0.30	0.17	0.28	0.19	-0.66	0.5079
Retained Ownership	0.60	0.25	0.54	0.29	-1.60	0.1104
Lock-up (days)	238.43	161.47	265.28	166.26	1.28	0.2025
Board Size	5.64	2.80	5.85	2.91	0.56	0.5749
Board Independence	0.25	0.29	0.26	0.26	0.19	0.8527
Female Board Members	0.09	0.13	0.08	0.14	-0.31	0.7589
CEO Duality	0.22	0.42	0.12	0.32	-2.28	0.0233**
N	90		194			

Table 2: Probit Analysis with Green Firm Dummy as Dependent Variable

This table considers the determinants of whether a firm is green or not for the 284 IPO observations between 2001 and 2017. The dependent variable is the Green Firm Dummy, which takes the variable 1 if a firm is classified as green, and 0 otherwise. The marginal effect coefficient represents the marginal effect of a unit change on the probability that the dependent variable takes the value 1 (i.e. a firm is classified as green), given that all other variables are held constant and the standard deviation of the error term is fixed to 1. The Hosmer-Lemeshow statistic is a measure of goodness of fit that the observed events taken from 10 subgroups of the population match the estimated events in 10 subgroups of the population. The p-value for this statistic is reported in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	Model One		Model Two		Model Three	
Variable	Coefficient	ME (%)	Coefficient	ME (%)	Coefficient	ME (%)
Market Characteristics						
Intercept	-0.832***		-0.180		-0.443	
IPO Withdrawal	0.219	0.0796			0.017	0.0057
AIM			-0.947***	-0.3108	-0.940***	-0.3031
Hotness					-0.360***	-0.1236
Trading Volume					0.1	0.0167
European Oil Price					-0.2896	-0.0992
Negative News					-0.1	-0.0346
Firm and Offer Characteristics						
Offer Size					0.0	0.0094
Primary Shares	0.143	0.0500			0.370	0.1236
Greenshoe Option					0.682	0.2278
Debt Retirement					0.103	0.0352
Private Equity	0.663***	0.2520	0.529**	0.1957	0.380	0.1363
Venture Capital	0.774***	0.2968	0.738**	0.2797	0.756**	0.2846
Intellectual Capital	-0.351**	-0.1207	-0.516***	-0.1699	-0.573***	-0.1844
Underwriter					0.3094	0.1034
Firm Size			-0.097***	-0.0329	-0.101**	-0.0336
Firm Age					-0.0222	-0.0074
CAPEX					-0.01958	-0.0065
ROA					0.1016	0.0339
Debt					0.1153	0.0385
High-tech					-0.2146	-0.0694
Multinationality					0.4778	0.1596
Retained Ownership	0.642**	0.2250	1.01***	0.3427	1.065***	0.3558
Lockup Period	-0.0006	-0.0002			0.0005	0.0002
Board Size					-0.0139	-0.0046
Board Independence					0.1027	0.0343
Female Board Members					-0.4993	-0.1668
CEO Duality					0.2483	0.0868
HL Statistic	15.25	(0.0545)	1.94	(0.9828)	7.53	(0.4809)
Pseudo R2	0.0650		0.1529		0.1929	
N	284		284		284	

Table 3: Determinants of IPO Withdrawal: Green versus Brown IPOs

This table considers the determinants of withdrawal for the 284 IPO observations between 2001 and 2017. The dependent variable is status, which takes the variable 1 if a firm withdraws from the IPO process, and 0 otherwise. The marginal effect coefficient represents the marginal effect of a unit change on the probability that the dependent variable takes the value 1 (i.e. IPO withdrawal), given that all other variables are held constant and the standard deviation of the error term is fixed to 1. The Hosmer-Lemeshow statistic is a measure of goodness of fit that the observed events taken from 10 subgroups of the population match the estimated events in 10 subgroups of the population. The p-value for this statistic is reported in parentheses. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	Model One		Model Two		Model Three	
Variable	Coefficient	ME (%)	Coefficient	ME (%)	Coefficient	ME (%)
Market Characteristics						
Intercept	0.293		-0.281		0.519	
AIM					-0.007	-0.0005
Hotness					0.052	0.0042
Trading Volume					0.121	0.001
Negative News			0.902**	0.1589	0.990**	0.159
European Oil Price	-0.722***	-0.1471	-0.900***	-0.1188	-0.929***	-0.1047
Green Oil Price Interaction	0.661	0.1476	1.189**	0.2124	1.205**	0.1888
Firm and Offer Characteristics						
Offer Size			0.134*	0.0134	0.108	0.0089
Primary Shares	-0.853***	-0.1490			-0.654*	-0.0537
Greenshoe Option					0.152	0.0125
Debt Retirement					0.095	0.0083
Private Equity	0.519*	0.1153			0.603	0.0746
Venture Capital	0.571	0.1328			0.516	0.0622
Intellectual Capital	-0.568**	-0.0943	-0.509*	-0.0484	-0.478	-0.0374
Underwriter			0.861*	0.0862	0.773	0.0635
Firm Size			-0.156***	-0.0156	-0.155***	-0.0128
Firm Age					0.057	0.0047
CAPEX					-0.004	0.0003
ROA			0.506**	0.0507	0.433	0.0356
Debt			0.310***	0.031	0.274**	0.0225
High-tech					-0.366	-0.026
Multinationality					-0.481	-0.0395
Retained Ownership	-0.543	-0.0943			-0.373	-0.0306
Lockup Period			-0.004***	-0.0004	-0.003***	-0.0003
Board Size			0.132***	0.0132	0.118***	0.0097
Board Independence			-1.781***	-0.1782	-2.024***	-0.1662
Female Board Members					0.484	0.0397
CEO Duality					-0.539	-0.0322
Green Firm Dummy	-0.886*	-0.1282	-0.770*	-0.0637	-1.204*	-0.0767
Pre-2011 Green Interaction	0.941**	0.2240			0.486	0.0514
HL Statistic	13.25	(0.1035)	2.09	(0.9781)	7.34	(0.5003)
Pseudo R2	0.1546		0.3817		0.4216	
N	284		284		284	

