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Climate Policy Risk and Asset Prices in Switzerland

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Climate Policy Risk and Asset Prices in Switzerland[☆]

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Abstract

This paper develops an index of Climate Policy Risk using text-analysis techniques on a large number of Swiss media articles for the period 2000-2022. The index captures a number of important international as well as domestic transition risk events. We consider two complementary approaches to explore the asset pricing implications of Climate Policy Risk. First, we adopt a mimicking portfolio approach and show that a simple CO2-based and sector-balanced portfolio is a valuable hedge to Climate Policy Risk innovations, both in and out-of-sample. These hedging properties are particularly clear towards the end of our sample. Second, to better identify the source of transition risk, we adopt an event-study approach and investigate the stock price response of firms depending on their CO2 emissions. We find that CO2-intensive firms perform significantly worse than their greener counterparts following events that increased transition risk. Overall, this paper provides evidence on the pricing of climate transition risk in Switzerland.

Keywords: Climate Policy, Transition Risk, Asset Prices, Portfolio Mimicking, Event-Study.

JEL Codes: G11, G18, Q54

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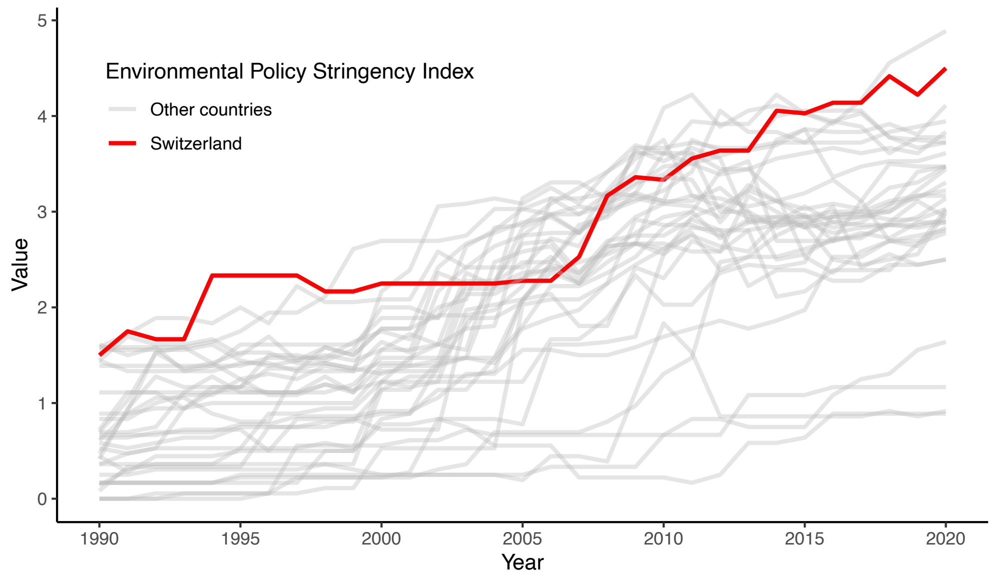
1 Introduction

In a world where an important number of government and private firms have made pledge to significantly reduce their carbon footprints to limit the effect of climate change and meet the objectives of the Paris Agreement, the financial effect of climate policies has become an increasingly relevant concern for investors all around the world. For example, Krueger et al. (2020) survey active investment managers and find that a large proportion of investors believe that climate change can have important implications for their portfolios. They document that 39% of investors are looking for ways to reduce the carbon footprint of their portfolios. Additionally, strategies to hedge climate risk are becoming increasingly relevant (Engle et al. (2020)).

As opposed to most of the literature which focuses on the U.S., this paper investigates these questions in the case of Switzerland. Figure 1 plots the Environment Policy Stringency Index from the OECD for all countries for which it is available. As a leader in terms of climate policies, transition in risk may be particularly high in Switzerland, making it an ideal laboratory to investigate the effect of transition risk on asset prices. An important challenge, however, relates to the difficulty to accurately and timely measure transition risk. For instance, the Environmental Policy Stringency (EPS) Index of the OECD is available only at the yearly frequency. Another challenge resides in the fact that climate concerns is a fairly recent phenomenon.

Our first contribution is to develop a simple index of Climate Policy Risk using text-analysis techniques on a large number of Swiss newspapers, following literature such as Baker et al. (2016) and Gavriilidis (2021). Our Climate Policy Risk (CPR) index rises around a number of important climate events such as international climate agreements, IPCC and other scientific reports, or development related to the introduction of climate policies. Furthermore, we observe a structural break in the intensity of Climate Policy Risk since 2018, in line with the idea that climate change has become a major and widely-shared

Figure 1 Environmental Policy Stringency Index



Note. This Figure displays the Environmental Policy Stringency Index from the OECD for all countries for which the index is available. The red line depicts this index for Switzerland. According to this measure, Switzerland is the second best performing country in 2021.

source of concerns only relatively recently. While being largely correlated with the US Climate Policy Uncertainty from Gavriilidis (2021), our Swiss index also displays distinct behaviours, notably related to domestic development in the US or Switzerland. Furthermore, our index is available at both the daily and monthly frequency and is easy to update, making it particularly useful to track climate transition risk in real time and investigate its effect on asset prices.

The second contribution of this paper is to evaluate the hedging properties of a simple sector-balanced portfolio which goes long in green firms and short in brown firms (GMB). In practive, we consider a firm brown (green) if its CO2 emissions are above (below) the median emission in a given sector. We argue that relying on CO2 data only is a simple yet powerful way to capture a firm's exposition to climate risk (see e.g. Bolton and Kacperczyk (2021a) for a similar argument). By having a sector-balanced portfolio, we ensure that our portfolio is reasonably diversified and discard portfolios that would overly concentrate the exposure on a few (green) sectors only. We document that such a portfolio turns out to provide significantly higher returns when our measure of Climate Policy Risk rises unexpectedly, and this in particular in the latter part of our sample. These hedging properties hold both in and out of sample. While we do not see our portfolio as the ultimate hedge and acknowledge the limitations of our measure of Climate Policy Risk, we interpret our results as suggesting the relevance of Climate Policy Risk in affecting asset returns in Switzerland, and see a CO2-based portfolio as a sensible starting point to hedge such risks.

Finally, the third contribution of this paper is to specifically investigate the effect of identified transition risk events on the behaviour of brown versus green firms. To do so, we read a large number of articles used to create our Climate Policy Risk proxy and manually label a number of arguably exogenous events which likely coincided with an increase in transition risk. We then run Jordà (2005)-type local-projection regression with a number of controls and fixed-effects to investigate the differential stock-price behaviour of brown versus green firms around these events. By relying on an event-study framework, we argue that the transition risk shocks are better identified. In terms of results, we find that brown firms suffer more in the days following the transition risk events, and that this effect appears to be persistent at the one-year horizon. Overall, we interpret these results as suggesting that investors care about transition risk, and that it affects the dynamics of asset prices.

