European Green Policy Announcements and Sectoral Stock Returns*

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Abstract

To fulfill the Paris Agreement commitments and stimulated by an unprecedented amount of public resources put in place to recover from the COVID-induced recession, European governments have recently announced sizable green policy plans. In this paper, we examine the behavior of green and brown stocks around green policy-related announcements (GPAs) made by major European governments in 2020 via a standard event study analysis and the use of returns of stocks listed in the "STOXX 100 All Europe". Our main empirical findings indicate the presence of positive cumulative abnormal returns (CARs) both in the green and brown sectors following GPAs. However, the estimated positive sentiment effect is stronger in the former sectors. A size effect in terms of the amount of resources announced to be allocated for a specific category of policy is also observed. We find that the observed positive sentiment is mainly driven by announcements on climate change mitigation-related policies, which account for 70% of the total allocated funds. At the sector level, positive and significant CARs due to GPAs are found in the (*i*) energy, (*ii*) financial and (*iii*) industrial sectors. At the country level, GPAs are found to drive a significant positive sentiment effect in the following European countries: Switzerland, Spain, UK, Ireland and Italy. Sector- and country-level analyses confirm the presence of larger benefits from GPAs among more sustainable portfolios.

JEL classification: G12, G13, G14, G18, L91, Q54

Keywords: Climate change, green policy announcements, green and brown stocks, event study

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1 Introduction

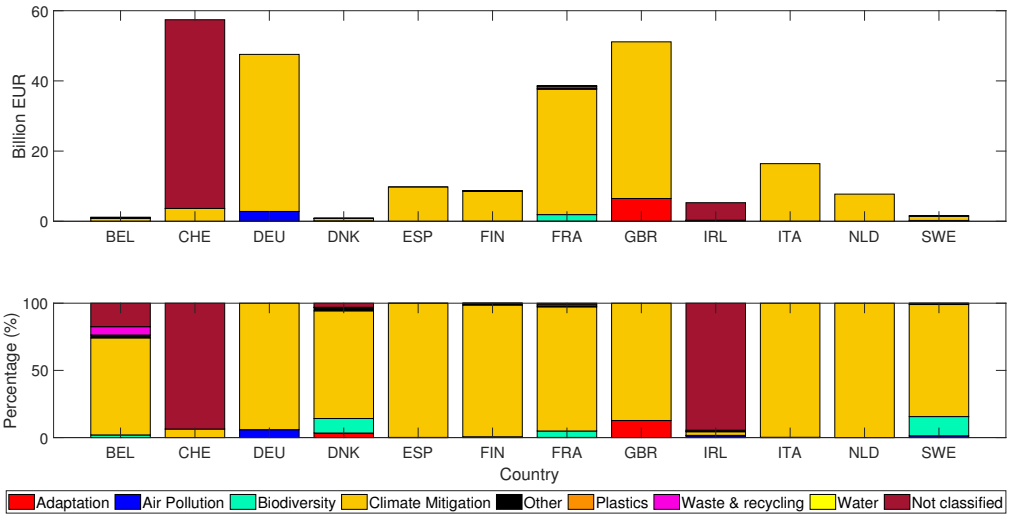
The increasing frequency of natural disasters observed worldwide has generated a large rise in climate change risk awareness (see, among others, Donadelli et al., 2019; Barnett, 2020; Ardia et al., 2021). Today, climate change is at the center of the global policy and academic debate. As a result, media attention towards climate change-related issues is skyrocketing (Engle et al., 2020). On October 7, 2021 the theoretical physicist Lawrence M. Krauss wrote an online article about climate science and climate change implications (Krauss, 2021). He stressed that climate science is surrounded by uncertainty, of course, as many other sciences. But, he also added that there is something certain about climate science, i.e., "an indubitable arithmetic based on atmospheric chemistry". And, given this certain fact, policymakers must undertake immediate actions to address the climate crisis. This has also been stressed by policymakers during the most recent COP26 in Glasgow. The speech of the Italian Prime Minister Mario Draghi, for instance, clearly acknowledges that if no actions are undertaken, the "climate change can tear us apart". As a consequence, governments around the world are facing the challenge to implement policies able to keep the rise in temperature below 1.5 degrees in the shortest possible time.

Actually, the first concrete global commitment in this direction goes back to the 2015 Paris Agreement when 196 Parties signed a treaty aimed at achieving a climate neutral world by mid-century. According to the Paris Agreement, countries committed to submit their plans for climate action known as nationally determined contributions (NDCs) by 2020. In their NDCs, countries should communicate actions they will take to reduce their Greenhouse Gas emissions in order to reach the goals of the Paris Agreement. Countries also communicate in the NDCs actions they will take to build resilience to adapt to the impacts of rising temperatures. As of 11 December 2019, to overcome the adverse effects of climate change and environmental degradation, the EU has further launched a European Green Deal, which has been followed by the presentation of the European Green Deal Investment Plan (14 January 2020) and Proposal of a Circular Economy Action Plan (11 March 2020).

In light of these commitments, the new European climate change related policy plans, and thanks to the rapid and huge resources put in place to smooth the adverse economic effects

of the pandemic, many governments, and in particular the European ones, have recently started to announce credible and concrete green policy plans. The common goal of these announced plans is represented by the willingness to speed the transition towards a greener economy. To achieve such goal, the EU has launched the largest recovery stimulus package ever implemented in its history, allocating a share of 30% of the overall funds to fight climate change and support the green transition. In terms of allocated funds, climate mitigation represents the wider dimension, followed by air pollution, while adaptation has a marginal role (see Fig. 1).

Figure 1: Green recovery funds by country and environmental dimension



Notes: This figure shows the allocation of green recovery funds among different environmental categories for the 12 European countries. Sample: 01 January 2020 - 31 December 2020.

In this paper we examine the effects of the most recent green plans launched by the major European governments to alleviate the adverse effect of climate change on the equity valuation of green and brown firms. More precisely, via an event study we estimate cumulative abnormal returns (CARs) of green vs. brown portfolios following green policy-related announcements (GPAs) made by 12 European governments over the year 2020 (i.e., post-European Green Deal). Using returns of stocks listed in the "STOXX 100 All Europe" and European GPAs retrieved from the OECD Green Recovery Database (OECD, 2021) for the year 2020, we find the presence of positive and significant CARs around GPAs both

in the green and brown sectors. Notably, twenty days after the events (i.e., green policy announcements) CARs for green (brown) stocks amount to +2.5% (+1.7%).

When different categories of GPAs are considered, we observed that positive and statistically significant CARs in both green and brown portfolios are mainly driven by announcements related to the allocation of resources for the implementations of "climate mitigation" policies. Similar effects, although less significant, are found following announcements related to the implementations of "air pollution" and "water" policies. A sectoral analysis reveals instead a more complex picture about the implications of GPAs for brown and green stocks. Actually, GPAs induce a positive sentiment only in the consumer discretionary, energy, financial and industrials sectors. A country-by-country analysis indicates the presence of significant CARs following country-specific GPAs only in the following European countries: Switzerland, Spain, UK, Ireland and Italy. Importantly, in all our analyses the GPAs-induced positive investor sentiment is found to have a stronger impact on green stocks, confirming thus a drop in the equity valuation of brown firms relative to green firms.

Taken together, our novel empirical findings indicate the presence of short run benefits among both brown and green stocks following governments' announcements to allocate resources to combat climate change and its adverse effects. In particular, a commitment in implementing climate mitigation policies is found to contribute most to a rise in firm equity valuations. Whether or not this is generated by a current "green bubble" or by investors' expectations is still unclear. On the one hand, the sizeable observed positive effects of GPAs can be due to the global euphoria surrounding climate change-related topics. This global euphoria seems to also be responsible for the surprising positive effects on brown stocks. On the other hand, it could be that investors believe in governments' green policy commitment having a potential positive impact on the long-run growth prospects of green firms, with a positive spillover effect on less sustainable stocks. It is, however, undeniable that commitments towards more sustainable climate policies influence green and brown firms differently. Regardless of the global euphoria, media coverage and public boost, the larger benefits observed among green firms following GPAs can lead to a reallocation of capital towards less carbon-intensive firms. This could have concrete adverse effects on high carbon-intensive firms in the medium run, with the labor market being more severely influenced. So far, a little attention has

been paid to the potential adverse effect of such capital re-allocation. Needless to say, this issue should be at the center of the policy agenda as well as green policies. Importantly, governments should consider to take actions aimed at supporting brown firms when green plans are announced and not when they will be truly implemented. If not, it could be too late to preserve labor market conditions and capital in the brown sector.

The rest of this paper is organized as follows. Section 2 summarizes the relevant literature. Section 3 describes data and methodology. Section 4 presents the empirical results and Section 5 concludes.

2 Related literature

Broadly, our paper fits into a growing literature aimed at examining the implications of climate change-related news/events for firms' equity valuations. More specifically, our paper is most closely related to a bunch of very recent empirical works attempting to capture the sectoral (brown vs. green or dirty vs. clean) effects of climate change-related news (Donadelli et al., 2019; Barnett, 2020; Ardia et al., 2021; Huynh and Xia, 2021; Diaz-Rainey et al., 2021; Birindelli and Chiappini, 2021). For instance, Donadelli et al. (2019) document that increasing climate change risk awareness has been responsible for the observed decline in the relative valuation of fossil fuel firms (i.e., high carbon intensive firms). Via a standard event study, they also show that the cumulative abnormal returns of the oil sector are considerably lower than the cumulative market returns (or the cumulative average return across the other sectors) following news/events associated with more stringent climate change policies.

In a similar fashion, Barnett (2020) examines the effect of different climate policy events on firms with high/low climate policy risk exposure. He observes that in the aftermath of all those events implying a downward shift in the likelihood of future climate policy occurring (e.g., 2016 US presidential election or the US Supreme Court decision to put a stay on the Clean Power Plan) the value of firms with high climate policy risk exposure (i.e., oil firms) increases. Following instead events that increase the likelihood of future climate policy actions (e.g., announcement of the Clean Power Plan or the UN's Paris Climate Accord), the opposite holds, i.e., the value of firms with high climate policy risk exposure drops.

Ardia et al. (2021) build a novel Media Climate Change Concerns index using news about climate change published by major U.S. newspapers to capture unexpected increases in climate change concerns. They find that an unexpected increase in climate change-related concerns is associated with a rise (drop) in the stock price of green (brown) firms.

In line with Ardia et al. (2021), Pástor et al. (2021a) builds on the theoretical model of Pástor et al. (2021b) and empirically show that green assets recent outperformance is driven by increasing climate change concern. In particular, those higher realized returns are due to unexpected environmental news and do not reflect high expected returns. In other words, green portfolios higher return are not the compensation for increased risk, but instead a premium for holding sustainable assets. Pástor et al. (2021a) call the green-brown return spread "greenium". Recently, the effects of climate change concern on asset valuation is studied by Kim and Park (2021), which investigate investors' awareness of climate change risk during Covid-19 in Korea. They show that rising attention to the environmental issue induces institutional investors to disinvest "brown" asset. However, retail investors do not shift their preferences toward more "green" and sustainable stocks.

Using the climate change news index constructed by Engle et al. (2020), Huynh and Xia (2021) examine the effect of climate change news risk on corporate bond returns. They first construct a climate change news beta, β^{CCN} capturing a bond's covariance with the climate change news risk index. They then show that bonds with a higher β^{CCN} are associated with lower future returns. They further observe that bonds of issuers with stronger environmental performance tend to exhibit higher β^{CCN}. In other words, the empirical evidence provided by Huynh and Xia (2021) indicate that investors accept to pay a premium for (and accept lower future returns on) bonds with a higher β^{CCN}, since these bonds offer better potential to hedge against climate change risk.

Engle et al. (2020) empirically show that during periods with negative news about the future path of climate change stocks of firms with relatively high E-Scores (i.e., firms with lower exposure to regulatory climate risk) have higher returns. Choi et al. (2020) observe instead an under-performance of high carbon-intensive firms during times with abnormally warm weather, that is, during periods characterized by higher investors' attention to climate risks. Diaz-Rainey et al. (2021) explore the stock market response of the oil and gas industry to

four policy events associated with the Paris Agreement and the election of Donald Trump. By performing a standard event study analysis they observe that the signing of the Paris Agreement had a large negative impact on the Oil & Gas sector.

Birindelli and Chiappini (2021) examine the implications of the main climate policy events occurred over the period 2013–2018 for the shareholders' value.[1] In an event study framework, they observe that all sectors have been significantly affected by climate policy announcements. On average, negative effects are found to be larger than positive effects, thus indicating that more stringent climate change policies may lead to a decline in equity valuations. In line with other studies, they also find that a new policy produced significant positive effects only on green firms.

We differ from these studies in several respects. First, we focus only on "2020 European climate change-related news/events". Second, our events rely exclusively on official governments' green policy-related announcements. Third, we classify the full set of green policy announcements in different categories so to capture different dimensions of climate change policies' implications for sectoral stock returns.

3 Empirical strategy

3.1 Methodology

In this Section we briefly describe the methodology and data employed to asses the impact of green policy announcements on the European stock market.

