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Article

Impact of green bond issues on Euronext firms' stock abnormal returns

Marcos Pereira[1], Luís Gomes[2,*], Isabel Maldonado[3], Cláudia Pereira[2]

[1] Porto Accounting and Business School, Polytechnic of Porto, 4465-004 S. Mamede de Infesta, Portugal
[2] Centre for Organisational and Social Studies, Porto Accounting and Business School, Polytechnic of Porto, 4465-004 S. Mamede de Infesta, Portugal
[3] Research on Economics, Management and Information Technologies, Governance, Competitiveness, and Public Policies, Centre for Organisational and Social Studies, Porto Accounting and Business School, Polytechnic of Porto, 4465-004 S. Mamede de Infesta, Portugal
*** Corresponding author:** Luís Gomes, pgomes@iscap.ipp.pt

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Abstract: Climate change is forcing countries to take strategic measures to reduce the negative impact on future generations. In this context, sustainable finance has played a key role in sustainable development since the establishment of environmental, social and governance principles. The underlying market has developed rapidly since its inception, with green bonds being the most prominent instrument. This article aims to study the impact of green bond issues on the abnormal stock returns of stocks listed on the main Euronext indices. The sample includes 58 issues carried out between 2014 and 2022 by 21 different firms listed on the AEX (Netherlands), BEL 20 (Belgium), CAC 40 (France), ISEQ 20 (Ireland), OBX (Norway) and PSI (Portugal) indices. The methodology follows the procedures of the event study using the market model. The results show significant positive stock price reaction on the issue date. After the abnormal losses just before the issues, suggesting the reserves of this consolidating market, abnormal gains persisted for over a week, providing evidence against the weak efficiency Euronext's financial markets. The findings are useful for policy makers and entrepreneurs to promote innovative initiatives that encourage the financing and development of environmentally sustainable infrastructures.

Keywords: green bonds; sustainability; event study; abnormal returns; price reaction; Euronext

1. Introduction

Climate change is one of the most sensitive and debated topics in current research. According to the World Bank (https://climateknowledgeportal.worldbank.org/overview), the climate has changed dramatically in recent decades and this trend is expected to continue in the next few years. These changes are mainly due to the emission of greenhouse gases—the main cause of global warming—the burning of fossil fuels and deforestation. According to the European Commission, climate change is visible all over the world. The polar ice caps are melting as temperatures rise, and extreme weather events are becoming more frequent, with heavy rainfall contrasting with heat waves and extreme drought.

Tackling climate change is a priority shared by most countries. The United Nations Environment Programme (https://www.unep.org/news-and-stories/story/10-ways-you-can-help-fight-climate-crisis) (UNEP) has highlighted some initiatives to involve ordinary people in solving the climate crisis: *"spread the word, keep up the political pressure, transform your transport, rein in your power use, tweak your diet, shop local and buy sustainable, don't waste food, dress (climate) smart, plant trees and focus on planet-friendly investments"*. Sustainable investing is linked to

sustainable finance, which is the allocation of capital that takes into account environmental, social and governance (ESG) factors.

Sustainable bonds (SB) are an example of sustainable financial instruments, representing securities whose capital can only be used to finance sustainable investments. Considering that green bons (GB) represent the most traded SB, this article aims to understand how the financial markets react to the issuance of this type of security. More specifically, the main objective is to study the impact of the GB issues on the abnormal returns (AR) of the involved firms listed on the Euronext stock indices. This choice was motivated by the size and importance of the Euronext platform. In December 2021, Euronext had nearly 2000 listed issuers worth 6.9 trillion euros in market capitalisation. In addition, this platform is the largest center for debt and funds listings in the world, providing technology and managed services to third parties.

Using the event study, the procedure follows the methodology of Mackinlay (1997) to determine AR and statistical tests based on the market model developed by Sharpe (1963). The study also uses the methodology of Beaver (1968) to determine the stock price reaction to the GB issue. The sample data was collected from the Euronext database, which contains all GB issues of the firms listed on the respective stock indices: AEX (Netherlands), BEL 20 (Belgium), CAC 40 (France), ISEQ 20 (Ireland), OBX (Norway) and PSI (Portugal). The research found 58 GB issues between 19 May 2014 and 23 December 2022, carried out by 21 different firms.

This article relies on a topical issue of financial research which empirical evidence is still scarce. The results of this study suggest a significant positive stock price reaction on the day of the GB issue, the maintenance of abnormal gains for about a week afterwards and, consequently, evidence against the weak form of efficiency of the Euronext financial markets.

The study's innovative perspective provides useful insights for policy makers and entrepreneurs: these markets value successful GB issues, highlighting the abnormal returns to investors and the effectiveness of policies to fund the development infrastructure that is environmentally friendly.

