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Climate Stress Test: bad (or good) news for the market? An Event Study Analysis on Euro Zone Banks

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CLIMATE STRESS TEST: BAD (OR GOOD) NEWS FOR THE MARKET? AN EVENT STUDY ANALISYS ON EURO ZONE BANKS

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Abstract

The scope of this paper is to assess the effect 2021 ECB Climate stress test on the stock prices of the banks included in the exercise. To this end, we set up an event study analysis, whereby at the relevant dates we use market data in order to test for the existence of abnormal returns. Three main results emerge from our research. First, on 18.03.2021 investors' fear arising from the details published about the methodology of the ECB climate stress test and some preliminary evidence had a negative impact on banks stock prices. Second, on the date of publication of the final results on 22.09.21, we find a positive reaction from market participants, since the market possibly expected the banks' exposure to climate risks to be greater than the one emerging from final results. Third, on the starting date of COP26, an event related to the worldwide consensus on the need to manage climate change, we find a negative effects on banks' quote that can be explained by the too tiny progresses reached by the summit, which are considered too mild and not adequate to reach the Paris Agreement goals. Finally, robustness tests including small banks not directly supervised by the ECB and banks with a business model not focused on credit intermediation, indicate that the market consider them less exposed to climate risks than larger banks. Our results may have implications in view of future climate stress tests.

Keywords: banks climate stress test, physical risk, transition risk, abnormal returns, event study

JEL : G14, G28, F55

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1. Introduction

Climate change is likely the most challenging issue the world has to face this century and, among policy reactions, the most cited is perhaps the Paris Agreement reached in December 2015 setting the ambitious aim of limiting climate change through a global response, by "keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius".[1]

Climate concerns have been receiving increasing attention in finance fostered, among other things, by the Sustainable Development Goals (SDGs) set in the 2030 Agenda by UN (2015), and the recent action plan to contrast climate change in the European Union known as Fit for 55 (European Commission, 2021a,b).

Negative impacts for all economies round the world and all economic sectors, non-financial and financial ones, are coming from both physical risks and transition risks. The definition of these two types of risk can be found e.g. in BCBS (2021a). Physical risks are represented by economic costs and financial losses resulting from the increasing severity and frequency of extreme climate change-related weather events (e.g. heatwaves, landslides, floods, wildfires, storms), longer-term gradual shifts of the climate (e.g. changes in precipitation, extreme weather variability, ocean acidification, and rising sea levels and average temperatures), and indirect effects of climate change such as loss of ecosystem services (e.g. desertification, water shortage, degradation of soil quality or marine ecology). Transition risks are related to the process of adjustment towards a low-carbon economy and include changes in public sector policies, legislation and regulation, changes in technology and changes in market and customer sentiment.

Banks are affected by climate risks via manyfold channels, whereby the two most relevant ones are the traditional risk categories, i.e. credit and market risk. In fact, banks' assets are affected in value and subject to fluctuations in connection with climate risks in the form of physical risks and/or transition risks, which are also intertwined (BCBS, 2021b). Specifically, climate risks can impact credit risk via the probability of default (PD), the loss given default (LGD) and hence the expected loss (EL), whereas market risk is mainly affected via the sensitivity of the price of securities to movements in market-risk factors due to climate risks.

Although bank regulation can in principle tackle the issue based on a prudential regulation by requiring an adequate level of capital against climate risks, the approach taken so far by supervisors and central banks to quantify exposure to climate risk has been based on climate stress tests (e.g. Bank of England, Banque de France).[2] At the moment, this is the approach taken also by the European

[1] https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[2] Consideration of climate risks could enter in the first Pillar by means of a "green supporting factor" or "brown penalty factor" in the calculation of Risk Weighted Assets, in the second Pillar with "ad hoc" capital requirements based on KPI

Central Bank in its first economy-wide climate stress test performed in 2021.

The aim of this paper is to test whether the results of the 2021 ECB climate stress test affected the market performance of the banks subject to it. Specifically, we aim to answer a set of related research questions: have market investors reacted to ECB climate stress test? If so, have bank quotes anticipated and/or reflected (expected) outcomes of this first test? Are other climate related international initiatives such as COP26 able to affect the perception of banks' climate risk exposure? To answer these questions, we set up an event study analysis, whereby at the relevant dates we have used market data in order to test for the existence of abnormal returns.

The paper is organized as follows. Section 2 briefly recalls the main features of the ECB climate stress test and the results that motivate the research in this paper. In Section 3 the Event study methodology is illustrated in terms of main steps and choices taken in the present study. While Section 4 describes the set-up of the sample, Section 5 discusses results and Section 6 presents robustness checks. Final Section concludes.

2. The 2021 ECB climate stress test

In order to assess whether the results of the 2021 ECB climate stress test affected the market performance of the banks in subject to it, it is worth recalling the main features and the results for banks of this climate stress test. It goes beyond the scope of this paper to provide a detailed description of the methodology and the results, for which we refer to Alogoskoufis et al. (2021). Rather, we focus to the main point explaining how this test may have informed participants in the stock market over the climate risk impact on banks.

The 2021 ECB climate stress test is based on a top-down approach, i.e. data, assumptions and models are developed by ECB staff, thus ensuring comparability.[3] The subjects tested are both non-financial companies and banks in the Euro area, and the impacts of physical and transition risks are jointly analysed. The time horizon is thirty years and a static budget hypothesis is adopted.[4] The dataset is very granular and it contains information on more than four million companies and over 1600 banking groups in the euro area. The model also takes into account climate risk mitigators and amplifiers, but only through assumptions regarding insurance coverage. The scenarios used are based

such as the Green Asset Ratio proposed by EBA, or in the third Pillar requiring disclosure on the exposure to physical and transition risks (Bolton et al., 2020).

[3] By contrast, bottom-up exercises are based on the self-assessments conducted internally by each bank and the results are then put together by the promoter of the climate exercise.