Event study: CARs. Following recent empirical studies, we first run an event study and estimate CARs in the spirit of MacKinlay (1997). The theoretical return is estimated by means of a standard one-factor model (i.e., CAPM), where as proxy for the market return

[1] Note that Birindelli and Chiappini (2021) rely only on the following eight events: (i) EU climate change adaptation strategy (April 16, 2013); (ii) EU policy framework for climate and energy in the period from 2020 to 2030 (January 23, 2014); (iii) Paris agreement on climate change (December 12, 2015); (iv) Paris agreement on climate change came into effect (November 4, 2016); (v) Proposal for a revised directive on energy efficiency (June 26, 2017); (vi) EU Council conclusions on the Paris agreement and preparation for the United Nations framework convention on climate change (UNFCCC) meetings (October 13, 2017); (vii) Action plan for the planet (December 12, 2017) and (viii) Adoption of the strategy "A clean planet for all", (November 28, 2018).

the value weighted return of all stocks belonging to the "STOXX All Europe 100 Index" is used. The estimation window is set from $t-250$ to $t-30$ with respect to the event occurred at time t. Abnormal returns are then defined as the difference between the realized and predicted returns over a relatively long window of 25 days (i.e., from $t-5$ to $t+20$) around the event date. The cumulative abnormal returns for each portfolio are then calculated as:

$$CARs_{i,t} = \sum_{t-5}^{t+20} \epsilon_{i,t} = \sum_{t-5}^{t+20} \left(R_{i,t} - \alpha_i - \beta_i \left(R_{m,t} - R_{f,t}\right)\right) \tag{1}$$

where $R_{i,t}$ is stock's i return, $R_{m,t}$ is the market return, $R_{f,t}$ is the risk free rate, α_i and β_i are stock's i estimated regression coefficients. CARs are computed for the green and brown value-weighted portfolios. In a set of additional tests, we also estimate CARs for different sectors (as classified by ICB) and by considering different categories of green policy announcements.[2]

Regression analysis. As a robustness test, to gain more insights on the stock market implications of green policy announcements, we employ a standard methodology to test the predictive power of green policy announcements on future realized returns (see among others, Campbell and Shiller, 1988; Fama and French, 1989; Fama, 1990; Croce et al., 2019). Specifically, we estimate a set of predictive regressions of cumulative returns at different horizons:

$$R^{cum}_{i,t+j} = \alpha_i + \beta_i R_{m,t} + \gamma_i D_t, \quad \text{for j=}\{1, 3, 5, 10, 20\} \tag{2}$$

where $R^{cum}_{i,t+j}$ is the j-periods ahead cumulative return of stock i, $R_{m,t}$ is the market return and D_t is a dummy variable taking value 1 if at time t a green policy is announced and 0 otherwise. This exercise allows us to explore the effects of GPAs on portfolio returns from a different point of view, i.e., we focus on the cumulative performance of portfolios at different

[2]For the sake of robustness, we compute CARs using: (i) equal-weighted returns, (ii) a different window, i.e. from $t-20$ to $t+20$, (iii) a three-factor model including SMB and HML retrieved from the Fama and French European factors https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html), (iv) a four-factor model including the Oil price change and (v) using country-specific GPAs. Results from all these additional empirical tests are shown in Appendix B.

horizons and not on the gap between realized and predicted returns.[3]

3.2 Data

Our study relies on green policy-related announcements/news (GPAs) and data on EU firms' daily stock returns. In what follows, we describe the data used for the analysis and the strategy employed to identify the most relevant GPAs.

3.2.1 Green policy-related announcements (GPAs).

We retrieve GPAs from the OECD Green Recovery Database for 2020. In order to match GPAs with returns of stocks listed in the STOXX All Europe 100, we focus on announcements made by the following 12 European countries: Belgium, Switzerland, Germany, Denmark, Finland, France, Ireland, Italy, Netherlands, Spain, United Kingdom, and Sweden.

GPAs have been collected for the period 1 January 2020 – 31 December 2020. Specifically, we consider the date of the first announcement to subsequently test its effect on portfolio returns. For events occurring on non-trading days, the next market opening day is considered. Multiple GPAs occurred in a single day are considered as a unique event. We end up with a total number of 73 events (i.e., 73 different days in which at least one green policy announcement has been made). The full list of events (i.e., GPAs) reporting the amount of resources (in million of euros) that will be allocated for a specific green policy is reported in Table A.1.

To gain more insights on the effects of green policies on sectoral returns, different categories of GPAs are also considered. To do so, we use the following green policy classification proposed by the OECD (2021): (i) climate mitigation, (ii) adaptation, (iii) air pollution, (iv) biodiversity, (v) water, (vi) waste and recycling, (vii) other environmental related measures.[4]

3.2.2 European stock market returns: green & brown portfolios.

We build green and brown portfolios using the stocks listed in the "STOXX All Europe 100 Index", i.e., an index composed by the largest companies in the Western and Eastern Europe

[3] Regression results are reported in Appendix B and will be discussed in Section 4.2.

[4] The category plastics has been excluded because it includes only one single announcement for Finland.

region. The database consists of 91 firms belonging to 12 different European countries.[5] Data on prices and market capitalization have been retrieved at daily frequency from 01 January 2019 to 15 June 2021 from Datastream.

We construct a green and brown portfolios by relying on the Environmental Pillar Score developed by Thomson Reuters. This indicator provides a percentile rank score on the environmental sustainability of a company expressed in letters from D- to A+ and based on three main categories: (*i*) resource use, (*ii*) emissions and (*iii*) innovation. Table 1 shows the distribution of firms across score grades. In particular, firms are classified as green if their rating is A or above and as brown otherwise. Based on the percentile distribution of the grades, the green portfolio includes the top 20% best performing companies compared to their industry group benchmark. Such classification leads to the construction of a green (brown) portfolio composed by 43 (48) firms. The list and summary statistics of green and brown stocks are shown in Appendix A.2.

Table 1: Green *vs*. Brown classification

Green		**Brown**									
A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-
19	24	19	10	5	7	3	0	2	1	0	1

Notes: This table reports the number of stocks in each percentile score rank. Companies grade A or A+ represent the top 20% best performing compared to their industry group benchmark.

Finally, we use for our event study analysis the one-year German government bond yield as proxy for the risk-free rate and the return of the STOXX All Europe 100 Index to capture the market return.

4 Empirical results

4.1 CARs.

In this section we examine the response of green and brown portfolios to European GPAs. We first present CARs estimated by focusing on all events (i.e., the full list of post-COVID

[5]Russia has been excluded because green policy announcements were not available for that country. The sector telecommunications has been excluded as well because weakly representative of the green and brown sectors.

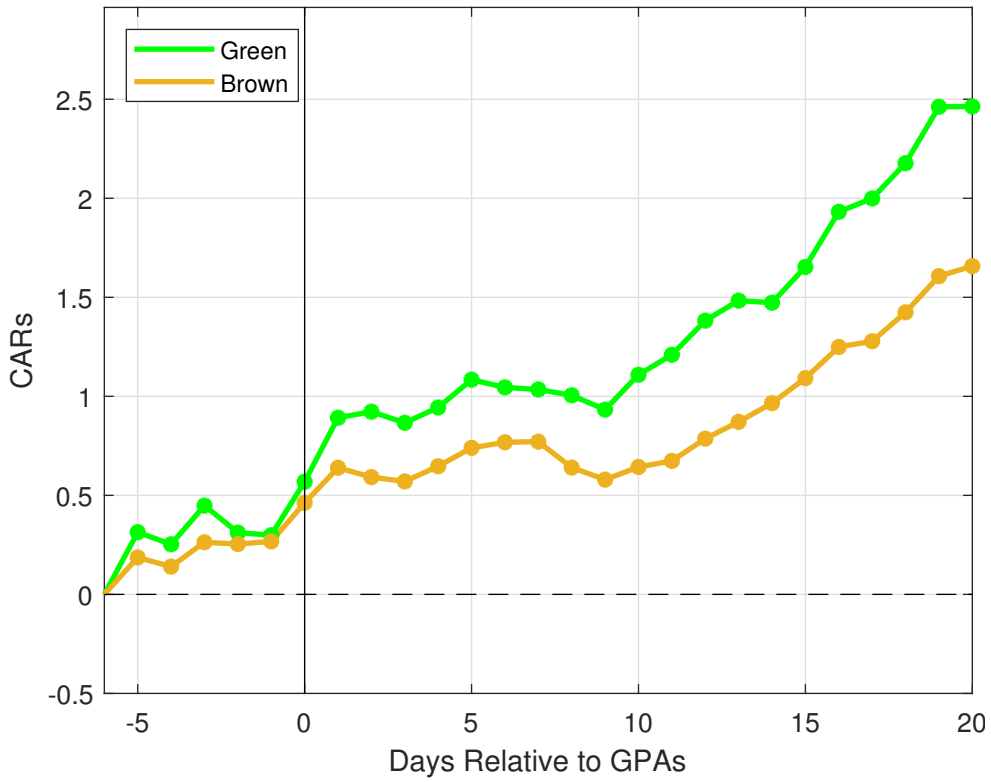
green announcements) and all green and brown stocks. Next, we report CARs estimated by (i) using different categories of green policies and (ii) relying of green and brown portfolios belonging to different sectors.

Main results. The dynamics of CARs depicted in Fig. 2 indicate that GPAs have a positive and significant impact on both green and brown portfolios. In line with existing studies (Ardia et al. (2021), Birindelli and Chiappini (2021) among others), we find green portfolios to benefit more than brown ones from announced policies to fight climate change. In fact, we observe an increase in CARs from $t-1$ to $t+1$ with respect to the announcement date. This increase is however larger for the green portfolio. The observed green-brown gap in CARs at the end of the estimation window amounts to about 1%. Twenty days after the policy announcement the cumulative abnormal return on the green (brown) portfolio is around 2.5% (1.6%). On the one hand, brown stocks are perceived as more exposed to climate change risk and in particular to the implementation of green policies. An additional premium is thus required to induce the purchase of brown stocks. On the other hand, the increasing climate change concern leads to a reallocation effect toward green and more sustainable stocks. In other words, in the presence of events/news associated with the implementation of more stringent climate change policies investors find green portfolios more attractive, which in turn pay the so called "Greenium" (Pástor et al., 2021a,b; Ardia et al., 2021).

Green policy announcement category. We compute CARs around the following different categories of GPAs: (i) adaptation, (ii) air pollution, (iii) biodiversity, (iv) climate mitigation, (v) other climate change issues, (vi) waste and recycling and (vii) water category of intervention. Results are shown in Fig. 3.

Not surprisingly, more significant effects are found for policies accounting for a larger proportion of funds. In fact, green announcements relying on climate mitigation policies, which is the most relevant category of intervention – both in terms of number of related announcements and allocated resources – seem to drive the main results reported in Fig. 2. Announcements of climate mitigation policies generate thus positive and statistically significant CARs both in the green and brown sector. Once again, larger benefits are found among more

Figure 2: CARs around GPAs



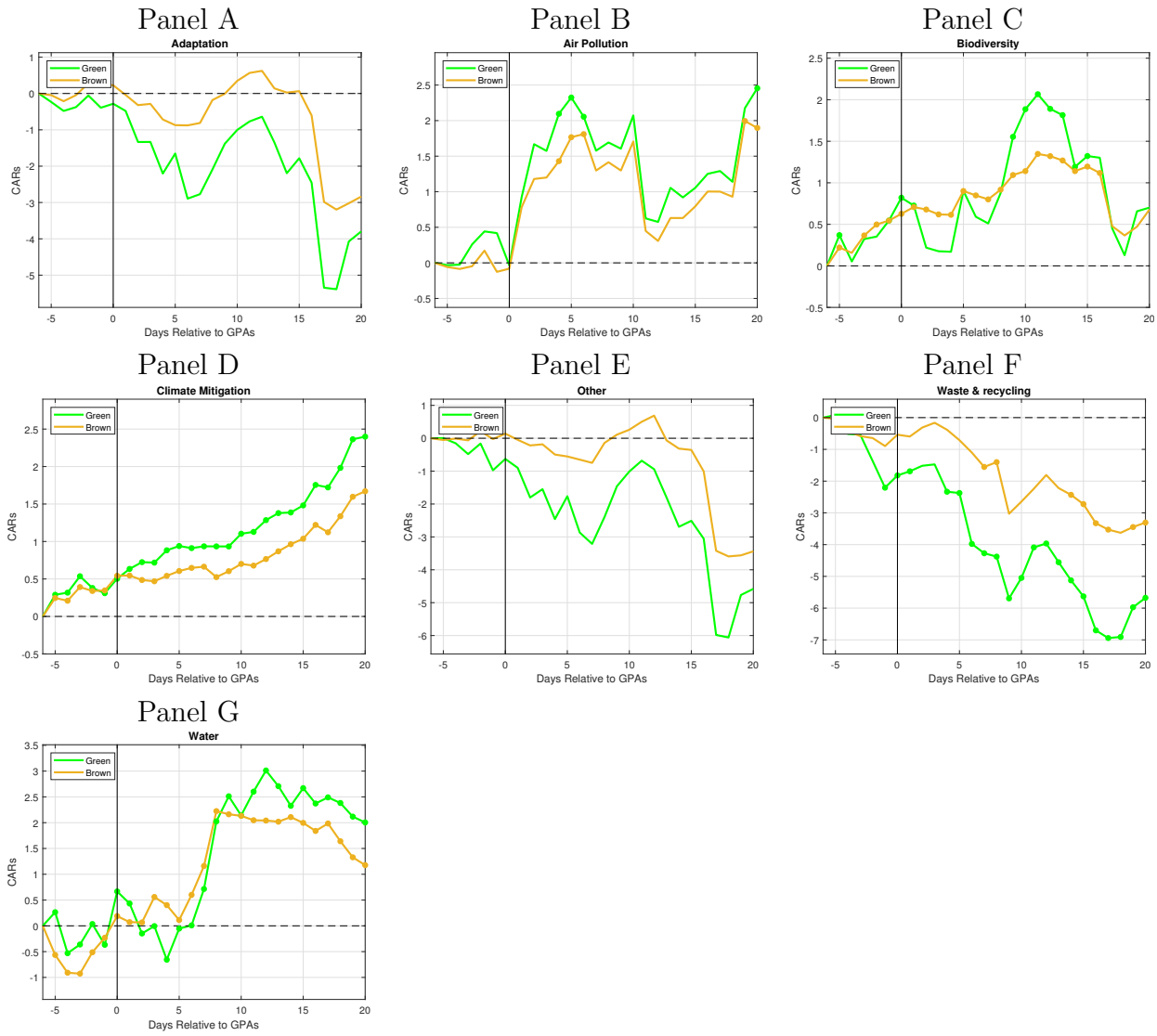
Notes: This figure depicts CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one-factor model (i.e., CAPM) over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market return. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

sustainable firms (Fig. 3, Panel D). Similar CARs are observed if we focus on air pollution-related policies. However, CARs are rarely significant for this policy type. Significant CARs are observed only several days after the event (Fig. 3, Panel B).

