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Transforming the COVID-19 Threat into an Opportunity: The Pandemic as a Stage to the Sustainable Economy

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Abstract: The aim of this research is to assess the impact of the economic shocks of supply and demand generated by the COVID-19 crisis on the climate sphere at the level of the Member States of the European Union. In this respect, a macroeconomic model was used to obtain firstly an estimate of the measure of demand shock and secondly an estimate of the supply of the economy. These milestones were eventually used to estimate the impact of the two economic shocks on the level of greenhouse gas emissions. The obtained results show that both the shock from the aggregate demand area and that from the aggregate supply area had the effect of decreasing the level of greenhouse gases, leading to a positive effect on the environment. From a quantitative point of view, the model estimates show that, as a result of the manifestation of the two cumulative shocks, the level of greenhouse gas emissions could decrease by about 10%.

Keywords: green economy; COVID-19; pandemic; economic shock; economic crisis; sustainable development; greenhouse gas emissions

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1. Introduction

Under the current conditions, the economic situations of all the states around the world have undergone substantial changes due to the COVID-19 crisis [1–3]. These changes brought to the surface the inequalities between states and the fragility of the social, financial, political, and economic systems that can be felt both at the level of the community of which we are part and within these various states [4–6]. In response to COVID-19, decision-makers in several countries have developed fiscal measures proposing to use a series of tools to assess the green economy in order to align monetary and fiscal policies to the ecological recovery process. In this way, COVID-19 has highlighted the increasing role of the state in all countries affected by this pandemic. The analysis of these effects resides in the measures adopted along with their impacts, especially in emerging countries where the effects of the economic crises will be felt for longer periods of time [1,6,7].

At the same time, state intervention in the climate stabilization process is necessary, in order to replace some energy systems with modern, high-performance ones featuring lower costs and the promise of a cleaner environment in the future [8–10]. In addition to economic measures, the application of environmental policies is also required. Indeed, decisions made about the COVID-19 crisis will have a major impact on health and the environment for decades. As a result, we must act responsibly against climate change and the negative externalities of intensive economic activities. Authors have highlighted the need for the transition to a new economic model based on low greenhouse gas emissions, greater use of renewable energy sources, and increased energy efficiency [8,9].

In this sense, an important role is played by the actions of supporting alternative economic elements through introducing the concept of the "Green Economy" [11]. The green economy offers opportunities to all states, regardless of their degree of development and economic structure [12]. Moreover, the green economy has been discussed in terms of the main tools used to achieve the process of sustainable development.

The perspectives offered by both the green and circular economy consider an extended approach to sustainable development with common actions employed to protect the environment and to increase both the competitiveness and the productivity of the resources relevant to every economy [13,14]. In view of the above factors, developed countries should provide financial support to help emerging countries reduce their carbon emissions, adapt to the consequences of climate change, and supplement their disaster-related funds in response to the COVID-19 crisis [15,16].

There is no doubt that the COVID-19 pandemic is an alarm signal that draws our attention to the fact that a return to the previous normal will be detrimental to the environment and human health because it puts the profit before the real cost of a balanced life, and therefore a new development model must be radically redefined [4,11,15]. Any positive and visible impact of reducing energy consumption and greenhouse gas emissions will only be temporary in the absence of a radical change in the direction of political will towards less polluting and sustainable solutions [8–10].

In this context, the central theme of the article presents, with the help of quantitative methods, the assessment of the impact of economic and supply shock on the environment, so that the present research answers a relevant question: Is the COVID-19 crisis, in addition to all its known threats, an opportunity for the transition to a green economy?

To perform the present analysis, a macroeconomic model was applied to estimate the impact of the shocks of supply and demand in the economy generated by the COVID-19 crisis at the level of the Member States of the European Union. The results obtained in estimating the impact of the two economic shocks on the level of greenhouse gas emissions will afford a better understanding of the current situation and will make it possible to take appropriate measures in the future. This requires consideration of structural paradigm shifts due to the coronavirus crisis that can go hand in hand with economic and environmental reforms so that 2020 can be a cornerstone not only for climate negotiations but also for the future world economy [15]. Thus, through the research question, this article can be considered as a reflection on the ambitions of climate neutrality in Europe, during the Covid-19 epidemic. Even more, it can reinforce the idea that a global health crisis is not the answer to greenhouse gas emissions, but the phenomenon can give us the chance to choose a new mentality in terms of the effects that human activities have on the planet.

From a practical point of view, the findings of this study also indicate that understanding the nature of this pandemic crisis and their impacts will require dedicated attention, because there should be some limits for scarifying economic and social goals in favor of ecological goals. In addition, a socially equitable transition, planned and implemented in the long run, is the only way to build a resilient society with a strong and sustainable economy. It is hoped that this study will lay a foundation for further research in this area and support enhanced closer cooperation from policy-makers on this critical matters, thus respecting the commitments made under the European Green Pact.

The rest of this paper is organized as follows: Section 2 provides a brief presentation of the literature, Section 3 provides the methodology, Section 4 analyses the empirical results and discussions the implications, and Section 5 presents the conclusions.

2. Literature Review

In recent years, the concept of the green economy has been increasingly discussed. Indeed, the concepts of the circular economy and the green economy are part of the concept of sustainable development advanced in 1987 by the Brundland Commission [14]. The plan for a green economy was first presented in 1989 in the Blueprint for a Green Economy by a group of environmental economists. This blueprint included a series of practical measures and policies for greening modern economies and ordering them in the context of sustainable development [11,13].

Later in 2008, this concept was revived in the context of discussions on the policy response to multiple global crises. At the same time, other publications of United Nations Environment Programme (UNEP) (2011), UNCTAD (2011), UN DESA (2011), and UNCSD (2011) considered the concept of the green economy and sought to outline a series of guidelines, benefits, and risks in implementing this economy [13]. In addition, there have been a number of non-governmental organizations and partnerships concluded in recent years that aimed to promote the green economy as a concept along with employment, research, analysis, and information [11].

Discussions with a particular focus on the transition to a green economy were addressed at the 2012 UN Conference on Sustainable Development (Rio + 20), giving a strong signal to governments, businesses, and civil societies around the world on the transformation of the green economy for sustainable development and poverty eradication [17].