Table 4: Post-IPO Withdrawal Outcome Distribution

Distribution of different post-IPO withdrawal outcomes over the 2001–2017 period. The database includes 38 IPO withdrawals of which 21 are classified as brown and 17 as green. The percentage distribution of the overall European dataset (2,808 observations) is listed for comparison.

Outcome	Private	Inactive	M&A	Trading
Brown IPO Withdrawals				
Average Months	150	56	17	20
Outcome	6	4	8	3
Percentage	28.57%	19.05%	38.10%	14.29%
Green IPO Withdrawals				
Average Months	139	88	44	0
Outcome	7	3	7	0
Percentage	41.18%	17.65%	41.18%	0.00%
Sample IPO Withdrawals				
Average Months	144	70	30	20
Outcome	13	7	15	3
Percentage	34.21%	18.42%	39.47%	7.89%
EU dataset	36.53%	22.46%	32.93%	8.08%

Table 5: Long-run post-IPO buy-and-hold abnormal returns

Long-run post-IPO buy-and-hold abnormal returns (BHARs) for green and brown firms. The full sample consists of 246 IPOs that occur between 2001 and 2017, with 73 green IPOs and 173 brown IPOs. The table reports BHARs for 12-, 24- and 36-month periods post-IPO for all IPOs, brown IPOs, and green IPOs relative to six benchmark indices including the FTSE100, DAX, N100, DAXAE, NEX and CAC40. Panel A represents BHARs for all IPOs combined, Panel B represents BHARs for brown IPOs only, and Panel C represents BHARs for green firms only. Further, in Panel D we report the difference in BHARs between equally weighted portfolios of green and brown firms at the 12-, 24-, and 36-month periods. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Panel A: All IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	0.0012	-0.0454	0.0026	-0.1503	-0.0244	0.0107
	(0.06)	(-0.30)	(0.07)	(-1.06)	(-0.14)	(0.14)
24	-0.2161	-0.3058	-0.2066	-0.4346	-0.2697	-0.1938
	(-1.68)**	(-2.29)**	(-1.61)*	(-3.05)***	(-2.01)**	(-1.51)*
36	-0.3735	-0.5111	-0.3443	-0.6420	-0.4339	-0.3291
	(-3.13)***	(-4.00)***	(-2.91)***	(-4.65)***	(-3.45)***	(-2.80)***
Panel B: Brown IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	0.0496	0.0098	0.0559	-0.1205	0.0282	0.0629
	(0.40)	(0.12)	(0.45)	(-0.72)	(0.25)	(0.50)
24	-0.1544	-0.2426	-0.1447	-0.4146	-0.2213	-0.1311
	(-1.01)	(-1.55)*	(-0.94)	(-2.47)***	(-1.40)*	(-0.85)
36	-0.3203	-0.4698	-0.2977	-0.6658	-0.4342	-0.2807
	(-2.28)**	(-3.12)***	(-2.12)**	(-4.02)***	(-2.86)***	(-2.01)**
Panel C: Green IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.1033	-0.1659	-0.1133	-0.2121	-0.1387	-0.1026
	(-0.96)	(-1.52)*	(-1.05)	(-1.90)**	(-1.26)	(-0.95)
24	-0.3352	-0.4280	-0.3260	-0.4643	-0.3590	-0.3148
	(-3.14)***	(-3.82)***	(-3.05)***	(-3.98)***	(-3.22)***	(-2.97)***
36	-0.4738	-0.5850	-0.4301	-0.5847	-0.4234	-0.4188
	(-4.24)***	(-4.90)***	(-3.91)***	(-4.82)***	(-3.72)***	(-3.83)***

Panel D: Green versus Brown IPOs			
	12-months	24-months	36-months
BHAR	-0.1679	-0.2407	-0.2236
Differential	(-1.00)	(-1.62)*	(-1.69)**

