# The Pandemic and Green Bond Market: Public  care of Global Issues in Crisis (the example of France)
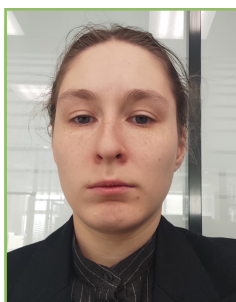
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**ABSTRACT**

*The paper sets out to investigate changes in the behavior of green bonds in the aftermath of the global social and economic crisis, using the relationship between the price of green French debt instruments and the database of reported cases of a new coronavirus infection from March 2020 to February 2021 as examples. The choice of French securities was justified by the high development of financing of environmental initiatives in the EU, especially in France. Also, the author compared data obtained with the existing index of French conventional bonds, and conducted the comparison on a vaster dataset from January 2019 to the end of October 2021. The need for this research is justified because the pandemic can play a significant role in shaping a more conscious attitude of the global population to the goals of sustainable development and implementing the Paris Agreement's objectives.*
***Keywords:*** *COVID-19; pandemic; green investments; conventional bonds; green bonds; interconnection; connectedness; France; European financial market; Euronext Paris; sustainable development; sustainable development goals*

ОРИГИНАЛЬНАЯ СТАТЬЯ

# Пандемия и рынок зеленых облигаций: внимание общественности к глобальным проблемам в период кризиса на примере Франции

**АННОТАЦИЯ**

*Эта статья ставит перед собой задачу исследования изменений в поведении зеленых облигаций вследствие глобального социального и экономического кризиса на примере взаимосвязи цены*

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зеленых французских долговых инструментов и базой данных о зарегистрированных случаях заболевания коронавирусной инфекцией в период с марта 2020 по февраль 2021 г. Выбор именно французских бумаг обоснован высокой развитостью финансирования экологических инициатив в ЕС, в особенности во Франции. Также было проведено сравнение полученных данных с существующим индексом французских конвенциональных облигаций. Необходимость данного исследования обоснована тем, что пандемия как социальный феномен может сыграть значительную роль в формировании более осознанного отношения населения планеты к целям устойчивого развития и выполнению задач, поставленных в рамках Парижского соглашения 2015 г.

**Ключевые слова:** COVID-19; пандемия; зеленые инвестиции; обычные облигации; зеленые облигации; взаимосвязь; взаимосвязанность; Франция; финансовый рынок ЕС; Euronext Paris; устойчивое развитие; цели устойчивого развития