Climate change is a defining threat to our societies, and our response to it will have important economic implications. Due to its central role in channeling funds and investment, financial markets have an important role to play in the transition towards a greener economy. There are two main types of risk related to climate change. The first is physical risk which includes risks of the direct impairment of productive assets resulting from climate change (e.g. flood, hurricanes, drought, etc). The other is transition risk which relates to changes in cash flows arising from a possible transition to a low-carbon economy (e.g. the implementation of carbon tax, the development of an ETS market, etc.).[1] In Switzerland, without minimizing physical risk, transition risk is likely to be the more acute risk (see Maechler and Moser (2019)). To the extent that climate risks may end up affecting asset prices, it is important to come up with accurate measure, quantification of their effects, and hedging strategies to reduce their potentially negative effects. Those are the aims of this paper.

This paper is structured as follows. Section 2 gives a short overview of the related literature. Section 3 provides information on the data, while Section 4 details the construction of the Climate Policy Risk (CPR) index. Section 5 applies the portfolio mimicking approach from Engle et al. (2020) to our Swiss data. Section 6 complements these results using an event-study approach. Section 7 concludes.

2 Related Literature

This paper contributes to the literature that tries to understand whether climate change considerations are integrated in asset prices, and how to hedge against it. On the empirical side, Bolton and Kacperczyk (2021a) investigate investors' attention to carbon risk and find that higher carbon emissions are associated with higher expected returns in the US stock market. Bolton and Kacperczyk (2021b) confirm these results more globally by documenting the existence of carbon premium in all sectors over three continents, namely Asia, Europe, and North America. They further argue that the premium has increased in importance since the Paris agreement. In line with this, Alessi et al. (2021) find the existence of a greenium (a negative risk premium) for firms which are more environmentally friendly and transparent. Choi et al. (2020) document that the stock price of low-emission firms tend to outperform when the weather is abnormally warm. On the other hand, Hong et al.

[1]Physical risk examples include the threat of damage induced by rising sea levels. Transition risk, on the other hand, includes risks faced by firms from a possible transition to a low-carbon economy. Typical examples include the introduction of a carbon tax (increasing the risk of having stranded assets), or also changes in technology and consumer preferences.

(2019) find that stock prices tend to underreact to physical climate risks. Theoretically, Pástor et al. (2021) propose an equilibrium model of sustainable investing. Their key results is that, in equilibrium, green assets have lower expected returns because investors value their (non-pecuniary) environment, social, and governance (ESG) characteristics. However, green assets outperform when there are positive shocks to the ESG factor. Ardia et al. (2022) confirm this empirically by showing that US green firms tend to outperform brown firms when climate change concerns change unexpectedly. Our paper differs from these predominantly US-focused studies by focusing on the pricing of transition risk in a small open economy like Switzerland.

A paper particularly close to ours is Engle et al. (2020) which builds an index of climate change risk using the Wall Street Journal and proposes a mimicking portfolio approach to hedge its innovations. They find that a portfolio going long in firms with better ESG scores tend to provide valuable hedging properties. Andersson et al. (2016) argue that a passive investment strategy tilted to low carbon emissions stocks is a good hedge against climate risk. We complement these results by looking at Switzerland but also provide new insights by relying on an event-study approach which arguably allows to better interpret the ultimate sources of transition risks.

On the methodological front, the construction of our index connects with a literature which uses text-search methods to produce new proxies of economic concepts. For instance, Baker et al. (2016) develop an index of economic policy uncertainty using 10 leading U.S. newspapers. Other examples of text-based indices include Gentzkow and Shapiro (2010), Hoberg and Phillips (2010), and Boudoukh et al. (2013). Finally, Gavriilidis (2021) adapts the approach from Baker et al. (2016) to construct an index of climate policy uncertainty.

3 Data

3.1 Newspapers data

We rely on a novel database called Swissdox to construct the index of Climate Policy Risk. The database is comprehensive and essentially covers the universe of published articles.[2] We focus on the the main Swiss outlets in French and German. German-written newspapers include the *Neue Zürcher Zeitung, Tages Anzeiger, Blick,* and *20 Minuten.* French-written newspapers include *Le Temps, 24 heures, Tribune de Genève, 20 minutes,* and *Le Matin.* The sample starts in January 2000 and ends in October 2022. For all newspapers, we focus on printed articles. The final dataset is made of over 4 millions articles, out of which roughly half are in German or French.

3.2 Firm-level data

We collect firm-level equity price data from Datastream at the daily frequency for all public firms in Switzerland. We complement the equity price data with firm-level proxies for carbon intensity, denoted by $CO2_{i,t}$. Specifically, we consider both Scope 1 and Scope 2 CO2 emissions at the firm-level from Datastream and available at the annual frequency. Scope 1 emissions include greenhouse gases (GHG) emissions that emanate from the operation of capital directly owned by the firms. Scope 2 emissions are indirect emissions associated with the purchase of electricity, steam, heat, or cooling. As the two measures are complementary, our main measure of interest is the sum Scope 1 and Scope 2 emissions. Finally, we consider a vector $Z_{i,t}$ constituted by a number of firm-level controls available at the quarterly frequency from Datastream, namely a measure of leverage (measured as the ratio of total debt to assets), a measure of profitability (sales growth), and a measure of size (total assets). In

[2]The media data is made available through Swissdox@LiRI by the Linguistic Research Infrastructure of the University of Zurich (see https://t.uzh.ch/1hI for more information). We thank the Swiss Institute of Applied Economics of the University of Lausanne (CREA) for giving us access to this data.

Table 1 Summary Statistics for CH Public Firm Data

Sector	Firms	Obs.	Share CO2	Scope 1 + 2 (mean)
Industrials	60	289,832	55%	4081
Consumer Staples	14	63,704	57.1%	1187
Basic Materials	8	45,603	50%	616
Health Care	32	12,4892	34.4%	379
Technology	13	63,341	38.5%	74
Consumer Discretionary	21	101,599	42.9%	65
Utilities	3	14,688	66.7%	47
Financials	42	224,678	40.5%	34
Telecommunications	3	17,724	100%	25
Real Estate	21	78,906	28.6%	13
Total	217	1,024,967	45.2%	1596

Note:
This table provides some summary statistics regarding the number of firms and observations, as well as the CO2 data coverage for public firms listed in the Swiss Performance Index (SPI), which is considered as Switzerland's overall stock market index. The original CO2 variable is expressed in tons and is divided by 1,000 in the table.

the full sample, there are 217 unique firms and 1,024,967 unique observations. The coverage of CO2 data is equal to 45.2% of the 217 public firms in the SPI index. Table 1 provides summary statistics at the sector level.

