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ECONOMIC ACTIVITY AND POLLUTION. A STUDY ON EUROPEAN COUNTRIES BEFORE AND AFTER COVID-19 OUTBREAK

It may be said that COVID-19 eased the nature from human pollution. Present paper may argue this perception by analyzing the connection between the economic impact before and after the COVID-19 outbreak, measured by national GDP and the level of pollution in the European countries, referring to air and water pollution. A simple linear regression model with two control variables was applied in order to obtain the results (the control variable were the number of COVID-19 cases and the austerity measures applied in the countries, in the specified period, classified by the impact over the labor productivity). Data was aggregated using the population values for each country and normalized using log normalization method. The paper also engages a multivariable regression, with exogenous variables composed of all NACE REV 2 activities that contribute to national GDP and endogenous variable being the composite pollution index (based on air and water pollution indicators). The control variables applied in the multivariable regression are the same as the ones described below. Results show that DGP dropped with 16.26 % from Q4 of 2019 to Q2 of 2020 and with 5.86 % from the same period of last year till second semester of this year, based on the austerity measures taken in order to stop the spreading SARS-CoV-2, especially the ones considering non trivial activity closure or entire sector closure. Findings include also a percent of 30% of air quality improvement (in terms of particle matter presence) during COVID-19 lockdown in Europe, that had a positive impact even after lockdown was suspended and a general water quality improvement of 32 % from 2018 to 2020. A moral problem is presented in the present paper: did COVID-19 killed or saved many lives, due to air pollution reduction, while fatality rate of COVID-19 is 1.4 % [40] and air pollution fatality rate was 7.6 % in 2016 [18], before air quality improved?

Keywords: Pollution, COVID-19, Austerity Measures, GDP.

Introduction. Due to last changes in societies lifestyle, caused by austerity measures, taken by necessity, in the new global context of COVID-19 pandemic, economic activities went into critical decline, general mobility and velocity of society members went down [27] and general consumption took the same descending trend [23]. The most affected economic sector was tourism, followed by air travel industry [23], while facemask production companies were kept under pressure, due to facemask shortage [23].

Due to the austerity measures [22] taken in the global context, all human life was restrained from the freedom and flexibility that characterized it before. In this context it is relevant to argue if the environment was less affected by human activities or not.

Air pollution is referring to alteration of air physical or chemical components, that might have a negative influence over human health or environment [22]. While it is responsible for 7 million deaths worldwide annually [6], air pollution is associated with respiratory infections, heart diseases, COPD or lung cancer [6]. It affects human health especially by stimulating pro-inflammatory immune responses, such as stimulating different immune cells (e.g. lymphocyte TH2 and TH17), or affect also in neonate and gastrointestinal tract [14]. Polluted air can affect both upper respiratory system and lower one. The gasses or small diameter particles enter respiratory system and can produce inflammatory responses at the upper respiratory structure, such as mucosa from nose, mouth or larynx (in case of gaseous components) or at trachea or lung, in case of particle matter [14].

Air pollution is refer to different geographical scales, such as local air pollution, urban, regional, continental or global air pollution [33]. We are going to refer in this study to urban air pollution. Pollutants actively recognized in urban air pollution are classified in primary or secondary pollutants [14].

Most important primary pollutants from anthropogenic sources are: (1) SOX – sulfur oxides, especially sulfur dioxide. SO_2 is a residue often produces by fossil fuel combustion. A secondary pollutant formed by oxidation of SO_2, generating acid rain, is H_2SO_4 [33], (2) CO2 (carbon dioxide) is responsible for almost 80 % of anthropogenic global warming due its properties as a greenhouse gas [16], emitted mainly from fossil fuel emissions and industrialization, (3) NOX – Nitrogen oxides, especially nitrogen oxides and nitrogen dioxide is also considered an greenhouse gas, although a indirect one, being emitted by vehicles engines and power plants, (4) CO – Carbon monoxide (CO) is one of the most distributed air pollutant, causing many lung diseases and environmental problems and being generated by incomplete burned fossil fuel gas [16], (5) VOC – Volatile organic compounds are chemicals evaporated and transformed into gases in natural conditions, being emitted by natural or anthropogenic sources (fossil fuel combustion, power plants), categorized into methane (CH_4), another greenhouse gas, or non-methane (NMVOCs) [14], (6) PM particulate matter is referring to atmospheric or fine particle matters, that are classified by particle diameter: 2.5 mm diameter or 10 mm diameter or more [34], (7) Persistent free radicals, (8) Chlorofluorocarbons (CFCs) and (9) Ammonia.

Although anthropogenic sources include stationary sources (such as fossil fuel power stations), mobile sources (such as fuel combustion of land, air or water vehicles), controlled burn, fumes, waste deposition, military resources (especially nuclear weapons) or fertilized farmland, they may be the major source for human or environmental problems generated by air pollution [6]. Natural sources, such as dust, digestion of food by animals, radioactive decay within the Earth's crust, smoke, vegetation or volcanic activity may contribute to negative effects of air pollution, but in a lower percentage [34].