Table 6: Four-factor Model

The total sample consists of 246 IPOs, of which there are 73 green and 173 brown IPOs, between 2001 and 2017. Excess returns are regressed against the factors listed in the left hand column of the table. MktRF is the market risk premium (market return minus the risk-free rate). SMB is the difference in returns between a portfolio of small and a portfolio of large firms. HML is the difference in returns between a portfolio of high book-to-market ratios minus the return to a portfolio of low book-to-market ratios. WML is the difference in returns between winning firms (top 30% of firms sorted on returns) and losing firms (bottom 30% of firms sorted on returns) in the prior 11 months. EUCRBRDT Index is the European Brent Crude Oil daily price series. MO1 Index is the merged carbon price series, including both the base EU ETS carbon price series, with the carbon futures price series included. The t-statistics for each coefficient are reported in parentheses.Model One: Significant variables only (stepwise at 5% level of significance), Model Two: Significant variables plus the oil and carbon prices, Model Three: Carhart (1997) Four-factor model, Model Four: Carhart (1997) Four-factor model plus the oil and carbon prices. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	All Firms				Brown Firms				Green Firms			
$(R_{it} - -R_{ft})$	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Intercept	-0.0255	-0.0256	-0.0228	-0.0247	-0.0258	-0.0258	-0.0218	-0.0244	-0.0262	-0.0262	-0.0255	-0.0258
	(-12.42)***	(-12.43)***	(-11.11)***	(-11.69)***	(-9.94)***	(-9.91)***	(-8.47)***	(-9.06)***	(-8.03)***	(-8.05)***	(-7.84)***	(-7.79)***
MktRF	0.1236	0.1238	0.1513	0.1214	0.1229	0.1228	0.1656	0.1172	0.1175	0.1264	0.1203	0.1248
	(14.56)***	(14.58)***	(17.79)***	(12.15)***	(11.29)***	(11.27)***	(15.38)***	(9.14)***	(10.70)***	(9.70)***	(8.98)***	(8.09)***
SMB	0.2232	0.2218	0.2445	0.2196	0.2397	0.2407	0.2809	0.2385	0.1730	0.1772	0.1591	0.1743
	(10.46)***	(10.34)***	(12.46)***	(10.22)***	(8.83)***	(8.82)***	(11.42)***	(8.74)***	(5.39)***	(5.29)***	(5.06)***	(5.18)***
HML			-0.0231	-0.0294			-0.0243	-0.0278			-0.0277	-0.0274
			(-1.01)	(-1.15)			(-0.83)	(-0.84)			(-0.78)	(-0.71)
WML			-0.0108	-0.0204			-0.0162	-0.0299			-0.0094	-0.0151
			(-0.97)	(-1.70)*			(-1.15)	(-1.96)**			(-0.52)	(-0.80)
EUCRBRDT	0.1449	0.1460		0.1504	0.2472	0.2464		0.2539		-0.0370		-0.0338
Index	(5.93)***	(5.96)***		(6.09)***	(7.85)***	(7.80)***		(7.96)***		(-0.99)		(-0.90)
EUETS Index		-0.0015		-0.0018		0.0010		0.0006		-0.0067		-0.0068
		(-0.66)		(-0.77)		(0.34)		(0.20)		(-1.83)*		(-1.87)*
Adj. R2	0.0764	0.0768	0.0668	0.0764	0.0920	0.0920	0.0728	0.0916	0.0549	0.056	0.0531	0.0555
N (monthly)	7,377	7,377	8,288	7,377	5,016	5,016	5,813	5,016	2,361	2,361	2,475	2,361

Figure 1: This figure shows the total absolute number of IPOs by country in the dataset from 2001 to 2017.

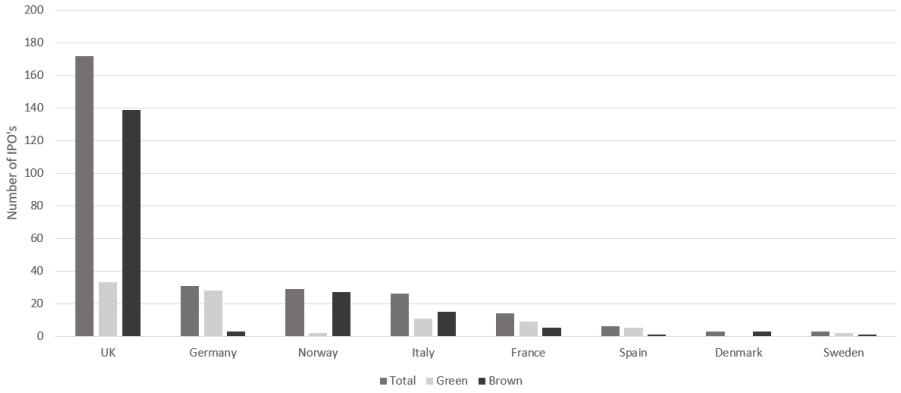


Figure 2: This figure shows the absolute number of green and brown IPOs for all countries across the whole sample period from 2001 to 2017.

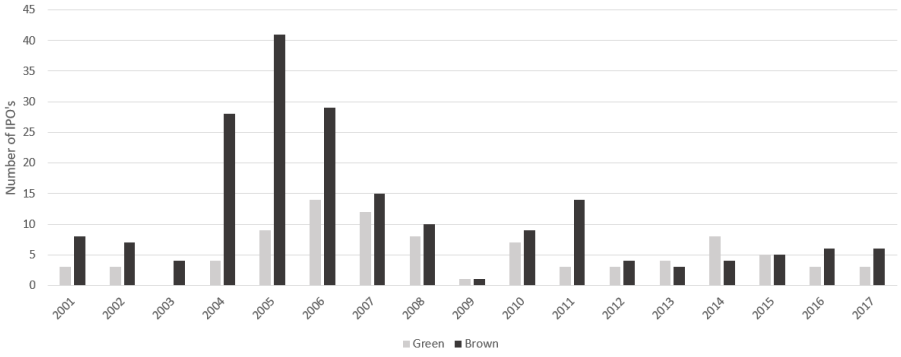


Figure 3: This figure shows the Kaplan-Meier survival estimates for green and brown companies that engage in M&A post-IPO withdrawal.