[4] The static balance sheet hypothesis, which in many cases is used as a simplifying hypothesis, is therefore not realistic, and will in future have to be replaced by a dynamic balance sheet hypothesis, as shown in the Banque De France climate stress test, which allows the composition of banks' assets to be changed over the time horizon of the year (Clerc et al., 2021).

on the Network for Greening the Financial System (NGFS), specifically on the three representative Phase I scenarios (NGFS, 2020): the ordered transition path (OT) is the baseline scenario taken as a reference for the other two, i.e the disorderly transition (DT) and the hot house world (HHW). The effects of these projections are mapped to bank exposures, making it possible to measure the impact of climate risks on credit institutions.

The results of the ECB's economy-wide climate stress test show that there are clear benefits in acting early and that the short-term costs of the transition are more than compensated in the medium to long term. The results also show that although the effects of climate risks would increase moderately on average until 2050 if climate change was not mitigated, they would be concentrated in certain geographical areas and sectors, especially in the mining and electricity and gas sectors, with a consequent increase in their probability of default in the short to medium term. The increase in default probabilities is also true for firms located in geographical areas that are most exposed to physical risk.

As for banks, results, which are published in aggregate form with no detail on single banks, show that for banks most exposed to climate risks the impact is potentially very significant, especially in the absence of further climate policies, and thus climate change represents a major source of systemic risk, particularly for banks with portfolios concentrated in certain economic sectors and, even more importantly, in specific geographical areas. Finally, the impact on banks' expected losses is mostly driven by physical risk and it is potentially severe. These results motivate the aim of this paper.

3. Event study methodology

The objective of the event study analysis performed in this paper is to detect the effect of the ECB 2021 climate stress test on stock returns of the EU banks, i.e. to test for the presence of abnormal returns. To this end, we follow Loipersberger (2018) event study aimed to test the effect of supranational banking supervision (SSM) on the financial sector. Main steps, detailed in the following subsections, are:

- The choice of a "normal return" model used to estimate the theoretical returns the stocks would have had in the absence of the event, the choice of the estimation window for their estimation, and the market index to be used in the estimation of normal returns;
- The events' dates, i.e. the dates where events occurred that revealed new information to investors.

3.1 The normal return model: estimation window and market index

A model for normal returns is required since abnormal returns, $AR_{i,t}$, are defined as:

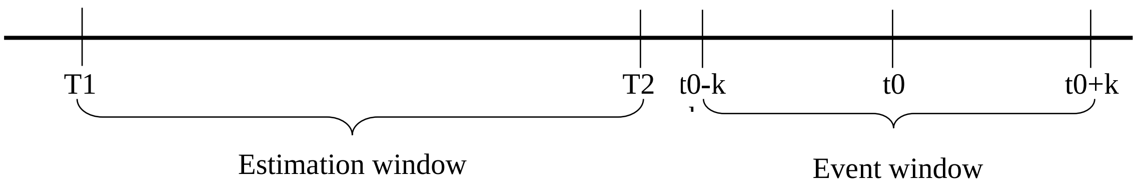
$$AR_{i,t} = R_{i,t} - NR_{i,t} \quad (1)$$

Where:

$R_{i,t}$ are market returns,

$NR_{i,t}$ are normal returns.

The latter are calculated on the event window of length ± k around the event day t0, based on the market model coefficient estimated on the estimation window [T1,T2].



Among the various models proposed in the literature (De Jong, 2007; Sorescu et al., 2017), following the event study literature on financial data (e.g. Kruger, 2015), we rest on the market model since it allows to separate the individual share's reaction to the market from its reaction to the event. The market model requires choosing a market index and estimating over the estimation window the equation:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (2)$$

whose residuals represent the abnormal returns.

As for the estimation window we take a 6-month length, since it allows to have sufficiently stable estimate and is in line with the comparable work by Loipersberger (2018). Given the event days of the present study, a longer period would be too much affected by the Covid pandemic negative effects on financial markets.[5] As for the market index, given our focus on banks of the Euro zone and in line with Loipersberger (2018) we take the Eurostoxx 50.

3.2 Event days

In relation to the ECB 2021 climate stress test three are the days that we assume being relevant: the first two characterized by official information revealed by the ECB to the market, the latter is connected to the climate concerns. Specifically, as summarized in Figure 1:

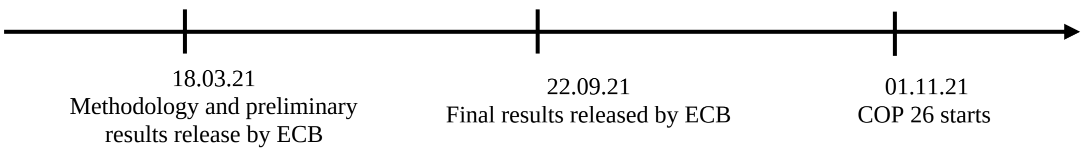
- **18.03.2021**: Luis de Guindos, Vicepresident of the ECB, communicated the framework for the economy-wide climate stress the ECB was conducting and preliminary (mainly

[5] On the whole results (in Section 5.3) are qualitatively the same although, as expected, they are much influenced by the financial market downturn characterizing the Covid period, which is completely included in the 3-year estimation window.

qualitative) results showing that, in the absence of further climate policies, the costs to companies arising from extreme weather events rise substantially, and greatly increase their probability of default. Results also show that there are clear benefits in acting early.[6]

- **22.09.2021**: ECB published final results of its economy-wide climate stress test. Results are in line with preliminary ones published in March 2021, but they are more quantitative, and detailed (e.g. over the increase in banks' default probability, expected losses, reduction in collaterals) although they are published in aggregate form and no detail on single banks is available.[7]
- **01.11.2021**: it is the starting date of COP26 in Glasgow, with China and India pushing for the language on coal to change from "phase out" to "phase down" in the deal in contrast to those who wanted a much more ambitious outcome at the conference. Although this date is not directly linked with the ECB climate stress test, the COP26 final agreement pointed to a climate risk (especially physical) level higher than expected, with a possible negative impact on banks' stocks in the Event Study Analysis. However, it has to be stressed that, since climate risks have impact not only on banks but on the economy in general, it could well be that the whole stock market has a negative performance and hence banks would not record abnormal returns.

Figure 1- Event days



4. The sample

Since the objective is to test the effect of the ECB climate stress test, only banks of the Euro area are considered. Further restrictions are set according to liquidity so as to have reliable estimates of the abnormal return, and those with missing information along the estimation window.[8] The resulting sample consists of 48 banks: Table1 reports their denomination, the country of residence, the total assets and the business model.