Water pollution may refer to changes into physical, chemical or pathogenically construction of the water. It is usually related to anthropogenic sources, but may be connected to natural ones, too. Oceans and seas are

polluted manly by municipal waste or oil spill disasters, that merge into deep changes of aquatic ecosystem and extension of marine species. We might take in consideration that "the oceans and seas are not infinite" [35]. Groundwater, being the main source for drinking water or irrigation, can be polluted by all of the human activities related to water pollution or soil pollution, due to the hydrological cycle, although, once polluted it cannot be cleaned up. Rivers and streams are mainly polluted by waste disposal or chemicals that remain from industrial water treatments, that long ago overload the assimilative capacity of the flowing water to clean themselves. Lakes and ponds are usually polluted by direct (waste) or indirect waste discharge (such as storm water, sewage from the septic tanks, fertilizers, insecticide or pesticide). "The quality of water our atmosphere is threatened by air pollution" (especially NO_x, that generates acid rain or CO_2 and creates the greenhouse effect [35].

Water pollution sources may be classified as follows: acid rain (especially die to NO_X from the atmosphere), agricultural waste (which eliminate organic compounds into the water), alien species (which can disrupt the basic resources such as light, nutrients, physical space, chemical compound or pathogenically one), climate change (especially areas where global warming cause high temperatures), disruption of sediments (driven by storm water), industrial waste and agrochemicals (pesticides and insecticides, chemicals from industrial water waste treatment), nutrient enrichment, crude oil spills, radioactive waste, sewage and oxygen demanding wastes, thermal pollution (such as hot water disposal from balneary unities) and urbanization [29].

Leading worldwide of death and disease, due to waterborne diseases, chemicals from water may damage nervous system (pesticides, lead), cause cancer (pesticides, arsenic, petrochemicals), endocrinal damage (pesticides), oxygen restrictions in the brain (nitrates), vascular diseases (arsenic), damage spinal cord (fluoride) [29].

Although water pollution may occur to all hydrological cycle, there are two types of water pollution: surface (marine pollution, rivers, estuary) and groundwater pollution (soil hydrology). Sources are also classified as point sources (which are single, identifiable sources of pollution in the water) or nonpoint sources, due to diffuse contamination, not flooding from a single, identifiable source (e.g. nitrogen from fertilized areas, urban runoff) [39].

Contaminants may be chemicals, pathogens or physical change. Change in concentration of chemicals in water may lead to modifications in acidity, electrical conductivity, temperature or eutrophication (growth in nutrients and minerals) of water. Pathogen (microorganisms that cause disease) pollution may include Burkolderia Pseudomullei, Cryptosporidium Parvum, Giardia Lamblia, Salmonella, Norovirus and parasitic worms. Physical change may include temperature or density change. Contaminants may be organic (herbicides, insecticides, detergents, disinfection products, food processing waste petroleum hydrocarbons, VOC, chlorinated solvents, perchlorate, drug pollution) or inorganic (acidity, ammonia, chemical waste, fertilizers, heavy metals, secretion of creosote, sediments) [35].

Measurements can be in situ: nutrients, organic matter, hazardous substances, other chemical in rivers, lakes groundwater or satellite data, especially Landsat 8 OLI/TIRS or Sentinel surface reflection map [7; 41].

Measurements taken in Europe started in early march 2020, firstly in Italy and spreading all over Europe quickly. Most of the measurements focused on intra or interstate human mobility, but also on limitation of human activities that demand interaction (such as school or other non-trivial activities). As these restrictions were applied, they could be categorized by the size of human mobility limitations, as follows: adaptation of workplace (partial or full), closing daycare, closing high school, closing primary school, closing pub activities (partial or full), closing sectors (partial or full), closing entertainment venues (partial or full), closing gyms and sports centers (partial or full), closing hotels or other accommodation (partial or full), forbidden indoor over 5, forbidden indoor over 100, forbidden indoor over 1000, masks mandatory and closed spaces partial, masks mandatory and closed spaces, masks mandatory and all partial, forbidden mass gather, closing non-essential shops (partial or full), forbidden outdoor over 5, forbidden outdoor over 50, forbidden outdoor over 500, forbidden outdoor over 1000, closing place of worship (partial or full), forbidden restaurants and cafes, stay home order, teleworking, closure of public transportation, suspended flights and workplace closure.

Restrictions were taken in order to minimize interaction between persons, due to high transmission rate of SARS-CoV-2, which is a "highly infectious respiratory disease" [3], having a rate of death of 2.84 % [38]. SARS-CoV-2 transmission was first to be attributed to mammals and birds, due to the connection of the first cases and wet animal market in Wuhan, where it all started, but afterword, related studies shown that the virus can be transmitted Person-to-person [3] and it is more likely that mammals are the link between SARS-Cov-2 and humans, as SARS-Cov-2 has 88 % identity with two bat-derived (SARS)-like coronaviruses [25]. Person to person transmission of the virus is based on direct contact (the cause targeted by almost all of the restrictions taken) and droplets spread in the coughing or sneezing process (that's where the mask restrictions interfere). It is uncertain if the virus can be transmitted in the intra-uterine transmission [8]. After penetrating the body, the virus binds to a receptor and fusions with the cell membrane. The virus is transmitted by "the binding between the receptor-binding domain of virus spikes and the cellular receptor which has been identified as angio-tensin-converting enzyme 2 (ACE2) receptor" [25].