The concept of the green economy is increasingly used at the international level. The Paris Agreement signed at the XXI Conference of the Parties (COP 21) to the UN Framework Convention on Climate Change represented a major global decision to reduce the global average temperature growth by 2 °C. Moreover, the Batumi Green Economy Initiative (BIG-E) envisages a pan-European strategic framework for the transition to an inclusive green economy. However, in addition to these frameworks, a number of other important initiatives can be listed (Table 1) [18].

Table 1. Initiatives related to the implementation of the green economy concept [18].

	Initiatives	Initiative Presentation
1	Green Growth Knowledge Platform (GGKP)	The GGKP brings together a number of international experts working in the field of the green economy and participates annually in a conference dedicated to this platform in connection with the conference organized by the OECD.
2	Partnership for Action on Green Economy (PAGE)	Launched in 2013, the Green Economy Partnership for Action (PAGE) was designed to support countries considering implementing a green approach to the economy.
3	Green Industry Platform	The platform initiated by UNIDO with UNEP being invited to involve national governments, as well as the private sector and NGOs, in the field of green industry around the world.
4	WIPO Green—The Sustainable Technology Marketplace (WIPO)	An initiative of the World Intellectual Property Organization (WIPO) that facilitates the adoption and implementation of environmental technologies, mainly in countries with emerging economies.
5	Greening Economies in the European Union's Eastern Neighbourhood (EaP GREEN)	EaP Green is structured in three components and aims to support the six Eastern Partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine) in order to progress towards a green economy by separating economic growth from environmental degradation and resource depletion.
6	SWITCH to Green Facility	A platform that facilitates cooperation to improve international progress towards the transition to a green economy.
7	GreenEcoNet	An initiative funded by the European Commission is being developed by six European research partner organizations to present a range of SMEs that have implemented sustainable business models.

The transition to a green economy must equally consider three dimensions of interconnected politics. The first dimensions relate to large investments in the process of the sustainable development of resources and natural capital; then, the right markets and regulatory conditions must be established, and, at the same time, the administration must be improved, along with an increase in private sector involvement [19–21]. On that basis, sustainable economic development must achieve a type of economy (green economy) based on reducing energy and obtaining clean energy, which will contribute to the creation of green jobs [22]. Moreover, the transition to the green economy involves a major concern based on adequate knowledge, research, and innovation to create a framework for promoting long-term sustainable development [23].

Another vision of the green economy is as a process of transformation that eliminates the dysfunctions of the current economy and aims to achieve human well-being and, at the same time, equitable access to opportunities for all people, while protecting economic and environmental integrity—i.e., the economy cannot be green without being equitable [24–26]. In 2012, at the UN Conference on Sustainable Development, the Green Economy Coalition, after a series of consultations with organizations around the world, proposed a series of principles in favor of supporting the green economy—an economy that is fair and favorable to social inclusion, thereby offering a better quality and more ecological life [27,28]. Since 2015, those campaigning for an inclusive green economy have worked together to build social, economic, and environmental resilience, both globally and locally, through policy reforms that reduce system vulnerabilities.

At the level of the European Union, the implementation of the circular economy reflects the European Union's direct awareness of the environment [29]. However, Europe's goal is to achieve climate neutrality through gradual and irreversible reductions and long-term goals, in order to build a resilient economy and a resilient society, and not through disruptive shocks [28]. Indeed, the European Commission in 2015 presented an ambitious plan related to environmental protection for a circular economy that reuses all available resources, replacing the so-called linear economy in which citizens consume and throw away resources [28]. The European Commission has also considered a number of elements that comprise the green economy. These include innovation, resource efficiency, promoting sustainable production and consumption patterns, waste prevention and management, and water resources management [30].

Among the priorities to be considered are recovery efforts for greening that can help the world's states better rebuild after the pandemic to increase resilience against future crises, ensuring a healthy environment that supports citizens. In this regard, green fiscal policies can play a major role in countries' recoveries by eliminating the inefficiency of public spending and increasing additional tax revenues that can be directed to immediate COVID-19 aid measures, while supporting medium- and long-term investment and planning for a more sustainable, resilient, and inclusive future [31–33].

The UNESCO report presents five important areas to ensure the transition to the green economy: education (to change behaviors and attitudes that are necessary for sustainability), science, innovation, and new technology that will lead to sustainable development. Culture must also consider new approaches to the development process. Moreover, information is very important in the process of the transition to the green economy, and the management of water systems must also be changed [31].

Another report presented three objectives that underlie the transition to the green economy (economic recovery, poverty eradication, and reduction of carbon emissions), but the fulfillment of these objectives is related to the allocation of financial resources from the state [34]. In the same way, the UNEP report, ILO (2011), highlights the so-called ecological jobs that will be found in agriculture, industry, research, development, and services that will contribute to preserving and increasing the quality of the environment. However, the report states that there will be both winners and losers and that the proposed public policies should reduce these differences [35].

At the same time, other authors noted that the business responses to climate change are also a part of the transition to a green economy [36–40]. In this economy, carbon emissions are reduced, resources are efficient, and emphasis is placed on social inclusion. Moreover, these authors note that in a green economy, increasing income and employment can generate both public and private investments aimed at reducing carbon emissions, improving resource efficiency, and reducing biodiversity loss. Firms can accelerate this transition by aligning their investments in the context of climate change, thereby changing their opportunities for adaptation and participating in the process of greening the economy [36].

Rizos et al. [41] noted that the costs of circular measures should be considered, taking into account the risks in the current business environment, as well as the long-term prospects. However, decision makers must evaluate concrete proposals before moving on to the application of this type of economy. Indeed, the circular economy and the green economy, as tools in the process of sustainable development, pursue key objectives that will lead to economic growth, job creation, reduction of carbon emissions, and environmental protection [42].

On the other hand, the crisis related to the spread of the COVID-19 pandemic represents an epoch-defining event destined to generate strong economic and social consequences. Moreover, the crisis has achieved an impact on the environment, with high costs for well-being and the economy. The response to climate change must be carefully planned, inclusive, and more sustained [43,44]. Thus, the coordinated economic response to the COVID-19 epidemic caused the cost of living to increase more than the income and affected people's satisfaction with living standards. For example, in China, at the economic level, the gross domestic product has decreased significantly; moreover, industrial activity and the volume of transport have decreased, reducing pollution by decreasing (CO2) emissions [45].