Since the business model may impact the abnormal returns, the main analysis will be performed

[6] https://www.ecb.europa.eu/home/search/html/stress_tests.en.html
[7] https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210922~59ade4710b.en.html
[8] As for liquidity restrictions, the minimum daily threshold is set to 5,000 units over the estimation window. As for banks with missing information they are only two: Oma Saastopankki Oyj and Nova Ljubljanska Banka dd Ljubljana).

on a more homogeneous sample in terms of exposure to climate risks, which is obtained by dropping banks with business model "asset managers and custodians" and "development/promotional lenders", and those with total asset lower than €30 billion so as to have only those banks under the direct SSM supervision.[9] Robustness analyses based on the extended sample are provided in Section 5.

The main sample resulting from the above restrictions and highlighted in bold in Table 1 consists of 33 banks: as Figure 2 shows most of them are in Italy and Spain, the great majority is Diversified lender in terms of Business model and are quite uniformly distributed in the three dimensional classes (€30-100 bn, €100-500 bn, >€500 bn).

Table 1 – Banks in the main and in the extended samples
(Main sample in Bold)

Name	*Country*	*Total Assets*	*Business model*
BAWAG Group AG	**AUT**	**54,370**	**Diversified lender**
Erste Bank	**AUT**	**309,240**	**Diversified lender**
Raiffeisen Bank International AG	**AUT**	**190,610**	**Diversified lender**
KBC Groep NV	**BEL**	**354,336**	**Diversified lender**
Bank Of Cyprus Holdings PCL	CYP	24,551	Diversified lender
Hellenic Bank	CYP	18,675	Diversified lender
Aktia Bank Abp	FIN	11,374	Asset manager and custodian
Nordea Bank Abp	**FIN**	**614,509**	**Universal and investment bank**
Bank of Aland PLC	FIN	6,353	Universal and investment bank
Evli Pankki Oyi	FIN	752	Asset manager and custodian
BNP Paribas SA	**FRA**	**2,725,667**	**G-sib**
Credit Agricole SA	**FRA**	**2,090,500**	**G-sib**
Societe Generale SA	**FRA**	**1,526,354**	**G-sib**
Commerzbank AG	**GER**	**541,258**	**Diversified lender**
Deutsche Bank AG	**GER**	**1,326,058**	**G-sib**
Deutsche Pfandbriefbank AG	GER	58,833	Development/promotional lender
Aareal Bank	**GER**	**46,751**	**Corporate/wholesale lender**
Umweltbank AG	GER	4,944	Corporate/wholesale lender
Alpha Bank SA	**GRE**	**73,075**	**Diversified lender**
Attica Bank SA	GRE	3,504	Corporate/wholesale lender
EFG Eurobank Ergasias	**GRE**	**73,374**	**Diversified lender**
National Bank of Greece SA	**GRE**	**81,610**	**Diversified lender**
Piraeus Bank SA	**GRE**	**75,421**	**Corporate/wholesale lender**
AIB Group PLC	**IRL**	**122,888**	**Diversified lender**
Bank of Ireland Group PLC	**IRL**	**149,932**	**Retail lender and consumer credit lender**
Permanent TSB Group Holdings PLC	IRL	21,504	Retail lender and consumer credit lender

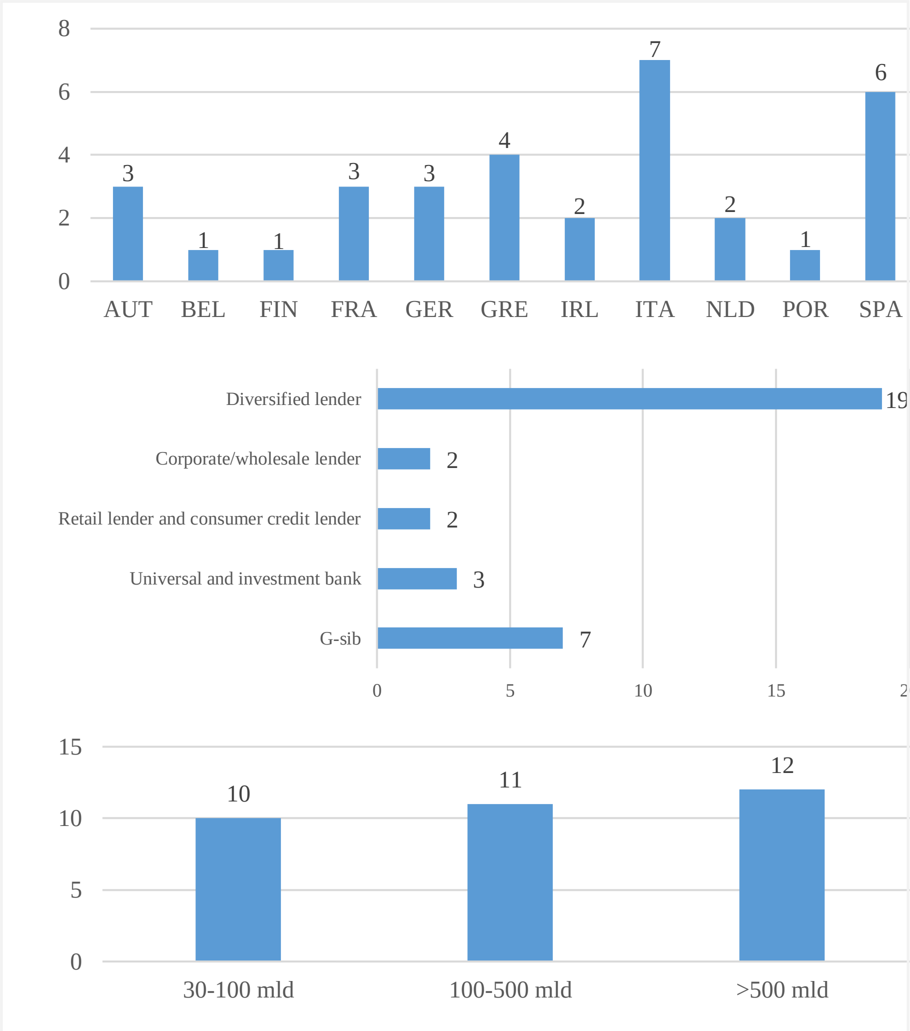
[9] Although this is not the only criterion used to classify banks for SSM supervision, we use it as a good proxy to distinguish between Significant and Less Significant banks. The issue is discussed when testing robustness to the sample in relation to banks' asset in Section 5.1.