A review shows that physical distance increased protection to SARS-Cov-2, the 1 m distance being an important level from which it decreases the exposure to the virulent particles [9]. Face protection with mask is linked to increased protection, especially when N 95 mask is used, in comparison with common surgical mask, while eye protection was also linked to lower risk of infection [9]. The review underlines the importance of wearing a face protection in a proper way and the risk of improper wearing of face protection, aspect that encourages the necessity of other measures to be taken, regarding physical distance restrictions.

Methodology. In order to search for a connection between human mobility restrictions, course of economic results and pollution we took in consideration the most important restriction from the ones presented above and created and index, that implied different weight in the aggregation process of the variables involved in the indexation, from 1 to 3,1 being the lower impact over activities that might contribute to air or water pollution (e.g. face mask order is a restriction that did not contribute to air and water pollution, societies being engaged in their normal activities with or without mask) and 3 being the restrictions that have the highest impact over the activities that might contribute to water and air pollution (stay home order is a restriction that had a big impact over urban air pollution [18; 21; 27; 32; 31], global CO2 emissions [19] or rivers [2; 24] and lakes pollution [41]. The index was computed for three

periods: 01 March – 15 May, 15 May – 14 July, 14 July – 30 September. The index was computing by averaging the restriction level of all European countries for every day of the involved period. The countries took in account for the indexation were Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Latvia, Lichtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia and Spain. The restrictions have derived into reduction of "30% and 50% for the energy, industry, road transport and international shipping sectors, and 80 % for the aviation sector" [10].

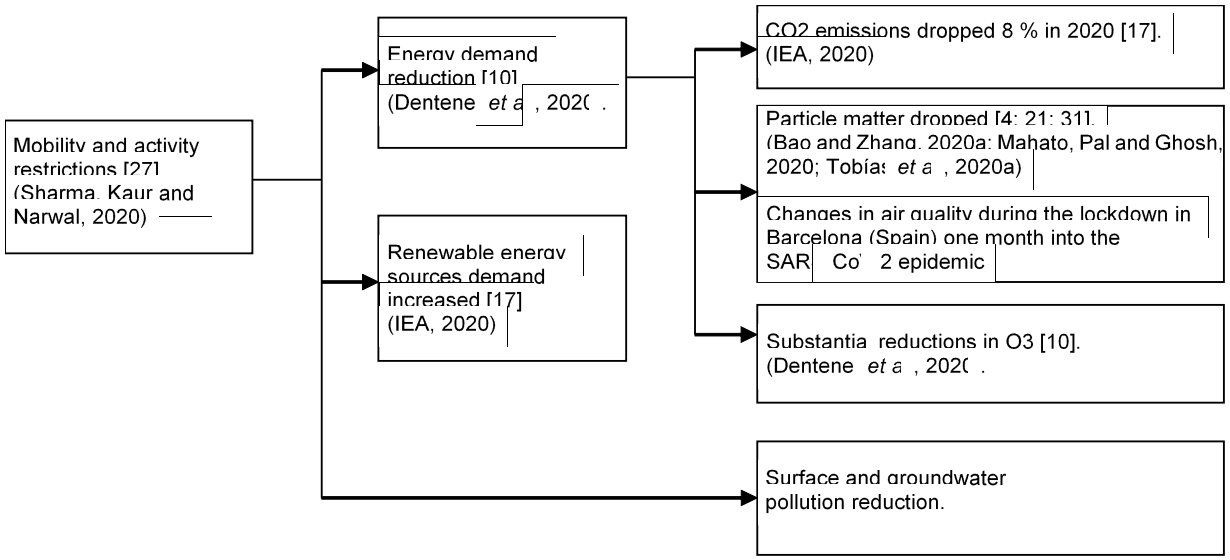

Fig 1. Pollution reduction due to COVID-19 restrictions

Source: authorial computation.

For the measurement of air pollution, we created an index that took in consideration PM 2,5 and PM 10 [30], due to lack of recent data for CO_2, SO_X, NO_X, CO, VOC and CFCs. CO_2 data is not up to second trimester of 2020, so it has not been taken into consideration, although some studies are available [17; 19]. EEA-33 emissions of Sulphur oxides (SO_X) have decreased by 74 % between 1990 and 2011 [13]. There is no measurement of VOC. Globally, consumption of ODS – ozone-depleting substances (ODS: hydrochlorofluorocarbons, chlorofluorocarbons, etc.), controlled under the Montreal Protocol, has declined by 99.67 % worldwide in the period 1986–2018 [12]. We used WAQI index and EPI data for air quality measurement.