Green bonds are a very young type of alternative investment; the European Investment Bank issued the first green bonds — Climate awareness bonds in 2007. Research related to green debt instruments has been attracting more and more attention from specialists in recent years, but a great deal remains unspoken on this topic. In particular, just a few works have been devoted to the study of the green bonds behavior during the pandemic. Conducted study is devoted to fill this very gap.
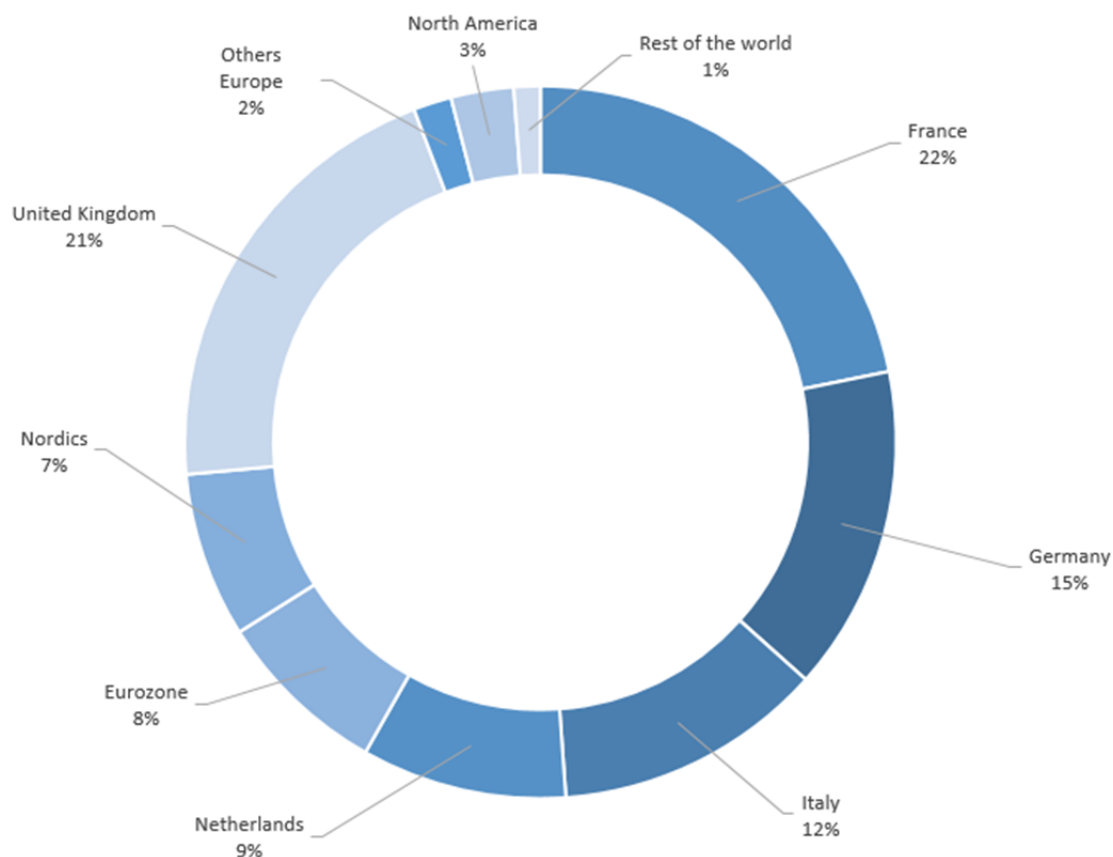
In research on green bonds, because of their heterogeneity, researchers try to capture data on as many bonds as possible in their work. We are not going to detach ourselves from this methodology, but we will focus specifically on bonds issued in France, would announced since at least the beginning of 2019, and redeemed no earlier than the beginning of 2024, and data on the number of coronavirus cases in the country since the first day in which cases were reported.

The research has limitations, expressed because French bonds, both sovereign and corporate, are traded on the world market and the demand for these financial instruments comes from different countries. According to information provided by Agence France Trésor to the second issue of green sovereign bonds, 22% of investors in the original issue originated from France, which can be explicitly seen on graph (*Fig. 1*). However, the resources raised in this way remain in French companies whose financial results are seriously affected by the pandemic situation. For a more holistic view of the topic, the author sees the need

to further extend the study to, at very least, the entire European market.

France, in particular the French government, is a driving force in the growing field of green bonds. Agence France Trésor issued the first French sovereign green bond in January 2017 with an issue size of 7 bln euros and a coupon rate of 1.75%, which would be repaid in full in June 2039. By November 2021, the most current amount of debt for this instrument is 30.94 bln euros. Overall green debt of both French corporations and the state left France behind economic giants, such as the USA and China — in the third place by total green debt worldwide, according to Climate Bonds Initiative database as of first half of 2021 was $ 146 bln. For a huge market of debt instruments valued at $ 123.5 trn in 2020, this is a small contribution, but for a growing market of sustainable financial initiatives, the actions of the French state and French corporations are hard to leave out. According to Bloomberg[1] (2021), after the issuance of the second green bond France guaranteed its leading position as the country that attracted the most financial resources to sustainable projects in state level (*Fig. 2*). As clear, European Union member states, governmental bodies are the keenest issuers of green instruments, but corporate climate initiatives are not that developed. The further, most of French green debt instruments are issued by state-owned enterprises, state, local

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[1] France Extends Green Bond Lead With $ 8 Billion Sale of New Deb. URL: https://www.bloomberg.com/news/articles/2021–03–16/france-offers-second-green-bond-to-cement-status-as-top-issuer

*Fig. 1.* **Geographical distribution of investors on an issue of second French green sovereign bond (March 16, 2021)**

*Source:* Agence France Trésor.

and municipal bodies, such as railroad agencies, or by large private financial institutions, such as Crédit Agricole Group or BNP Paribas S. A., that are also listed in CAC 40 index among the largest French companies.

In March 2021, they issued a second green bond with a maturity of 23 years and a coupon rate of 0.5%. Its issue, as noted in a press release of the agency, is because of a significant investor appetite for green government bonds.