The structure is divided into five sections, beginning with the Introduction, which frames the topic and presents the work. Section 2 focus on green financial flows, highlighting international guidelines and standards, and identifying green bonds as a type of sustainable bond. Section 3 frames the study of events and identifies some empirical evidence on the subject. Section 4 identifies the research objectives, presents the sample and describes the empirical methodology. Section 5 presents the results and discussion. Finally, the conclusions of the study are summarised.

2. Green financial flows: Guidelines and international standards

The financial sector has strengthened its role in accelerating the transition to sustainability and climate neutrality (Maltais and Nykvist, 2020). This has been driven by the need to efficiently finance large-scale investments to meet the climate goals of the Paris Agreement and the UN Sustainable Development Goals (SDGs) (OECD/IEA and IRENA, 2017; UNEP, 2015).

In recent years, there has been a growing demand from institutional investors,

mainly from OECD countries, for investment opportunities that i) mitigate the risks arising from climate change, ii) generate social impact and iii) support sustainable development. This has led to a number of initiatives such as the Principles for Responsible Investment (https://www.unpri.org/), the Global Investor Statement on Climate Change (https://theinvestoragenda.org/) and the GB funds. The emergence of green bonds has been recognised by the UN as *"one of the most significant developments in the financing of low-carbon, climate-resilient investment opportunities"* (SBN, 2018).

Internationally, the Green Bond Principles (GBP) are the main benchmark for GB issuance, resulting from an initiative by the International Capital Market Association (ICMA) to promote integrity and transparency in the market through recommended guidelines (https://www.icmagroup.org/green-social-and-sustainability-bonds/): *"use of proceeds, process for project evaluation and selection, management of proceeds and reporting"*. The GBP were introduced in January 2014 and set out management processes for the use of revenue and for the work of independent auditors in the context of environmental credentials and reporting practices. The platform has also published the Social Bond Principles (SBP) and the Sustainability Bond Guidance (SBG). The SBPs differ in the categories eligible for funding, which are targeted at projects with social benefits, namely basic infrastructure, job creation, guaranteed food production and poverty alleviation (SBN, 2018).

Other active initiatives aim to ensure that the financial sector contributes to achieving sustainability, such as the United Nation's Principles for Responsible Investment and the Financial Stability Board's Task Force on Climate-related Financial Disclosures. In addition, the European Commission's ongoing Action Plan on Sustainable Finance includes the development of legislative proposals to facilitate the movement of capital for sustainable investments. Two key elements of the plan are the development of a taxonomy of sustainable economic activities and the establishment of standards for sustainable financial products (EC, 2018, 2019).

2.1. Sustainable bonds

Since the outbreak of the first industrial revolution in the United Kingdom at the end of the 18th century, the world has seen a number of changes, particularly in industry. The underlying development has improved the quality of life for people in general (Hobsbawm, 1979). However, this rapid and unsustainable development has led to serious environmental problems.

The emergence of various concerns about this problem has led to adjustments, including in the area of finance. More recently, sustainable finance has emerged, which, according to the European Commission (https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en), is characterised by investment decisions that take ESG factors into account: (i) environmental factors can include biodiversity conservation, pollution prevention or the circular economy; (ii) social factors can involve issues of inequality, inclusion, investment in human capital or even issues such as human rights; (iii) governance factors from public and private institutions play a key role in integrating social and

environmental considerations into the decision-making process.

Unlike conventional bonds, SBs are instruments for financing sustainable investments that bring environmental and socio-economic benefits (Mathew and Sivaprasad, 2022). There are currently four different types of SB: green bonds, social bonds, sustainability bonds and sustainability-linked bonds. The first three are dedicated to funding environmental and socio-economic projects, while the latter are not project-specific, although the issuing organisation must commit to achieving environmental or social targets within a specified timeframe (Mocanu et al., 2021).

2.2. Green bonds

GBs are a relatively new financial instrument, similar to conventional bonds, for financing firms that want to implement environmentally sustainable projects (Bhutta et al., 2021). According to ICMA (2021), *"Green bonds are any type of bond instrument where the proceeds or an equivalent amount will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible green projects"*. These bonds are therefore a component of green finance, which aims to internalise environmental externalities and adjust risk perceptions to attract environmentally friendly (Ehlers and Packer, 2017) and sustainable investments. In turn, these investments are related to mitigating climate change or strengthening resilience to other environmental challenges.

GBs can offer several benefits to issuers and investors (Flammer, 2020). For the former, the increase in the base of socially responsible investors and the reputation enhanced by positive publicity stand out. For the latter, the opportunity to invest capital in sustainable activities with a risk-return profile more comparable to traditional securities stands out. In addition, GBs introduce an element of transparency, ensuring that funds are used for green assets and providing investors with assurances about the issuers' governance processes.

The GB market began in 2008 with multilateral development banks and has diversified with the entry of new issuers in new regions (Flammer, 2020; Hachenberg and Schiereck, 2018), particularly since 2015 following the Paris Agreement. The market is currently led by public sector issuers, through municipalities, state agencies or development banks, although the share of the private corporate sector is growing.