There are many sources of air and water pollution data. Most trustable are international organizations quality indices and satellite data. We used Eurostat waterbase source to measure pollution from 2018 and 2020 (as it was the most recent data). For water quality index we used: sanitation & drinking water data, unsafe drinking water index, wetland loss fisheries data, fish stock status, marine trophic index, fish caught by trawling, water resources data and water waste management index.

Results. COVID-19 restrictions in Europe had a higher level in the second trimester of the year, due to outbreak of the virus from Asia to Europe, starting from Italy, with the first registered restrictions in 06 March 2020 and rapidly spreading through Europe. Restrictions had a relaxation trend, even though SARS-CoV-2 positive cases increased. The second wave of COVID-19 infection started in October 2020, but data is still not available. It can be seen a relaxation of restriction in the second half of the year, due to economic activities resumption policies.

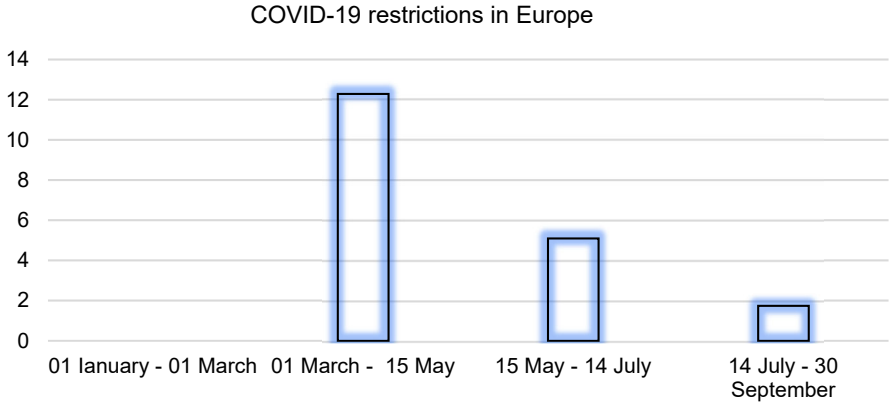

Fig 2. COVID-19 restrictions in 2020

Source: authorial computation.

European GDP had a descending trend from the last trimester of 2019, when mobility restrictions, such as suspended international flights or two-week quarantine for the income tourists, were taken. It can be seen that DGP dropped with 16.26 % from Q4 of 2019 to Q2 of 2020 and with 5.86 % from the same period of last year till second semester of this year. Foundation of this descending trend were the austerity measures taken in order to stop the spreading SARS-CoV-2, especially the ones considering non trivial activity closure or entire sector closure. After restrictions had a relaxation course, GDP took another descending value, based on the society panic and on "a new type of recession that was different from the past triggers of a recession" [23].

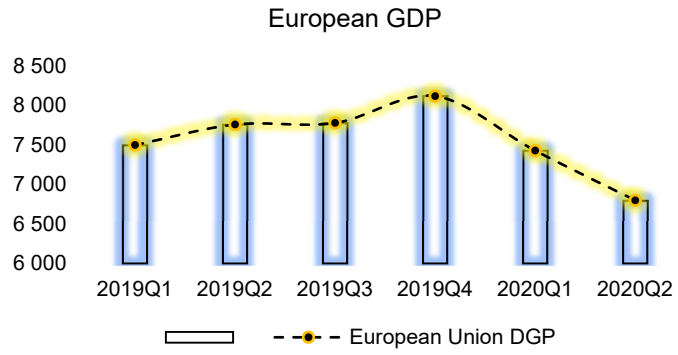

Fig 3. European DGP and COVID-19 restrictions

Source: authorial computation.

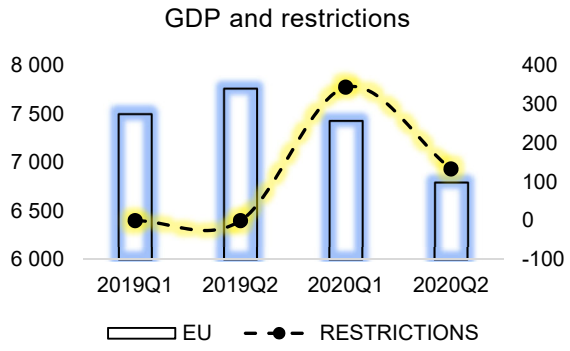

Fig 4. European DGP

Source: authorial computation.

As it can be seen in figure 5 and figure 6, COVID-19 restrictions had a higher influence over Italy, due to highest infection rate in the beginning of the pandemic and higher public health impact, which spilled over economic performances of some of the main sectors, such as tourism and services sector [23].

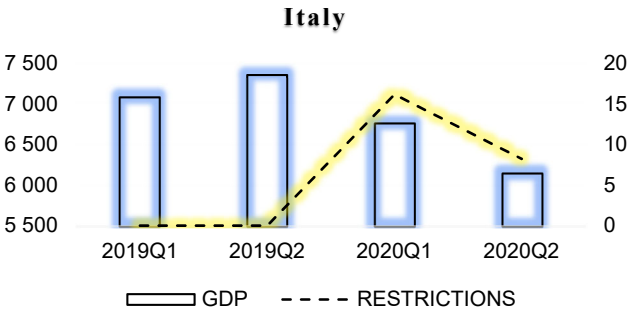

Fig 5. Italy GDP and COVID-19 restrictions

Source: authorial computation.