## Previous investigations

Speaking of investor appetite, they recognize green bonds as an option for portfolio diversification [1], especially during pandemic [2], but this type of alternative investment has a high possibility of losses during market downturn [3]. Some survey-based research papers highlight that environmental impact and availability of impact reporting are prior to the diversification purpose as a motivation for green investment [4]. In fact, yields on green bonds are proved to be

lower than those on conventional bonds [5]. This brings us to the idea that investors could give up some amount of potential yield willingly in return for future benefits of climate protection, aside from diversification benefits, that green investments promise to sustain. There is a set of methods existing in the field of mathematical analysis that allow to predict human behavior. [6] Also, large body of research articles have shown, that investors react positively on company's issuance of green bonds, especially when there is credible evidence of a company's commitment to environment [7–9].

## Methodology

ESG bonds traded on Euronext Exchange were used for the further research, the information about which was available on the website of the stock exchange on the day of access.[2]

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[2] Euronext ESG Bonds. URL: https://live.euronext.com/en/products/fixed-income/esg-bonds (accessed on 24.11.2021).

**Green Machine**

France is the world's biggest sovereign issuer of green bonds

■ Total green bonds outstanding
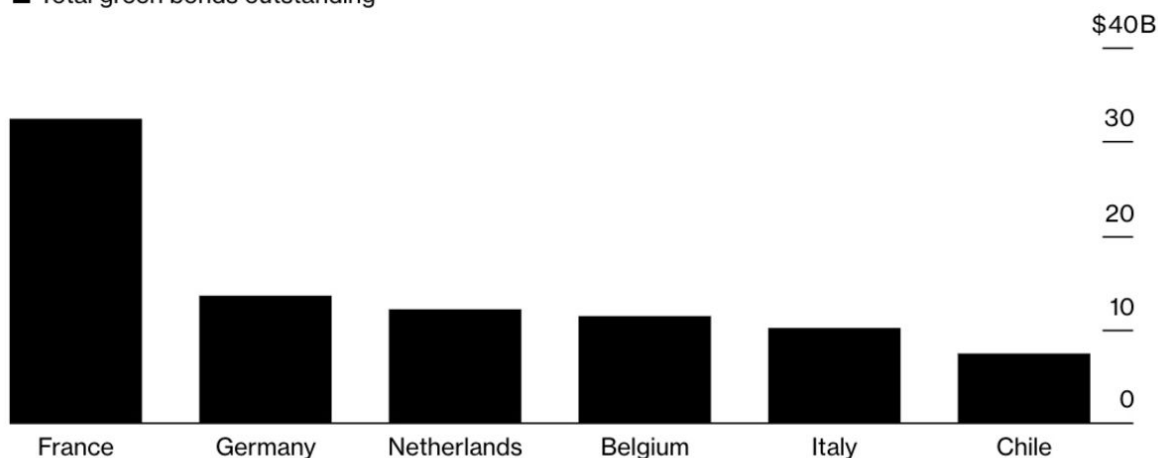


Source: BloombergNEF

*Fig. 2.* **Total green sovereign debt outstanding (data for March 2021)**

*Source:* Bloomberg.com.

Bonds were selected from the list in accordance with the following procedure:

1. The bonds traded on Euronext Paris were selected.

2. From the list obtained in item 1, bonds of the "Green Bond" type were selected.

3. Next, bonds issued not earlier than 01.01.2019 were selected.

4. Then, the bonds with amount that is greater or equal to 100 mln euro were selected from the list.

5. Finally, redeemed bonds were manually deleted (3 positions) and bonds issued in a currency other than euro (1 position).

The procedure is completed mostly for convenience and simplification of index composition and unity of currency, since no financial instruments were excluded from index and no additions of newer issues were made and no companies with foreign parent company fell under investigation.

Thus, the list of 27 green bonds was obtained. The author presented the full list of bonds below in Appendix 1, which were selected for the study. Predominantly, these are bonds issued by the government, the Ile-de-France region (as well as the city of Paris) or state-owned enterprises. Among the other issuers are the two largest systematically important French banks, and the fourth largest real-estate investment fund in Europe. All bonds have a high rating of both an issue and an issuer

with lowest rating of an issue: BBB-[3] (for a single bond, according to S&P rating), lowest rating of an issuer: BBB.[4]