Banca Popolare di Sondrio ScpA	**ITA**	**53,334**	**Diversified lender**
Banco Bpm SpA	**ITA**	**196,781**	**Diversified lender**
Banco Desio SpA	ITA	17,699	Diversified lender
Bper Banca SpA	**ITA**	**134,174**	**Diversified lender**
Credito Emiliano SpA	**ITA**	**66,793**	**Universal and investment bank**
Illimity Bank SpA	ITA	4,331	Corporate/wholesale lender
Intesa Sanpaolo SpA	**ITA**	**1,071,418**	**Universal and investment bank**
Mediobanca Banca di Credito Finanziario SpA	**ITA**	**85,555**	**Diversified lender**
UniCredit SpA	**ITA**	**948,584**	**G-sib**
Banca Mediolanum SpA	ITA	67,554	Asset manager and custodian
FinecoBank Banca Fineco SpA	ITA	33,534	Asset manager and custodian
Banca Generali	ITA	15,579	Asset manager and custodian
Banca IFIS SpA	ITA	12,769	Corporate/wholesale lender
ABN AMRO Group NV	**NLD**	**417,026**	**Diversified lender**
ING Groep NV	**NLD**	**988,751**	**G-sib**
Banco Comercial Portugues SA	**POR**	**91,463**	**Diversified lender**
Banco Bilbao Vizcaya Argentaria SA	**SPA**	**651,834**	**Diversified lender**
Banco de Sabadell SA	**SPA**	**249,922**	**Diversified lender**
Banco Santander	**SPA**	**1,578,295**	**G-sib**
Bankinter	**SPA**	**102,469**	**Diversified lender**
CaixaBank S.A.	**SPA**	**685,737**	**Diversified lender**
Unicaja Banco SA	**SPA**	**109,144**	**Retail lender and consumer credit lender**

Data source Bloomberg

Notes: Data in million, Business Model according to Supervisory Banking Statistics according to 3rd Q statements (ECB, 2021). In bold banks in the main sample.

Figure 2 – Distribution by country, business model and total asset



5. Results

Based on daily data, a 6-month estimation window (non overlapping with the event windows) to estimate normal return according to the market model in (2), the cumulative average abnormal return over the period +/- k from the event date (t_0) are:

$$CAAR_{t_0+/-k} = \sum_{t=t_{0-k}}^{t_0+k} AAR_t \tag{3}$$

where

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \tag{4}$$

AAR_t is the average abnormal return over the sample of N = 33 banks,

k=1,3,5,10.

The event windows of +/-1,3,5 days are chosen in line with Loipersberger (2018), and the widest range of +/-10 days is taken so as to test the robustness of the results.

The null hypothesis is tested against the alternative of cumulative average abnormal return statistically different form zero, i.e.:

$$\begin{cases} H_0: E(CAAR_{i,t}) = 0 \\ H_1: E(CAAR_{i,t}) \neq 0 \end{cases} \tag{5}$$

Four different testing procedures are employed, whereby the four tests are meant to provide an increasing order of conservativeness. First of all, a simple cross-sectional T-test, which serves as a benchmark case, is performed. Second, in order to cope with the assumption behind the T-test of i.i.d. abnormal returns, which is known to be contradicted by data since e.g. Fama (1976), abnormal returns are standardized based on their historical time-series variance, to get the Standardized Abnormal Return (SAR) and the Z-score SAR test is constructed. Third, the Z-score Boehmer test is employed, based on cumulative average returns standardized with the cross-sectional variance: it is a test developed by Boehmer et al. (1991) that is robust to so-called event-induced variance, i.e. when the event itself changes the variance of the distribution of stock returns and it should be more conservative when the event increases the variance. Finally, although the test has problems in testing CAR (Kolari and Pynnonen, 2011), a nonparametric rank test proposed by Corrado (1989) is applied, in line with many research paper adopting event studies.

Details on the three alternatives to the T-test are given in the Appendix.

Results for the three event dates, reported in Table 2, are discussed in the following subsections.

Table 2 – Statistical significance of CAARs at the three event dates

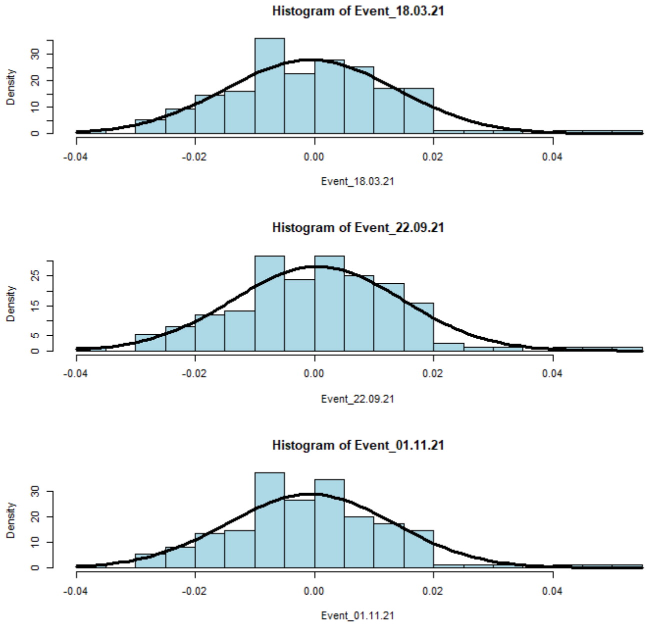
Window	+/-10 days	+/-5 days	+/-3 days	+/-1 day	Event day
18.03.21					
CAAR	-8.80%	-2.15%	-2.50%	-1.48%	-0.41%
T-Test	-4.9599***	-1.6157*	-2.4610***	-0.9526	-0.5216
Z-score SAR Test	-20.5133***	-3.9275***	-4.9035***	-0.9902	0.3704
Z-score Boehmer Test	-6.5248***	-1.6553**	-2.7823***	-0.4607	0.3095
Corrado Rank Test	1.0785	0.0274	0.3214	-0.1850	-0.5033
22.09.21					
CAAR	8.63%	6.43%	2.81%	-1.08%	0.79%
T-Test	6.5587***	6.3787***	3.6426***	-1.9780**	3.0633***
Z-score SAR Test	23.8657***	17.6189***	7.9409***	-1.8486**	2.3869***
Z-score Boehmer Test	6.9479***	7.4101***	4.7566***	-1.7179**	4.4909***
Corrado Rank Test	-1.7815**	-1.7222**	-0.9443	0.3349	-0.8966
01.11.21					
CAAR	-9.31%	-5.25%	-4.48%	-1.38%	0.25%
T-Test	-7.4839***	-6.5974***	-6.6833***	-3.0073***	1.2547
Z-score SAR Test	-23.0039***	-12.6417***	-11.3036***	-2.9882***	0.8670
Z-score Boehmer Test	-7.4903***	-5.6817***	-5.9931***	-2.7042***	1.7673**
Corrado Rank Test	1.1380	0.9485	1.1592	0.3118	-0.4835