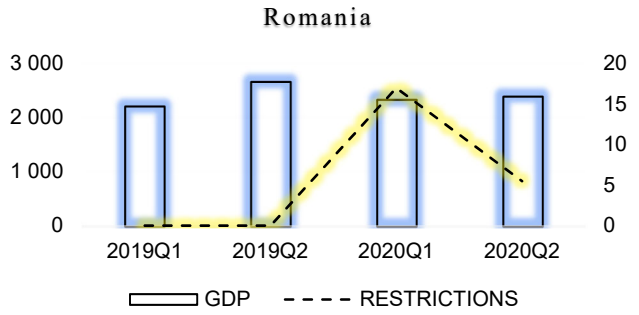

Fig 6. Romanians GDP and COVIS-19 restrictions

Source: authorial computation.

As reported before, air quality was measure din PM2.5 and PM10, and included almost all of the European countries. Air quality was measured using PM2.5 and PM10 indicators and had a 30 % decrease in the concentration on the particle matters in the urban outdoor air, across Europe. March and April were the most urban air polluted months from 2020. The air self-cleaning capacity took over one month in order to cut out the particle matters that flew within urban air, but human mobility and activity restrictions, especially stay home order, school closure and workplace closure had a big impact over PM dropdown and over CO2 and O3 dropdown [10; 17].

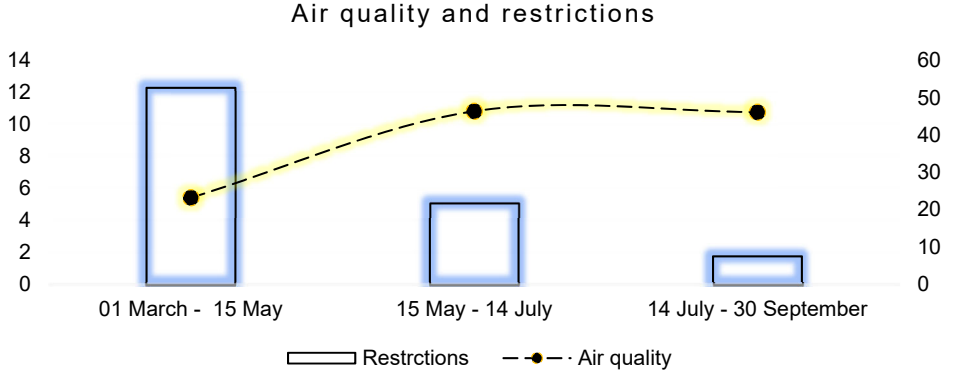

Fig 7. Air pollution and COVID-19 restrictions

Source: authorial computation

From the figures 8 and 9 we can observe air quality improvement (in terms of particle matter presence) during COVID-19 lockdown in Europe, that had a positive impact even after lockdown was suspended. Air quality improvement remained at a higher level after lockdown, than before COVID-19 breakdown restrictions. Most positively affected countries, that suffered an improvement in urban air quality condition, were Italy (with a particle matter reduction of 73 %), Spain (75 % air quality improvement), Romania (with a 66 % urban air quality improvement in terms of PM), Slovenia, Norway, Cyprus, Iceland and United Kingdom (with more than 50 % improvement in air quality, in terms of PM). A slightly reduction of air quality was found in Denmark and Germany (5–7 %). Most polluted countries before lockdown (first weeks of March) were, in this exact order: Italy, Romania, Slovenia, Luxembourg, Spain and Cyprus. After lockdown, most polluted countries remain Croatia, France, Luxembourg, Cyprus, Denmark, Germany and Lithuania. Highest level of austerity measures was taken in Romania, Slovenia, France, Cyprus, Netherland, Italy and Spain. Most prolonged period of restrictions has been established in Italy, Portugal, Romania and Spain (not exactly in this order).