According to data from NORDEA (2023), between 2018 and the first quarter of 2023, GB accounted for the majority of SB share, rising to 50% in 2020. In 2022, almost USD$bn 1000 was issued across all SBs, of which 50% was exclusive to GB issues. SB emissions grew strongly until 2021, coinciding with a peak, while GB emissions decreased between 2018 and 2020. From that year onwards, the behaviour reversed and the GB became the most important SB instrument with a share of 63% in the first quarter of 2023. According to NORDEA (2023), this performance may have been due to investors' increased risk aversion by investors during the period of uncertainty caused by the COVID-19 pandemic, opting for "tried-and-tested formats".

According to the Climate Bonds Initiative (https://www.climatebonds.net/market/data/), between 2014 and 2022 around USD $bn 2.15 were made available by GBs to finance energy, buildings and transport projects. According to the same source

(https://www.climatebonds.net/files/files/climate-bonds-standard-v3-20191210.pdf), GB directly contributes to 6 of the 17 SDGs: *"6-Clean Water and Sanitation, 7-Affordable and Clean Energy, 9-Industry, Innovation and Infrastructure, 11-Sustainable Cities and Communities, 13-Climate Action, 15-Life and Land"*.

The main difference between GBs and conventional bonds lies in the "use of proceeds", as conventional bonds can finance any kind of investment (Gianfrate and Peri, 2019; Löffler, et al., 2021; Karpf and Mandel, 2018). Although GBs offer less favourable yields than conventional bonds (Zerbib, 2019), investors are willing to pay a green premium to invest in green bonds that finance sustainable projects.

3. Event studies

The event study methodology allows the analysis of asset price reactions to different relevant phenomena in financial markets. The underlying procedures analyse price fluctuations in the period around the event date (Kothari and Warner, 2006).

It is therefore necessary to identify the event of interest, the estimation window and the post-event window. The study is based on the possibility of AR caused by a specific phenomenon. According to Lobo and Gomes (2022), the methodology eliminates the general economic conditions and the differences in risk and return of the firms in order to calculate the AR in the period of the event, which is the difference between the observed return and the return modelled by the market model.

The approach is based on the hypothesis that the event conveys new information that leads to changes in expectations about the firms involved, with a consequent impact on market prices (Lobo and Gomes, 2022; Martynova and Renneboog, 2008).

Empirical evidences

The growing need for countries to take steps towards the sustainability of the planet justifies the strong growth in the volume of GB in recent years. Research in this area still needs to be deepened, particularly as regards the reaction of international stock markets to the issue of this financial instrument.

Glavas (2020) used a multi-country event study methodology on a sample of 780 GB emissions in 22 countries between 2013 and 2018. Abnormal stock returns were higher after the 2015 Paris Agreement, evidencing that stocks react positively to the issuance of GB. Using a market model, Wang et al. (2020) calculate abnormal stock returns on a sample of 159 GB issues by 56 firms in China. The results show that financial markets reacted positively to the issues. According to the authors, this performance suggests that green instruments can play an important role in sustainable development. Cioli et al. (2021) conducted an event study on the issuance of GBs by 414 firms listed on various stock exchanges between 2013 and 2019. The calculated CARs suggested significant increases in stock prices around the time of the first issues. Later, Verma and Bansal (2023) studied the reaction of 6 Indian financial institutions to the GB issue using the mean-adjusted returns, market-adjusted returns and risk-adjusted models. The results show that although the AR are negative for all banks on the issue date, the accumulated abnormal returns (AAR) become positive from day $t = +10$. Fan et al. (2023) examined 2160 GBs issued by Chinese agencies between 2016 and 2022. Using event research, the authors found a positive stock market reaction to

emissions and concluded that green instruments motivate firms to improve environmental disclosure and attract green investors in the long term. Also on the same market, Wang's (2023) sample dataset consisted of 214 GBs issued by 87 firms between 2016 and 2021. The author concluded that the Chinese stock market reacted positively to the issuance of these loans, although this reflects speculative trading behaviour. More recently, Yuan (2024) examined stock market reactions to the issuance of 402 ESG bonds by 153 listed Japanese firms. The study showed a strong positive market response to GB.

4. Materials and methods

Overall, this research aims to provide insights into the impact of GB issuance by firms listed on the main Euronext stock indices. Using the study of events, the analysis follows Mackinlay's (1997) methodology to determine AR and Beaver's (1968) methodology to assess the price reaction to GB issuance.

The work begins with the definition of the event and the identification of the time windows in **Table 1** for the estimation and analysis of stock returns along the time line τ (Mackinlay, 1997):

Table 1. Time windows.