The COVID-19 pandemic has profoundly changed our daily lives in many ways, and the authorities' responses to this global challenge have involved quarantines and isolation to prevent the transmission of the virus and infection of the population. The effects of these measures did not take long to appear, including blocking the functioning of the economy under normal parameters, increasing unemployment, and leading to the loss of businesses [46–48]. Nevertheless, the isolation imposed during the COVID-19 pandemic crisis has helped reduce carbon emissions, improve air quality, and reduce noise—goals that were expected to be achievable only in a few years [47]. According to the Global Energy Review report [49], CO2 emissions fell the most in regions that suffered the greatest impact from COVID-19 (China −8%, European Union −8%, and United States −9%). However, it is not yet known to what extent the COVID-19 pandemic will continue to affect annual CO2 emissions, especially since no quantitative assessment has been made of the decrease in CO2 due to the pandemic [50,51]. In addition, the COVID-19 crisis will eventually produce negative and significant indirect effects on the environment. Although the decrease in CO2 concentrations has produced a positive impact on the environment in a short period of time, this impact is not a sustainable way to clean the environment. With the end of the pandemic, there will eventually be a revival of the state economy, leading at the same time to an increase in carbon emissions [52,53].

Other studies show a positive relationship between emissions of carbon dioxide, the most important greenhouse gas (GHG) involved in global warming, and GDP per capita [54,55]. According to a previous study [3,56], financial markets around the world have suffered heavy losses, especially in the first months after the crisis.

For the COVID-19 crisis, the international community must take concrete action related to financial collapse, economic systems, global climate change and the environment, and growing inequalities [57]. Moreover, the COVID-19 pandemic triggered a series of shocks related to the supply and demand of the economy, such as the shock of liquidity, uncertainty, and a shock to the financial sector [58]. As a result, government action and post-crisis economic incentives could have a global impact on CO_2 emissions for decades [4,15].

However, before COVID-19 is cured, mankind needs a "careful vaccine against the viruses of the mind".

3. Materials and Methods

The year 2020 represents the end point of the last financial cycle over an interval of over 10 years. However, unlike the crises that took place during the 21st century (e.g., the crisis of 2007–2008 or that at the beginning of the 2000s), the present crisis has introduced several novel factors. The first, and perhaps most important, is the generating element of the crisis, which, unlike previous situations, was not an element within the financial system (endogenous) but an exogenous element, foreshadowed by a health crisis that quickly echoed its effects in the economic sector and beyond. The second element of novelty is related to the origin of the economic shock—more precisely, whether the health context manifested itself as a shock on the demand side or on the supply side in the economy.

Until now, economic crises resulted either as a result of a shock to demand or as a result of a shock to supply. In the case of the COVID-19 crisis, the shock came from both components of the economy. The pandemic limited the possibility for large masses of people to continue their professional activities due to the measures of physical distancing, which affected production capacity and ultimately the aggregate supply of the economy. At the same time, because a state of emergency or a state of alert was established in most states, the possibility for citizens to exercise their right to free movement was also limited, which is why the consumption of goods and services was also limited, which ultimately affected aggregate demand, as can be seen in Figure 1.

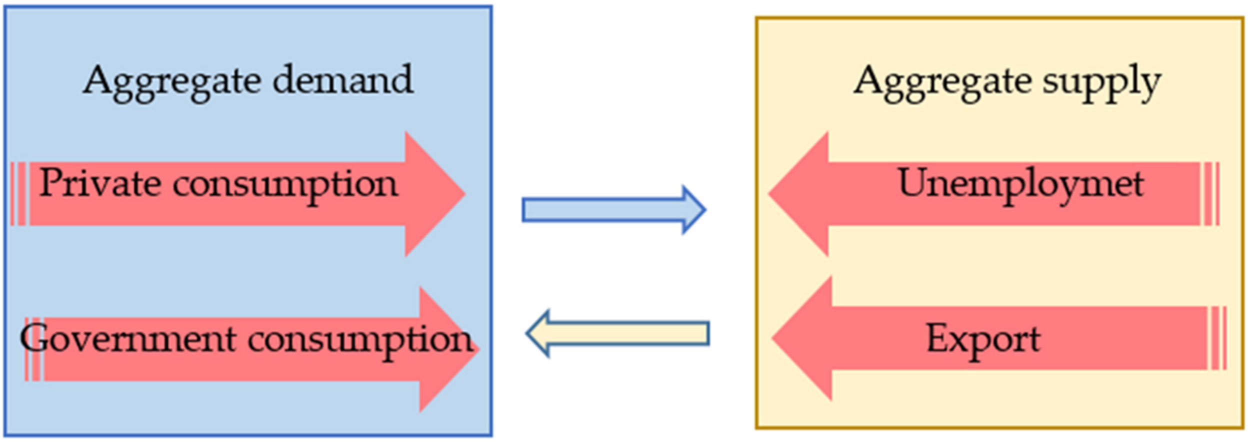

Figure 1. The effects of the COVID-19 crisis on the global economy.

Figure 1 also took into account a set of variables that were severely affected during the COVID-19 pandemic: private consumption as a result of households reaction, government consumption as a result of all the measures it took to stimulate the economy, the unemployment rate due to the whole context that made it impossible for a large part of the employees to work for the situations where work from home is impossible, and the export, due to the way in which trade flows between states were influenced, taking into account all traffic restrictions from this period. Practically, governmental and public consumption has directly and strongly influenced the aggregate demand, while the unemployment rate but also the level of exports has strongly and directly influenced the aggregate supply. The export component was put on the supply side because due to the traffic restrictions that have been implemented, many companies have been unable to deliver or carry out activities outside of the country (for example, the companies that export a large part of their products), but due to all of the restrictions, the time until the products reach the recipient state has been increased sharply, situation which gave an incentive to some of these companies to reduce their supply in order not to stay with it in the form of inventories.