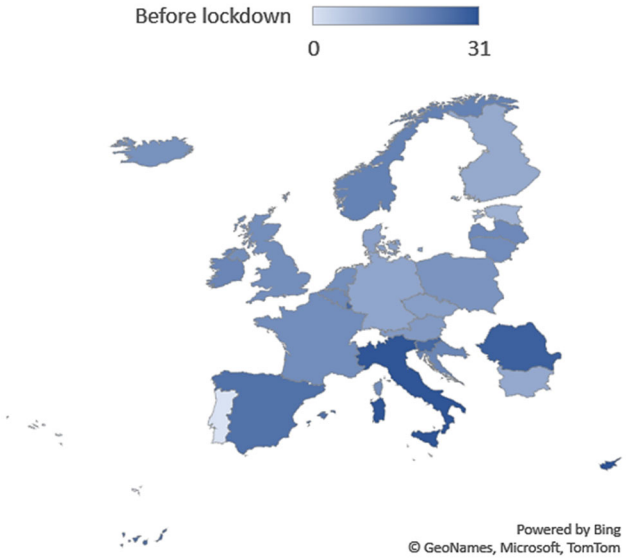

Fig 8. Air pollution in Europe before lockdown

Source: authorial computation

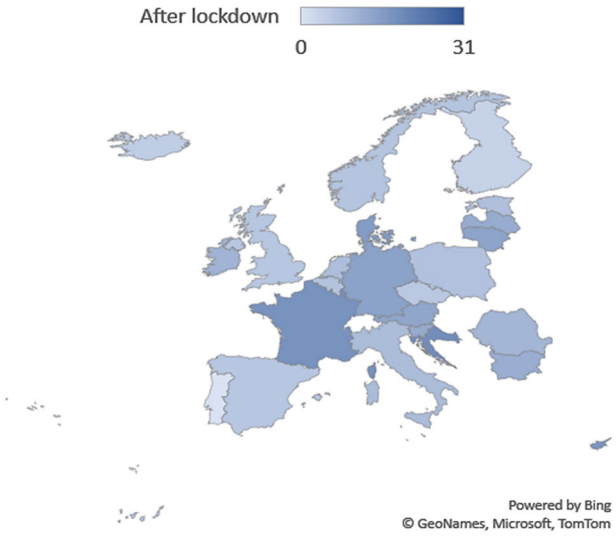

Fig 9. Air pollution in Europe after lockdown

Source: authorial computation

Besides PM dropdown, O_3 and CO_2 had a major dropdown, too, "twice as large as the combined total of all previous reductions since the end of World War II" [17]. CO_2 had a dropdown of 8 % from 2019 to 2020, reaching the value from 2010, after repeated increases, specially in 2018 (approx. 2 %). CO_2 emission dropdown, after lockdown restrictions was accomplished due to decline of the energy demand (especially from coal, oil and natural gas) [17]. Another important restriction that contributes CO_2 dropdown was stay home order or workplace closure, that suspended fossil fuel combustion from personal and public transportation and cleaned air from gasses and particles released in this process (CO, CO_2, SO_2, PM).

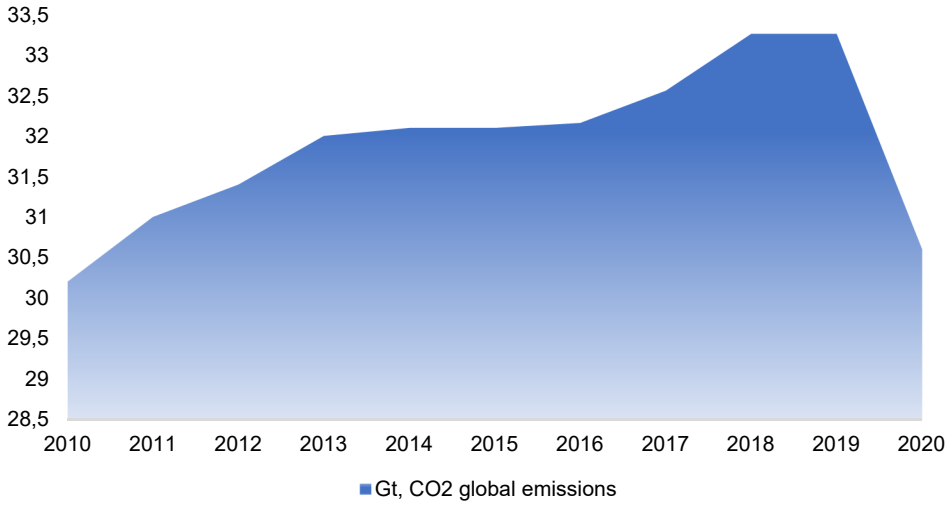

Fig 10. CO2 global emissions

Source: authorial computation

Water pollution, measured with Eurostat data regarding surface and groundwater pollution, including drinking water safety, wetland loss fisheries and fish stock, marine trophic index, water resources and water waste management. The index created used equal weights for all of the variables included, which were normalized using maximum value method. From the fig. 9 and 10 it can easily be seen that water quality has improves from 2018 to 2020, the countries that had the highest improvement of water quality were, in this exact order, Croatia (with 48 % improvement in water quality), Lithuania (47 % improvement in water quality), Poland, Ireland, Estonia, Italy and Norway (all with over 40 % improvement in water quality). In general, water quality improved with 32 % from 2018 to 2020, based on industrial activities closure and improvement in water waste management techniques and legislation restrictions. Many sources linked surface and groundwater pollution reduction to industrial activity drop, caused by COVID-19 restrictions.