Estimation window		**Event window**	**Post-event window**	
		τ		
T_0	T_1	0	T_2	T_3

The date of the event (τ_0) corresponds to the day on which the GBs were issued by the sample firms. The pre-event estimation window (L1) has a length of 61 days $[T_0 = -90;\ T_1 = -30]$ and is used to estimate the parameters that calculate the AR; the event window (L2) last 45 days $[T_1 + 1 = -29;\ T_2 = +15]$, including the period around the event; the post-event window (L3) lasts 15 days $[T_2 + 1 = +16;\ T_3 = +30]$.

The study proceeds with the selection of the sample, which includes GB issuers listed on the main Euronext stock indices: AEX (Netherlands), BEL 20 (Belgium), CAC 40 (France), ISEQ 20 (Ireland), OBX (Norway) and PSI (Portugal). Initially, 60 GB issues were identified, between 19 May 2014 and 23 December 2022, carried out by 22 different firms. Greenvolt was excluded from this sample as; despite issuing GBs on 26 February 2019 and 10 November 2021, it did not list until June 2021, compromising the study window. As a result, the final sample consisted of 58 GB issues from 21 different firms.

The issue dates of the GBs were consulted on the Euronext (https://live.euronext.com/en/products/fixed-income/esg-bonds?field_type_value=2057) database to produce **Table 2** and the share prices were consulted on the Investing website (https://pt.investing.com/equities/).

Table 2. Green bonds issued by firms listed on Euronext.

Issuer	Listing Date	Amount (million EUR)	Listing Venue
ABN AMRO BANK N.V.	31/05/2016	500	Amsterdam
ABN AMRO BANK N.V.	18/04/2018	750	Amsterdam
ABN AMRO BANK N.V.	15/04/2019	750	Amsterdam
ABN AMRO BANK N.V.	23/09/2021	1000	Amsterdam
ABN AMRO Bank N.V.	21/11/2022	1250	Amsterdam
AIB GROUP PLC	30/09/2020	1000	Dublin
AIB GROUP PLC	17/05/2021	750	Dublin
AIB GROUP PLC	16/11/2022	750	Dublin
AKER ASA	23/12/2022	124.46	Oslo
AKER HORIZONS ASA	22/07/2021	240.85	Oslo
AXA LOGISTICS EUROPE MASTER S.C.A	15/11/2021	500	Dublin
BANK OF IRELAND GROUP PLC	16/09/2022	1004.62	Dublin
BNP PARIBAS	01/12/2016	500	Paris
BNP PARIBAS	17/04/2018	500	Paris
BNP PARIBAS	28/02/2019	750	Paris
BNP PARIBAS	04/12/2019	750	Paris
BNP PARIBAS	14/10/2020	750	Paris
BNP PARIBAS	30/11/2021	1000	Paris
COFINIMMO	09/12/2016	55	Brussels
CREDIT AGRICOLE CIB FINANCIAL SOLUTIONS	06/06/2022	30	Dublin
CREDIT AGRICOLE CIB FINANCIAL SOLUTIONS	22/12/2022	3	Dublin
CREDIT AGRICOLE S.A.	09/12/2020	1000	Paris
CREDIT AGRICOLE S.A.	21/09/2021	1000	Paris
CREDIT AGRICOLE S.A. LONDON BR	05/12/2018	1000	Paris
CREDIT AGRICOLE S.A. LONDON BR	21/10/2019	1000	Paris
DNB BANK ASA	19/02/2018	103.55	Oslo
DNB BANK ASA	21/01/2022	1200	Dublin
DNB BANK ASA	02/09/2022	186.05	Dublin
EDENRED	01/07/2021	399.99	Paris
EDP - ENERGIAS DE PORTUGAL, S.A.	30/01/2019	1000	Dublin
EDP - ENERGIAS DE PORTUGAL, S.A.	15/04/2020	750	Dublin
EDP FINANCE B.V.	16/09/2019	600	Dublin
EDP FINANCE B.V.	22/03/2022	1250	Dublin
EDP FINANCE B.V.	11/10/2022	500	Dublin
ENGIE	19/05/2014	1300	Paris
ENGIE	27/03/2017	800	Paris
ENGIE	16/01/2018	1000	Paris
ENGIE	28/01/2019	1000	Paris
ENGIE	24/10/2019	900	Paris
ENGIE	30/11/2020	850	Paris
ENGIE	02/07/2021	750	Paris

Table 2. (*Continued*).