The social and economic effects generated by the context of the COVID-19 pandemic were also reflected in other aspects such as climate, with the quantification of these effects providing the subject of the present analysis. Specifically, the impact of the economic shock of supply and demand on the environment will be assessed in the quantitative section. The supply side shock will be quantified by the industrial Production Index (PI), which is an aggregate measure of the level of production of goods in the economy. The shock on the demand side will be quantified by the industrial turnover (TI) index. The element through which the effect on the environment will be quantified is the level of greenhouse gas (GS) emissions.

Because the units of measurement of the three variables are different, standardization was performed using the logarithmic and difference operators, so all variables are expressed as a percentage:

$$\ln\left(\frac{GS_{t+1}}{GS_t}\right) = \gamma_1 \pm \gamma_2 \times \ln\left(\frac{PI_{t+1}}{PI_t}\right) \pm \gamma_3 \times \ln\left(\frac{TI_{t+1}}{TI_t}\right) + \varepsilon_{t+1}. \quad (1)$$

In a simpler form, the above equation can be written as

$$GS^{\nabla}_{t+1} = \gamma_1 \pm \gamma_2 \times PI^{\nabla}_{t+1} \pm \gamma_3 \times TI^{\nabla}_{t+1} + \varepsilon_{t+1}, \quad (2)$$

where GS^{∇}_{t+1} represents the rate of change (increase or decrease) in the level of greenhouse gas emissions from year $t+1$ compared to the previous year t. Further, PI^{∇}_{t+1} and TI^{∇}_{t+1} represent the rate of change in the level of the industrial production index and the turnover index from year $t+1$ compared to the previous year, respectively. In this way, we dynamically illustrate the impact of both supply and demand shocks on the proxy variable for the environment.

However, the two shocks make their presence felt as a result of the effects of a greater accumulation of macroeconomic variables. Thus, here, we illustrate the equation of supply and demand, after which the quantitative impact will be used to quantify the shocks:

$$\begin{cases} PI^{\nabla}_{t+1} = \lambda_1 \pm \lambda_2 \times UR_{t+1} \pm \lambda_3 \times \ln\left(\frac{EX_{t+1}}{EX_t}\right) + \lambda_4 \times \ln\left(\frac{LP_{t+1}}{LP_t}\right) + \theta_{t+1}, \\ EX^{\nabla}_{t+1} = \ln\left(\frac{EX_{t+1}}{EX_t}\right), \\ LP^{\nabla}_{t+1} = \ln\left(\frac{LP_{t+1}}{LP_t}\right), \end{cases} \quad (3)$$

where UR_{t+1} represents the unemployment rate in year $t+1$, the variable EX^{∇}_{t+1} represents the rate of change at the level of exports, and the variable LP^{∇}_{t+1} represents the annual rate of change in labor productivity. The demand equation uses the following system:

$$\begin{cases} TI^{\nabla}_{t+1} = \mu_1 \pm \mu_2 \times \ln\left(\frac{CP_{t+1}}{CP_t}\right) \pm \mu_3 \times DB_{t+1} + \theta_{t+1}, \\ CP^{\nabla}_{t+1} = \ln\left(\frac{CP_{t+1}}{CP_t}\right), \end{cases} \quad (4)$$

where DB_{t+1} represents the budget deficit in year $t+1$, and variable CP^{∇}_{t+1} represents the rate of change at the level of private consumption in year $t+1$ based on year t. Following the econometric analysis, the equations described above will take the following form:

$$\begin{cases} \check{GS}^{\nabla}_{t+1} = \gamma_1 \pm \gamma_2 \times \check{PI}^{\nabla}_{t+1} \pm \gamma_3 \times \check{TI}^{\nabla}_{t+1}, \\ \check{PI}^{\nabla}_{t+1} = \lambda_1 \pm \lambda_2 \times \overline{UR_{t+1}} \pm \lambda_3 \times \overline{EX^{\nabla}_{t+1}} \pm \lambda_4 \times \overline{LP^{\nabla}_{t+1}}, \\ \check{TI}^{\nabla}_{t+1} = \mu_1 \pm \mu_2 \times \overline{CP^{\nabla}_{t+1}} \pm \mu_3 \times \overline{DB_{t+1}}. \end{cases} \quad (5)$$

Then, the cumulative impact of supply and demand shocks at the level of greenhouse gas emissions takes the following analytical form, through which we estimate the potential effects of the COVID-19 pandemic through economic levers on the quality of the environment:

$$\check{GS}^{\nabla}_{t+1} = \gamma_1 \pm \gamma_2 \left[\lambda_1 \pm \lambda_2 \times \overline{UR_{t+1}} \pm \lambda_3 \times \overline{EX^{\nabla}_{t+1}} \pm \lambda_4 \times \overline{LP^{\nabla}_{t+1}}\right] \pm \gamma_3 \left[\mu_1 \pm \mu_2 \times \overline{CP^{\nabla}_{t+1}} \pm \mu_3 \times \overline{DB_{t+1}}\right], \quad (6)$$

$$\check{GS}^{\nabla}_{t+1} = \gamma_1 \pm \gamma_2 \times \lambda_1 \pm \gamma_3 \times \mu_1 \pm \gamma_2 \times \lambda_2 \times \overline{UR_{t+1}} \pm \gamma_2 \times \lambda_3 \times \overline{EX^{\nabla}_{t+1}} \pm \gamma_2 \times \lambda_4 \times \overline{LP^{\nabla}_{t+1}} \pm \gamma_3 \times \mu_2 \times \overline{CP^{\nabla}_{t+1}} \pm \gamma_3 \times \mu_3 \times \overline{DB_{t+1}}. \quad (7)$$

Using the variable change operation, the system of equations through which the effect of the economic shocks generated by the COVID-19 crisis at the level of greenhouse gases can be estimated as follows:

$$\begin{cases} \check{GS}^{\nabla}_{t+1} = \zeta_1 \pm \zeta_2 \times \overline{UR_{t+1}} \pm \zeta_3 \times \overline{EX^{\nabla}_{t+1}} \pm \zeta_4 \times \overline{LP^{\nabla}_{t+1}} \pm \zeta_5 \times \overline{CP^{\nabla}_{t+1}} \pm \zeta_6 \times \overline{DB_{t+1}} \\ \zeta_1 = \gamma_1 \pm \gamma_2 \times \lambda_1 \pm \gamma_3 \times \mu_1 \\ \zeta_2 = \gamma_2 \times \lambda_2 \\ \zeta_3 = \gamma_2 \times \lambda_3 \\ \zeta_4 = \gamma_2 \times \lambda_4 \\ \zeta_5 = \gamma_3 \times \mu_2 \\ \zeta_6 = \gamma_3 \times \mu_3. \end{cases} \quad (8)$$

The econometric analyses were performed by means of multiple regressions applied to structured observations (panel type). Thus, the countries of the European Union were included in the analysis range. The United Kingdom was excluded due to the Brexit event and Ireland was excluded due to the lack of data for the set of variables within the model. The analysis period covers 2010–2018, with each of the three regression equations having over 200 observations. The econometric program used to perform the analyses was Eviews 10.