Notes: *** <1%, ** <5%, * <10%

5.1 Event date 18.03.21

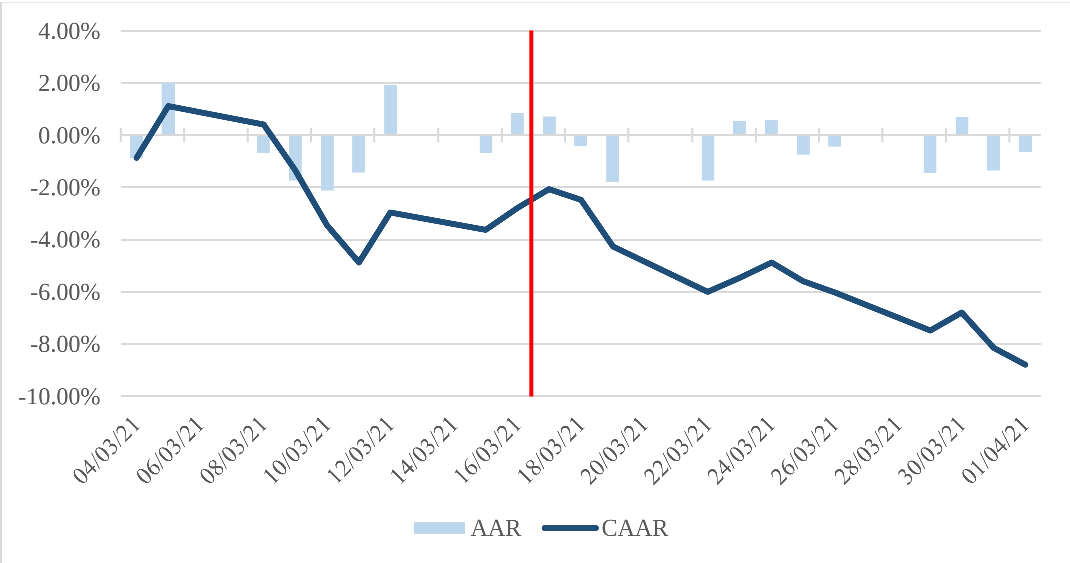
On the day the methodology and some preliminary result were announced, the market negatively reacts to the news from the day after the announcement. In fact, the CAARs are negative and more so as the event window length becomes broader, and they are highly significant from a +/-3 days (-2.50%) up to +/-5 days (-2.15%) and +/-10 days (-8.80%). To be noted that Corrado rank test, based on more stringent assumptions, is the only non significant one. However, the rank test may be too conservative and significant results of other tests based on normality appear to be sufficiently sound given the AAR distribution (Figure 3).

Figure 3 – AARs empirical distribution



The negative market reaction is highlighted by Figure 4 plotting the AARs and CAARs over time and showing a clear downward trend of CAARs, given that negative AARs are not as frequent as the positive ones in the period under observation.

Figure 4 – AARs and CAARs (18.03.21)



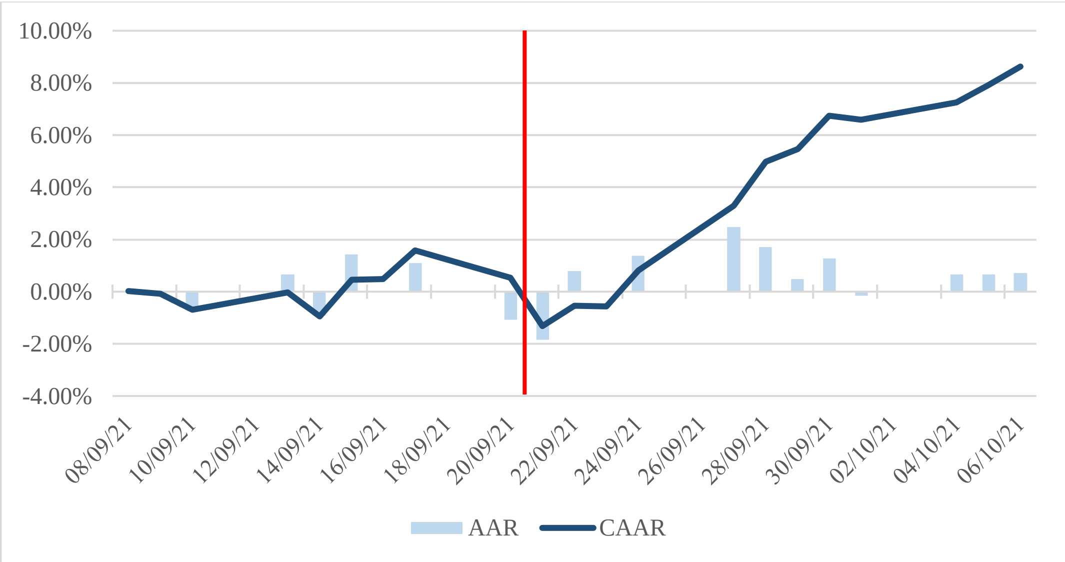
In sum, investors' fear arising from the details about the ECB climate stress test methodology and preliminary evidence have negatively impacted on the stock prices of the banks included in the exercise.