Issuer	Listing Date	Amount (million EUR)	Listing Venue
ENGIE	27/09/2022	650	Paris
ING GROEP N.V.	15/11/2018	1500	Amsterdam
ING GROEP N.V.	24/08/2022	1000	Amsterdam
KBC GROEP	27/06/2018	500	Brussels
KBC GROEP	01/12/2021	750	Brussels
MOWI ASA	26/06/2020	200	Oslo
NN GROUP N.V.	30/08/2022	500	Amsterdam
SALMar ASA	22/07/2021	337.20	Oslo
SMURFIT KAPPA TREASURY UNLIMITED COMPANY	24/09/2021	500	Dublin
SOCIETE GENERALE	25/11/2015	500	Paris
SOCIETE GENERALE	05/10/2016	500	Paris
SOCIETE GENERALE	22/09/2020	1000	Paris
SOCIETE GENERALE SFH	18/07/2019	1000	Paris
SOCIETE GENERALE SFH	11/02/2020	1000	Paris
SOCIETE GENERALE SFH	02/12/2021	1500	Paris
STOREBRAND LIVSFORSIKRING AS	31/03/2021	300	Dublin
VINCI	27/11/2020	500	Paris

Note: **Table 2** presents information regarding the Issuer, Listing Date, Amount (million EUR) and Listing Venue of the 58 GB issues listed on the main Euronext stock indices: AEX (Netherlands), BEL 20 (Belgium), CAC 40 (France), ISEQ 20 (Ireland), OBX (Norway) and PSI (Portugal), in our database.

The empirical study uses the market model to estimate the parameters for calculating stock returns independently of the occurrence of relevant events:

$$R_{i,t} = \alpha_i + \beta_i \times R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the real return of stock i on day t, α_i is the average return of stock i not explained by the market, β_i is the systematic risk of stock i, $R_{m,t}$ is the return of market m on day t and $\varepsilon_{i,t}$ is the regression error term.

Daily real returns, in turn, are determined by the logarithmic difference between successive closing prices $P_{i,t}$:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \quad (2)$$

This procedure is used to correct for the occurrence of shocks or extreme phenomena that often characterise time series.

In general, ordinary least squares (OLS) provides consistent and efficient estimates of the market model parameters through the following procedures:

$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1}\left(R_{i,\tau} - \hat{\mu}_i\right)\left(R_{m,\tau} - \hat{\mu}_m\right)}{\sum_{\tau=T_0+1}^{T_1}\left(R_{m,\tau} - \hat{\mu}_m\right)^2} \quad (3)$$

in which the numerator expresses the covariance between stock returns and market returns, while the denominator expresses the variance of market returns, where $\hat{\mu}_i$ is the average of stock returns and $\hat{\mu}_m$ is the average of market returns calculated in period $L1$:

$$\hat{\mu}_i = \frac{1}{L1}\sum_{\tau=T_0+1}^{T_1} R_{i,\tau} \tag{4}$$

$$\hat{\mu}_m = \frac{1}{L1}\sum_{\tau=T_0+1}^{T_1} R_{m,\tau} \tag{5}$$

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i \times \hat{\mu}_m \tag{6}$$

The difference between the actual returns and the returns estimated from the Equation (1) is then used to determine the daily stock AR:

$$AR_{i,\tau} = R_{i,\tau} - \hat{\alpha}_i - \hat{\beta}_i \times R_{m,\tau}; AR_{i,\tau} \sim N\left[0, \sigma_i^2\left(AR_{i,\tau}\right)\right] \tag{7}$$

The AR are aggregated (over time and between stocks) in order to draw conclusions about the event of interest. The sample CAR between τ_1 and τ_2 is given by:

$$\mathrm{CAR}_i(\tau_1, \tau_2) = \sum_{\tau_1}^{\tau_2} AR_{i,\tau}\,; \mathrm{CAR}_i(\tau_1, \tau_2) \sim N\left[0, \sigma_i^2(\tau_1, \tau_2)\right] \tag{8}$$

The average abnormal returns (AAR) of individual stocks can be determined using the Equation (7) for each period τ. Considering N events, the statistic is given by:

$$\mathrm{AAR}_\tau = \frac{1}{N}\sum_{i=1}^{N} AR_{i,\tau} \tag{9}$$

$$\mathrm{Var}(\mathrm{AAR}_\tau) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_{\varepsilon_i}^2 \tag{10}$$

Finally, the average abnormal returns can be aggregated (CAAR) over the event window:

$$\mathrm{CAAR}(\tau_1, \tau_2) = \frac{1}{N}\sum_{i=1}^{N} \mathrm{CAR}_i(\tau_1, \tau_2) \tag{11}$$

$$\mathrm{Var}\left(\mathrm{CAAR}(\tau_1, \tau_2)\right) = \frac{1}{N^2}\sum_{i=1}^{N}\left(\mathrm{CAR}(\tau_1, \tau_2) - \mathrm{CAAR}(\tau_1, \tau_2)\right)^2 \tag{12}$$

Statistical inferences can be drawn under the null hypothesis that AR are zero. Since $\sigma_{\varepsilon_i}^2$ is unknown in Equation (10), a common estimator must be used to calculate the variance of the AR in the estimation window:

$$\theta_1 = \frac{\mathrm{AAR}_\tau}{\sqrt{\mathrm{Var}(\mathrm{AAR}_\tau)}} \sim N(0,1) \tag{13}$$

$$\theta_2 = \frac{CAAR(\tau_1, \tau_2)}{\sqrt{\mathrm{Var}(\mathrm{CAAR}(\tau, \tau_2)}} \sim N(0,1) \tag{14}$$

In a two-tailed test with significance α, the null hypothesis will be rejected if θ is in the critical range, i.e, $\theta < c\left(\frac{\alpha}{2}\right)$ or $\theta > c\left(1 - \frac{\alpha}{2}\right)$.