4 An Index of Climate Policy Risk

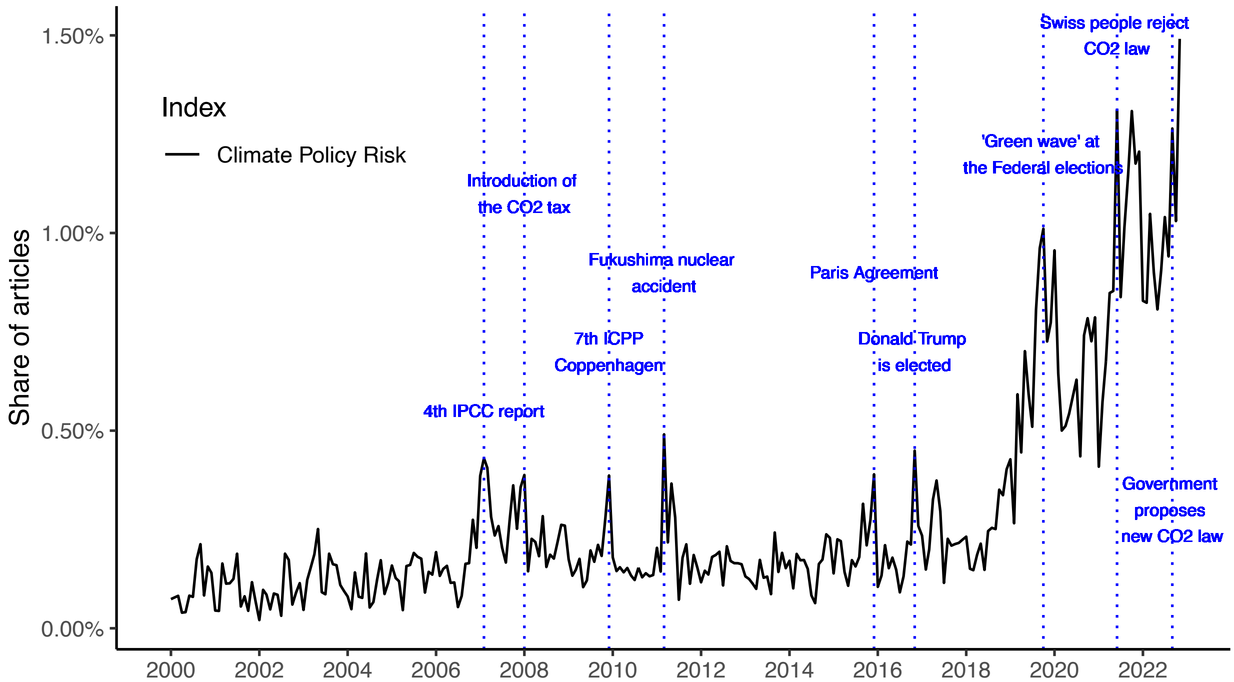
4.1 Methodology

To develop the index of Climate Policy Risk, we adopt an approach similar to Baker et al. (2016) in the context of economic policy uncertainty (EPU), and Gavriilidis (2021) who develops a climate policy uncertainty index for the United States. To construct the Climate Policy Risk index, we search for articles which contains words related to climate change (such as climate, CO2, greenhouse gases, renewable energy, etc). We then refine the search by adding terms related to policy (such as government, law, parliament, regulation, federal, Bern, etc). Finally, we add keywords related to risk and uncertainty (uncertainty, risk, doubt, unanticipated, unstable, etc). For each newspaper, we divide the number of articles related to Climate Policy Risk by the total number of articles in each month. The Climate Policy Risk index is then obtained by taking the average share of Climate Policy Risk articles across all newspapers in each month.

4.2 Results

The resulting Climate Policy Risk (CPR) index is displayed in Figure 2. As we can see, the index displays a clear upward trend at the end of the sample. Interestingly, it exhibits a relatively stable trend prior to 2018. It also raises around a number of climate-related events which are indicated on the figure. The index notably spikes around a number of domestic climate-related policies, such as a new proposal of CO2 law by the Swiss government in 2022M9. The index also spikes in 2021M6 after the rejection of the CO2 law by Swiss people and in 2019M10, a period that coincides with a "Green wave" at the federal elections. The index also spikes around a number of international events, such as the Paris Agreement, the election of Donald Trump or the 7th ICPP in Copenhagen. Generally speaking, the index appears to be particularly effective at identifying periods which are likely to have coincided with increases in transition risk. For information, we compare the (scaled) CPR with the US Climate Policy Uncertainty (CPU) index from Gavriilidis (2021) in Figure B.1. The two series turn out to be closely related with a correlation of 0.74, as can be expected as climate change is a global phenomenon. However, they also diverge during certain periods, for example around the election of Donald Trump which appears to be a significantly larger shock for the US CPU. Similarly, the spike related to the rejection of the CO2 law is virtually absent from the US CPU. We interpret this as evidence that our index captures transition risk that is most relevant to Switzerland. We also compare a yearly version of our index with the Environmental Policy Stringency from the OECD for Switzerland in B.3. The correlation turns out to be lower but still high at 0.57.

Figure 2 THE CLIMATE POLICY RISK INDEX IN SWITZERLAND



NOTE. This Figure displays the Climate Policy Risk Index for Switzerland over the period 2000-2020. The frequency here is monthly but the index is available also at the daily frequency. Details on its construction can be found in Section 4.1

4.3 Discussion

A potential concern regarding our CPR index is that it rises in 2021M6, that is the month in which Swiss people rejected an amendment to the Federal act on the reduction of greenhouse gas emissions (CO2 Act). Of course, given our text-based approach, it is no surprise that this event coincides with a large increase, as a large number of articles were devoted to this decision and were likely to contain climate-related keywords. At first sight, the fact that the new law was turned down may suggest that transition risk actually decreased following this event. However, there are a number of reasons that suggest the opposite. For one, the law was rejected by a small margin only, with 51.59% to 48.41%. Second, it is generally accepted that the rejection of the law was not about the ecological argument, but rather motivated by a perception that the law was regressive, with middle and low-income bearing most of its cost. A further element confirming this is that the Federal Council actually came up with a new (and more progressive) CO2 law less than a year after the initial rejection. This suggests that even though the initial law was turned down, it actually didn't prevent further climate policies to take place. As such, transition risk is likely to have remained high. However, that type of event shows the potential limits of our approach, and highlights why it is also important to rely on other ways to measure the effect of transition risk, as is explored in Section 6. More generally, a potentially more convincing interpretation of our index is that of one of attention devoted to Climate Policy Risk. In that context, there is an argument to be made that higher attention generally translates to higher transition risk in Switzerland, at least in the more recent period.

5 Hedging Climate Policy Risk

In this section, we propose a simple sector-balanced "green minus brown" (GMB) portfolio to hedge Climate Policy Risk. We rely on the mimicking portfolio approach from Lamont (2001) and recently adopted in Engle et al. (2020) to hedge climate change news. As climate considerations become an increasingly important concern for investors, and as tighter climate policies become increasingly likely to be implemented in the near future, we see work on finding good hedging portfolios particularly valuable.