Index was constructed by the formula[5]:

$$I_t = I_{t-1} \cdot \frac{\sum_{i=1}^{n} \left[ P_{i,t} + ACI_{i,t} + G_{i,t} \right] \cdot N_{i,t}}{\sum_{i=1}^{n} \left[ P_{i,t-1} + ACI_{i,t-1} + G_{i,t-1} \right] \cdot N_{i,t}},$$

where:

$I$ — index value at time period $t$ (or $t - 1$), base value is taken as 100 points;

$P$ — price of $i^{th}$ bond in index at time $t$ ($t - 1$);

$ACI$ — accrued coupon interest for $i^{th}$ bond in index at time $t$ ($t - 1$);

$G$ — coupon payment, equal to coupon size when paid or to 0 otherwise;

$N$ — volume of issue of $i^{th}$ bond in index at time $t$.

Completed index of green bonds was compared with performance of conventional corporate bond index, the closest existing index to the matter of

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[3] Rating given by a rating agency in accordance with a level of credit risk, where AAA (Aaa) is best possible rating, D (C) is worst possible rating. In the brackets — special remark for Moody's ratings, for S&P and Fitch best and worst ratings are depicted in the same manner.

[4] All information about bond prices and ranking was taken from cbonds.com

[5] Here was used the same pattern of calculating index as for the Cbonds France Corporate USD Index. URL: https://cbonds.com/indexes/Cbonds-France-Corporate-Index/
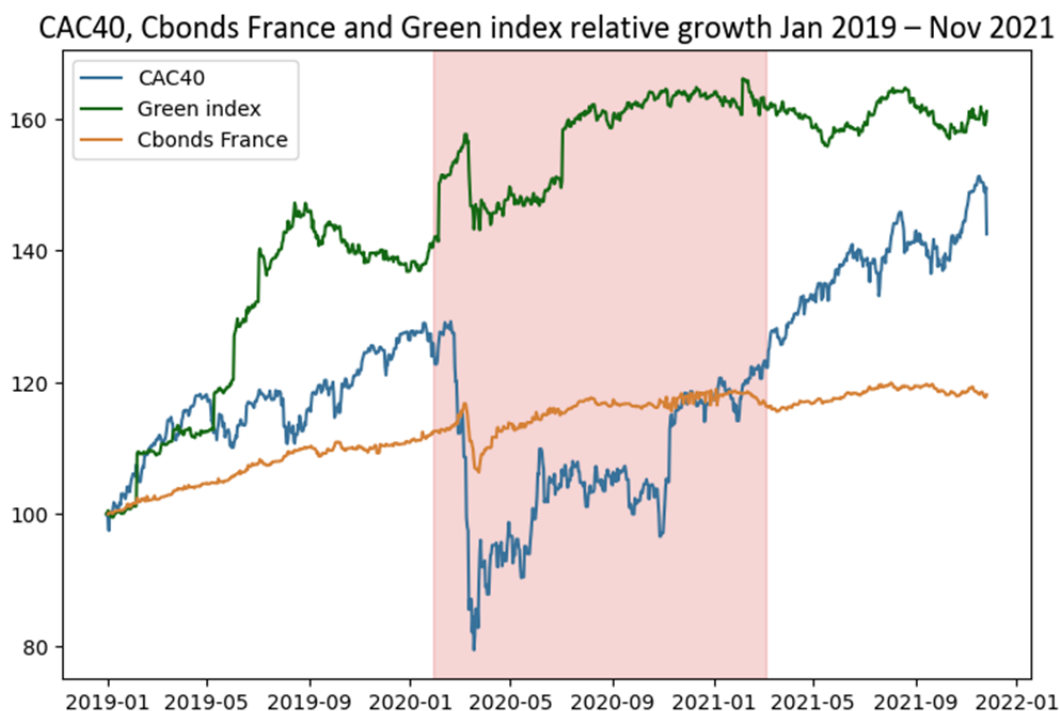
*Fig. 3.* **CAC 40, Cbonds France and Green index relative growth January 2019 — November 2021**

*Source:* developed by the author.

## Market dynamics

The behavior of bond prices within the index was very uneven, but the overall index showed a profound increase for the time of study. The author depicted the time series showing a change in index value for green bond in the graph below (*Fig. 3*).