The empirical study also measures the reaction of the stock market price around the date of the event:

$$R = \frac{AR_{it}^2}{\sigma_{\varepsilon i}^2} \tag{15}$$

5. Results and discussion

Figure 1 shows the positive and negative CAAR of the firms' stocks on days [−5; +15] around the GB issue date:

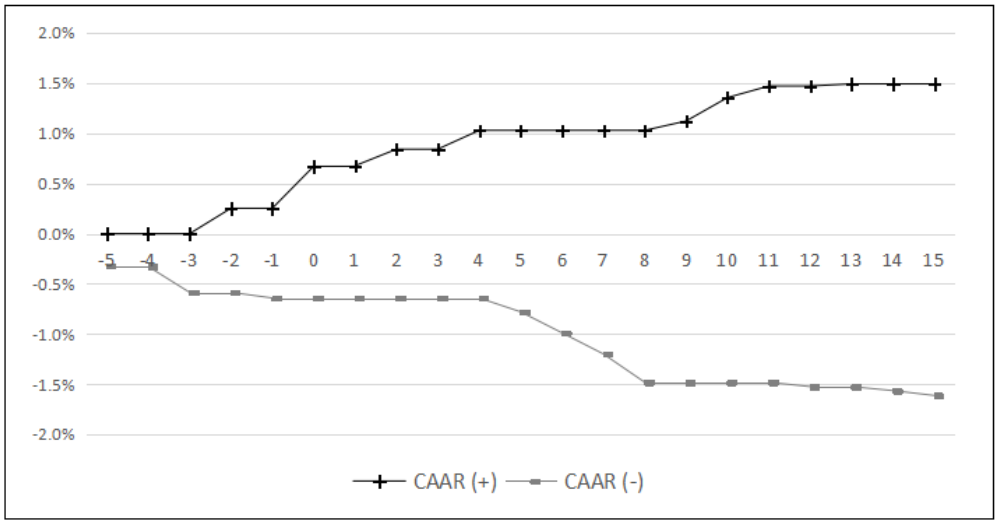

Figure 1. Cumulative average abnormal returns (positive and negative) on days [−5; +15].

In the initial period [−5; −3] the AAR accumulated negative values, falling from −0.33% on day $t = -5$ to −0.58% on day $t = -3$. Subsequently, between days [−3; +4] only positive AARs accumulated up to 1.03%, while between days [+4; +8] only negative AARs accumulated up to −1.48%. After a slight increase in positive CAARs between days [+8; +11], the statistic stagnated in a zero-sum equilibrium.

The largest peak formed during the period [−5; +15] occurred on the day of the event, in which the positive AAR of GB issuers increased by 0.42%.

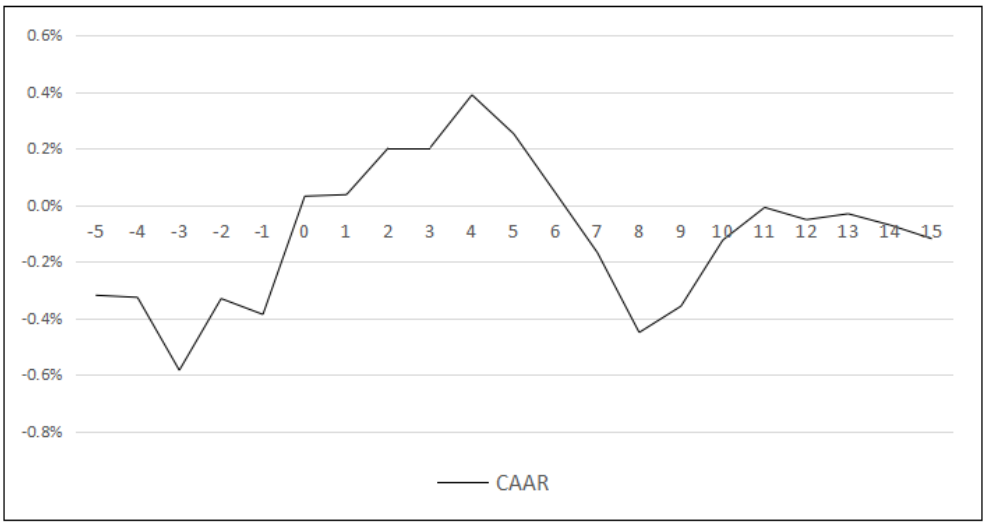

Figure 2. Cumulative Average Abnormal returns.

Figure 2 shows the aggregate CAAR of the sample firms' stocks on days [−5; +15] around the GB issue date.