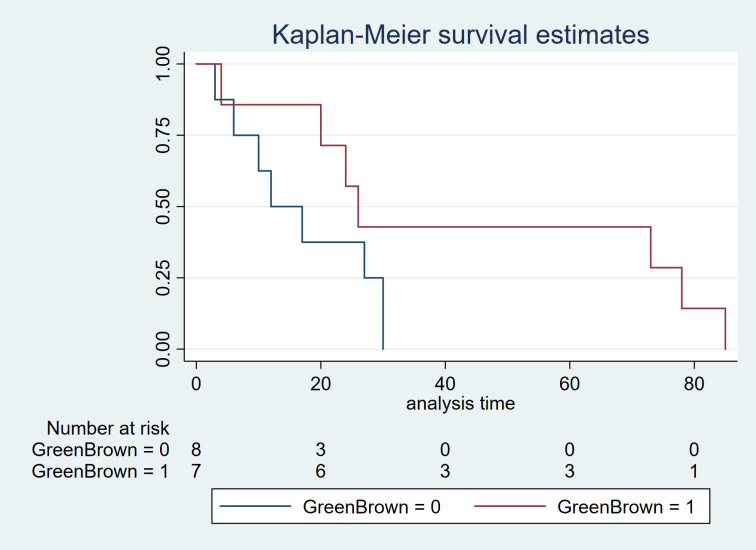


Figure 4: This figure shows absolute returns for brown IPOs to an equally weighted portfolio of brown firms in the 36 months post-IPO. The yellow line indicates the return to the equally weighted brown firm portfolio, whilst the black lines represent the returns to the six equally weighted market indices. As each IPO occurs at a different time, each month for each IPO is a different 21-day period. Returns for IPOs are included from month 1 up until month 36, or delisting of the IPO, whichever is earliest.