4. Results and Discussion

The results obtained from the analyses are presented in the following section in three stages. In the first stage, through the dynamics of a set of exogenous variables, the extent of the impact of the health crisis on the demand side will be analyzed. In the second stage, the same mechanism will be applied to a set of exogenous variables specific to the aggregate supply to quantify the impact on the supply side. In the third stage, we quantify the impact of the two previously calculated shocks on the proxy variable for the green economy based on the level of greenhouse gas emissions. All these macroeconomic links are analyzed in the context of the COVID-19 health crisis. Based on the results obtained, it will be possible to determine whether, from the point of view of climate risk, the effect of the pandemic was positive, negative, or neutral.

Figure 2 illustrates that millions of tonnes of greenhouse gases are emitted by each Member State in the European Union each year. This is why the potential climate problems are increasing every year.

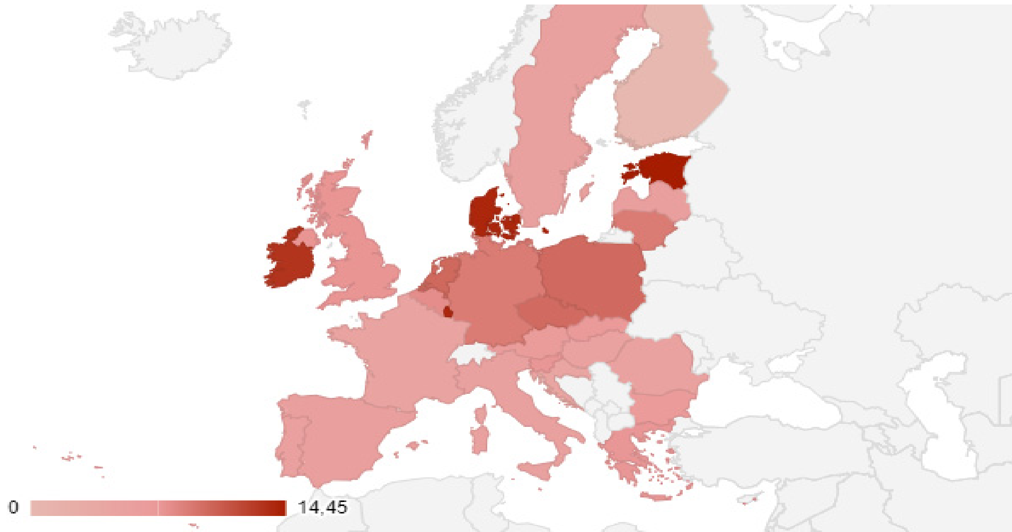

Figure 2. The level of greenhouse gas emissions in the EU Member States in 2018 [59,60]. Note: Greenhouse gas emissions are expressed as millions of tons per million inhabitants.

The current crisis has once again demonstrated how vulnerable humanity is to an unforeseen shock of global proportions. One of the areas that would have the potential to create global problems of a similar magnitude is climate risk.

In the first stage of the analysis, we quantify the shock on the demand side felt as a result of the socio-economic context generated by the pandemic. Thus, in the econometric model, a proxy variable was selected in the first phase to illustrate this shock as accurately as possible. Following the analyses, the most appropriate choice was the turnover index. This variable directly illustrates the level of sales made by companies in the industry and is strongly influenced by macroeconomic variables that determine aggregate demand—namely, private consumption and government consumption. Following the econometric analysis, at the level of the European Union countries during the last financial cycle, the link between the exogenous variables and the proxy variable illustrating the shock on the demand side took the following form (Table 2).

Table 2. Econometric results of the first regression model.

Dependent Variable: TURNOVER_INDEX (TI^{∇}_{t+1})				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
PRIVAT_CONSUMPTION (CP^{∇}_{t+1})	0.941655	0.136238	6.911833	0.0000
BUDGETARY_DEFICIT (DB_{t+1})	−0.391679	0.139234	−2.813106	0.0053
C	0.003682	0.007428	0.495606	0.6206
R-squared	0.115788			
Adjusted R-squared	0.111976			
F-statistic	30.38044			
Prob(F-statistic)	0.000000			

Source: authors' processing based on data provided by Eurostat [59].

According to the results in Table 2, all coefficients of the independent variables are statistically significant at probability levels of 90, 95, and 99%. This fact highlights the existence, scope, and direction of the link between these macroeconomic variables. From the perspective of the direction of these links, an increase in the dynamics of private consumption also generates an increase in the dynamics of the turnover index. Analyzing the impact of the second component, the budget deficit (which is a proxy for the level of public consumption above the equilibrium level), shows that an increase in this indicator leads to a decrease in the level of the turnover index.

In quantitative terms, however, the variable that replaces the private consumption component tends to show a much stronger impact than that represented by public consumption on the dynamics of the turnover index—i.e., on aggregate demand. If a budget equilibrium were to be reached (zero budget deficit), and the level of private consumption remained unchanged ($CP^{\nabla}_{t+1} = 0$), then the dynamics of the turnover index would be only 0.36% and could be based on macroeconomic elements outside the national economy. However, taking into account the results of the statistical test t, this last parameter can vary significantly in the real economy compared to the level recorded in the analysis.

From a mathematical point of view, the relation illustrated above can be written as follows:

$$\check{TI}^{\nabla}_{2020} = 0.003682 + 0.9416 \times \overline{CP^{\nabla}_{t+1}} - 0.391679 \times \overline{DB_{t+1}}. \quad (9)$$

Following the analyses carried out by the European Commission for the first set of estimates of the dynamics of the most important macroeconomic variables for 2020 (the spring forecast) [61], the estimated level expected to be reached by the independent variables within the model was published as $\overline{CP^{\nabla}_{2020}}$ and DB_{2020} in 2020 (Table 3).