The sign shows that the losses were more pronounced up to day $t = -3$, suggesting that the market anticipated some reserves on the GB issue. In addition to being a new financial instrument that is still consolidating on the markets, the yield offered is less favourable than conventional bonds (Zerbib, 2019). However, from the day before the event, abnormal gains accumulated up to $t = +4$, suggesting that investors valued successful sustainable issues to finance innovative investments related to mitigating climate change or strengthening resilience to other environmental challenges, such as the depletion of natural resources and the loss of biodiversity, air, water or soil.

Furthermore, this performance confirms the significant evolution of the CAARs on day 0. After a natural price correction over the next few days in the respective markets, the ARs stagnated at $t = +11$.

Figure 3 shows the aggregate AAR of the sample firms' stocks on days [−5; +15] around the GB issue date.

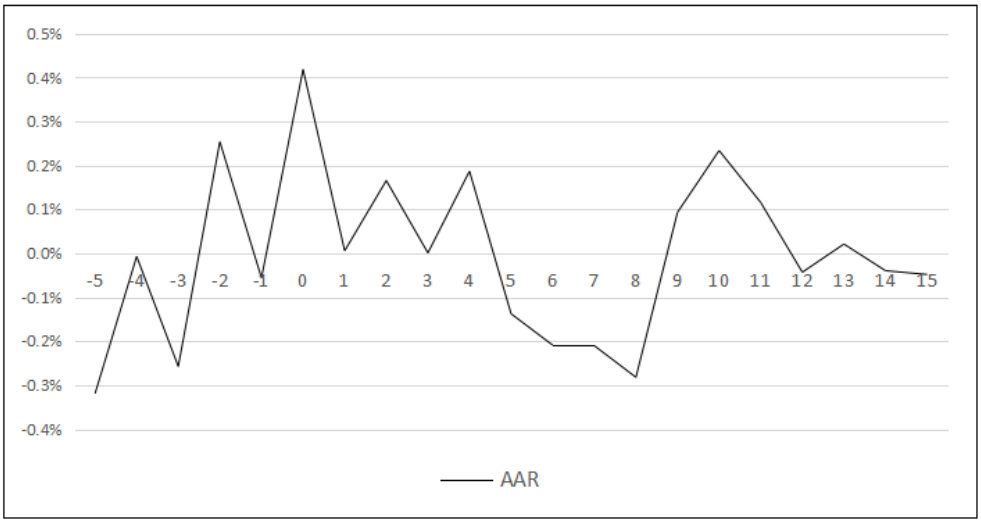

Figure 3. Average abnormal returns.

Apart from some minor aftershocks around day 0, the configuration shown reinforces the large peak formed by the impact of the GB issue on the ARs of the sample firms' stocks. These findings are consistent with the results of recent studies, such as Glavas (2020), Wang et al. (2020) and Fan et al. (2023).

On the other hand, the graphical configurations show that ARs tend to disappear from the second week after the GBs are issued, contrary to the results of Verma and Bansal (2023). This delay in the recovery of market equilibrium provides evidence against the weak form efficiency hypothesis. The efficient market hypothesis (EMH) assumes a market in which prices constantly reflect all available information (Fama, 1970). Even so, the weak form of efficiency assumes that asset prices reflect historical information, and it is not possible for investors to obtain AR based on past analysis.

Figure 4 shows the aggregate price reactions of the sample firms' stocks on days [−5; +15] around the GB issue date.

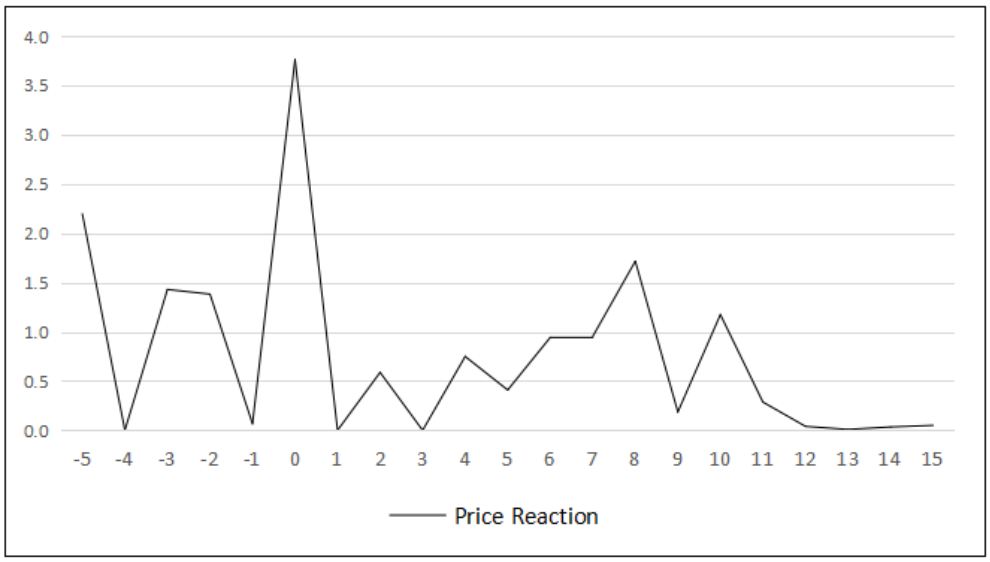

Figure 4. Price reaction.