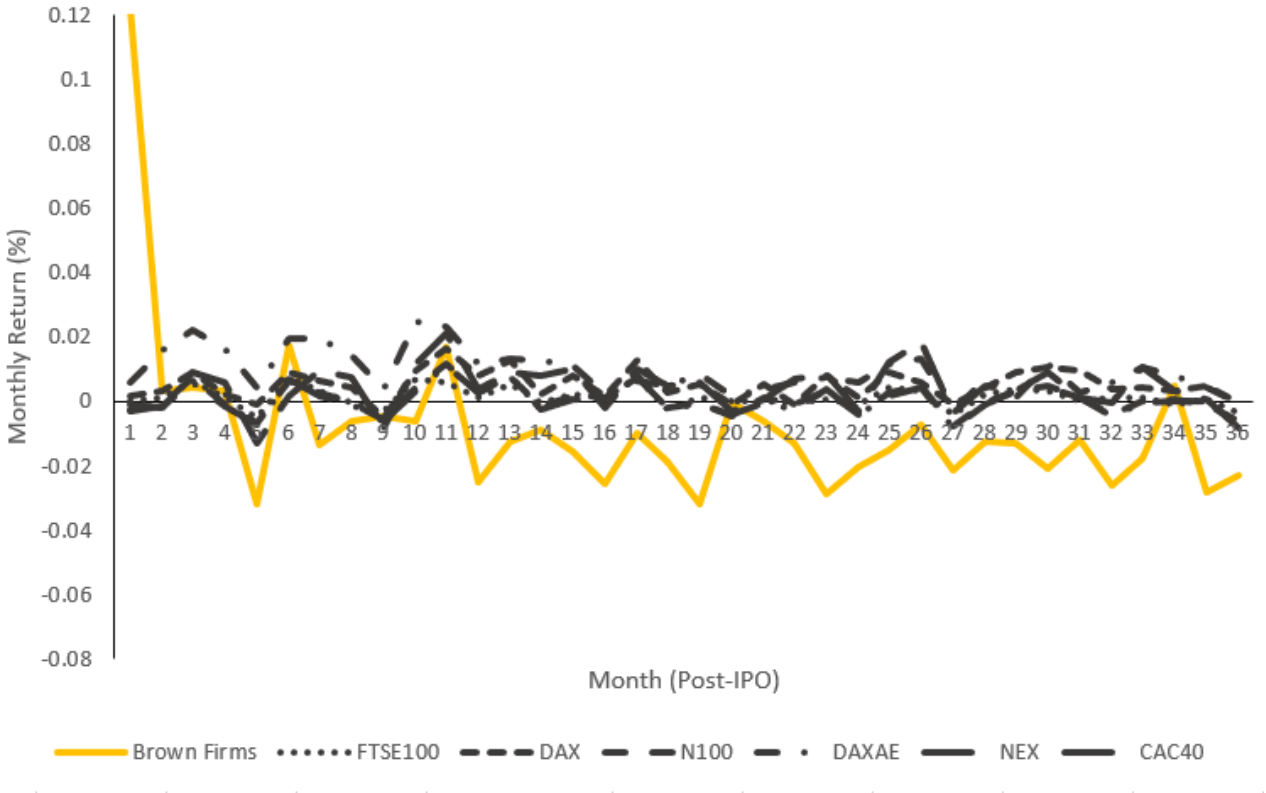
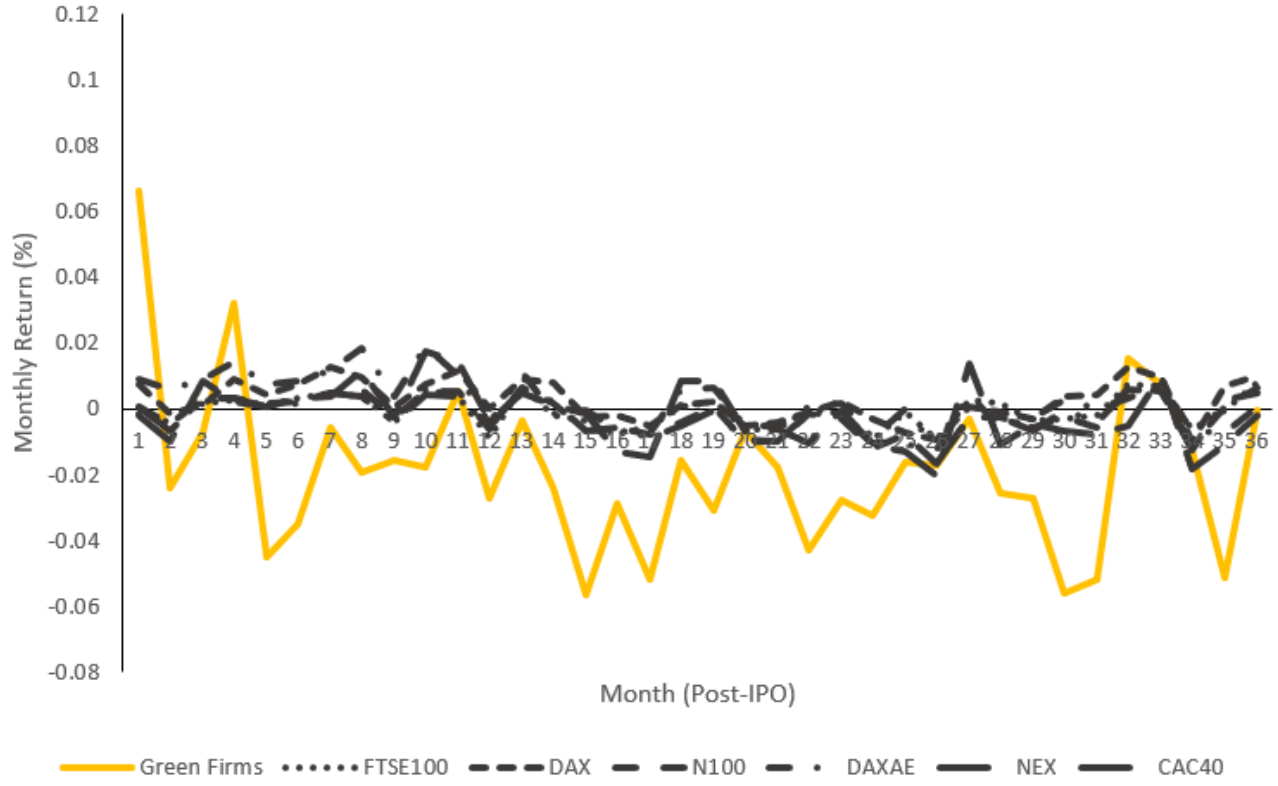


Figure 5: This figure shows absolute returns for green IPOs to an equally weighted portfolio of green firms in the 36 months post-IPO. The yellow line indicates the return to the equally weighted green firm portfolio, whilst the black lines represent the returns to the six equally weighted market indices. As each IPO occurs at a different time, each month for each IPO is a different 21-day period. Returns for IPOs are included from month 1 up until month 36, or delisting of the IPO, whichever is earliest.



Appendix

Table A.1: Industry classification of the IPO database

Industry	Number of IPOs
Airlines	1
Building Materials	4
Electric	3
Electrical Components and Equipment	2
Energy	281
Environmental Control	2
Mining	6
Oil and Gas	9
Transportation	2
Total	310