Table 3. European Commission spring forecast for independent variables in the model.

	2019	2020	2021
Annual dynamics of private consumption at the EU level	1.3%	−9.0%	7.1%
The deficit budget at the EU level	0.6%	8.3%	3.6%

Source: authors' processing based on data provided in [61].

Figure 3 provides a graphical representation of the expected dynamics of the budget deficit along with the effects of these dynamics on the formation of public debt. An important factor to note here is that the level of both deficit and public debt forecasting for 2020 are well above the levels recorded in the previous economic crisis but also above the level recorded during the sovereign debt crisis.

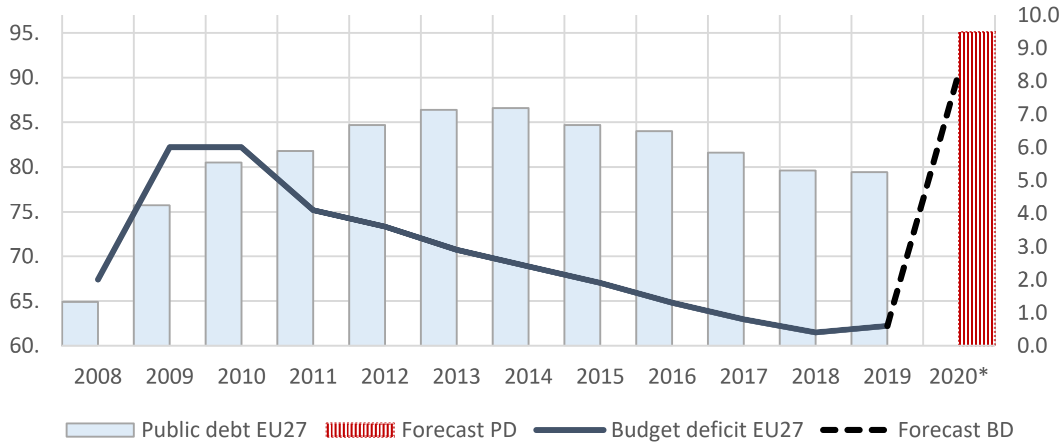

Figure 3. The evolution of the EU budget deficit and public debt (27) in the pre- and post-pandemic period. Source: authors' processing based on data provided by Eurostat [59]. * estimated values.

Starting from the coefficients estimated by the previous econometric model and including the values forecasted by the European Commission for the independent variables, a preliminary forecast was made for the proxy variable related to the shock on the demand side. Thus, following the calculations, by the end of 2020, this variable should register the following dynamics: $\check{TI}^{\nabla}_{2020} = -11,3571\%$. This result illustrates that, in terms of the level of the turnover index and considering the projected developments in private consumption alongside the budget deficit, a decrease of around 11.35% is expected by the end of 2020, which would be equivalent to the demand shock created by the COVID-19 crisis.

In the second stage of the analysis, the form of the supply shock felt as a result of the economic context and the measures generated by the pandemic is calculated. The macroeconomic variable used as a proxy and a true illustration of this shock in the analysis is the industrial production index. The macroeconomic variables that determine this shock are the unemployment rate, the dynamics of labor productivity, and the rate of change in the value of exports. Each of these three elements are known for their very important contribution to both capacity and production needs, ultimately affecting the aggregate supply. Following the econometric analysis performed for the last financial cycle, the following macroeconomic links were discovered (Table 4).

Table 4. Econometric results of the second regression model.

Dependent Variable: IND_PROD_INDEX (PI^{∇}_{t+1})				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
UNEMPLOYMENT (UR_{t+1})	−0.092195	0.051555	−1.788303	0.0750
LABOUR_PRODUCTIVITY (LP^{∇}_{t+1})	1.204282	0.139974	8.603602	0.0000
EXPORT (EX^{∇}_{t+1})	0.075970	0.020335	3.735959	0.0002
C	0.016788	0.005837	2.875980	0.0044
R-squared	0.341767			
Adjusted R-squared	0.333181			
F-statistic	39.80674			
Prob(F-statistic)	0.000000			

Source: authors' processing based on data provided by Eurostat [59].

Similar to the first and second econometric models, the coefficients of the dependent variables are significantly different from zero, with some showing a significance level of 90% and others as high as 99%. For this reason, the three variables indicate a significant impact on the dynamics of the industrial production index. Regarding the direction of influence in this situation, there are two variables that generate an increase and one that causes a decrease of the proxy variable for the aggregate supply. Specifically, an increase in the unemployment rate has the effect of lowering the industrial production index, which is an economically sound situation given that the main factors of production are labor and capital. Thus, when either of these two factors decreases, the level of production also decreases, generating a decrease in aggregate supply.

As materialized in the dynamics of exports, an increase in the second variable has a direct proportional effect on the industrial production index. Again, this effect was also predictable from an economic point of view because when the level of exports increases, higher production must be achieved to cover domestic demand, giving the industrial production index important potential for growth.

The third variable has a dynamic that is also positively correlated with a change in the dependent variable. Thus, an increase in labor productivity has a direct effect, according to economic theory, leading to an increase in the production capacity and ultimately the aggregate supply in industry. However, among the three factors whose impacts were explained earlier, the effect of a marginal increase in labor productivity tends to be the element through which a much stronger result is expected than an equivalent marginal increase in exports or an equivalent decrease in labor productivity or unemployment rate. Given that the labor market would be in equilibrium (without unemployment) with a constant level of labor productivity, and exports would also remain constant, the industrial production index would increase by 1.67%, an increase that would be achieved based on the dynamics of other factors, either production or macroeconomics, in the domestic economy.

Mathematically, the above relation takes the following form:

$$\check{PI}^{\nabla}_{t+1} = 0.016788 + 0.07597 \times \overline{EX^{\nabla}_{t+1}} - 0.092167 \times \overline{UR_{t+1}} + 1.204282 \times \overline{LP^{\nabla}_{t+1}}. \quad (10)$$

The forecast values for the independent variables for 2020 are also found in the European Commission's spring forecast outlined in Table 5 [61].