The configuration shows that the largest reaction (3.76) of the stock price to the GB issue occurred on the operation date (day 0). Although there were no other such extreme price reactions in the analysis period, there were some less intense aftershocks on days $t = -3$, $t = +8$ and $t = +10$. This configuration confirms that there is a tendency for the ARs to stagnate from day $t = +11$ onwards, with the statistics tending to annul themselves.

In addition, the empirical study continues with a test to determine the statistical significance of the abnormal stock returns caused by the GB issue. The null hypothesis of the bilateral test at 5% significance level corresponds to zero AR. In this case, the critical values in the standardised distribution are ±1.96, rejecting H0 when θ_1 and θ_2 are in the intervals $[-\infty ; -1.96]$ and $[+1.96; +\infty]$.

Table 3 shows the results of the hypothesis tests for the aggregate AAR and CAAR of the sample firms' stocks on days [−5; +15] around the GB issue date:

Table 3. Hypothesis tests (θ_1 and θ_2).

Period	θ_1 (AAR)	θ_2 (CAAR)
−5	−1.661336	−0.383130
−4	−0.038830	−0.392085
−3	−1.340277	−0.701174
−2	1.318090	−0.397202
−1	−0.291535	−0.464434
0	2.174330	0.037000
1	0.028802	0.043643
2	0.859589	0.241877
3	0.003926	0.242783
4	0.970401	0.466572
5	−0.717054	0.301208
6	−1.088326	0.050223

Table 3. (*Continued*).

Period	θ_1 (AAR)	θ_2 (CAAR)
7	−1.094859	−0.202268
8	−1.468567	−0.540943
9	0.484375	−0.429238
10	1.214781	−0.149091
11	0.600167	−0.010683
12	−0.225075	−0.062589
13	0.108399	−0.037590
14	−0.207318	−0.085401
15	−0.251713	−0.143450

NOTE: **Table 3** presents the results of the hypothesis tests for the aggregate AAR and CAAR of the sample firms' stocks on days [−5; +15] around the GB issue date for the 58 GB issues listed on the main Euronext stock indices: AEX (Netherlands), BEL 20 (Belgium), CAC 40 (France), ISEQ 20 (Ireland), OBX (Norway) and PSI (Portugal), in our database.

The test results show statistical significance ($\theta_1 = 2.174$) regarding the AAR generated by the firms' stocks at the GB issue date (day 0). This evidence confirms the previous graphical configurations. However, the test did not reveal any significance in terms of the CAAR for the period under review.

6. Conclusions

Following the event study methodology, the main objective of the article was to analyse the impact of the GB issues on the AR of the involved firms listed on the Euronext, one of the largest international stock index platforms. The sample included 58 issues between 2014 and 2022 by 21 different firms listed on the AEX, BEL 20, CAC 40, ISEQ 20, OBX and PSI indices.

The results show that the losses were more pronounced up to day t = −3, suggesting that the market penalised GB issues at an earlier stage. From an economic point of view, it could be argued that GBs are financial instruments that are still being consolidated in the market and that the yields offered are lower than those of conventional bonds. However, the strongest gains were made up to day t = +4, suggesting that investors were rewarding successful sustainable operations. There was also an extreme positive spike in ARs on issue day, meaning the event had significant market impact.

After a natural price adjustment in the following days, ARs stagnated and practically disappeared from day t = +11 onwards. Although there were no other significant reactions to returns over the analysis period, there were some small replications on days t = −3, t = +8 and t = +10. These dynamics maintain that markets do not immediately discount new public information, thereby generating AR and providing evidence against the weak form of efficiency.

The market's positive reaction to this type of issue may be due, among other factors, to the growing sensitivity of investors to climate concerns.

In terms of contributions, the outcomes provide insights for policy makers and entrepreneurs: these markets value successful GB issues, highlighting the abnormal gains for investors and thus the effectiveness of this instrument to finance

environmentally friendly infrastructure. However, these Euronext markets are not yet fully financial efficient.

In terms of policy implications, it is important to emphasise the need to define investment strategies related to climate change mitigation or environmental resilience that are financed through green issues, to improve tax incentives for this type of instrument, and to deepen regulatory processes that contribute to financial market efficiency.

The main limitation of this work comes from the scarcity (only two cases) of GB issues by Euronext firms in the pre-Paris Agreement period, making it impossible to compare the results between the two sub-periods.

For future work, we suggest analysing the reaction of the financial markets to the issuance of different types of SBs in order to identify the instrument that is most valued by investors' sensitivity to sustainability issues, as well as examining difference cross indexes.

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