Table A.2: Data Description

Variable Name	Definition
IPO Withdrawal	This dummy takes a value of 1 if the IPO is withdrawn, and 0 otherwise.
Green Firm	This dummy takes a value of 1 if the firm undertaking the IPO is green, and 0 otherwise.
Market Characteristics	
AIM	This dummy takes a value of 1 if the firm has listed shares on the AIM, and 0 otherwise.
Market Hotness	The rolling averages of the number of filings 180 days prior to the specific IPO filing date are computed. If the company faces higher competition than average, the dummy takes a value of 1, and 0 otherwise.
Trading Volume	The rolling averages of the trading volume 180 days prior to the specific IPO filing date are computed. If the company files for an IPO during intensive trading, the dummy takes a value of 1, and 0 otherwise.
European Oil Price Hotness	The rolling averages of the end of month European Crude Brent oil price 180 days prior to the specific IPO filing date are computed. If the oil price at the time of filing is higher than average, the dummy takes a value 1, and 0 otherwise.
European Carbon Price Hotness	The rolling averages of the end of month European ETS carbon price 180 days prior to the specific IPO filing date are computed. If the carbon price at the time of filing is higher than average, the dummy takes a value 1, and 0 otherwise. Carbon price series are merged to avoid the large collapse in carbon prices observed in 2007/2008.
Green Firm Oil Price Interaction	This dummy takes a value of 1 if a firm is classified as green during periods of above-average oil prices, and 0 otherwise.
Negative News	If the IPO company is mentioned in the same paragraph with terms given by the LexisNexis Negative News Search one year prior to the IPO or withdrawal, the dummy takes a value of 1, and 0 otherwise.
Firm and Offer Characteristics	
Offer Size	The natural logarithm of the company's offer size is computed.
Primary Shares	The percentage of newly created shares being sold in the IPO.
Secondary Shares	The percentage of existing shares being sold in the IPO.
Greenshoe Option	The percentage of extra shares that the underwriter is granted to sell additionally in the IPO.
Debt Retirement	This dummy takes a value of 1 if the IPO company intends to retire debt with the IPO proceeds, and 0 otherwise.
Private Equity	This dummy takes a value of 1 if the company mentions private equity involvement in the prospectus, and 0 otherwise.
Venture Capital	This dummy takes a value of 1 if the company mentions venture capital involvement in the prospectus, and 0 otherwise.
Intellectual Capital	This dummy takes a value of 1 if the company discloses the intellectual capital or its competitive advantage in the prospectus, and 0 otherwise.
Underwriter	The underwriter reputation is classified according to the European ranking of Migliorati and Vismara (2014) which ranges from 0 to the highest reputation of 1.
Firm Characteristics	
Firm Size	The natural logarithm of the company's total assets is computed.
Age	The natural logarithm of the company's age is computed.
CapEx	The position of capital expenditures is divided by the total assets of the IPO company.
Return on Assets	The position of net income is divided by the total assets of the IPO company.
Debt	The position of total debt is divided by the total assets.
High-Tech	This dummy takes a value of 1 if the IPO company belongs to the high-tech industry based on the Eurostat definition, and 0 otherwise.
Multinationality	The scale of Aggarwal et al. (2011) is taken to quantify the degree of multinationality which includes for instance the revenue created abroad or foreign assets.
Pre-2011 Green	This interaction dummy takes a value of 1 if a firm is green, and the IPO is before 2011, and 0 otherwise.
Corporate Governance Characteristics	
Retained Ownership	The proportion of ownership in shares hold by insiders post IPO.
Lock-up (days)	Number of days the pre-IPO owners agree not to sell their shares.
Board Size	This variable accounts for the absolute number of board members.
Board Independence	This variable accounts for the ratio of board members that have no link to the IPO company.
Female Board Members	This variable accounts for the ratio of female board members.
CEO Duality	This dummy takes a value of 1 if the roles of a CEO and chairman are combined, and 0 otherwise.

Table A.3: Kyoto 2005 Long-run post-IPO buy-and-hold abnormal returns

Long-run post-IPO buy-and-hold abnormal returns (BHARs) for green and brown firms. The full sample consists of 195 IPOs that occur between 2005 and 2017, with 67 green IPOs and 128 brown IPOs. The table reports BHARs for 12-, 24- and 36-month periods post-IPO for all IPOs, brown IPOs, and green IPOs relative to six benchmark indices including the FTSE100, DAX, N100, DAXAE, NEX and CAC40. Panel A represents BHARs for all IPOs combined, Panel B represents BHARs for brown IPOs only, and Panel C represents BHARs for green firms only. Further, in Panel D we report the difference in BHARs between equally weighted portfolios of green and brown firms at the 12-, 24-, and 36-month periods. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Panel A: All IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.0368	-0.0956	-0.0366	-0.1568	-0.0517	-0.0267
	(-0.28)	(-0.77)	(-0.28)	(-1.26)	(-0.40)	(-0.19)
24	-0.2750	-0.3756	-0.2598	-0.3993	-0.2899	-0.2445
	(-2.41)***	(-3.13)***	(-2.28)***	(-3.21)***	(-2.45)***	(-2.16)**
36	-0.4179	-0.5385	-0.3686	-0.5417	-0.3857	-0.3538
	(-4.01)***	(-4.82)***	(-3.60)***	(-4.69)***	(-3.60)***	(-3.48)***
Panel B: Brown IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	0.0076	-0.0460	0.0146	-0.1242	0.0023	0.0237
	(0.11)	(-0.30)	(0.17)	(-0.87)	(0.06)	(0.24)
24	-0.2118	-0.3098	-0.1926	-0.3409	-0.2288	-0.1753
	(-1.64)*	(-2.29)**	(-1.49)*	(-2.42)***	(-1.70)**	(-1.36)*
36	-0.3720	-0.4971	-0.3212	-0.5210	-0.3677	-0.3040
	(-3.12)***	(-3.88)***	(-2.73)***	(-3.90)***	(-2.92)***	(-2.61)***
Panel C: Green IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.1155	-0.1839	-0.1280	-0.2131	-0.1483	-0.1167
	(-1.02)	(-1.61)*	(-1.13)	(-1.83)**	(-1.28)	(-1.03)
24	-0.3754	-0.4808	-0.3677	-0.4908	-0.3861	-0.3562
	(-3.33)***	(-4.04)***	(-3.25)***	(-4.03)***	(-3.29)***	(-3.18)***
36	-0.4934	-0.6052	-0.4467	-0.5708	-0.4099	-0.4361
	(-4.33)***	(-4.97)***	(-3.99)***	(-4.69)***	(-3.59)***	(-3.92)***