5.2 Event date 22.09.21

When ECB published final results of its economy-wide climate stress test, investors had an optimistic reaction with the CAARs that are positive and significant according to any test, except for the +/-1 day window with a decrease of -1.08%. Specifically, the CAAR on the event date is +0.79%, and increases as the event window becomes wider: +2.81% at +/-3 days, + 6.43% at +/-5 days, +8.63% at +/-10 days.

Figure 5 displays daily AARs and CAARs, highlighting a first positive market reaction in the very same day of publication. Reactions remain positive in the following days CAARs have a clear upward trend.

Figure 5 - AARs and CAARs (22.09.21)



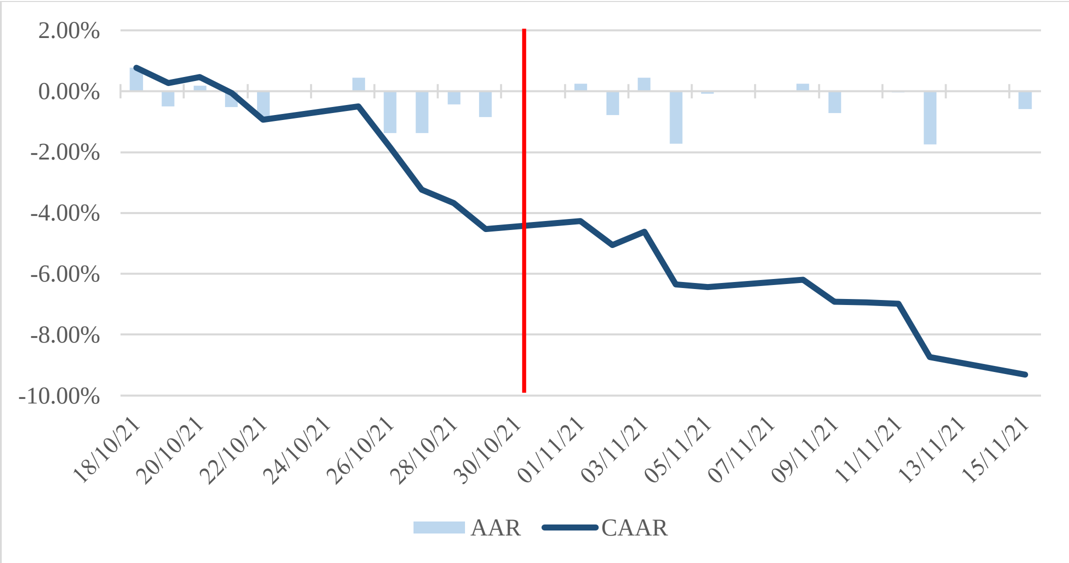
To interpret these results, recall that the outcomes the ECB climate stress test published on 22.09.21 were overall not really positive, pointing to transition costs in the short term, compensated only in the long term, and a higher exposure of significant banks to climate risk. Hence the positive market reaction has to be interpreted as a positive surprise for investors, who had likely expected a higher exposure to climate risk and more negative impacts, especially after the information received on 18.03.21. In fact, following the communication by the Vicepresident of the ECB, Luis de Guindos, not only they became aware of the climate stress test but they also obtained qualitative information about the banking system exposure to it. In other words, the negative piece of news was with preliminary information and not with the final outcome, which, has to be stressed, was given only at an aggregate level.

5.3 Event date 01.11.21

The COP26 event produced a small positive reaction (+0.57%), significant only according to Boehmer test, only on the very same event date. Over the other event windows CAARs are negative and significant: -1.38% at +/1 day, -4,48% at +/- 3 days, -5.25% at +/- 5 days and -9.31% at +/- 10 days.

From Figure 6 it is apparent that CAARs start becoming negative before the beginning of COP26, likely because of anticipations about China and India critical on too ambitious goals.

Figure 6 - AARs and CAARs (01.11.21)



The negative effects on banks' quote can be explained by the progresses reached by COP26 that are considered too mild and not adequate to reach the Paris Agreement goals. As a consequence, the "hot house world" scenario might have been considered as more likely with respect to an "orderly transition" scenario.

6. Robustness

Robustness tests are performed in two main directions. First, some of the assumptions to make the sample more homogeneous are relaxed so that the sample is extended both in relation to the bank dimension (Section 5.1) and to the bank business model (Section 5.2). Second, we test robustness of results against a different length of the estimation window (Section 5.3).

6.1 Sample including smaller banks

We set up a sample starting from the one represented in Table 1 dropping the restriction of assets above €30 billion. The restriction is set in order to have only those banks under the direct SSM supervision, but dimensionality is not the only criterion that implies falling under the SSM supervision. In fact, two Cypriot banks, Bank of Cyprus Holdings PLC and Hellenic Bank, are under SSM supervision since their assets are larger than 20% of the country GDP.

The comparison is performed without and with normalization in terms of sample β. In fact, the extended sample has a lower β than the baseline one (1.30 vs. 1.44). In order to normalize CAAR of the extended sample, we use:

$$\widehat{CAAR}_t = CAAR_{t,extended} \cdot (1 + \beta_{baseline} - \beta_{extended}) \qquad (6)$$

Results are summarized in Table 3: for reasons of space only statistical significance from the Boehmer test for CAARs extended are shown. To be noted that from previous analyses the Boehmer test results to be the most appropriate. Overall results show that the effect on CAARs are the same in terms of sign and significance at all the three dates. However, the magnitude of the reaction is higher in absolute term when the reaction is negative, and smaller when the reaction is positive. A possible interpretation is that market believes smaller banks are less able to face and manage climate risks, possibly also because of a less direct ECB supervision.