Table 5. European Commission spring forecast for independent variables in this model.

	2019	**2020**	**2021**
Expected annual dynamics at the level of exports	2.2%	−11.5%	8.4%
Projected level of unemployment rate at the EU level	6.7%	9.0%	7.9%
Projected annual labor productivity dynamics	0.5%	−3.2%	2.7%

Source: authors' processing based on data provided in [61].

One of the macroeconomic variables that was strongly affected by the current health crisis was the unemployment rate because, unlike other global economic crises, to reduce the number of infected people, public authorities have engaged social distancing measures since the virus began to spread. This fact, in addition to the social implications, also had strong economic implications, as for many employees, it was impossible to substitute their daily activities with work from home, the main alternative during the pandemic. As a result, the unemployment rate has risen sharply, as can be seen in Figure 4. In countries such as the Czech Republic, the projected unemployment rate by the end of 2020 has been estimated to be more than double the level recorded in 2018, indicating that the effects of the pandemic on the labor market have been very strong.

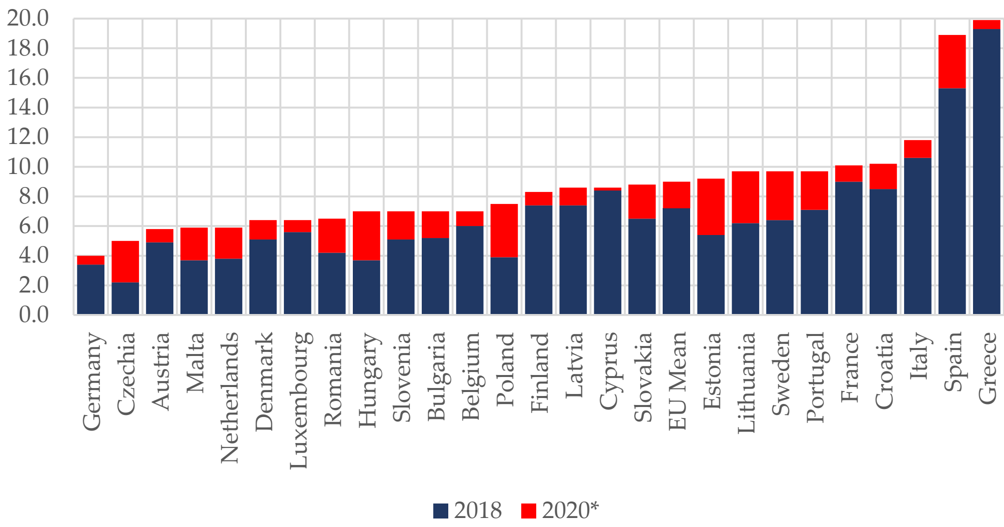

Figure 4. Evolution of the unemployment rates in the Member States of the European Union in the pre- and post-pandemic period. Source: authors' processing based on data provided by Eurostat [59]. * estimated values.

Replacing the values forecasted by the European Commission in the relationship resulting from the econometric model illustrated above, the industrial production index is estimated to record the following dynamics: $\check{PI}^{\nabla}_{2020} = -5.54\%$. According to the estimates of the econometric model, a decrease of 5.54% is expected by the end of 2020 as a result of the impact of the three macroeconomic factors mentioned above. An important factor that emerged from the econometric model is that, in terms of quantity, the impact of the demand shock was much higher than that of the supply shock as a result of the economic context generated by the COVID-19 pandemic.

The third stage of the analysis brings together the results obtained in the first two stages to illustrate the impact of the economic shocks generated by the COVID-19 crisis on the climate to answer the fundamental issue addressed in this analysis. From an econometric point of view, the estimated effect of supply and demand shock on the level of greenhouse gas emissions was analyzed at this stage to ultimately provide a quantitative forecast of the impact of the current macroeconomic context in the climatic sphere. The third econometric model illustrates the link between the turnover index, the proxy for the economic effect on demand, and the level of greenhouse gas emissions (Table 6).

Table 6. Econometric results of the third regression model.

Dependent Variable: GREENHOUSE_GAS (GS_{t+1}^{∇})				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
TURNOVER_INDEX (TI_{t+1}^{∇})	0.273918	0.049696	5.511846	0.0000
C	−0.018436	0.003773	−4.886260	0.0000
R-squared	0.115788			
Adjusted R-squared	0.111976			
F-statistic	30.38044			
Prob(F-statistic)	0.000000			

Source: authors' processing based on data provided by Eurostat [59].

Firstly, this model is also statistically significant, with all its coefficients significantly different from zero at a confidence level of 99%. The sign of the factor variable coefficient is positive, so increases in the dynamics of the industry turnover index are increased in the dynamics of greenhouse gas emissions. This link is also visible in the real economy, where the increase in demand leads to an increase of production and greater potential in this process, thereby increasing the level of greenhouse gas emissions. Table 7 illustrates the quantitative results of the economic impact generated by the supply area on greenhouse gas emissions.

Table 7. Econometric results of the third regression model.

Dependent Variable: GREENHOUSE_GAS (GS_{t+1}^{∇})				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
IND_PROD_INDEX (PI_{t+1}^{∇})	0.489545	0.064872	7.546359	0.0000
C	−0.021383	0.003555	−6.014404	0.0000
R-squared	0.197086			
Adjusted R-squared	0.193625			
F-statistic	56.94754			
Prob(F-statistic)	0.000000			

Source: authors' processing based on data provided by Eurostat [59].

This model is similar to the previous model, and all parameters within it are statistically significant. Regarding the sign of this link, the results of the econometric model show that an increase in the dynamics of the industrial production index leads to an increase in the dynamics of greenhouse gas emissions. The econometric link is also confirmed in the real economy by the fact that an increase in the level of production generates a higher consumption of material resources, indicating the potential to increase the level of greenhouse gas emissions.

Taking into account the results obtained from the last two regression models, presented in Tables 6 and 7, together with the results obtained from the previous regression models (Tables 2 and 4), a preliminary estimate can be made regarding the dynamics able to be recorded by the greenhouse gas emissions indicator in 2020 as an effect of the economic transformations generated by the COVID-19 pandemic.