It shows the fluctuation of daily closing prices of CAC 40, the main stock index of French companies, as well as the composite green index and the corporate index. For scaling, the first day price of the indices was taken as 100 units. The red zone is the period from the first contagion in France to the end of the study period. After a strong appreciation, the green index declined a quarter before pandemic started, but rehabilitated faster than the general stock index, surpassing the previous highest value of index by 3 units. Noticeable, that the green index reacted sharply positively to the news about the coronavirus. A reason for such growth may be the desire to diversify risk from the expected stock collapse, as companies are obliged to pay

[6] Cbonds France Corporate USD Index.

debt obligations regardless of the financial results. Similarly, the index rose again after correcting in the fall of 2020 — during the second lockdown.

Moreover, the author performed the Granger casualty test to establish whether it is possible to forecast changes in index value, operating with a dataset of coronavirus cases in France. Two hypotheses were simultaneously tested: null is "new COVID cases does not Granger cause green index value" and alternative is "green index value does not Granger cause new COVID cases". While lag value that is less than or equal to 3, the null hypothesis is accepted with probability 0.3404, while alternative is rejected (probability <0.01), so green index Granger cause changes in COVID cases dataset.

Other words, change in index value can estimate the change of situation with coronavirus, which literally means, that change in index price firmly precedes new disease cases and is based on the prediction of new cases of disease and the main reason for that is an abundance of news about pandemic spread. The same proceeds were obtained from Granger testing of datasets for conventional corporate bonds and new confirmed cases of COVID-19: the null hypothesis of COVID cases does not Granger causing conventional bond prices is firmly accepted with a probability 0.7535.
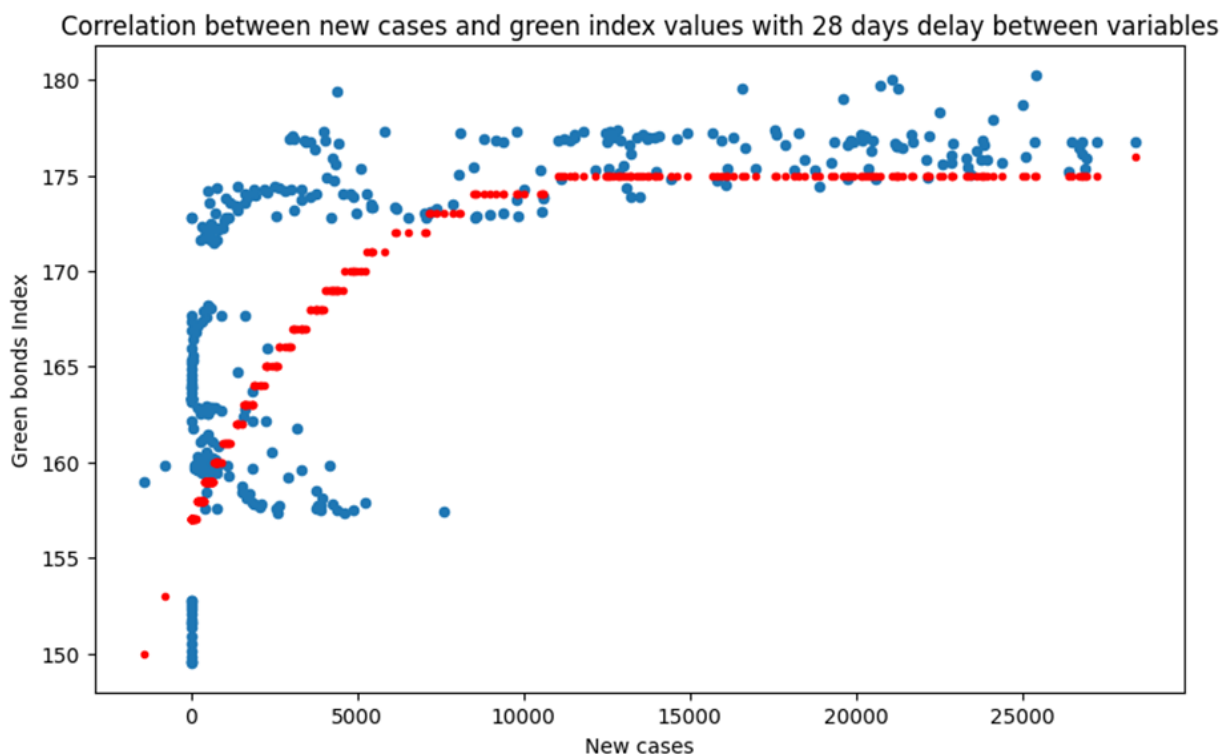
*Fig. 4.* **Correlation between new registered COVID-19 cases and value of constructed index**

*Source:* developed by the author.