Fig 11. Water pollution in Europe, in 2018

Source: authorial computation

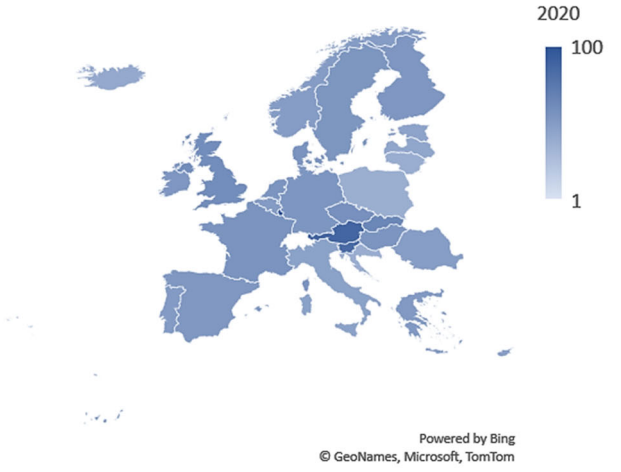

Fig 12. Water pollution in Europe, in 2020

Source: authorial computation

Lowest water quality, in 2018, was there to be found in Luxembourg, Austria, Czech Republic, Slovakia, Slovenia, Hungary, Ireland, Finland, Norway and Greece, and in 2020, Luxembourg, Austria, Slovenia, Slovakia and United Kingdom, while the highest water quality was there to be found in Poland, Croatia and Romania.

Conclusion & Discussion. Our results show that economic result in Europe had a decreasing pattern from the time restrictions were imposed, based on activities, companies and sectors closure, that affected national DGP and gross added value in almost all European countries. Similar results are shown in [15; 22; 23]. Economic activity endured disruptions in the supply and demand equilibrium, due to consumer behavior change, after COVID-19 panic and restrictions changed the consumer priorities. This disruptions in supply and demand equilibriums, from different markets, had major implications into unbalancing important economic sectors.

One of the most affected sectors by human mobility restrictions was the tourism sector, with a loss of $200 billion from cancelled hotel bookings, international events or flights, until April 2020 [23]. Also, the sport industry was hardly affected by the pandemic context, all of the major football, rugby leagues were suspended, motorsport game from Portugal was postponed, snooker and swimming championship were also postponed, that concluded into billions of dollars deficit [23]. Oil-dependent countries had major spillovers, due to oil price fall from the early 2020 and the mobility restrictions imposed by the COVID-19 restrictions, that led into down drop of energy demand, especially down drop of fossil fuel combustion process (which was also a big contributing factor for air quality improvement across Europe). Also, import dependent countries had suffered from shortages of supply from China and India, due to major restrictions imposed in these countries with large population, especially those targeting the workplace closure. Also, the benefits from company closure are hardly related to air pollution reduction. Monetary sector was affected due to inefficient loans required by SME's, while financial markets encounter major fell downs based on the general instability and disruptions of important markets [23]. Tourism and food chain support pandemic outbreaks, originated from China, a big food supplier, that is why this is an aspect that might denigrate food industrialization [15].

All the activities, industries and sectors closure did affect national economic indicators, but, on the other side, it positively affected environmental quality of the urban areas, especially in the metropoles or larger cities. Results show a 5.86% dropdown in DGP/capita from the second trimester of last year till the second trimester of 2020, based on tourism sector closure, activities and industries closure and consumption drop or disruptions in supply and demand chain, due to changes consumer behavior. In the same time, air quality (measured in density of PM presence in the most important urban area through Europe) improved with a mean of 30%, with a maximum value of 73 %. Similar studies had consistent results. For example, in Bao and Zhang [4] air quality improved with 24 % due to 70 % human mobility dropdown. Most sources cover China and India (Bao and Zhang [5]; Lokhandwala and Gautam [20]; Mahato, Pal and Ghosh [21]; Sharma et al. [28]; Wang and Su [37]; Wang et al. [36]). Other sources showed a drop-down of CO_2 with 45 to 51 % during lockdown in Barcelona [32].

A moral problem is there to be argue: did COVID-19 killed or saved many lives (based on air pollution reduction)? While fatality rate of COVID-19 is 1.4 % [40], air pollution had a fatality rate of 7.6 % in 2016 [18]. Since air quality improved with 30 %, based on decrease of 3.8 % of the total energy, in the first quarter of 2020 [17], the air pollution fatality rate should decrease to 5.3 %. Similar studies support this finding. "The COVID-19 pandemic might, paradoxically, have decreased the total number of

deaths during this period, by drastically decreasing the number of fatalities due to air pollution" [11].

Although fossil fuel combustion reduction had a negative impact over oil-dependent countries [23], it had positive effects over global CO_2 emissions, as there was registered a major drop in CO_2, in similar studies [17; 19]. Substantial reduction in 0_3 was also found in the lockdown phase, accompanied by the improvement of the ozone layer [10].