On the theory side, Pástor et al. (2021) show how asset prices can reflect climate considerations; they argue that greener assets can outperform browner ones when concerns about climate change shifts unexpectedly. We test this prediction using a simple CO2-based measure to define whether a firm is green or brown, and proxy for unexpected changes in climate concerns using our Climate Policy Risk index. We find that greener stocks indeed outperform browner ones when Climate Policy Risk unexpectedly. In line with growing climate awareness, we find that this out-performance is particularly clear at the end of our sample. We then analyse the out-of-sample properties of our GMB portfolio and find that it is able to successfully hedge news in Climate Policy Risk in real time, thereby allowing investors to reduce their exposure to Climate Policy Risk without changing their exposure to other risk factors.

5.1 The Mimicking Portfolio Approach

To construct our hedge portfolio, we closely follow the approach laid out in Engle et al. (2020). We provide a concise summary of the different steps below but refer the reader to the original article for additional information.

Let r_t denote a $n \times 1$ vector of excess returns over the risk-free rate of n assets at time t and let assume that these returns follow a linear factor model. We postulate that these factors include innovations to Climate Policy Risk (denoted as CPR_t) as well as p other factors denoted by F_t. Formally:

$$r_t = \beta_{CPR}\gamma_{CPR} + \beta_{CPR}CPR_t + \beta_F\gamma_F + \beta_F F_t + u_t \tag{1}$$

The vector β_{CPR} ($n \times 1$) is the risk exposure to Climate Policy Risk, and β_F ($n \times p$) denotes the risk exposures to the other p risk factors. γ_{CPR} and γ_F denote the risk-premium associated with the Climate Policy Risk factor and the other p risk factors, respectively. The objective is to construct a hedge portfolio, that is a portfolio with unit exposure to the Climate Policy Risk factor ($\beta_{CPR} = 1$) but no exposure to the other p risk factors. This ensures that investors can change their exposure to climate risk by trading in this portfolio, without modifying their exposure to the other risk factors.

In the mimicking portfolio approach, we directly project the Climate Policy Risk factor onto a set of portfolios with excess returns denoted by $\tilde{r}_t$. Formally:

$$CPR_t = \alpha + w'\tilde{r}_t + e_t \tag{2}$$

The hedge portfolio is then constructed using the weights (denoted by w) from this regression. As shown in Engle et al. (2020), a sufficient condition for this equation to retrieve the desired hedge portfolio is that the portfolios (defined by $\tilde{r}_t$) span the same space as the true factors.

To build the hedge portfolio, we thus need a set of well-diversified portfolios such that their excess returns $\tilde{r}_t$ capture different dimensions of risk and can be assumed to span the factor space. A further restriction from equation (1) is that the portfolios need to have constant risk exposure over time. A standard way to achieve this is to form portfolios by sorting assets based on their characteristics. Formally, let Z_t denote a matrix of firm-level characteristics appropriately cross-sectionally normalized, we can rewrite the portfolio excess returns as:

$$\tilde{r}_t = Z'_{t-1} r_t \tag{3}$$

such that equation (2) becomes:

$$CPR_t = \alpha + w' Z'_{t-1} r_t + e_t \tag{4}$$

Equation (4) can be interpreted as a projection of the hedge target CPR_t onto characteristic-sorted portfolios ($Z'_{t-1} r_t$) that are assumed to have constant risk exposure, and which span the entire factor space.

5.2 Empirical Implementation

Empirically, the Climate Policy Risk factor (CPR_t) is estimated by taking the residual of an auto-regressive process on the Climate Policy Risk index displayed in Figure 2. For the universe of assets used to build the hedge portfolio, we consider all assets from the SPI index, which essentially covers all public firms in Switzerland. Data is from Datastream.

For the risk factors in F_t, we follow standard risk factor models (e.g. Fama and French (1993)) and consider 4 main factors, namely size, value, momentum, and the market. This is in line with Ammann and Steiner (2008) who show the relevance of these factors in the Swiss context. Appendix A details the construction of these factors.

To measure the climate policy factor, we form a green minus brown portfolio. To define whether a firms is green or brown, and in contrast to Engle et al. (2020) who relies on proprietary ESG scores, we decide to rely on CO2 emissions only. This is partly motivated because CO2 data is easily available for public firms in Switzerland, but also because it appears to us as a relatively objective measure of a firm exposure to Climate Policy Risk. In practice, we consider Scope 1 + Scope 2 CO2 emissions in order to account for both direct and indirect emissions. A firm is labelled as green (brown) if its CO2 emissions are below (above) the median within a given sector. By having a sector-balanced portfolio, we ensure that our portfolio is reasonably diversified and discard portfolios that would overly concentrate the exposure on a few green sectors only. For the weighting vector Z_t^{CO2}, we do not rely on the level emissions, mostly because a few firms have such high CO2 emissions level that they would end-up accounting for the vast majority of the weight in the portfolio. Rather, we rank firms from the highest to the lowest polluting and weight firms according to this ranking. In words, a firm with lower CO2 emission will get a larger weight in the green portfolio, while the opposite is true in the brown portfolio. The GMB portfolio is then obtained by subtracting the returns of the brown portfolio to the returns of the green portfolio. We denote the excess returns from this portfolio by $r_{GMB} = Z_{t-1}^{CO2} r_t$.

Formally, our equation of interest is the following:

$$CPR_t = \alpha + w_{GMB} Z_{t-1}^{CO2} r_t + w_{SIZE} Z_{t-1}^{SIZE} r_t + w_{HML} Z_{t-1}^{HML} r_t + w_{MOM} Z_{t-1}^{MOM} r_t + w_{MKT} Z_{t-1}^{MKT} r_t \tag{5}$$

where $w_{GMB}, w_{SIZE}, w_{HML}, w_{MOM}, w_{MKT}$ are scalars that capture the weight of the corresponding portfolios in the mimicking (hedge) portfolio for CPR_t. In words, if $w_{GMB} > 0$, it means that the GMB portfolio has higher returns when Climate Policy Risk increases, thereby forming the basis to work as a hedge.

5.3 In-sample results

We estimate regression (5) on a sub-sample from 2000M5 to 2009M12, and another from 2010M1 to 2022M10. Results are displayed in Table 2. Before 2010, the estimated coefficient $\hat{w}_{GMB}$ is not significant, in line with the idea that climate risk considerations was not a priced factor and that the GMB portfolio did not provide any hedge. After 2010, however, the coefficient turns significant and positive, suggesting that the GMB portfolio tends to have higher returns when Climate Policy Risk increases unexpectedly. Under the assumption that our Climate Policy Risk correctly captures Climate Policy Risk, the GMB portfolio thus appears to behave as a hedge over the period 2010-2022.