Panel D: Green versus Brown IPOs			
	12-months	24-months	36-months
BHAR	-0.1343	-0.2019	-0.1485
Differential	(-0.85)	(-1.46)*	(-1.25)

Table A.4: Kyoto 2005 Four-factor Model

The total sample consists of 195 IPOs, of which there are 67 green and 128 brown IPOs, between 2005 and 2017. Excess returns are regressed against the factors listed in the left hand column of the table. MktRF is the market risk premium (market return minus the risk-free rate). SMB is the difference in returns between a portfolio of small and a portfolio of large firms. HML is the difference in returns between a portfolio of high book-to-market ratios minus the return to a portfolio of low book-to-market ratios. WML is the difference in returns between winning firms (top 30% of firms sorted on returns) and losing firms (bottom 30% of firms sorted on returns) in the prior 11 months. EUCRBRDT Index is the European Brent Crude Oil daily price series. MO1 Index is the merged carbon price series, including both the base EU ETS carbon price series, with the carbon futures price series included. The t-statistics for each coefficient are reported in parentheses.Model One: Significant variables only (stepwise at 5% level of significance), Model Two: Significant variables plus the oil and carbon prices, Model Three: Carhart (1997) Four-factor model, Model Four: Carhart (1997) Four-factor model plus the oil and carbon prices. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	All Firms				Brown Firms				Green Firms			
$(R_{it} - -R_{ft})$	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Intercept	-0.0242	-0.0242	-0.0228	-0.0233	-0.0221	-0.0221	-0.0211	-0.0220	-0.0267	-0.0267	-0.0260	-0.0261
	(-11.23)***	(-11.24)***	(-10.31)***	(-10.58)***	(-7.80)***	(-7.80)***	(-7.32)***	(-7.72)***	(-8.05)***	(-8.05)***	(-7.74)***	(-7.76)***
MktRF	0.1226	0.1230	0.1459	0.1179	0.1082	0.1082	0.1634	0.1121	0.1147	0.1247	0.1120	0.1205
	(14.22)***	(14.25)***	(16.20)***	(11.48)***	(8.54)***	(8.54)***	(13.99)***	(8.40)***	(10.38)***	(9.49)***	(8.12)***	(7.71)***
SMB	0.2168	0.2149	0.2503	0.2105	0.2350	0.2349	0.2991	0.2336	0.1582	0.1638	0.1559	0.1591
	(9.94)***	(9.81)***	(11.83)***	(9.57)***	(8.36)***	(8.31)***	(10.92)***	(8.26)***	(4.89)***	(4.85)***	(4.80)***	(4.68)***
HML			-0.0279	-0.0346			-0.0284	-0.0312			-0.0348	-0.0343
			(-1.07)	(-1.34)			(-0.83)	(-0.93)			(-0.90)	(-0.88)
WML			-0.0182	-0.0277	-0.0308	-0.0309	-0.0199	-0.0360			-0.0227	-0.0235
			(-1.48)	(-2.25)**	(-2.09)**	(-2.09)**	(-1.26)	(-2.28)**			(-1.19)	(-1.23)
EUCRBRDT	0.1387	0.1402		0.1464	0.2636	0.2637		0.2636		-0.0426		-0.0377
Index	(5.45)***	(5.50)***		(5.70)***	(7.79)***	(7.78)***		(7.77)***		(-1.13)		(-0.99)
EUETS Index		-0.0021		-0.0025		-0.0002		-0.0002		-0.0068		-0.0071
		(-0.91)		(-1.05)		(-0.05)		(-0.07)		(-1.87)*		(-1.93)*
Adj. R2	0.0800	0.0800	0.0754	0.0805	0.1015	0.1012	0.0875	0.1012	0.0523	0.0536	0.0524	0.0535
N (monthly)	6,504	6,504	6,537	6,504	4,234	4,234	4,264	4,234	2,270	2,270	2,273	2,270

Table A.5: Long-run post-IPO buy-and-hold abnormal returns excluding first day returns