Differently, the green policies related to adaptation, waste & recycling and other climate change issues have a negative impact on both green and brown portfolios leading thus to negative CARs. Moreover, around those type of green policy announcements brown portfolios outperform sustainable ones (Fig. 3, Panels A, E and F).

Overall, our results suggest that the size of the announced green plan matters. In fact, announced climate mitigation policies, which account for 70% of the total amount allocated, produce larger benefits on green as well as on brown firms.

Figure 3: CARs around GPAs (Different GPAs)



Notes: This figure depicts CARs around different category of GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements have been grouped in seven categories according to the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery): (*i*) "Adaptation", (*ii*) "Air Pollution", (*iii*) "Biodiversity", (*iv*) "Climate Mitigation", (*v*) "Other", (*vi*) "Wasterecycling", (*vii*) "Water". The category "Plastic" has been excluded because it included only one policy announcement for Finland. The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

Sectors. Results by sector are shown in Fig. 4. Sectoral CARs suggest some degree of heterogeneity in the green and brown stocks' reaction to GPAs. For instance, the brown portfolio for the basic material sector reacts (on average) positively before green announcement dates, with a reversal effects observed after a couple of days. Differently, GPAs are

found to have a sizable positive and more linear impact for the basic materials green portfolio (Fig. 4, Panel A). A similar, but opposite effect is observed for the consumer staples sector, i.e., green stocks positively react to green policies and reverse then back one week after the event. At the end of the estimation horizon the difference in CARs for the two subsamples is rather small (Fig. 4, Panel C).

For consumer discretionary (Panel B), energy (Panel D), financials (Panel E) and industrial (Panel G) sectors CARs become positive and significant immediately after the announcement and follow an almost linear positive trend until the end of the estimation window. Notably, the impact on brown firms is lower than that one observed among more sustainable stocks, with a positive green-brown gap ranging from 1% up to 3%.

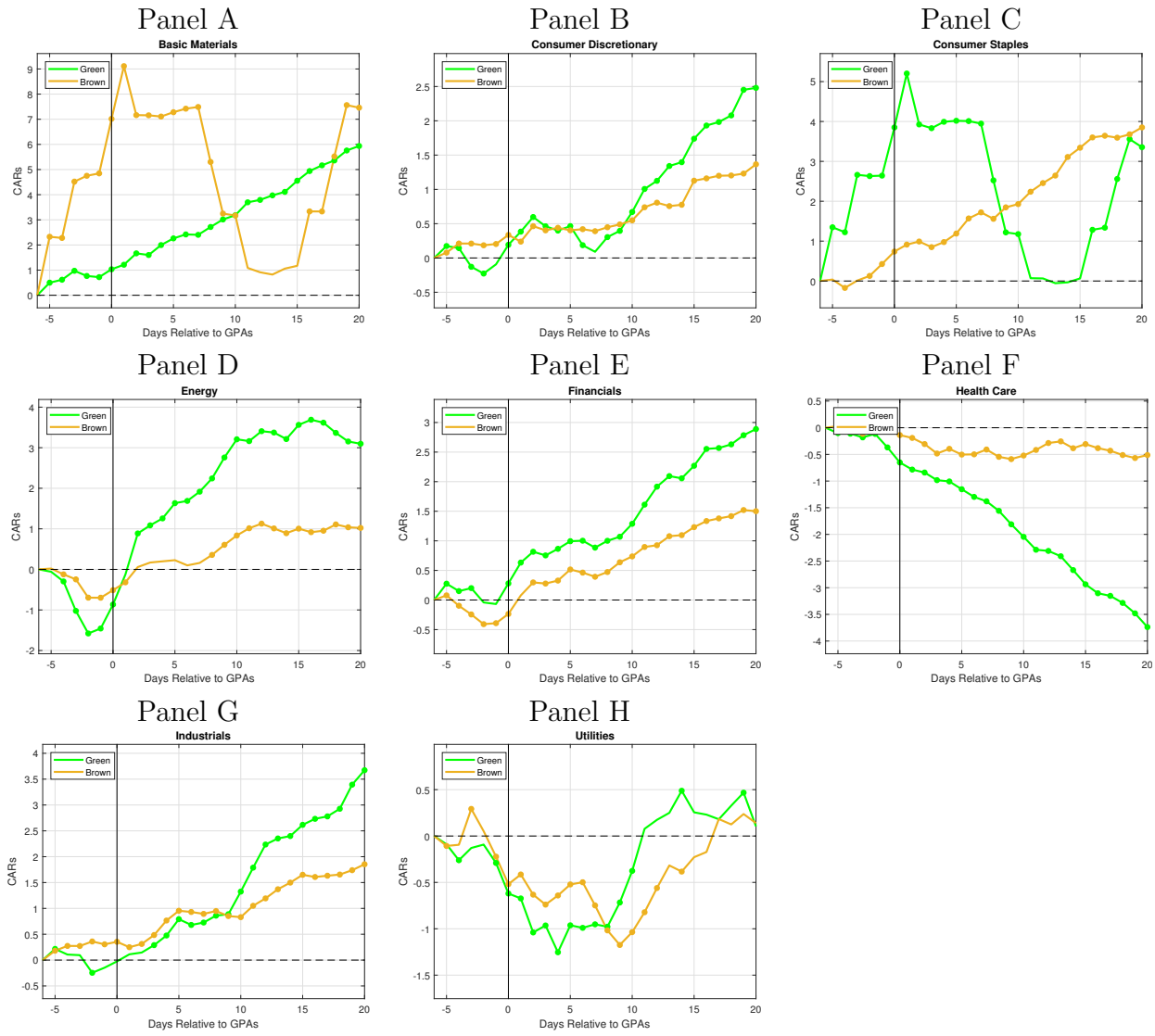
Negative CARs are instead found for the healthcare (Panel F) and utilities (Panel H) sectors. However, a several days after the GPAs a reversal effect is observed in the utilities sector (see Fig. 4, Panel F vs. Panels H). In fact, utilities portfolios' CARs are positive (but not significant for the green utilities portfolio) at $t + 20$. Differently, CARs in healthcare sector are always negative, with the green portfolio most severely affected (Fig. 4, Panel F).

Taken together, our novel empirical findings indicate that the impact of the post-COVID GPAs is (on average) positive, in particular for green portfolios. Some differences emerge when the analysis is performed by relying on different sectors. Somehow, it seems that not all sectors benefit from GPAs (for instance health care) and in some cases brown portfolios exhibit larger CARs compared to the green portfolios (basic materials, consumers staples and health care).

4.2 Additional empirical tests.

In this section we briefly describe the results of a battery of additional empirical tests. In particular, we re-estimate CARs using: (i) equal-weighted green and brown portfolio returns, (ii) a wider CARs estimation window from $t - 20$ to $t + 5$, (iii) a three-factor model with SMB and HML retrieved from Fama and French European factors (iv) a four-factor model where the oil price change (Δ Oil) is also included. Moreover, we compute CARs at the country-level focusing on country-specific GPAs. Our final additional test invokes the use of predictive regression to explore links between cumulative green and brown stock performance

Figure 4: CARs around GPAs (Different Sectors)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in eigth sectoral value-weighted portfolios: (*i*) "Basic Materials", (*ii*) "Consumer Discretionary", (*iii*) "Consumer Staples" and (*iv*) "Energy", (*v*) "Financial", (*vi*) "Health Care", (*vii*) "Industrials" and (*viii*) "Utilities" sectors. The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one-factor model (i.e., CAPM) over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market return. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

and GPAs. Results from all these additional tests are shown in Appendix B.

CARs: Equal-weighted portfolios. Equal-weighted CARs are broadly consistent with the estimates described in the previous section. Only few differences are noteworthy. First,

when computing the CARs around all firms and events, the spread between green and brown shrinks, although the dynamics is virtually indistinguishable. Second, for what concerns the financial sector, there is now evidence of larger benefits from GPAs among brown stocks (see Fig. 4-Panel E vs. Fig. B.3-Panel E).

CARs: Different estimation window. Our main results are robust to the choice of the CARs estimation window. When using the interval ranging from $t-20$ to $t+20$, we still observe positive and statistically significant CARs both in the brown and green sector following GPAs. Once again, GPAs generate a stronger positive sentiment effects among more sustainable stocks (see Fig. B.4). Moreover, CARs are still found to be mainly driven by climate mitigation-related policies (see Fig. B.5).

CARs: Three-factor model. When a three-factor model is used most of our results remain unaltered. Some differences, however, emerge. In particular, the brown sector exhibits larger positive CARs compared to its green counterpart (see Fig. 2 vs. Fig. B.7). A similar dynamics is observed when climate mitigation policies only are considered (Fig. B.8, Panel D). At sectoral level, we find positive and larger CARs in the brown consumer discretionary and energy portfolios compared to green ones (Fig. B.9, Panel B and D), differently to what reported in the main results (Fig. 4). Moreover, green consumer staples portfolios largely outperform their "dirty" counterpart (Fig. B.9, Panel C).

CARs: Four-factor model. Including a fourth factor, namely oil price change, produces results very close to those previously reported. The overall effect of green policy announcements on STOXX stocks is still positive for both green and brown portfolios (Fig. B.10), with the former showing a more positive impact. The green-brown gap is however closer and equal to 0.5%. No relevant differences are observed around different policy categories announcements, whereas at industry level some dissimilarities emerge. The green industrial portfolio CARs (Fig. B.12, Panel G) are negative during the whole estimation interval. CARs are instead larger for green portfolios in the consumer staples, energy, financial and utilities sectors (Panels C, D, E and H), in line with the results reported in Fig. 4.

CARs: country-by-country. In this last check we examine whether brown and green portfolios have a different reaction following green plans announced by governments. Estimated CARs for the different European countries announcements are depicted in Fig. B.13. In line with the main pooled results reported in Fig. 2, for most European countries, we still find both brown and green portfolios exhibiting positive CARs following GPAs. The stronger positive sentiment effect on the green portfolio rather than on the brown one is still observed. Notably, the countries with the largest gap between green and brown CARs following GPAs are Switzerland (Fig. B.13, Panel B) and Italy (Fig. B.13, Panel L). Milder positive CARs are also found, mainly among green portfolios, in Belgium and Germany. Our additional empirical test confirms thus that government's announcements on their commitment to fight climate change produce – on average – a positive sentiment effects among international investor that boosts short run stock market valuations. This sentiment effect is found to be stronger among green portfolios in the following European countries: Switzerland, Spain, UK, Ireland and Italy.

Predictive regressions. To gain more insights on the stock market impact of GPAs, we estimate a set of predictive regressions as defined in Eq. (2).[6] The estimated coefficients for each value-weighted sectoral portfolio at every j-ahead horizon for the green and brown portfolios are reported in Panels A and B of Table B.1, respectively.

Panel A presents the results for green portfolios. Positive CARs are associated with GPAs for consumers staples, consistent with event study estimation. The energy sector exhibits a negative reaction to climate change related news up to 5 days, then becomes non significant. Similarly, utilities cumulative returns are negative at short horizons (although not significant), even though we observe a recover at $j = 20$. This effects are very close to those reported in the event study section (see Fig. 4). Negative and significant CARs are instead found for green basic materials, financials and industrials.

With respect to brown portfolios, our predictive regression results are in line with CARs

[6]Notice that cumulative returns are substantially different from CARs, which are computed as the difference between realized and predicted returns. In this tests we instead look at the cumulative performance over a certain horizon.

estimation for basic materials, energy, health care and utilities. The latter two, together with the healthcare sector negatively react to GPAs. Moreover, we observe positive coefficients for the event dummy in basic materials. Energy stocks confirm the negative, but not significant reaction and a recover after ten and twenty days. Negative CARs are instead associated to the consumer discretionary, financials and industrials, as opposed to what indicated by our previous event study analysis.

5 Conclusions and policy implications

In this paper we collect green policy announcements (GPAs) for 12 EU countries made over the year 2020 and evaluate their implications for EU green and brown stocks. A standard event study analysis reveals the presence of a positive impact on both brown and green stocks around GPAs. However, the impact on the green portfolio is larger than the one observed on the brown portfolio. Twenty days after the events the green-brown CARs gap amount to 1%. An additional empirical exercise where different categories of GPAs are considered, suggests that the size of the funds allocated matters. In fact, the evidence of positive and significant CARs in both the brown and green sector seems to be supported by the larger amount of funds announced to be allocated for climate change mitigation policies. A similar, although slightly weaker in magnitude, effect is driven by air pollution policies. Still, green portfolios outperforms brown ones. These results suggest that GPAs can be a key driving force of the whole economic system, the more so the larger the size of the announced intervention. Although the brown sectors might enjoy a beneficial spillover effect from the overall economic growth in the short run, the increasing CARs gap with respect to the green sectors deriving from GPAs is likely to induce and possibly accelerate the green transition process in the middle-long run. At the sector level, we observe larger CARs for green than brown portfolios in consumer discretionary, energy, financial and industrials sectors. Nevertheless, brown portfolios' cumulative abnormal returns are still positive and significant. At the country level, we find the presence of significant CARs following country-specific GPAs only in the following European countries: Switzerland, Spain, UK, Ireland and Italy. This idiosyncratic result might reflect the fact that GPAs were perceived as credible

and/or particularly new government's commitments by the public opinion in these countries, differently from other countries in which government's signals might have been weaker or the public opinion might have been more used to GPAs.