To shed light on the potential time-varying properties of the GMB portfolio, we rerun equation (5) using a rolling 8-year window and report the resulting $\hat{w}_{GMB}$ coefficient alongside its 90th percentile confidence intervals in Figure 3. As we can see, there is a clear upward trend, suggesting that the returns of the GMB portfolio are more correlated with innovations in Climate Policy Risk in the more recent period, in line with the fact that the rise in investor attention to climate risk is a fairly recent phenomenon. This suggests that the GMB portfolio has significantly increased its hedging properties in the last few years.

Table 2 CPR and GMB returns : In-sample results

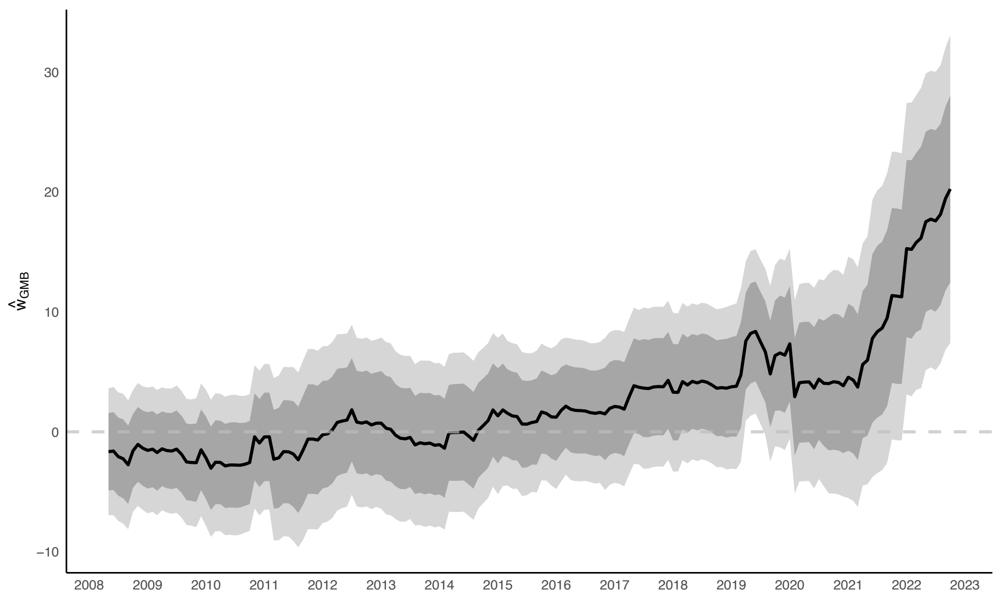
	Dep. variable : CPR_t	
Sample	*Before 2010*	*After 2010*
GMB	−1.476	**12.431****
	(2.958)	(4.961)
RMRF	−0.382	3.850
	(1.627)	(3.133)
SMB	−0.279	−6.492
	(2.335)	(4.826)
HML	0.870	2.979
	(1.840)	(4.431)
UMD	3.007	−2.111
	(2.495)	(5.808)
Constant	−0.081	0.010
	(0.078)	(0.096)
Obs.	117	154
R^2	0.019	0.053

Note: This Table shows the results from estimating regression (5) on two sub-samples, namely 2000M5 to 2009M12, and 2010M1 to 2022M10. Standard errors are indicated in the parenthesis. $*p < 0.1, **p < 0.05, ***p < 0.01$

5.4 Out-of-sample results

Now that we have established that the GMB portfolio tends to provide higher returns when Climate Policy Risk is high *in sample*, we perform a real-time *out-of-sample* test of the hedging properties of the portfolio. We follow the approach from Engle et al. (2020): at time t, we use data from t_{min} up to $t-1$ to estimate equation (5) and retrieve the optimal weights of each portfolio. We then compute the return of this portfolio in t and compare it with the actual realization of the Climate Policy Risk factor. In practice, we consider t_{min} =2005M1 to have sufficient data to estimate the model and report out-of-sample results starting from 2012M1. Panel A) of Figure 4 plots the correlations between realized CPR_t values and the return of the GMB portfolio. The correlation is significant at around 17%,

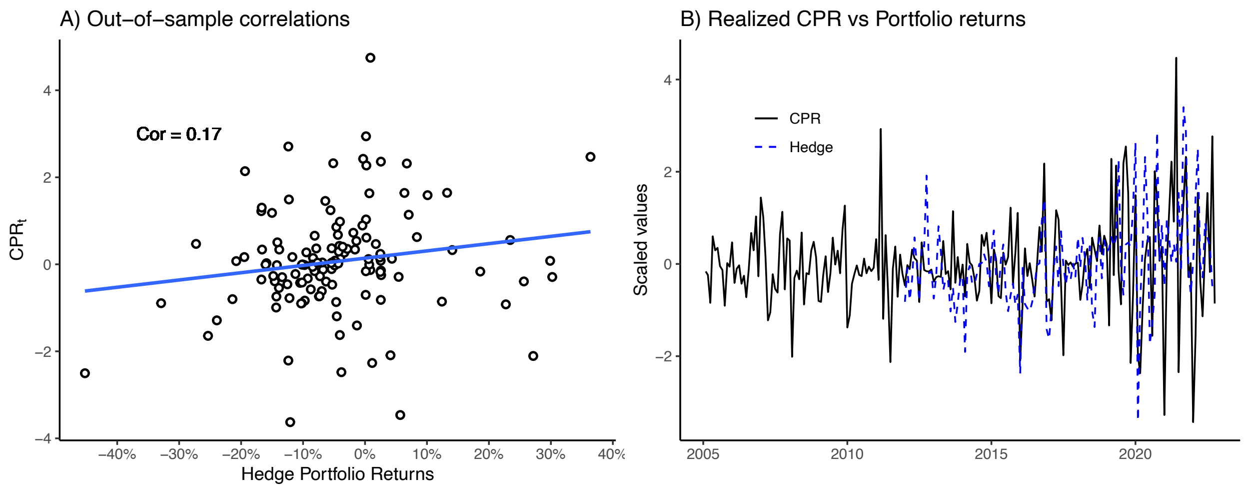
Figure 3 $\hat{w}_{GMB}$ OVER TIME



NOTE. This Figure plots the coefficient $\hat{w}_{GMB}$ from equation (5) using a rolling 8-year sample. For instance, the coefficient in January 2020 is obtained by running equation (5) on a sample spanning 2012M1 to 2020M1.

which is comparable to the performance of the hedge portfolio considered in Engle et al. (2020). Panel B) proposes a graphical representation of the real-time hedging exercise by comparing the realized CPR_t with the actual portfolio returns. In summary, our simple GMB portfolio performs remarkably well in hedging Climate Policy Risk out-of-sample.

Figure 4 Out-of-sample : hedging portfolio



Note. This Figure assesses graphically the out-of-sample hedging properties of the GMB portfolio. Panel A) displays the cross-sectional correlation between the actual CPR innovation (CPR_t on the y-axis) and the returns of the hedge portfolio in real-time using equation (5) to form the weights. Panel B) plots the (scaled) time-series of the hedge portfolio returns and the actual innovation in Climate Policy Risk.