This suggests that both indices are very sensitive to news about the future increase in number of cases, which in fact confirms previous findings, and as was clear from the graph, the green index was less selective and increased more dynamic over the course of the pandemic.

## Construction of a model

At the final step was constructed an approximate model that describes changes of green index value based solely on new COVID-19 cases. In a structural form model is presented below:

$$I = a_0 + a_1 \cdot c_t + a_2 \cdot c_t^2 + a_3 \cdot e^{a_4 \cdot c_t} + \varepsilon_t,$$

where:

$I$ — index value, in relative units;

$c$ — new cases of disease, in persons;

$a_0, a_1, a_2, a_3, a_4$ — estimated parameters;

$\varepsilon_t$ — random disturbance term.

Model parameters were estimated by means of Python scipy.optimize module. Final model takes form written below:

$$I = 187.27 - 9.05e^{-4} \cdot c_t + 1.84e^{-8} \cdot c_t^2 +$$
$$+ 29.91 \cdot e^{-1.73e^{-4}c_t} + \varepsilon_t.$$

For a non-linear model of relation between new COVID-19 cases and constructed, measured by the author an index of green instruments as 28 days for the investigated period: index reacted on expected change in COVID situation, at the level of $R^2 = 0.8126$.

Speaking of conventional bonds, this model has shown little applicability: the maximum $R^2$ equal to 0.6619 is reached at a lag of 34 days. Presumably, it may arise from the fact that conventional bonds in the study period are not as strongly tied to the change in number of COVID-19 cases as green bonds and depend on other unexplored factors.

## Proceeds from the study

The study shows in general, bonds reacted positively to disease growth during the study period, the growth of green bonds was especially significant during this period, as the fluctuations of the price of conventional bonds were noticeably lower. The average annual growth of this index over the study period was about 10%, while green bonds rose by almost a quarter and were not subject to a significant plunge in value, unlike the other two indices.

The bond market reacted to news about the coronavirus before there was a change in the

disease's incidence, unlike the stock market, which presumably reacted to the actual restrictions.

The green bonds' behavior is amenable to an approximation by a model with one independent variable, a positive relationship between the surge in incidence and the rise in price is present. That is, it is indeed possible to describe it during a pandemic based on morbidity data or, more precisely, on news about future disease outbreak.

For further investigation would be highly important to take into consideration not only the direct increase in number of cases, but such indicators as news sentiment at the moment of price change in order to estimate the influence of news channel on price change. Alternatively, studies can be extended to another EU country or the country with a high level of green financing. The obtained results can be various because of the difference in disease spread pattern.

## References

1. Reboredo J.C. Green bond and financial markets: Co-movement, diversification and price spillover effects. *Energy Economics.* 2018;(74):38–50.
2. Naeem M.A., Peng Zh., Suleman M.T., Nepal R., Shahzad S.J.H. Time and frequency connectedness among oil shocks, electricity and clean energy markets. *Energy Economics.* 2020;(91).
3. Huynh T.L.D., Hille E., Nasir M.A. Diversification in the age of the 4th industrial revolution: The role of artificial intelligence, green bonds and cryptocurrencies. *Technological Forecasting and Social Change.* 2020;(159).
4. I. Sangiorgi I. Schopohl L. Why do institutional investors buy green bonds: Evidence from a survey of European asset managers. *International Review of Financial Analysis.* 2021;(75).
5. Zerbib O.D. The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance.* 2019;(98):39–60.
6. Vladova A.Y., Shek E.D. Data preprocessing for machine analysis of sales representatives' key performance indicators. *Business Informatics.* 2021;(15):48–59.
7. Krüger P. Corporate goodness and shareholder wealth. *Journal of Financial Economics.* 2015;115(2):304–329.
8. Flammer C. Corporate green bonds. *Journal of Financial Economics.* 2021;142(2):499–516.
9. Tang D.Y., Zhang Y. Do shareholders benefit from green bonds? *Journal of Corporate Finance.* 2020:(61).