Our novel empirical evidence indicates that European governments' commitment to implement green policies produces short run benefits, in particular for firms less exposed to more stringent climate change rules (i.e., green firms). Such commitment is also found to induce a positive short-run spillover effect on less sustainable firms (i.e, brown firms). These benefits are particularly relevant when governments announce to implement climate mitigation-related policies. There seems to be thus an incentive for all firms to progressively allocate resources in order to improve their environmental performance and GPAs can be the engine for this transition. Two requirements, however, are crucial for an effective and orderly transition in the system: (i) the GPAs need to be credible and (ii) they have to be able to produce a smooth transition process.

As to the first aspect, a credible announced policy can anticipate and/or accelerate the transition by inducing the financial market to shift from brown to green portfolios. If the announcement is perceived as credible by market operators, such a shift may occur even before the promised resources are actually introduced in the system by the government. Policy-makers have, therefore, an incentive to reinforce the message, as shown by numerous examples in the past (think, for instance, of the famous "whatever it takes" pronounced by Draghi when he was Governor at the European Central Bank). However, as it is well known, policy-makers should not deviate ex-post from the announced policy if they want it to be credible in the future. This aspect should be carefully considered by governments when making GPAs which imply long-run commitments since they will have to comply with the announced policy "whatever it takes" (to use Draghi's words) or "whatever may happen" in the meantime if they want to effectively support the green transition.

As to the second aspect, it must be acknowledged that an increasing attention to green policies from governments can lead to a reallocation of capital from brown to green investment, making high-carbon intensive firms less desirable. In the long-run this may generate adverse effects in the brown sector, which will face a competitiveness loss and further capital raising issues. While announcing new green policies (e.g., introduction of a carbon tax, the

reduction of energy subsidies or subsidies to green technologies) governments should account for the potential adverse economic effects generated by the investment drop and the related worsening in labor market condition among brown firms.

On the one hand, therefore, governments must be credible and effective in announcing green plans aimed at fighting global warming. On the other hand, such green policies should be accompanied by additional policies to support all those sectors that are more sensitive to announced green plans and thus favor a smooth transition process. There are no doubts that the transition to a greener and more circular economy represents a clear and massive business opportunity. However, greener and more stringent climate change policies will lead to capital reallocation both between and within economic sectors. Compared to other trends in the economy (e.g., automation) this reallocation is still small in size, but is likely to become increasingly important in the years to come. Future government policies should effectively mitigate the adverse consequences of this reallocation process.

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A Data

A.1 List of green policy announcements

Table A.1: List of GPAs by country and environmental policy category

Date	Country	Adaptation	Air Pollution	Biodiversity	Climate Mitigation	Other Other	Waste & Recycling	Water	Source type
07/07/20	BEL								online doc.
09/07/20	BEL				10.92				online doc.
29/09/20	BEL				637.00				online link
30/09/20	BEL				191.00				online doc.
30/10/20	BEL			23.00					online link
16/11/20	BEL								online link
04/05/20	CHE								online link
05/05/20	CHE				195.65				online link
06/05/20	CHE				2003.00				online link
10/06/20	CHE				455.00				online link
01/07/20	CHE				794.43				online link
19/08/20	CHE				136.50				online link
21/10/20	CHE				63.70				online link
03/06/20	DEU		2300.00		20405.00				online link
05/06/20	DEU		500.00		10000.00				online link
22/06/20	DEU				550.00				online link
02/07/20	DEU				9000.00				online link
09/07/20	DEU				1800.00				online link
06/12/20	DNK	29.12		92.31	684.83	21.84	0.55		online link
17/03/20	ESP								online link
19/03/20	ESP								online link
30/03/20	ESP								online link
14/04/20	ESP								online link
22/04/20	ESP								online doc.
04/05/20	ESP								online link
07/05/20	ESP								online doc.
19/05/20	ESP								online doc.
23/05/20	ESP								online link
16/06/20	ESP				901.71				online link
23/06/20	ESP								online link
09/07/20	ESP								online doc.
21/07/20	ESP								online link
04/08/20	ESP				300.57				online link
05/08/20	ESP				522.34				online link
10/09/20	ESP				316.00				online link
08/10/20	ESP			10.70	6734.00				online doc.
15/10/20	ESP			4.30					online doc.
20/03/20	FIN				600.00				online link
08/05/20	FIN				700.00				online link
02/06/20	FIN			33.90	6461.30				online link
05/06/20	FIN				30.75				online link
11/06/20	FIN				24.80				online link
12/06/20	FIN				2.90				online link
16/09/20	FIN			20.00					online link

16/10/20	FIN							10.00	online link
22/10/20	FIN					100.00			online link
23/10/20	FIN				300.00				online link
19/11/20	FIN				12.00				online link
09/03/20	FRA	50.00		900.00	14834.70	250.00	500.00		online doc.
28/04/20	FRA				100.00				online link
26/05/20	FRA				5690.00				online doc.
12/06/20	FRA				7000.00				online link
03/09/20	FRA			950.00	6700.00				online link
01/02/20	GBR				15812.00				online link
17/03/20	GBR				5127.60				online link
04/05/20	GBR				129.80				online link
09/05/20	GBR				2393.30				online link
13/05/20	GBR				23.60				online link
16/06/20	GBR				11.96				online link
23/06/20	GBR				86.73				online link
02/07/20	GBR								online link
08/07/20	GBR				7953.40				online link
14/07/20	GBR	203.21							online link
20/07/20	GBR				227.50				online link
22/07/20	GBR				405.09				online link
29/07/20	GBR				1719.90				online link
04/08/20	GBR				2478.00				online link
01/09/20	GBR				1911.00				online link
28/10/20	GBR								online link
18/11/20	GBR	6288.10			6143.06				online doc.
19/06/20	IRL					11.00			online link
23/07/20	IRL	10.00				10.00		30.00	online link
24/07/20	IRL				42.00				online link
07/11/20	IRL		63.25	15.00			10.00		online link
20/11/20	IRL				100.00				online link
13/05/20	ITA				3300.00				online doc.
19/05/20	ITA			40.00	12080.00				online doc.
14/07/20	ITA				500.00				online doc.
20/07/20	ITA								online doc.
05/11/20	ITA				500.00				online doc.
17/03/20	NLD								online link
24/04/20	NLD				2690.00				online link
05/06/20	NLD				1650.00				online link
20/11/20	NLD				3400.00				online link
18/03/20	SWE				500.00				online link
15/04/20	SWE				12.00				online link
20/04/20	SWE				15.00				online link
20/09/20	SWE		20.00	219.00	873.00		15.00		online link

Notes: This table reports the list of green policy announcements (GPA) and their value in millions of Euros made by 12 European countries over the period 01 January 2020 – 31 December 2020. GPAs have been retrieved from OECD (2021). Dates correspond to the first day in which the announcement was available online either as "online official statement/article" (*online link*) or as "online official document" (*online doc*)

A.2 List of stocks and related summary statistics

Table A.2: Summary statistics: Green stocks

Name	Industry	Rating	Return	Std. Dev	Mkt Cap. (%)	Mkt. Cap	Revenues	Emp
Zurich Insurance Group	Financials	A+	-0.043	2.117	1.314	207949	55.00	55.09
Novartis	Health Care	A	-0.030	1.466	1.526	241436	46.58	110.74
Roche Holding	Health Care	A+	0.015	1.583	0.161	25543	58.32	101.47
Credit Suisse Group	Financials	A	-0.100	2.934	0.220	34763	30.61	48.77
ABB	Industrials	A+	0.054	2.003	0.311	49164	24.34	105.60
Nestle	Consumer Staples	A+	0.018	1.224	0.171	27102	84.34	268.35
UBS Group	Financials	A+	0.036	2.399	0.264	41825	29.06	72.89
Daimler	Consumer Discretionary	A+	0.110	2.204	0.918	145332	154.31	288.48
Siemens	Industrials	A	-0.014	1.969	0.294	46479	57.14	293.00
Volkswagen Pref	Consumer Discretionary	A+	0.110	3.075	0.569	90065	222.88	662.58
Muenchener Rueck	Financials	A+	-0.009	2.302	0.370	58552	64.10	39.64
Adidas	Consumer Discretionary	A	0.029	2.305	0.194	30742	19.84	62.29
Basf	Basic Materials	A+	-0.018	2.357	0.333	52687	59.15	110.30
Bayer	Health Care	A	-0.042	2.601	2.055	325136	41.40	99.54
Novo Norddisk B	Health Care	A	0.065	1.579	1.444	228432	126.95	45.32
Bco Santander	Financials	A	0.043	1.832	0.439	69477	64.37	191.00
Iberdropla	Utilities	A+	-0.033	3.203	0.612	96865	33.15	37.13
Industria de Diseno Textil SA	Consumer Discretionary	A+	-0.006	2.290	0.159	25222	28.29	176.61
Totalenergies	Energy	A	-0.053	2.831	1.373	217230	104.34	105.48
Sanofi	Health Care	A	-0.004	1.552	0.348	55022	37.37	99.41
Danone	Consumer Staples	A	-0.060	1.689	0.296	46863	23.62	101.91
LVMH Moet Hennessy	Consumer Discretionary	A	0.130	2.034	0.592	93663	44.65	150.48
Kering	Consumer Discretionary	A+	0.061	2.291	0.411	64959	13.10	38.55
Vinci	Industrials	A+	-0.011	2.956	0.218	34513	43.93	217.73
BNP Paribas	Financials	A+	0.014	3.077	0.190	30032	61.17	193.32
Diageo	Consumer Staples	A	0.014	34.730	0.413	65293	11.75	27.78
British American Tobacco	Consumer Staples	A+	0.065	3.241	0.563	89088	25.78	55.00
HSBC	Financials	A	0.003	34.416	0.248	39273	61.47	231.04
Lloyds Banking Group	Financials	A	0.009	1.640	0.451	71296	34.12	61.58
Astrazeneca	Health Care	A	-0.022	1.848	0.192	30460	20.59	76.10
Barclays	Financials	A	0.035	2.753	0.450	71271	27.58	83.00
Royal Dutch Shell	Energy	A	-0.021	2.274	0.251	39676	157.37	87.00
Anglo American	Basic Materials	A	-0.066	2.356	0.298	47132	23.91	61.38
Reckitt Benckiser Group	Consumer Staples	A	0.004	3.163	0.236	37284	13.99	39.58
BHP Group PLC.	Basic Materials	A	-0.060	1.648	0.233	36827	34.00	31.59
CRH	Industrials	A	0.087	2.200	0.957	151373	24.05	77.10
Linde	Basic Materials	A	0.043	2.688	0.301	47624	27.24	74.21
Intesa Sanpaolo	Financials	A	0.008	2.448	0.519	82147	23.76	85.72
Enel	Utilities	A+	0.023	2.166	0.245	38702	62.62	66.72
Glencore PLC	Basic Materials	A+	0.055	3.129	0.259	40957	110.13	87.82
Airbus	Industrials	A+	-0.045	4.018	1.534	242679	49.91	131.35
ING Group	Financials	A	0.005	3.430	0.365	57720	28.27	58.56
Volvo B	Industrials	A+	0.080	3.354	2.774	439003	338.45	87.49

Notes: This tables reports the summary statistics for the green stocks subsample. Rating refers to the MSCI Environmental Pillar Score. Stocks are classified as green if the rating is equal to A or above. Market capitalization (Mkt Cap.), revenues (Rev.) and employment (Emp.) are reported as of 15 June 2021. Revenues and employment refer to the fiscal year 2020. All data have been retrieved from Datastream. Sample: 01-01-2020 to 15-06-2021.

Table A.3: Summary statistics: Brown stocks

Name	Industry	Rating	Return	Std. Dev	Mkt Cap. (%)	Mkt. Cap	Revenues	Emp
Anheuser-Busch Inbev	Consumer Staples	B-	-0.0359	2.9482	0.249	39374	40.86	164.00
Givaudan	Basic Materials	B+	0.0811	1.4959	0.356	56272	6.32	15.85
Holcim	Industrials	B+	0.0055	2.1380	0.406	64202	23.14	67.41
Lonza	Health Care	B	0.1612	1.9462	2.039	322599	4.51	16.54
Swiss Reinsurance Company	Financials	B	-0.0904	2.5087	0.380	60160	39.95	13.19
CIE Financiere Richemont	Consumer Discretionary	B-	0.0936	2.2072	0.343	54296	15.57	35.66
Sika	Industrials	A-	0.1005	1.9474	0.202	31911	7.88	24.85
Alcon	Health Care	D-	0.0402	2.2271	0.446	70614	6.38	23.00
Deutsche Post	Industrials	A-	-0.0035	2.4436	0.537	85002	66.81	
Deutsche Boerse	Financials	B-	-0.0230	2.3555	0.281	44401	3.78	
Infineon Technologies	Technology	A-	-0.1063	2.4385	0.534	84549	8.57	46.67
SAP	Technology	A-	0.0374	1.7009	0.745	117861	27.34	102.43
Allianz	Financials	A-	0.1061	3.2211	0.209	33133	122.78	150.27
DSV Panalpina	Industrials	B+	0.1383	2.2914	2.316	366488	115.93	56.62
Orsted	Utilities	A-	0.0120	2.2714	5.820	920847	50.15	6.18
Vestas Wind Systems	Energy	A-	0.1156	2.8203	0.184	29057	110.45	29.38
Amadeus IT Group	Technology	B+	-0.0211	3.2022	0.375	59409	2.17	16.25
Kone B	Industrials	B+	0.0251	1.5304	0.803	126999	9.94	61.38
Hermes International	Consumer Discretionary	B+	0.1574	1.6816	0.332	52610	6.39	16.60
Safran	Industrials	B-	-0.0299	3.8637	0.433	68485	16.63	78.89
Air Liquide	Basic Materials	C+	0.0355	1.6768	0.683	108033	20.49	64.45
L'Oréal	Consumer Discretionary	A-	0.1032	1.6906	0.708	112034	27.99	85.39
AXA	Financials	B-	-0.0304	2.5087	0.258	40777	113.35	114.63
Pernod Ricard	Consumer Staples	A-	0.0296	1.5687	2.162	342125	8.45	18.78
Essilor Luxottica	Health Care	B-	0.0213	2.0294	0.488	77217	14.43	144.51
Schneider Electric	Industrials	B+	0.0956	2.1313	0.361	57139	25.16	146.79
Vivendi	Consumer Discretionary	A-	0.0278	2.0294	0.446	70576	16.09	42.53
Engie	Utilities	A-	-0.0473	2.2500	0.514	81335	55.75	172.70
Prudential	Financials	C+	-0.1142	3.2538	0.474	75040	43.31	18.69
Rio Tinto	Basic Materials	A-	-0.0137	34.3589	0.426	67348	34.52	47.50
BP	Energy	A-	0.0207	2.3361	0.215	34002	139.55	63.60
GlaxoSmithKline	Health Care	A-	-0.0497	3.0109	0.692	109525	34.10	94.07
London Stock Exchange	Financials	B+	-0.0908	1.9131	0.717	113492	2.44	5.57
Unilever PLC	Consumer Staples	A-	0.0124	2.0012	0.160	25358	45.03	149.00
Experian	Industrials	B-	-0.0578	1.9697	0.258	40880	4.07	17.80
Relx PLC	Consumer Discretionary	A-	0.0716	2.4479	0.183	28973	7.11	33.20
Compass Group	Consumer Discretionary	B	-0.1095	3.2713	0.208	32958	20.20	
National Grid	Utilities	C+	-0.0593	2.9353	0.284	45008	14.54	
Tesco	Consumer Staples	B	0.0074	3.3606	0.211	33366	64.76	405.51
ENI	Energy	B+	-0.0697	2.8672	0.270	42771	43.99	30.78
Philips	Health Care	A-	0.0095	1.8963	0.168	26567	19.54	81.59
Koninklijke DSM	Consumer Staples	A-	0.0703	1.6352	0.562	88962	8.11	23.13
ASML Holding	Technology	B	0.2060	2.3998	0.173	27314	13.98	28.07
Ahold Delhaize	Consumer Staples	B+	0.0241	1.4815	0.277	43873	74.74	414.00
Adyen	Industrials	C-	0.2526	2.4343	0.863	136601	3.64	
Prosus	Technology	D+	0.0559	2.3780	40.802	6456210	3.00	20.52
Atlas Copco A	Industrials	A-	0.0679	2.0926	2.253	356462	99.79	39.61
Investor B	Financials	C-	0.0991	1.7808			49.12	