6 Event-study Approach

To complement our previous results, we propose to adopt an event-study approach combined with local projections to investigate the dynamics of brown versus green firms around a number of transition risk events, both at the daily and monthly frequency. We find that in the days following a transition risk event, the stock price of brown firms typically appear to decline significantly more than their greener counterparts, thereby suggesting that investors pay attention to transition risk, and confirming the relevance of a green minus brown portfolio. The results of the monthly-frequency regressions suggest that the relatively larger drop in the stock price of brown firms is persistent. By relying on an event-study framework, we argue that it is easier to interpret the sources of transition risk.

6.1 Identifying climate events

The first step to conduct our event-study approach is to identify a number of transition risk events which are likely to have affected investors' perceptions regarding transition risk, and are arguably independent of other economic developments. To do so, we consider a daily version of our CPR index and identify dates during which the share of climate-related articles was particularly high. Relying on such dates ensure that the events received a relatively large media coverage. We then manually label each of these dates to a particular event by reading all the retrieved articles. We then select events which we deem sufficiently important and related to an increase transition risk.[3] We identify 19 such events, which relate to both domestic and international development. The resulting events are displayed in Table 3. As we can see and consistent with the secular increase in our CPR index since 2019, most of the transition risk events take place after this date. However, a number of events also take place before, such as the acceptance by Swiss voters of the revised Federal Energy Act in May 2017, or the ratification of the Paris Agreement by Switzerland in October 2017. Roughly half of the events relate to domestic development, while the other half is more internationally inclined.

6.2 Econometric Approach

Now that we have identified transition risk events, we detail the econometric approach to investigate the potentially different dynamics of the stock price of brown versus green firms. In particular, we follow an approach similar to Ottonello and Winberry (2020) and use Jordà (2005)-type local projection methods. Let $\Delta p_{i,t+h} = p_{i,t+h} - p_{i,t-1}$ be the price change at horizon $t+h$ (in days or months depending on the specification) relative to the price in $t-1$. We further define $I\{Event\}_t$ as a dummy taking the value 1 when a transition risk event

[3] An increase in transition risk is defined as an increase in the probability to adopt policies to mitigate the negative effects of climate change.

Table 3 Transition Risk Events

Date	Label	Type
2022-09-16	Switzerland sets out revised C02 law plan	Domestic
2022-04-04	New IPCC report	International
2021-10-30	G20 meets in Rome	International
2021-09-26	Bern voters approve constitutional amendment codifying climate neutrality by 2050	Domestic
2021-08-09	IPCC report warns of the rapid degradation of the planet	International
2021-07-14	European Comissions unveils its plan for CO2 reductions (fit-for-55 package)	International
2021-06-04	127 Nobel Prize winners call for climate actions	International
2021-05-31	FINMA specifies transparency obligations for climate risks	Domestic
2021-03-16	Federal Environment Office warns of climate change risks in Switzerland	Domestic
2020-12-11	EU agrees on tougher climate goals for 2030	International
2020-11-07	Election of Joe Biden	International
2020-01-04	A right-wing-Green coalition takes office in Austria	International
2019-10-20	"Green Wave" at the Swiss Federal Election	Domestic
2019-10-10	Report finds that climate change could have large costs for Swiss infrastructures	Domestic
2019-09-25	New alarming IPCC report	International
2019-08-16	A plane ticket tax is proposed by a state comission	Domestic
2019-06-22	FDP officially supports the Paris Climate Agreement	Domestic
2017-10-06	Switzerland ratifies the Paris Agreement	Both
2017-05-21	Swiss electorate accepts the revised Federal Energy Act	Domestic

from Table 3 takes place. Consistent with our portfolio approach, we further define $Brown_{i,t}$ as a within-sector brown dummy that takes the value 1 if a firm's CO2 emissions are above the median within a given sector. Finally, let $Z_{i,t}$ be a vector of firm-level controls (sales growth, total assets, price-to-book value, and debt-to-assets). We estimate the following local projection event-study regression for $h = 1, ..., 12$:

$$\Delta p_{i,t+h} = \alpha_i + \alpha_{h,s} + \beta_h (I\{\text{Event}\}_t \times Brown_{i,t}) + \Gamma Z_{i,t} + u_{i,t+h} \quad (6)$$

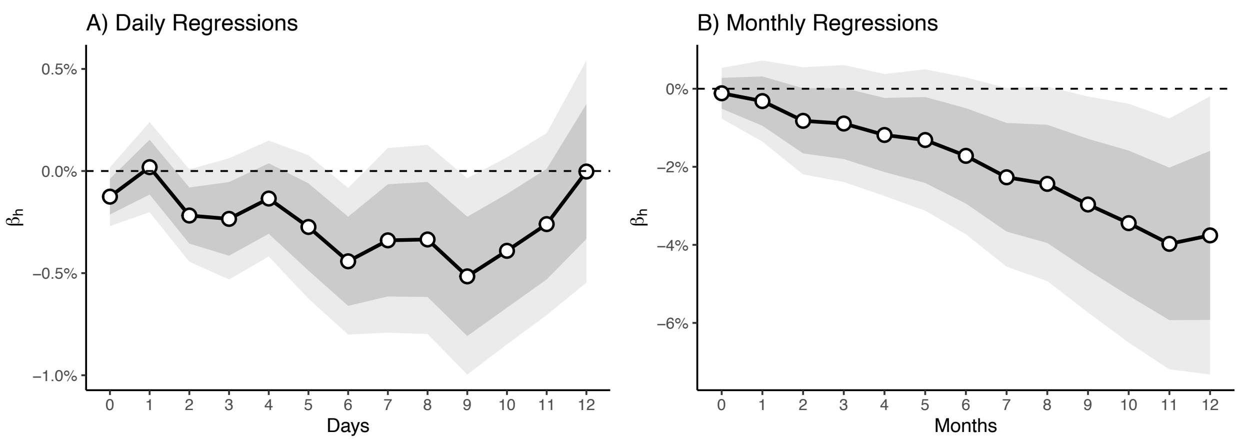
On top of firm-level controls $Z_{i,t}$, we control for firm fixed-effect (α_i) to capture permanent differences across firms. We further add a double interacted fixed-effect ($\alpha_{h,s}$ with horizon (h) and sector (s)) to control for any sectoral characteristics that may affect the firm price response over time. The coefficient of interest β_h captures the differing response in the variation of stock price at horizon h between a brown and a green firm *in a given sector*. A negative β_h indicates that brown firms see their stock prices react more negatively (either increase less or decrease more) than its greener counterpart, following a transition risk event.