Long-run post-IPO buy-and-hold abnormal returns (BHARs) for green and brown firms excluding the first day returns. The full sample consists of 246 IPOs that occur between 2001 and 2017, with 73 green IPOs and 173 brown IPOs. The table reports BHARs for 12-, 24- and 36-month periods post-IPO for all IPOs, brown IPOs, and green IPOs relative to six benchmark indices including the FTSE100, DAX, N100, DAXAE, NEX and CAC40. Panel A represents BHARs for all IPOs combined, Panel B represents BHARs for brown IPOs only, and Panel C represents BHARs for green firms only. Further, in Panel D we report the difference in BHARs between equally weighted portfolios of green and brown firms at the 12-, 24-, and 36-month periods. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Panel A: All IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.1185	-0.1677	-0.1188	-0.2735	-0.1477	-0.1110
	-2.36	-3.21	-2.34	-4.83	-2.60	-2.19
24	-0.3119	-0.3998	-0.3027	-0.5356	-0.3734	-0.2891
	-5.35	-6.41	-5.13	-7.52	-5.70	-4.94
36	-0.4519	-0.5858	-0.4203	-0.7259	-0.5215	-0.4033
	-7.71	-9.12	-7.16	-9.76	-7.84	-6.93
Panel B: Brown IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.0940	-0.1341	-0.0896	-0.2698	-0.1194	-0.0826
	-1.60	-2.19	-1.50	-4.03	-1.81	-1.38
24	-0.2598	-0.3440	-0.2505	-0.5294	-0.3331	-0.2362
	-3.95	-4.88	-3.76	-6.55	-4.50	-3.56
36	-0.3998	-0.5440	-0.3746	-0.7477	-0.5209	-0.3557
	-5.97	-7.35	-5.53	-8.59	-6.62	-5.30
Panel C: Green IPOs						
Month	FTSE100	DAX	N100	DAXAE	NEX	CAC40
12	-0.1734	-0.2439	-0.1845	-0.2811	-0.2112	-0.1748
	-2.79	-3.80	-2.97	-4.19	-3.13	-2.83
24	-0.4118	-0.5078	-0.4027	-0.5375	-0.4471	-0.3908
	-5.62	-6.45	-5.42	-6.47	-5.57	-5.31
36	-0.5522	-0.6624	-0.5059	-0.6712	-0.5119	-0.4933
	-6.68	-7.43	-6.19	-7.28	-5.87	-6.09
Panel D: Green versus Brown IPOs						
	12-months		24-months		36-months	
BHAR	-0.0921		-0.2096		-0.1936	
Differential	(-1.19)		(-2.66)***		(-2.54)***	

Table A.6: Four-factor Model excl. first day returns

The total sample consists of 246 IPOs, of which there are 73 green and 173 brown IPOs, between 2005 and 2017, excluding the first day of trading. Excess returns are regressed against the factors listed in the left hand column of the table. MktRF is the market risk premium (market return minus the risk-free rate). SMB is the difference in returns between a portfolio of small and a portfolio of large firms. HML is the difference in returns between a portfolio of high book-to-market ratios minus the return to a portfolio of low book-to-market ratios. WML is the difference in returns between winning firms (top 30% of firms sorted on returns) and losing firms (bottom 30% of firms sorted on returns) in the prior 11 months. EUCRBRDT Index is the European Brent Crude Oil daily price series. MO1 Index is the merged carbon price series, including both the base EU ETS carbon price series, with the carbon futures price series included. The t-statistics for each coefficient are reported in parentheses.Model One: Significant variables only (stepwise at 5% level of significance), Model Two: Significant variables plus the oil and carbon prices, Model Three: Carhart (1997) Four-factor model, Model Four: Carhart (1997) Four-factor model plus the oil and carbon prices. *** significant at 1% level, ** significant at 5% level, * significant at 10% level

	All Firms				Brown Firms				Green Firms			
$(R_{it} - -R_{ft})$	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Intercept	-0.0287	-0.0288	-0.0272	-0.0284	-0.0287	-0.0287	-0.0265	-0.0280	-0.0300	-0.0301	-0.0293	-0.0297
	(-14.06)***	(-14.09)***	(-13.55)***	(-13.53)***	(-11.04)***	(-11.03)***	(-10.48)***	(-10.4)***	(-9.48)***	(-9.48)***	(-9.25)***	(-9.22)***
MktRF	0.1315	0.1318	0.1625	0.1350	0.1305	0.1304	0.1789	0.1331	0.1284	0.1357	0.1269	0.1344
	(15.67)***	(15.71)***	(19.63)***	(13.66)***	(12.07)***	(12.06)***	(17.05)***	(10.44)***	(12.06)***	(10.7)***	(9.79)***	(8.95)***
SMB	0.2264	0.2234	0.2494	0.2218	0.2440	0.2441	0.2899	0.2427	0.1663	0.1762	0.1578	0.1737
	(10.68)***	(10.49)***	(12.99)***	(10.40)***	(8.98)***	(8.93)***	(11.99)***	(8.88)***	(5.34)***	(5.42)***	(5.19)***	(5.32)***
HML			-0.0307	-0.0372			-0.0404	-0.0429			-0.0222	-0.0260
			(-1.36)	(-1.46)			(-1.40)	(-1.29)			(-0.64)	(-0.70)
WML			0.0011	-0.0095			-0.0001	-0.0149			-0.0068	-0.0136
			(0.10)	(-0.80)			(-0.01)	(-0.98)			(-0.39)	(-0.74)
EUCRBRDT	0.1365	0.1387		0.1403	0.2370	0.2369		0.2392		-0.0388		-0.0357
Index	(5.58)***	(5.66)***		(5.69)***	(7.47)***	(7.45)***		(7.45)***		(-1.06)		(-0.97)***
EUETS Index		-0.0032		-0.0033		0.0001		-0.0001	-0.0101	-0.0098		-0.0100
		(-1.38)		(-1.42)		(0.03)		(-0.02)	(-2.83)***	(-2.75)***		(-2.79)***
Adj. R2	0.0817	0.0819	0.0738	0.0819	0.0946	0.0944	0.0794	0.0944	0.0677	0.0677	0.0616	0.0672
N (monthly)	7,377	7,377	8,287	7,377	5,016	5,016	5,812	5,016	2,361	2,361	2,475	2,361