Notes: This tables reports the summary statistics for the green stocks subsample. Rating refers to the MSCI Environmental Pillar Score. Stocks are classified as brown if the rating is equal to A- or below. Market capitalization (Mkt Cap.), revenues (Rev.) and employment (Emp.) are reported as of 15 June 2021. Revenues and employment refer to the fiscal year 2020. All data have been retrieved from Datastream. Sample: 01-01-2021 to 15-06-2021.

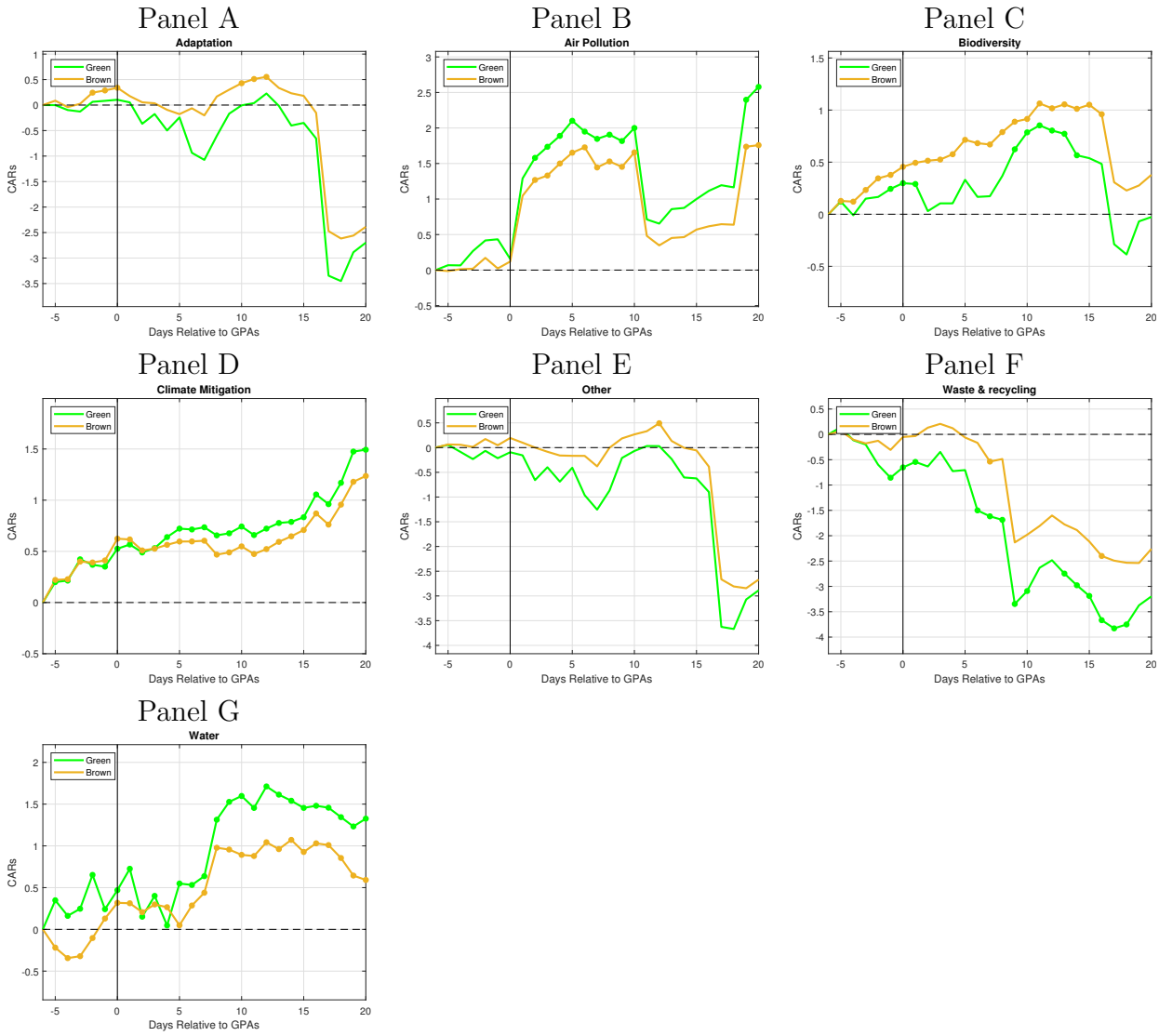
B Additional empirical tests

B.1 Equally-Weighted Portfolios

Figure B.1: CARs around GPAs (Equally-Weighted Portfolios)

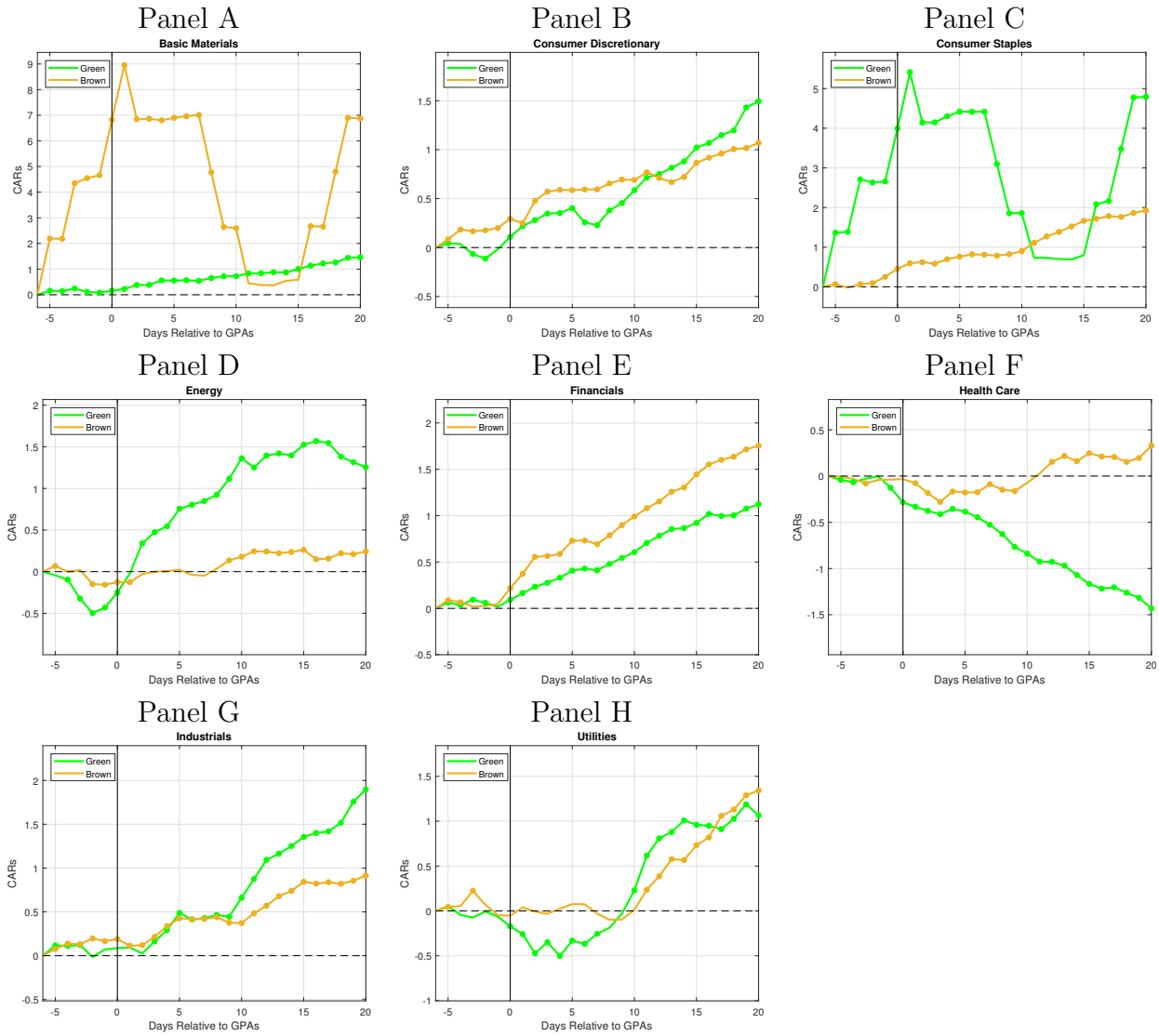
Notes: This figure depicts CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown equal-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

Figure B.2: CARs around GPAs (Equally-Weighted Portfolios/Different GPAs)



Notes: This figure depicts CARs around different category of GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown equal-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements have been grouped in seven categories according to the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery): (*i*) "Adaptation", (*ii*) "Air Pollution", (*iii*) "Biodiversity", (*iv*) "Climate Mitigation", (*v*) "Other", (*vi*) "Wasterecycling", (*vii*) "Water". The category "Plastic" has been excluded because it included only one policy announcement for Finland. The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1% of cumulative average abnormal returns (CAARs) as indicated by Brown and Warner (1985)

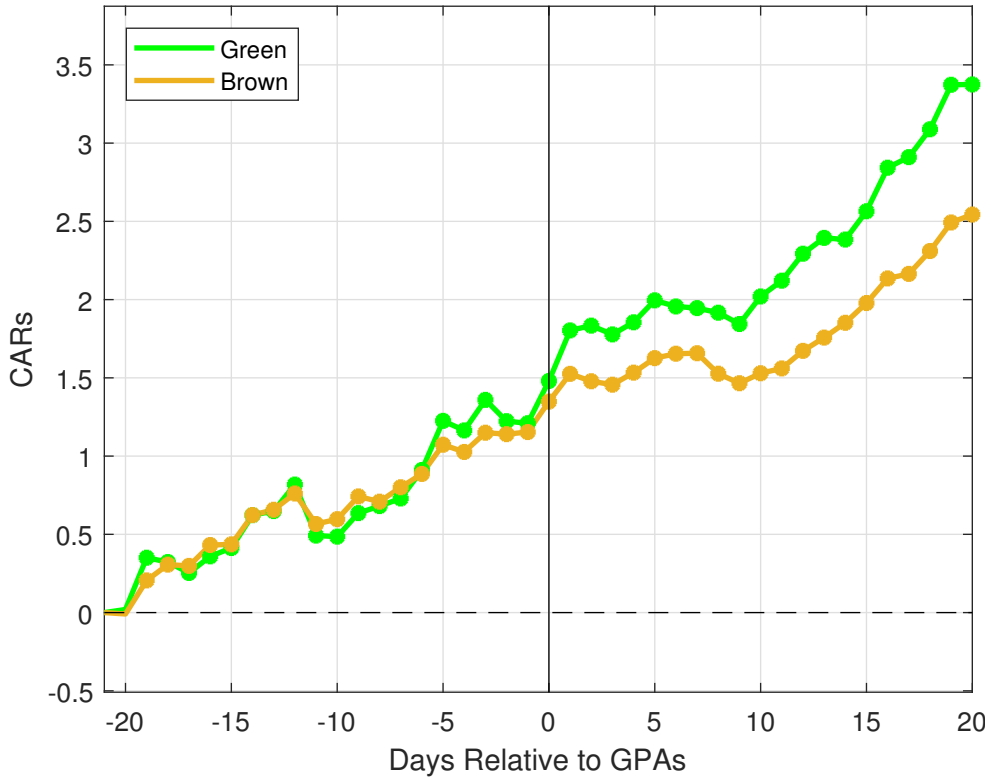
Figure B.3: CARs around GPAs (Equally-Weighted Portfolios/Different Sectors)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown equal-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in eigth sectoral value-weighted portfolios: (*i*) "Basic Materials", (*ii*) "Consumer Discretionary", (*iii*) "Consumer Staples" and (*iv*) "Energy", (*v*) "Financial", (*vi*) "Health Care", (*vii*) "Industrials" and (*viii*) "Utilities" sectors. The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