6.3 Results

Figure 5 plots the results. Panel A) depicts the differing behaviour of brown versus green firms following a transition risk event at the daily frequency. As we can see, the coefficient is negative and statistically significant at the 90% confidence interval around 6 days after the event. Taken at face value, the results suggest that investors pay attention to transition risk event, and tend to reallocate their funds towards greener firms when transition risk increases, in line with the model of Pástor et al. (2021). Quantitatively, the drop in stock price is around 0.5% larger for brown firms 6 days after the event. Panel B) plots the same regression but at the monthly frequency. As we can see, the negative coefficient suggests that the stock price of brown firms tend to react more negatively than greener firms, and that this effect is persistent. Quantitatively, a brown firm see its stock price decrease by roughly

3-4% more 12 months after the event. Figure B.2 in the Appendix re-runs the regressions only considering *domestic* transition risk events. Results are qualitatively similar. Overall, the results confirm the relevance of transition risk for the dynamics of stock prices, both in the short and longer run.

Figure 5 TRANSITION RISK SHOCKS



NOTE. This Figure plots the coefficient β_h from equation (refeq:firm for $h = 1, ..., 12$. Panel A) estimates the equation using daily stock prices, while Panel B) uses monthly stock prices. Standard errors are clustered two-ways at the date and firm level. Confidence bands display the 68 and 90% intervals, respectively.

7 Conclusion

This paper provides empirical evidence on the pricing of transition risk in Switzerland. To do so, we develop a new Climate Policy Risk index using a large dataset of Swiss newspaper articles for the period 2000-2022. We show that a simple CO2-based and sector-balanced portfolio provide significant hedging properties out-of-sample to innovations in the Climate Policy Risk index. We further provide evidences that transition risk appears to have gained in importance in the last few years. To complement these results and better interpret the source of transition risk, we conduct an event-study approach and find that the stock price of brown firms perform significantly worse than green firms following transition risk events, both in the short and longer run. These results shed light on the importance of climate considerations for asset prices in Switzerland, and on how investors can use this information to reduce their exposure to Climate Policy Risk. Understanding whether our results also hold for other countries constiute an interesting venue for further research.

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A Risk-Factors for Switzerland

As in Ammann and Steiner (2008), we consider a four-factor model for asset prices in Switzerland:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_1 RMRF_t + \beta_2 SMB_t + \beta_3 HML + \beta_4 UMD + e_{it} \quad \text{(A.1)}$$

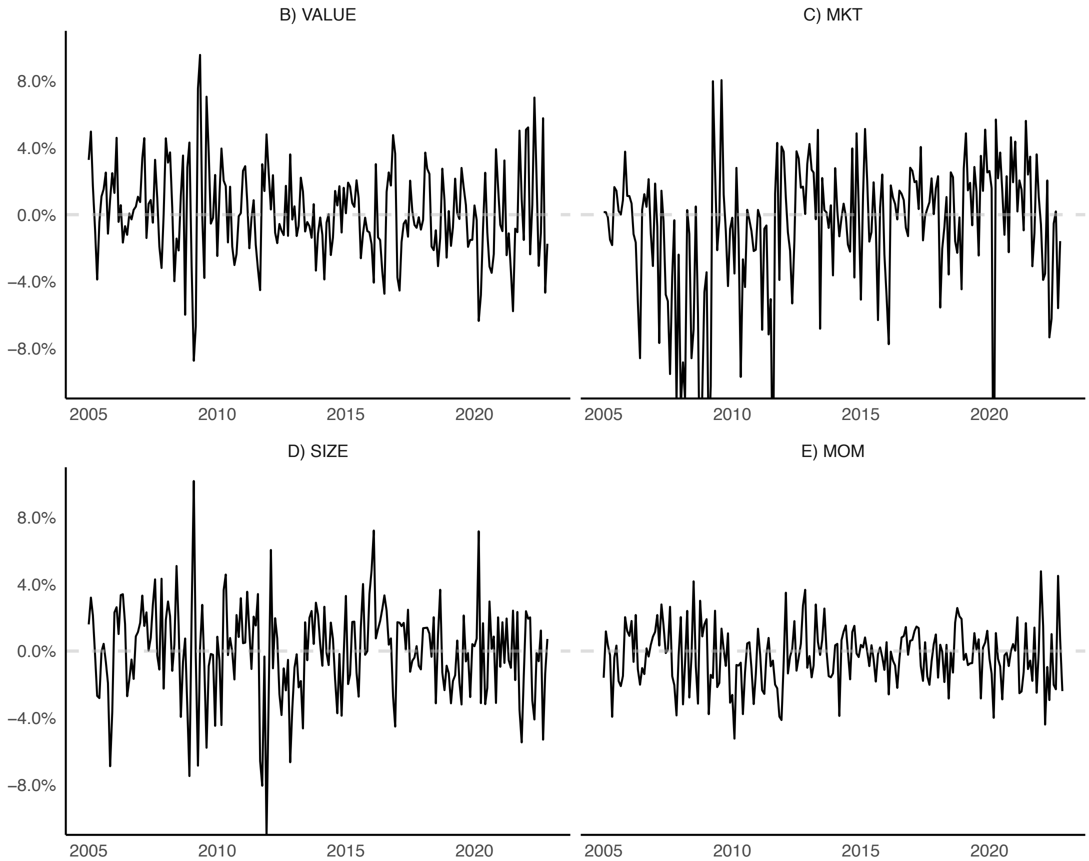
Where $R_{i,t}$ is the monthly (end-of-period) return of stock i and $R_{f,t}$ is the risk-free rate, and $RMRF_t$, SMB_t, HML_t and UMD_t are the excess returns from, respectively, the market portfolio, the small-minus-big portfolio (size factor), the high-minus-low portfolio (value factor), and the up-minus-down portfolio (momentum factor). Ammann and Steiner (2008) show the relevance of this four risk factors model for excess returns in Switzerland.

The market factor is obtained by computing the excess return of a market value weighted portfolio. To construct the three other factors, we proceed as follows. First, all stocks are divided into two sub-groups, namely big (B) and small (S), where the division is achieved by using the median market capitalization as the threshold. At the same time, the stocks are divided in two groups according to their book-to-market ratio (”High” (H), and ”Low” (L)), and their one-year past return (”Up” (U), and ”Down” (D)). We then create 8 portfolios based on the combinations of these characteristics, namely S/H/U, S/H/D, S/L/U, S/L/D, B/H/U, B/H/D, B/L/U, or B/L/D. The portfolios’ weights are defined using the market capitalization. The three risk factors are then computed as follows:

$$SMB = 1/4 * ((S/H/U - B/H/U) + (S/H/D - B/H/D) + (S/L/U - B/L/U) + (S/L/D - B/L/D))$$
$$HML = 1/4 * ((S/H/U - S/L/U) + (S/H/D - S/L/D) + (B/H/U - B/L/U) + (B/H/D - B/L/D))$$
$$UMD = 1/4 * ((S/H/U - S/H/D) + (S/L/U - S/L/D) + (B/H/U - B/H/D) + (B/L/U - B/L/D))$$

Intuitively, the SMB portfolio can be interpreted as a portfolio going long, while controlling for market, value, and momentum effects. The HML and UMD portfolios can be interpreted similarly. The resulting four risk factors are displayed in Figure A.1.