Table 3 - CAARs comparison: baseline sample, extended sample, extended sample normalized

Window	+/-10 days	+/-5 days	+/-3 days	+/-1 day	Event day
18.03.21					
CAAR baseline	-8.80%	-2.15%	-2.50%	-1.48%	-0.41%
CAAR extended	-8.24%	-2.34%	-2.64%	-1.62%	-0.51%
CAAR extended normalized	-9.42%	-2.68%	-3.02%	-1.85%	-0.59%
Z-score Boehmer Test	-5,4605***	-1,3073*	-2,7256***	-1,2294	-0,7609
22.09.21					
CAAR baseline	8.63%	6.43%	2.81%	-1.08%	0.79%
CAAR extended	5.68%	4.79%	2.26%	-1.11%	0.65%
CAAR extended normalized	6.50%	5.47%	2.59%	-1.27%	0.75%
Z-score Boehmer Test	2,9759***	4,0729***	3,1588***	-2,1371**	3,1525***
01.11.21					
CAAR baseline	-9.31%	-5.25%	-4.48%	-1.38%	0.25%
CAAR extended	-8.49%	-4.94%	-4.08%	-1.42%	0.19%
CAAR extended normalized	-9.70%	-5.65%	-4.66%	-1.62%	0.21%
Z-score Boehmer Test	-6,4146***	-4,7368***	-4,5418***	-3,4535***	0,6332

Notes: *** <1%, ** <5%, * <10%

6.2 Sample including other business models

Although in this case betas are more similar, we perform the analysis on both the CAAR BM extended and the CAAR BM extended normalized. Results are summarized in Table 4: for reasons of space only statistical significance from the Boehmer test for CAARs BM extended are shown. To be noted that from previous analyses the Boehmer test results to be the most appropriate.

Overall the effect is slightly lower in magnitude and in a few cases less significant. These results are consistent with expectations, since the banks added are, because of their different business model, less exposed to climate risk typical of lenders and hence less affected by climate related events.

Table 4 – CAARs comparison: baseline sample, BM extended sample, BM extended sample normalized

Window	+/-10 days	+/-5 days	+/-3 days	+/-1 day	Event day
18.03.21					
CAAR baseline	-8,80%	-2,15%	-2,50%	-1,48%	-0,41%
CAAR BM extended	-8,08%	-2,02%	-2,13%	-1,13%	-0,28%
CAAR BM extended normalized	-8,84%	-2,21%	-2,33%	-1,24%	-0,31%
Z-score Boehmer Test	-5,2151***	-1,1423	-2,0814**	-0,1045	0,2798
22.09.21					
CAAR baseline	8.63%	6.43%	2.81%	-1.08%	0.79%
CAAR BM extended	7.42%	5.57%	2.52%	-0.62%	0.88%
CAAR BM extended normalized	8.12%	6.10%	2.76%	-0.68%	0.97%
Z-score Boehmer Test	5,1096***	5,6376***	4,1705***	-0,3113	4,2247***
01.11.21					
CAAR baseline	-9.31%	-5.25%	-4.48%	-1.38%	0.25%
CAAR BM extended	-8.57%	-4.72%	-4.36%	-1.43%	0.30%
CAAR BM extended normalized	-9.39%	-5.17%	-4.77%	-1.56%	0.33%
Z-score Boehmer Test	-5,2883***	-4,1686***	-5,8387***	-3,7816***	1,9390**

Notes: *** <1%, ** <5%, * <10%

6.3 Longer estimation window

In the main analysis we take a 6-month length estimation window, since it allows to have sufficiently stable estimates and is in line with the comparable work by Loipersberger (2018). Moreover, we expect a longer period to be affected by the Covid pandemic negative effects on financial markets. The estimation window taken in the present robustness test is a 3-year one.

Results are reported in Table 5. On the whole, they are qualitatively the same although, as expected, they are much influenced by the financial market downturn characterizing the Covid period, which is completely included in the 3-year estimation window. Specifically, when the reaction is negative (18.03.21 and 01.11.21) the CAARs are less negative in terms of magnitude and less significant, given the lower levels of normal returns when they are estimated over a period encompassing the negative Covid effects on financial markets. By contrast, when the reaction is positive, the CAARs are higher and more significant.

Table 5 – Three-year estimation window

Window	+/-10 days	+/-5 days	+/-3 days	+/-1 day	Event day
18.03.21					
CAAR	-2.91%	0.41%	-0.94%	-0.86%	-0.10%
T-Test	-1.4722*	0.2786	-0.8666	-0.5412	-0.1237
Z-score SAR Test	-7.1901***	2.0651**	-1.5743*	0.6352	1.4611*
Z-score Boehmer Test	-1.9784**	0.7607	-0.7569	0.2667	1.0868
Corrado Rank Test	0.5507	-0.4249	0.0836	-0.4870	-0.8656
22.09.21					
CAAR	12.13%	8.28%	4.28%	0.23%	1.24%
T-Test	11.3916***	8.6668***	5.8853***	0.4467	4.8112***
Z-score SAR Test	36.0622***	24.8246***	13.1780***	1.6920**	3.8348***
Z-score Boehmer Test	10.6918***	9.5473***	6.9893***	1.3205*	6.5473***
Corrado Rank Test	-2.8758***	-2.5141***	-1.5137*	-0.2931	-1.4400*
01.11.21					
CAAR	-4.31%	-2.38%	-2.62%	-0.51%	0.57%
T-Test	-4.6630***	-3.3124***	-4.0553***	-1.1105	2.8182**
Z-score SAR Test	-11.9049***	-6.0931***	-7.1227***	-0.8206	1.9130**
Z-score Boehmer Test	-4.3875***	-2.7517***	-3.7581***	-0.6387	3.2399***
Corrado Rank Test	0.7049	0.5891	0.9192	0.0704	-0.7615

Notes: *** <1%, ** <5%, * <10%

Conclusions

Climate change is likely the most challenging issue to be faced in this century also by financial institutions and at no surprise the ECB has engaged in many supervisory actions. First, in order to foster a homogeneous climate risk management approach lacking so far among banks, the ECB has published its supervisory expectations on the management of climate risks (ECB, 2020). Moreover in 2021, its first economy-wide climate stress test was implemented in order to assess the resilience of non-financial companies and euro area banks to transition and physical risk under climate policy scenarios. Given the relevance this type of tests may have in the future also in terms of regulatory requirements for banks, an impact on banks market value was in principle to be expected.