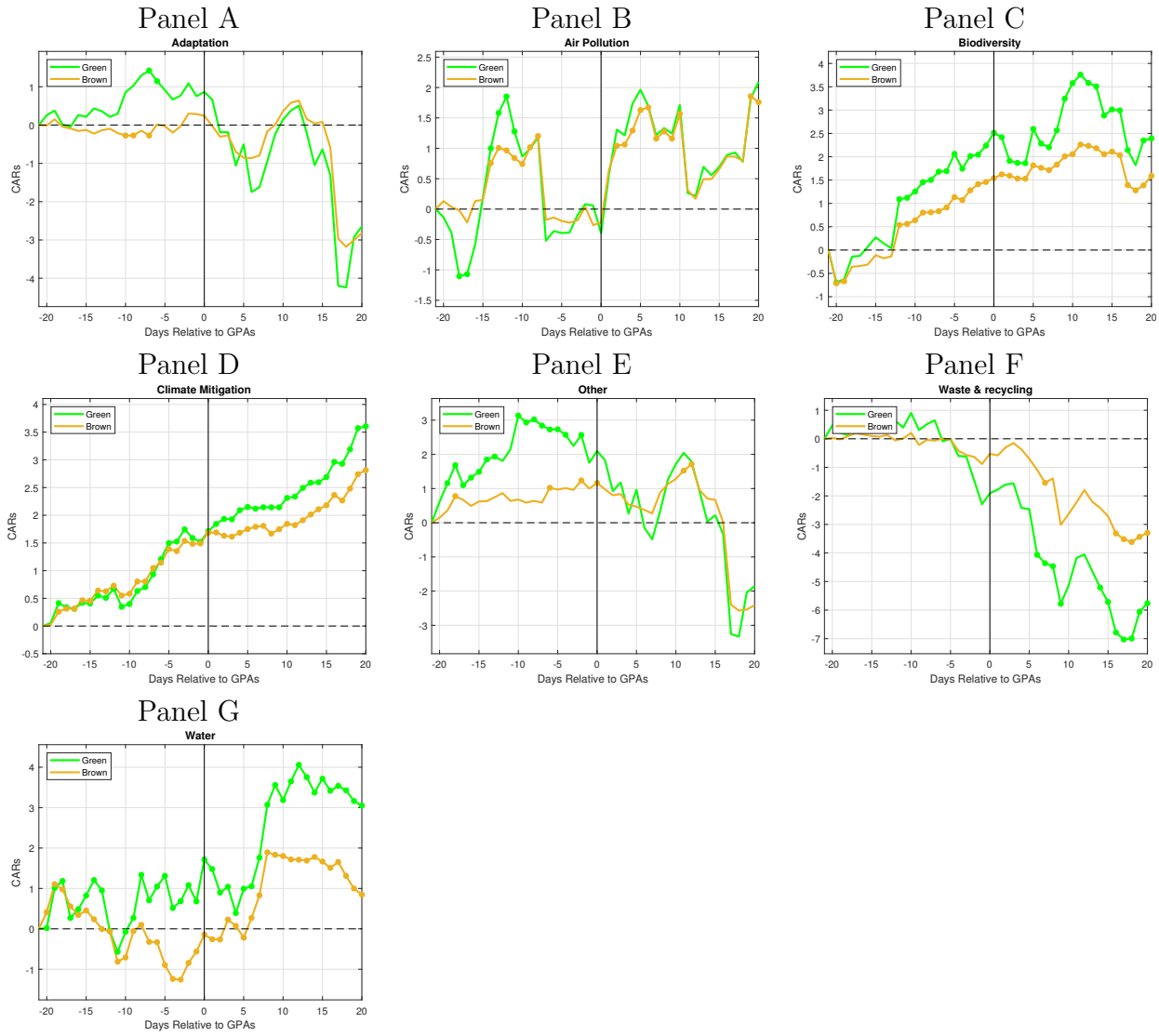
B.2 Different CARs estimation window

Figure B.4: CARs around GPAs (Different Estimation Window)



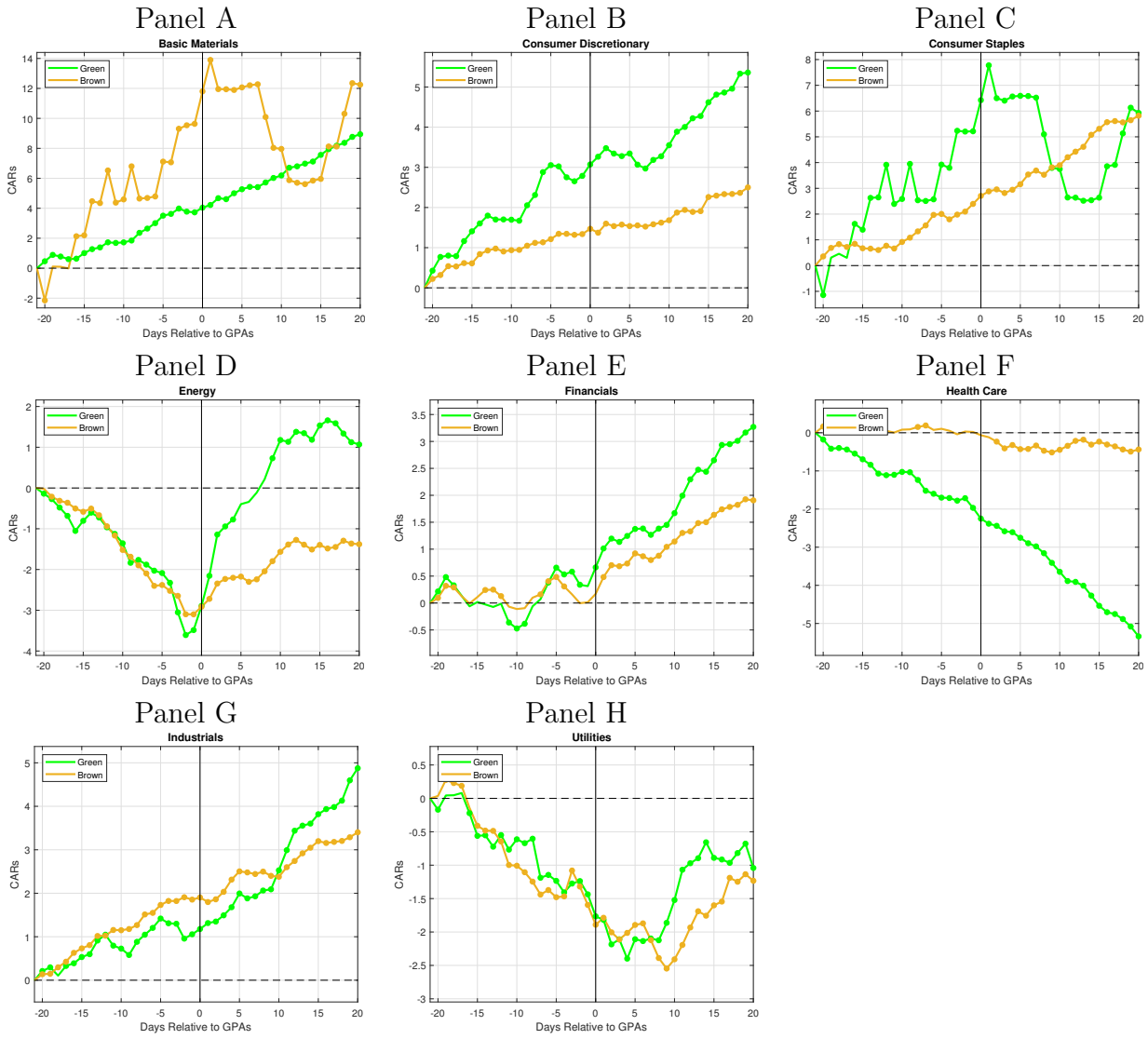
Notes: This figure depicts CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

Figure B.5: CARs around GPAs (Different Estimation Window/Different GPAs)



Notes: This figure depicts CARs around different category of GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements have been grouped in seven categories according to the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery): (*i*) "Adaptation", (*ii*) "Air Pollution", (*iii*) "Biodiversity", (*iv*) "Climate Mitigation", (*v*) "Other", (*vi*) "Wasterecycling", (*vii*) "Water". The category "Plastic" has been excluded because it included only one policy announcement for Finland. The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

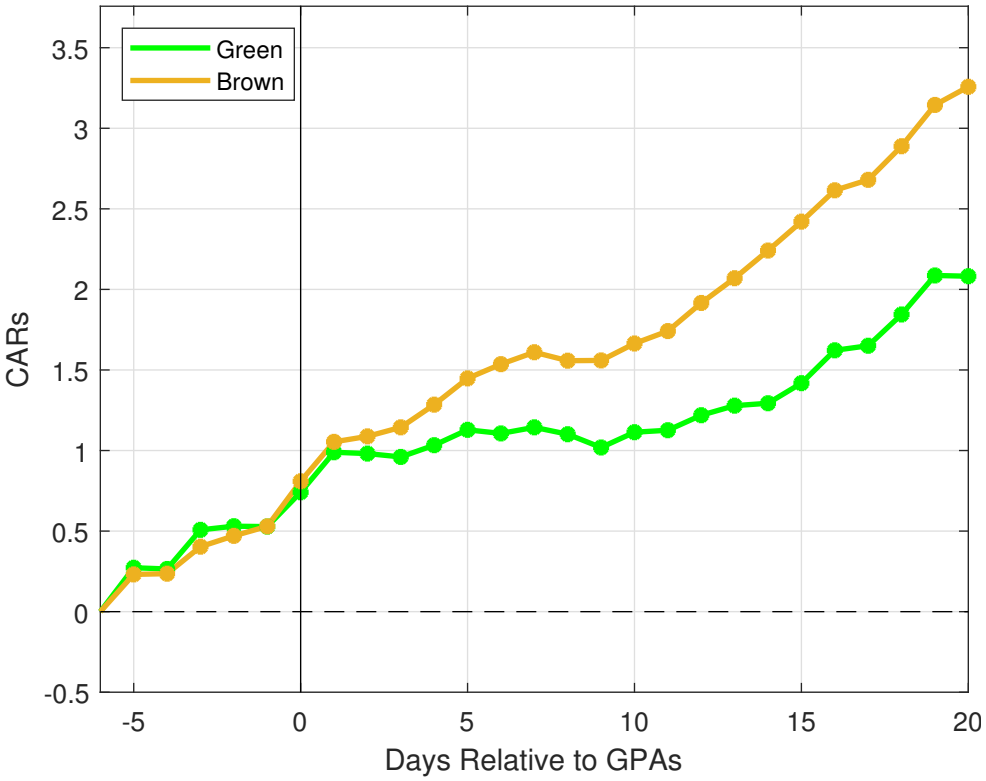
Figure B.6: CARs around GPAs (Different Estimation Window/Different Sectors)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in eight sectoral value-weighted portfolios: (*i*) "Basic Materials", (*ii*) "Consumer Discretionary", (*iii*) "Consumer Staples" and (*iv*) "Energy", (*v*) "Financial", (*vi*) "Health Care", (*vii*) "Industrials" and (*viii*) "Utilities" sectors. The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

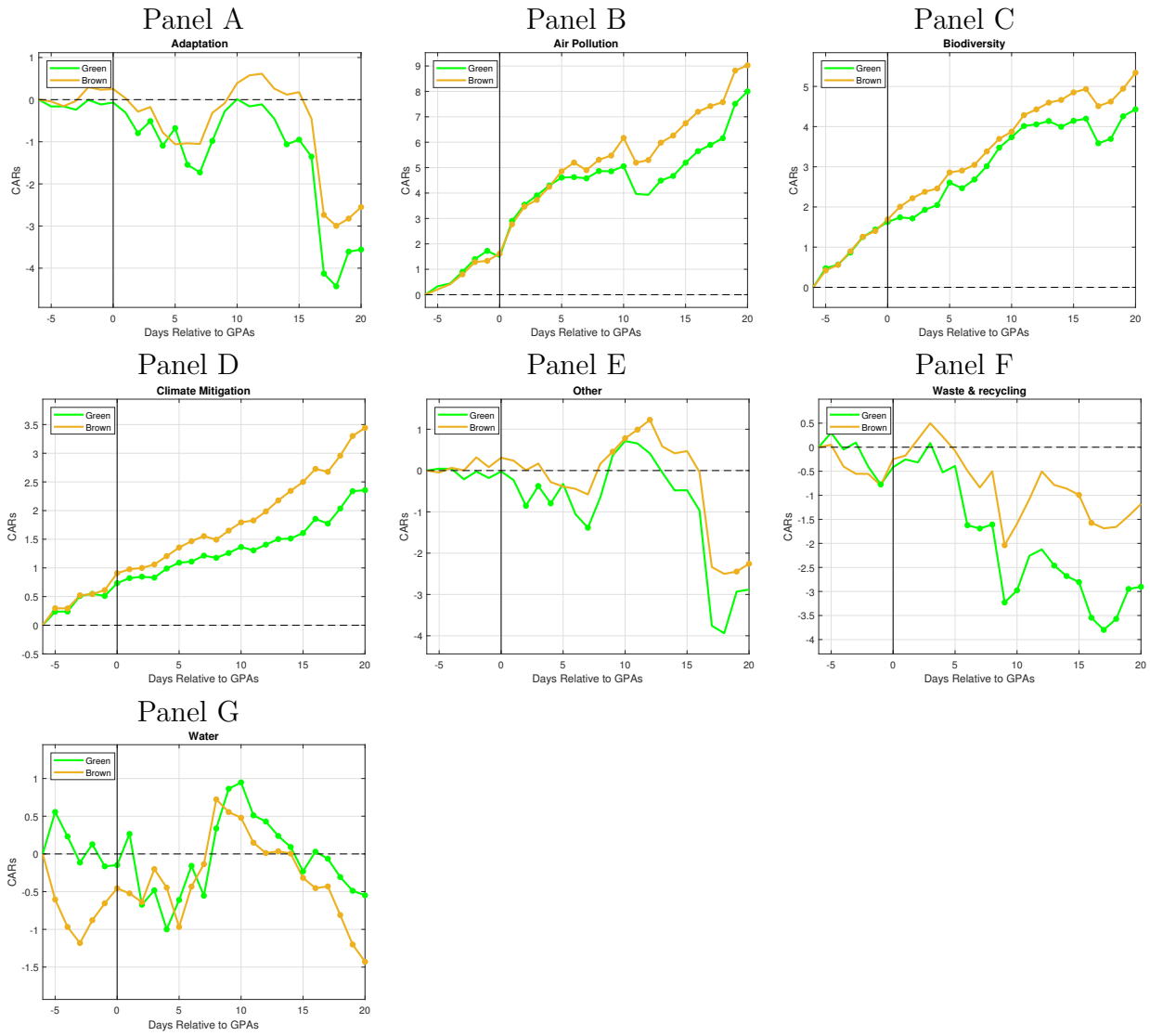
B.3 Three factor model

Figure B.7: CARs around GPAs (3F-Model)