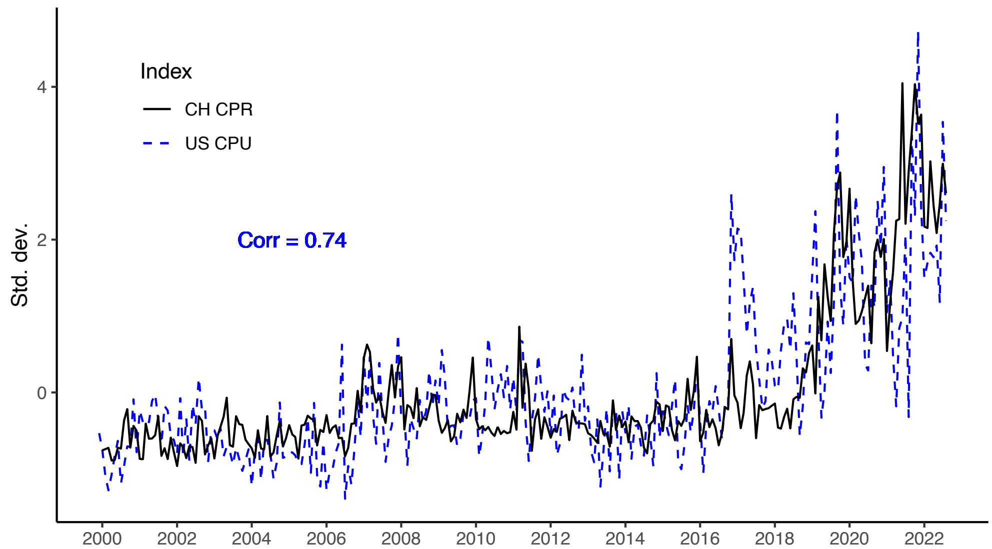
Figure A.1 Risk Factors



Note. This Figure displays the four risk factors following the methodology developed in Ammann and Steiner (2008) and summarised in Appendix A

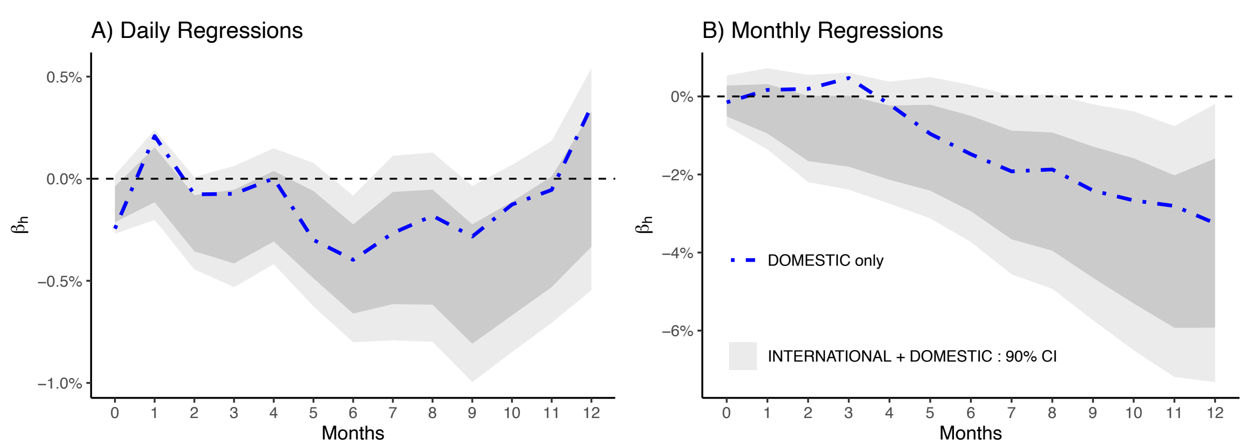
B Additional results

Figure B.1 CH Climate Policy Risk vs US Climate Policy Uncertainty



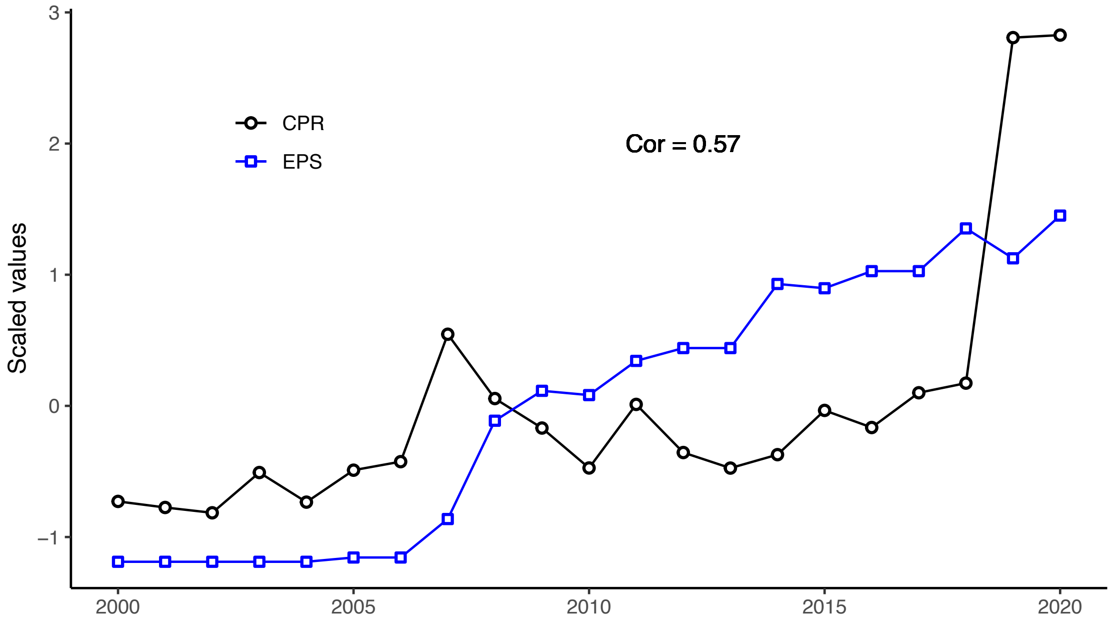
Note. This Figure compares the CH Climate Policy Risk from this paper to the US Climate Policy Uncertainty Index from Gavriilidis (2021).

Figure B.2 Robustness : Only Domestic Events



Note. The blue line depicts the coefficient from regression (6) when only relying on domestic transition risk events. The shaded grey area is the corresponding regression (alongside the 68 and 90% confidence intervals) relying on both domestic and international transition risk events.

Figure B.3 Comparison between EPS and CPR



Note. This Figure compares the Climate Policy Risk to the Environmental Policy Stringency Index from the OECD for Switzerland. To match the frequency of the OECD index, the Climate Policy Risk is aggregated at the yearly frequency by taking the mean.