Considering the fact that both the industrial production index and the turnover index showed a decreasing trend, this variable may also have a downward dynamic. In quantitative terms, following the calculations, the index's dynamics take the value $\check{GS}^{\nabla}_{2020} = -9.8\%$.

Finally, following the results obtained in previous econometric models used as the basis for the forecast calculations, it is estimated that by the end of 2020, the level of greenhouse gas emissions will decrease by about 10% (Figure 5).

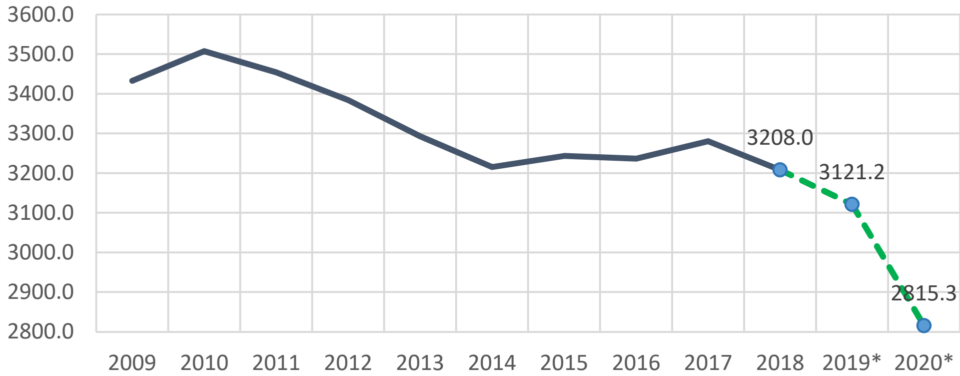

Figure 5. Forecast of the dynamics of greenhouse gas emissions, following the COVID-19 crisis. Source: authors' processing based on data provided by Eurostat [59]. * estimated values.

Through our analysis, we observed important effects in the direction of mitigating climate risk, a risk that currently has significant potential to generate unanticipated systemic shocks in the global economy. We hope that our study will lay the foundation for further research in this area and foster enhanced understanding and closer cooperation between the scientific community and policy makers at the level of greenhouse gas emissions and other critical matters. There is much to be gained by facilitating effective decision-making that can help identify actions to avert and both address and minimize the levels of greenhouse gas emissions.

During this period, a slightly different perspective appeared and the current crisis also shows us why it is necessary for the transition to be fair, in order to provide new opportunities and support to those most affected. In addition, a socially equitable transition, planned and implemented in the long run, is the only way to build a resilient society with a strong and sustainable economy.

As a result of the study, one question should be added to future research: What happens beyond the adaptation to the COVID-19 pandemic? Clearly, more studies on the climate change impacts faced by vulnerable communities are needed. Learning from the COVID-19 pandemic could, moreover, be a precursor to the international debate on decreasing the levels of greenhouse gas emissions. Taking into account the particularities of 2020, and the fact that among all the negative effects, this situation has the potential to generate a reduction of the greenhouse gas emissions and noise, our recommendation is to implement a legislative framework through which the employees of the companies continue to work from home one or two days a week, even when the COVID-19 pandemic will be over. This recommendation could give an incentive to reduce the pollution that is created through the daily commute that must be made between home and work.

A limitation of this article is that the analysis did not include the component of private investment strictly for econometric reasons, by including a large number of variables, based on a relatively small data range only decreases the significance of the parameters, which is why we selected only the most important variables, whose impact was very strongly noticed during the COVID-19 pandemic period. We need to mention that the impact of the COVID-19 crisis on private investment is a research topic that could be addressed in a future article.

5. Conclusions

The COVID-19 pandemic ended the last economic cycle, generating strong repercussions in all countries of the world. The first effects felt were sanitary ones, but with the implementation of social distancing measures, the impact was quickly reflected in the economic system, through shocks at both the level of demand and at the level of aggregate supply.

Economic developments are closely linked, inter alia, to climate effects, which is why the impact of the COVID-19 pandemic has been indirectly felt in this area, as well. Thus, the goal of this research was to analyze the effects of the economic supply and demand shocks on the environment generated by the COVID-19 crisis, precisely to determine whether, in addition to the known negative effects of the health crisis, there are other sectors in which opportunities have materialized during this period.

The first part of this analysis quantified the shock at the level of aggregate demand, conditioned by the socio-economic context of the pandemic. Using both private sector and government sector variables, a preliminary measurement of the economic shock was estimated. At the EU level, current estimates show that, as a result of the demand shock, the turnover index will decrease by about 11.35% by the end of 2020.

The second part of the analysis quantified the shock at the level of aggregate supply, starting both from the context of labor market dynamics at the national level and from the evolution of transactions with foreign economies. In this way, both the internal and external elements of national economies were included, allowing a measurement of the supply shock at the level of the economy to be estimated. At the EU level, the model estimates illustrate that due to the supply shock, by the end of the year, the industrial production index will decrease by about 6%.

The third part of the analysis brought together the results obtained in the first two stages to illustrate the impact of the economic shocks generated by the COVID-19 crisis on the climate sphere. At this stage, the estimated effect of the supply and demand shock on the level of greenhouse gas emissions was particularly focused upon.

The results of the model also show that, during the current year at the level of the European Union, the amount of greenhouse gas emissions will decrease by about 9.8%. This climate change mitigation effect currently has significant potential to generate unanticipated systemic shocks in the global economy. These results are also in line with the findings of other previous studies that highlighted the increased focus on adapting economies to the negative effects of climate change and achieving the goal of reducing greenhouse gas emissions [62–65]. Thus, achieving climate neutrality will require contributions from all economic sectors.

Taking into consideration all previous arguments, one of the recommendations of the research question is to take advantage of the current opportunity to rethink how the economy of the future will function, being an important opportunity to pay more attention to the green economy, which could lead to other unforeseen shocks in the future, which may occur as a result of climate risk. It is a reality that the COVID-19 pandemic has generated the strongest economic shock of the 21st century. However, in addition to the pandemic's negative elements, the world now has the opportunity to rethink how the economy of the future will work. This represents an important opportunity to give a much higher level of attention to the green economy, which could save humanity from other unforeseen shocks and the magnitude of the health crisis that could occur as a result of climate risk.

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