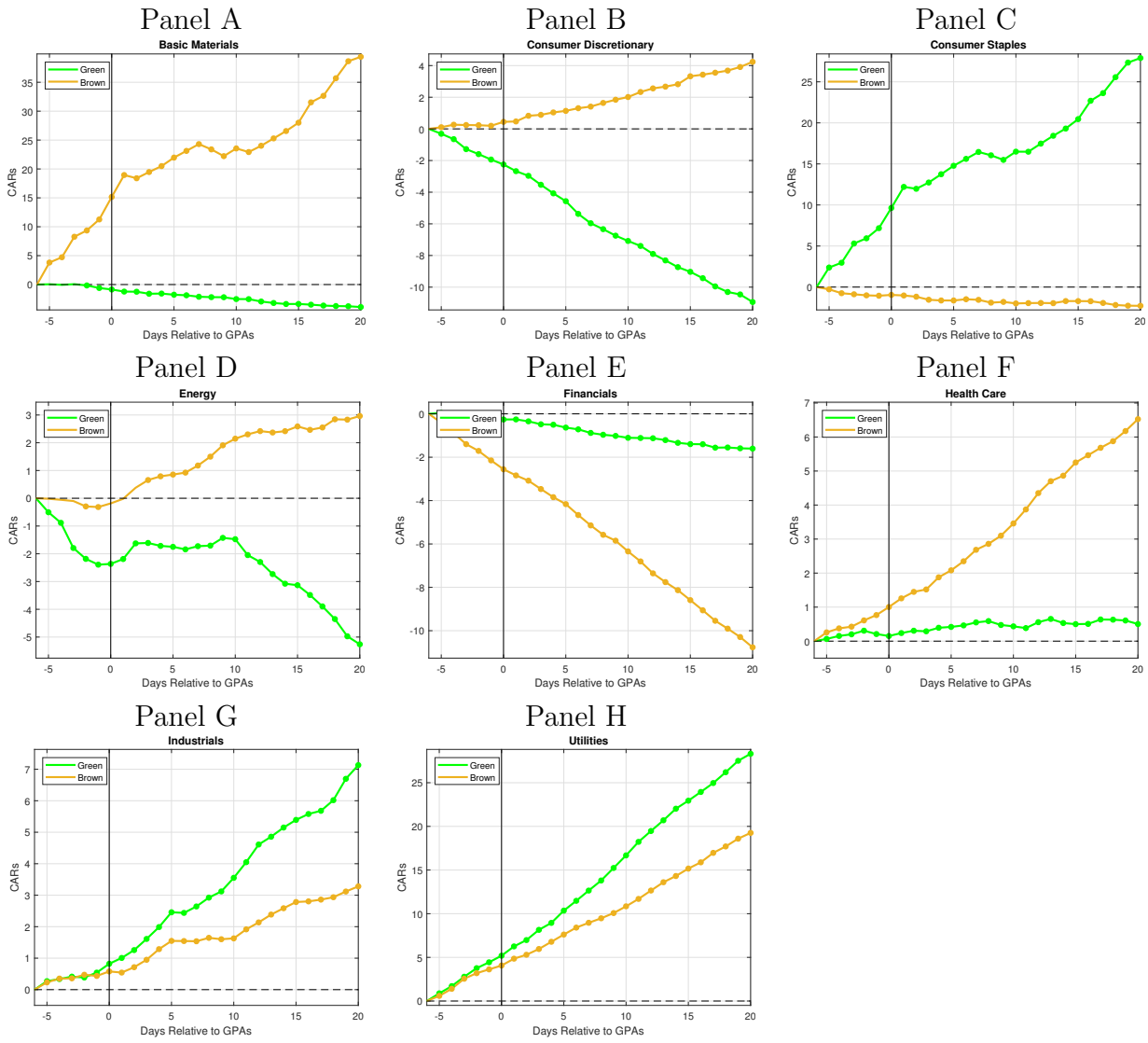
Notes: This figure depicts CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a three factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

Figure B.8: CARs around GPAs (3F-Model/Different GPAs)



Notes: This figure depicts CARs around different category of GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements have been grouped in seven categories according to the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery): (*i*) "Adaptation", (*ii*) "Air Pollution", (*iii*) "Biodiversity", (*iv*) "Climate Mitigation", (*v*) "Other", (*vi*) "Wasterecycling", (*vii*) "Water". The category "Plastic" has been excluded because it included only one policy announcement for Finland. The theoretical price is estimated according to a three factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

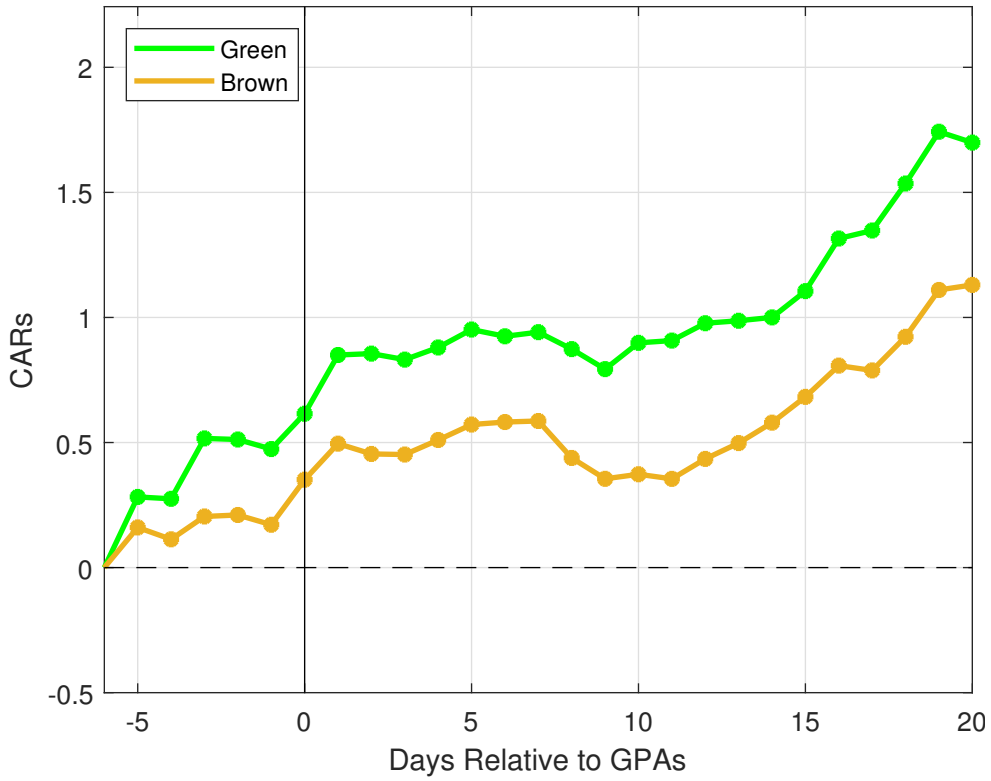
Figure B.9: CARs around GPAs (3F-Model/Different Sectors)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in eigth sectoral value-weighted portfolios: (*i*) "Basic Materials", (*ii*) "Consumer Discretionary", (*iii*) "Consumer Staples" and (*iv*) "Energy", (*v*) "Financial", (*vi*) "Health Care", (*vii*) "Industrials" and (*viii*) "Utilities" sectors.The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a three factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