The scope of this paper is to assess the market reaction to the results of the climate stress test on banks by answering a set of related research questions: have market investors reacted to 2021 ECB climate stress test? If so, have bank quotes anticipated and/or reflected (expected) outcomes of this first test? Given that information was released in two steps, i.e. first preliminary (March 2021) then final information (September 2021), was the reaction alike? Was an important climate related initiative such as COP26 (November 2021) also bearing information to the market? To answer these questions, we set up an event study analysis, whereby at the relevant dates we have used market data in order to test for the existence of abnormal returns.

A few main results emerge from our research. First, on 18.03.2021 investors' fear arising from the details about the methodology of the ECB climate stress test and some preliminary evidence have negatively impacted the stock prices of the banks included in the exercise. Second, on the date of publication of the final results on 22.09.21, the evidence shows a positive reaction from market participants, which can be due to the market having had a positive surprise, i.e. after the release of the information in March, the market expected the banks' exposure to climate risks to be greater than the one emerging from final results published in November. Third, on the starting date of COP26, an event related to the worldwide consensus on the need to manage climate change, we find a negative effects on banks' quote that can be explained by the too tiny progresses reached by COP26, which are considered too mild and not adequate to reach the Paris Agreement goals. Finally, robustness tests including small banks not directly supervised by the ECB and banks with a business model not focused on credit intermediation, indicate that the market consider them less exposed to climate risks than larger banks.

Our results may have policy implications for future stress tests. First, the way information is released is relevant especially if it is provided to the public in one or more steps and, in the latter case, the consistency between the various pieces of information may determine different market reactions. Second, information on an issue such as the climate change, which is shared worldwide, comes also from the message conveyed by initiatives proving the success (or not) of the cooperation among countries all over the world.

Appendix A - Statistical tests on Cumulative Average Abnormal Returns (CAARs): alternatives to T-test

A.1 Standardized abnormal return (SAR test)

In order to cope with the assumption behind the T-test of i.i.d. abnormal returns, which is known to be contradicted by data since e.g. Fama (1976), abnormal returns are standardized based on their historical variance, to get the Standardized Abnormal Return (SAR)

$$SAR_{i,t} = \frac{AR_{i,t}}{\widehat{s_i}} \qquad \text{(A1)}$$

and then the Average Standardized Abnormal Return (ASAR) as:

$$ASAR_t = \frac{1}{N}\sum_{i=1}^{N} SAR_{i,t} = \frac{1}{N}\sum_{i=1}^{N} \frac{AR_{i,t}}{\widehat{s_i}} \qquad \text{(A2)}$$

In our study we are interested to Cumulative Standardized Abnormal Return (CSAR).

CASAR (Cumulative Average Standardized Abnormal Return) is:

$$CASAR_{t_0 \pm k} = \frac{1}{N} \cdot \sum_{i=1}^{N} CSAR_{i,t_0 \pm k} \qquad \text{(A3)}$$

And the Z-statistic is:

$$Z = \sqrt{N} \cdot CASAR_{t_0 \pm k} \approx N(0,1) \qquad \text{(A4)}$$

A.2 Boehmer test

In the presence of a possible event-induced variance, i.e. when the event itself changes the variance of the distribution of stock returns, the variance estimated prior to the event may underestimate the event window variance, the T-statistic will tend to be bigger and to reject the null too often. To cope for this, the Z-score Boehmer test is employed: it is a test developed by Boehmer et al. (1991) that is robust to the event-induced variance, and it should be more conservative when the event increases the variance.

Boehmer et al. (1991) propose to calculate CASAR as in (A3) and to calculate the T-statistic as:

$$T = \frac{CASAR_{t_0 \pm k}}{S_{t_0 \pm k}/\sqrt{N}} = \sqrt{N} \cdot \frac{CASAR_{t_0 \pm k}}{S_{t_0 \pm k}} \qquad \text{(A5)}$$

where

$$S_{t_0 \pm k} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(CSAR_{i,t_0 \pm k} - CASAR_{t_0 \pm k})^2} \qquad \text{(A6)}$$

This statistic accounts for non i.i.d. abnormal returns and it is robust to event-induced variance.

A.3 Corrado rank test

Corrado rank test is a nonparametric rank test proposed by Corrado (1989), which has the advantage of not relying on any distributional assumptions by contrast to the normality assumption behind the T-test. Moreover, with respect to the latter, the rank test is less affected by the event-induced variance.

The test requires ranking abnormal return from the biggest to the smallest over the whole time span, including both the estimation and the event window. The rank of each abnormal return is then normalized to construct the K-statistic:

$$K_{i,t} = \frac{rank(AR_{i,t})}{L_1+L_2} \quad \text{(A7)}$$

where L_1 and L_2 are the number of days of the estimation window and the event window respectively. The K-statistics è uniformly distributed, under the assumption that abnormal return in the event period do not differ from those in the estimation period. The cross-section mean is:

$$\bar{K}_t = \frac{1}{N}\sum_{i=1}^{N} K_{i,t} \quad \text{(A8)}$$

and the statistic test is:

$$T_{rank} = \sqrt{(t_{0+k}) - (t_{0-k}) + 1} \cdot \frac{\bar{K}_{t_{o-k},t_{0+k}} - 0.5}{S_{\bar{K}}} \approx N(0,1) \quad \text{(A9)}$$

where $[(t_{0+k}) - (t_{0-k}) + 1]$ is the number of days in the window $[t_{0-k}; t_{0+k}]$ and $\bar{K}_{t_{o-k},t_{0+k}}$ the mean of the statistic $\bar{K}_t$ in the event window $[t_{0-k}; t_{0+k}]$, with $k = \{0,1,3,5,10\}$, and $S_{\bar{K}}$ is the variance of $\bar{K}_t$ on the whole period, and 0.5 is the expected value of $\bar{K}_t$, since under the null it is uniformly distributed:

$$S_{\bar{K}} = \sqrt{\frac{1}{L_1+L_2} \cdot \sum_{t=T_1}^{t_{0+10}} (\bar{K}_t - 0.5)^2} \quad \text{(A10)}$$

Although the statistic test (A9) is also based on the central limit theorem, with respect to the T-test, convergence to the normal distribution is faster, especially in the presence of fat tails. Thus, in small sample the rank test is more reliable.

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