*Appendix*

## Composition of Dummy Index

| ISIN | Issuer | ISIN | Listing Date | Amount (million) | Currency |
|---|---|---|---|---|---|
| FR 0013365376 | AGENCE FSE DE DEVELOPPEMENT | FR 0013365376 | 17.09.2018 | 500.0 | EUR |
| XS 1111084718 | AGENCE FSE DE DEVELOPPEMENT | XS 1111084718 | 17.09.2014 | 1000.0 | EUR |
| FR 0013296373 | AGENCE FSE DE DEVELOPPEMENT | FR 0013296373 | 15.11.2017 | 750.0 | EUR |
| FR 0013067170 | BPCE | FR 0013067170 | 14.12.2015 | 300.0 | EUR |
| FR 0013239985 | CAISSE DEPOTS ET CONSIGNATIONS | FR 0013239985 | 01.03.2017 | 500.0 | EUR |
| FR 0013170834 | COVIVIO | FR 0013170834 | 20.05.2016 | 500.0 | EUR |

| ISIN | Issuer | ISIN | Listing Date | Amount (million) | Currency |
|---|---|---|---|---|---|
| FR 0013385515 | CREDIT AGRICOLE S.A. LONDON BR | FR 0013385515 | 05.12.2018 | 1000.0 | EUR |
| FR 0013213295 | EDF | FR 0013213295 | 13.10.2016 | 1750.0 | EUR |
| FR 0011637586 | EDF | FR 0011637586 | 27.11.2013 | 1400.0 | EUR |
| FR 0013310505 | ENGIE | FR 0013310505 | 16.01.2018 | 1000.0 | EUR |
| FR 0013284247 | ENGIE | FR 0013284247 | 28.09.2017 | 500.0 | EUR |
| FR 0013245859 | ENGIE | FR 0013245859 | 27.03.2017 | 700.0 | EUR |
| FR 0013284254 | ENGIE | FR 0013284254 | 28.09.2017 | 750.0 | EUR |
| FR 0013245867 | ENGIE | FR 0013245867 | 27.03.2017 | 800.0 | EUR |
| FR 0011911247 | ENGIE | FR 0011911247 | 19.05.2014 | 1300.0 | EUR |
| FR 0013234333 | FRANCE EMPRUNT D'ETAT | FR 0013234333 | 04.05.2018 | 1096.0 | EUR |
| FR 0013234333 | FRANCE EMPRUNT D'ETAT* | FR 0013234333 | 25.06.2018 | 4000.0 | EUR |
| FR 0013234333 | FRANCE EMPRUNT D'ETAT* | FR 0013234333 | 06.01.2017 | 1632.0 | EUR |
| FR 0013234333 | FRANCE EMPRUNT D'ETAT* | FR 0013234333 | 12.07.2017 | 1065.0 | EUR |
| FR 0013234333 | FRANCE EMPRUNT D'ETAT* | FR 0013234333 | 24.01.2017 | 7000.0 | EUR |
| FR 0013343175 | ILE DE FRANCE (REGION D') | FR 0013343175 | 20.06.2018 | 500.0 | EUR |
| FR 0013242336 | ILE DE FRANCE (REGION D') | FR 0013242336 | 14.03.2017 | 500.0 | EUR |
| FR 0013183167 | ILE DE FRANCE (REGION D') | FR 0013183167 | 14.06.2016 | 650.0 | EUR |
| FR 0012685691 | ILE DE FRANCE (REGION D') | FR 0012685691 | 23.04.2015 | 500.0 | EUR |
| FR 0011225325 | ILE DE FRANCE (REGION D') | FR 0011225325 | 27.03.2012 | 375.0 | EUR |
| FR 0013384567 | POSTE (LA) | FR 0013384567 | 30.11.2018 | 500.0 | EUR |
| FR 0013264488 | RATP | FR 0013264488 | 29.06.2017 | 500.0 | EUR |
| XS 1648462023 | SNCF RESEAU | XS 1648462023 | 20.07.2017 | 1100.0 | EUR |
| XS 1588061777 | SNCF RESEAU | XS 1588061777 | 30.03.2017 | 1000.0 | EUR |
| XS 1514051694 | SNCF RESEAU | XS 1514051694 | 09.11.2016 | 900.0 | EUR |
| FR 0013054897 | VILLE DE PARIS | FR 0013054897 | 18.11.2015 | 300.0 | EUR |

*Source:* compiled by author based on data from Euronext official website.

*\*Note:* additional issues of a sovereign bond.