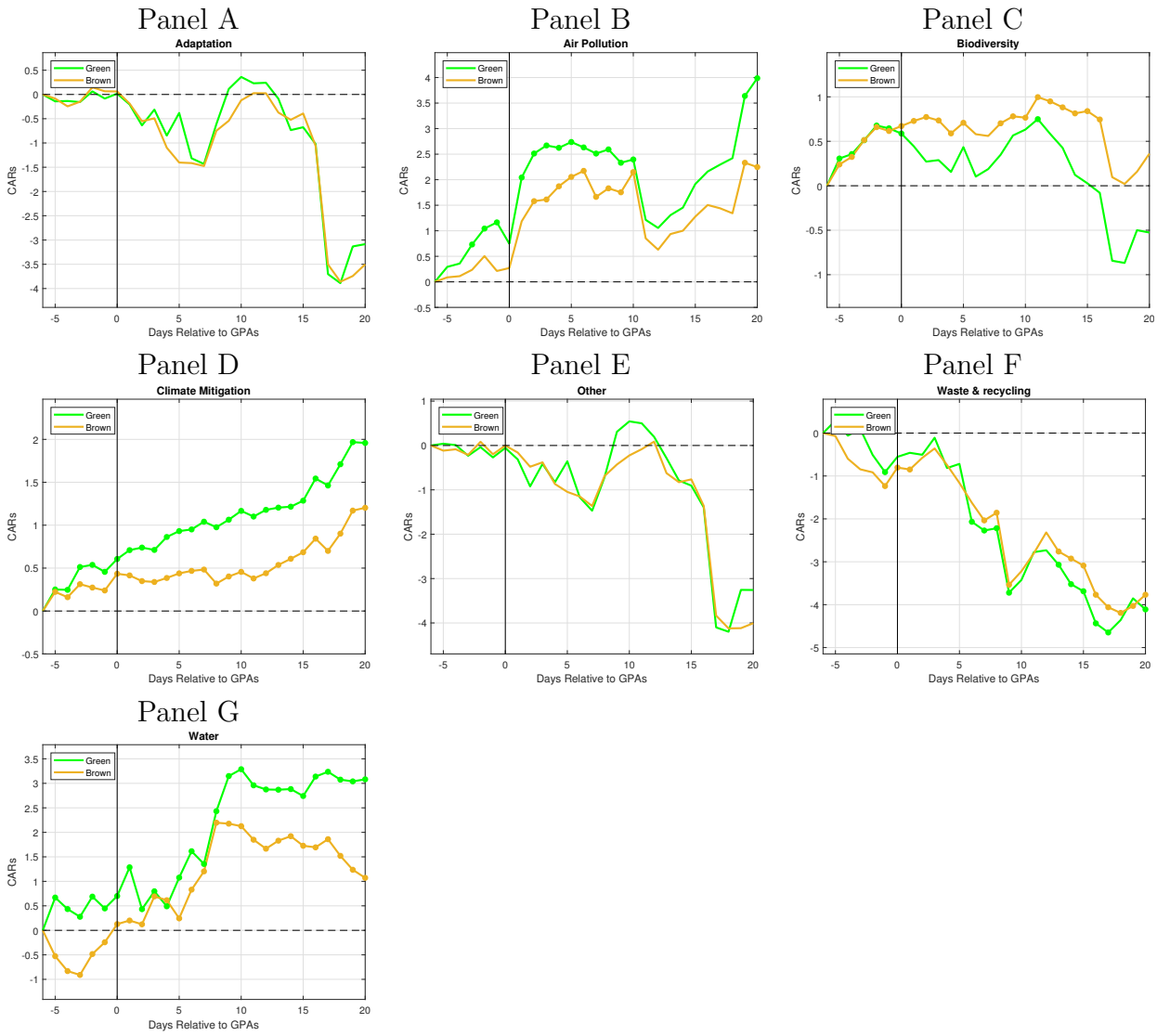
B.4 Three factor model and Δ Oil price

Figure B.10: CARs around GPAs/4F-Model



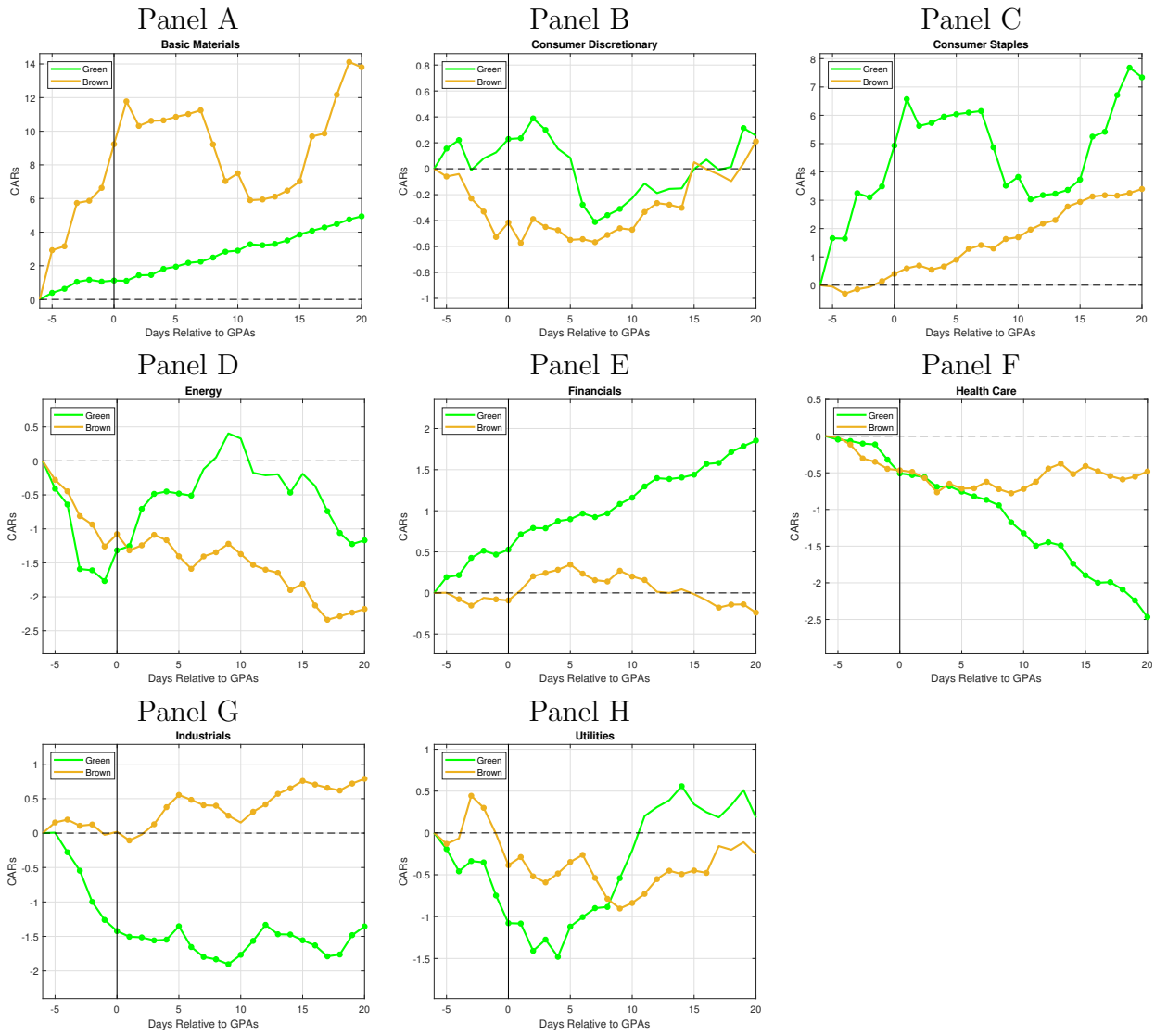
Notes: This figure depicts CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a four factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors. (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). and Δ OIL is the price change of WTI crude Oil. The risk free rate is captured by the one-year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

Figure B.11: CARs around GPAs (4F-Model/Different GPAs)



Notes: This figure depicts CARs around different category of GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio are listed in Table A.2 (A.3). Green policy announcements have been grouped in seven categories according to the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery): (*i*) "Adaptation", (*ii*) "Air Pollution", (*iii*) "Biodiversity", (*iv*) "Climate Mitigation", (*v*) "Other", (*vi*) "Wasterecycling", (*vii*) "Water". The category "Plastic" has been excluded because it included only one policy announcement for Finland. The theoretical price is estimated according to a four factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors. (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html) and Δ OIL is the price change of WTI crude Oil. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

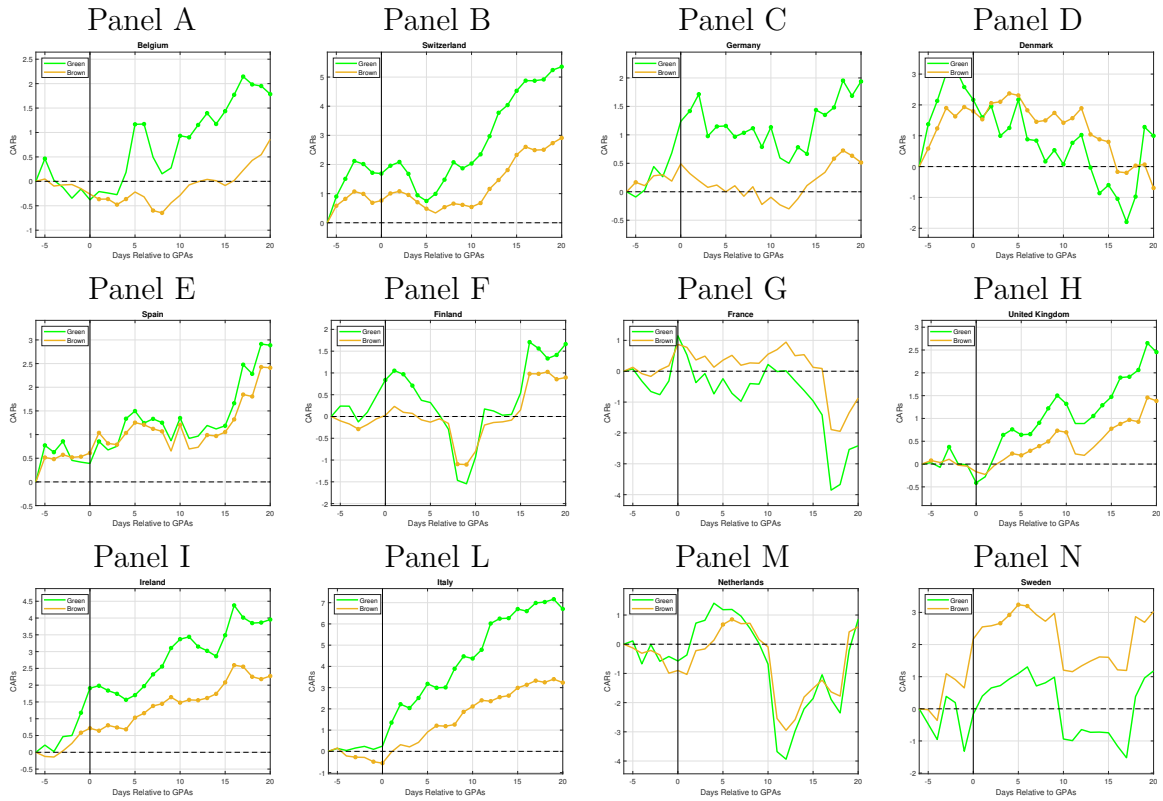
Figure B.12: CARs around GPAs (4F-Model/Different Sectors)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in eigth sectoral value-weighted portfolios: (*i*) "Basic Materials", (*ii*) "Consumer Discretionary", (*iii*) "Consumer Staples" and (*iv*) "Energy", (*v*) "Financial", (*vi*) "Health Care", (*vii*) "Industrials" and (*viii*) "Utilities" sectors. The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a four factor model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns, SMB and HML are from Fama and French European Factors. (https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). and Δ OIL is the price change of WTI crude Oil. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-20$ to $t+20$. Dots indicate significance at 1%.

B.5 CARs: country-by-country

Figure B.13: CARs around GPAs (Different Countries)



Notes: This figure depicts sectoral CARs around GPAs for the green portfolio (green line) and the brown portfolio (brown line). Green and brown value-weighted portfolios are constructed using stocks listed in the "STOXX All Europe 100". Stocks included in the green (brown) portfolio and belonging to a specific sector/industry are listed in Table A.2 (A.3). Stocks have been grouped in twelve country value-weighted portfolios: (*i*) Belgium, (*ii*) Switzerland, (*iii*) Germany, (*iv*) Denmark, (*v*) Spain, (*vi*) Finland, (*vii*), France, (*viii*) United Kingdom, (*ix*) Ireland, (*x*) Italy, (*xi*) Netherlands, (*xii*) Sweden. Green policy announcements are from the OECD Green Recovery Database (https://www.oecd.org/coronavirus/en/themes/green-recovery). The theoretical price is estimated according to a one factor CAPM model over a window from $t-250$ to $t-30$ using the STOXX as a proxy for the market returns. The risk free rate is captured by the one year German government bond. CARs are estimated from $t-5$ to $t+20$. Dots indicate significance at 1%.

B.6 Predictive regressions

Table B.1: Predictive regressions results

Panel A: Green									
Horizon		**Basic Materials**	**Consumer Discretionary**	**Consumer Staples**	**Energy**	**Financials**	**Health Care**	**Industrials**	**Utilities**
	D_t	-0.142***	-0.139***	0.111***	-0.096***	-0.172***	0.196***	-0.171***	-0.023
(1)		(0.029)	(0.031)	(0.039)	(0.037)	(0.025)	(0.043)	(0.024)	(0.03)
	Mkt	-0.003	0.001	-0.012	-0.003	-0.001	-0.029	-0.001	-0.025
		(0.025)	(0.027)	(0.034)	(0.032)	(0.021)	(0.038)	(0.021)	(0.026)
	D_t	-0.131***	-0.126***	0.114***	-0.071**	-0.160***	0.195***	-0.163***	-0.022
(3)		(0.029)	(0.031)	(0.039)	(0.036)	(0.025)	(0.043)	(0.024)	(0.03)
	Mkt	-0.008	-0.008	-0.016	-0.012	-0.003	-0.029	-0.006	-0.029
		(0.025)	(0.027)	(0.034)	(0.031)	(0.021)	(0.038)	(0.021)	(0.026)
	D_t	-0.125***	-0.122***	0.119***	-0.068*	-0.158***	0.200***	-0.157***	-0.021
(5)		(0.029)	(0.031)	(0.039)	(0.036)	(0.024)	(0.043)	(0.024)	(0.03)
	Mkt	-0.015	-0.022	-0.037	-0.009	-0.002	-0.057	-0.003	-0.041
		(0.025)	(0.027)	(0.034)	(0.031)	(0.021)	(0.038)	(0.021)	(0.026)
	D_t	-0.101***	-0.105***	0.092**	-0.037	-0.140***	0.199***	-0.134***	0.002
(10)		(0.030)	(0.032)	(0.039)	(0.034)	(0.024)	(0.044)	(0.025)	(0.03)
	Mkt	-0.015	-0.018	-0.039	-0.009	-0.002	-0.053	0.001	-0.033
		(0.026)	(0.027)	(0.034)	(0.030)	(0.021)	(0.038)	(0.021)	(0.026)
	D_t	-0.051*	-0.050	0.132***	-0.015	-0.091***	0.187***	-0.070***	0.052*
(20)		(0.030)	(0.033)	(0.039)	(0.031)	(0.024)	(0.044)	(0.025)	(0.03)
	Mkt	-0.008	-0.006	-0.013	0.001	0.003	-0.024	0.003	-0.014
		(0.028)	(0.030)	(0.036)	(0.029)	(0.022)	(0.041)	(0.023)	(0.028)
Panel B: Brown									
Horizon		**Basic Materials**	**Consumer Discretionary**	**Consumer Staples**	**Energy**	**Financials**	**Health Care**	**Industrials**	**Utilities**
	D_t	0.056	-0.087***	-0.084***	-0.034	-0.136***	-0.052***	-0.134***	-0.126***
(1)		(0.034)	(0.019)	(0.012)	(0.048)	(0.019)	(0.010)	(0.026)	(0.019)
	Mkt	0.003	0.001	0.006	-0.018	0.003	0.009	0.009	-0.002
		(0.030)	(0.017)	(0.011)	(0.042)	(0.016)	(0.009)	(0.023)	(0.016)
	D_t	0.058*	-0.083***	-0.080***	-0.022	-0.124***	-0.051***	-0.128***	-0.124***
(3)		(0.034)	(0.019)	(0.012)	(0.048)	(0.019)	(0.010)	(0.027)	(0.019)
	Mkt	0.005	-0.003	-0.001	-0.026	-0.007	0.005	0.004	-0.001
		(0.030)	(0.017)	(0.011)	(0.042)	(0.017)	(0.009)	(0.023)	(0.016)
	D_t	0.059*	-0.081***	-0.080***	-0.010	-0.123***	-0.047***	-0.116***	-0.119***
(5)		(0.034)	(0.019)	(0.012)	(0.048)	(0.019)	(0.010)	(0.027)	(0.019)
	Mkt	0.002	-0.012	-0.002	-0.054	-0.001	0.011	0.004	0.009
		(0.030)	(0.017)	(0.011)	(0.042)	(0.016)	(0.009)	(0.023)	(0.016)
	D_t	0.017	-0.072***	-0.065***	0.019	-0.105***	-0.035***	-0.097***	-0.115***
(10)		(0.035)	(0.019)	(0.012)	(0.048)	(0.019)	(0.010)	(0.027)	(0.019)
	Mkt	-0.000	-0.010	-0.002	-0.056	-0.001	0.013	0.007	0.007
		(0.030)	(0.017)	(0.011)	(0.042)	(0.016)	(0.009)	(0.023)	(0.016)
	D_t	0.079**	-0.043**	-0.038***	0.056	-0.067***	-0.020*	-0.058**	-0.079***
(20)		(0.035)	(0.020)	(0.013)	(0.049)	(0.019)	(0.010)	(0.028)	(0.019)
	Mkt	0.005	0.000	0.002	-0.031	0.005	0.007	0.006	0.006
		(0.032)	(0.018)	(0.012)	(0.045)	(0.017)	(0.010)	(0.026)	(0.017)

Notes: This table depicts the results of the the regression described in Eq. 2 on green (Panel A) and brown (Panel B) value weighted j-ahed cumulative sectoral portfolios returns from the STOXX index. Stocks included in each sector are listed in the Appendix (Table A.2 and A.3). The sectors "Real Estate" and "Technology" have been excluded because they didn't include at least one stock in each portfolio. E_t is a dummy variable equal one if at time t a green policy is announced, zero other wise. Mkt is the market return proxied by the value weighted returns of all stocks in out sample. For the sake of brevity, the constant α is not reported. Standard errors are reported in parenthesis. *, **, *** indicate a significance level of 1%, 5% and 10%, respectively.