Our results show that water quality improved with 32 % from 2018 to 2020. This improvement is partially relied on mobility restrictions and partially on improvement in water waste management techniques and legislation worldwide. Other studies, that included in situ measurements, found that lockdown phase indeed had a positive impact over surface or groundwater quality. For example, PH, conductivity, D0, BOD and COD concentrations showed 1–10 %, 33–66 %, 51 %, 45–90 % and 33–82 % reductions during the lockdown phase, as compared to the pre-lockdown phase in Yamuna river [2]. Estuaries cleaned up in the lockdown phase, as the intensity of industrial activity had a strong effect on the bathing water quality in the area surrounding the Boukhalef river estuary [7]. The study illustrates that level of bathing water quality improved during the COVID-19 lockdown. Also, groundwater quality in India improved during lockdown, in Tuticorin industrial city. Reduction of groundwater pollution was due to reduction of human activities, that had a major impact in releasing pollutant components [26]. In Vembanad lake, the surface water quality had improved during lockdown, based on the Landsat-8 OLI data, by decreasing the concentration of industrial pollution components with 15.9 % on average, while non-industrial pollution had the same level during lockdown [41].

Air quality improved with 45 %, average PM2,5 and PM10 had dropped to half of their initial size, after the most restrictive lockdown month (March), when almost 95 % of human mobility was restrained. Also, O_3, Co_2 and NO dropped down during lockdown (Dentener et al. [10]; IEA, 2020 [17]; Le Quéré et al. [19]).

Water pollution has a significant decreasing trend, attributed especially to water waste management and plastic recycling programs worldwide, but some empirical evidence states that human activity restrictions had a positive impact over surface water pollution, especially over lakes and rivers, as water quality improved with 32 % from 2018 to 2020. Surface and groundwater quality improved during lockdown [2; 7; 26; 41], results showing that anthropogenic activities did have a negative impact over both water and air pollution.

DGP had a descending trend after significant restrictions, with major impact over Q2 of 2020, after the restrictions caused major problems regarding closing sectors, activities and industries. A direct connection between anthropogenic activities and air and water pollution was observed in the present study, with remark that activity restriction generated both a drop in national economic result and an improvement in environmental health.

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ЕКОНОМІЧНА АКТИВНІСТЬ І ЗАБРУДНЕННЯ НАВКОЛИШНЬОГО СЕРЕДОВИЩА. ДОСЛІДЖЕННЯ ЄВРОПЕЙСЬКИХ КРАЇН ДО І ПІСЛЯ СПАЛАХУ ЕПІДЕМІЇ COVID-19

Схоже, COVID-19 послабив антропогенне забруднення. Це відчуття підтверджується аналізом зв'язку між економічним впливом до і після спалаху епідемії COVID-19, що вимірюється національним ВВП і рівнем забруднення в європейських країнах відносно забруднення повітря і води. Для отримання результатів була застосована модель простої лінійної регресії із двома контрольними змінними (контрольними змінними були кількість випадків захворювання COVID-19 і заходи жорсткої економії, що застосовуються в країнах у зазначений період, класифіковані за впливом на продуктивність праці). Дані були агреговані з використанням значень чисельності населення для кожної країни і нормалізовані за допомогою методу логарифмічної нормалізації. У роботі також використовується багатовимірна регресія, екзогенними змінними якої є всі види діяльності, що входять до NACE REV 2, які роблять внесок у національний ВВП, і ендогенної змінної – складовою індекс забруднення (заснований на показниках забруднення повітря і води). Контрольні змінні, використані в багатовимірній регресії, ті ж, що й описані нижче. Результати показують, що DGP знизився на 16,26 % із четвертого кварталу 2019 року по другий квартал 2020 року і на 5,86 % з аналогічного періоду минулого року по другий квартал поточного року, що обумовлено заходами жорсткої економії, прийнятими для того, щоб зупинити поширення SARS-CoV-2, особливо тими, які передбачають закриття нетривіальних видів діяльності або закриття всього сектора. Виявлено також 30 % поліпшення якості повітря (з точки зору присутності частинок) під час блокування COVID-19 у Європі, що позитивно впливало навіть після припинення локалізації, і загальне поліпшення якості води на 32 % із 2018 по 2020 рік. Представлена моральна проблема: COVID-19 забрав чи врятував багато життів через зниження забруднення повітря, ураховуючи, що рівень смертності від COVID-19 становить 1,4 % [40], а рівень смертності від забруднення повітря становив 7,6 % у 2016 році [18], до поліпшення якості повітря?

Ключові слова: забруднення, COVID-19, заходи жорсткої економії, ВВП.

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ЭКОНОМИЧЕСКАЯ АКТИВНОСТЬ И ЗАГРЯЗНЕНИЕ ОКРУЖАЮЩЕЙ СРЕДЫ. ИССЛЕДОВАНИЕ ЕВРОПЕЙСКИХ СТРАН ДО И ПОСЛЕ ВСПЫШКИ ЭПИДЕМИИ COVID-19

Похоже, COVID-19 ослабил антропогенное загрязнение. Это ощущение подтверждается анализом связи между экономическим воздействием до и после вспышки эпидемии COVID-19, измеряемым национальным ВВП и уровнем загрязнения в европейских странах относительно загрязнения воздуха и воды. Для получения результатов была применена модель простой линейной регрессии с двумя контрольными переменными (контрольными переменными были количество случаев заболевания COVID-19 и меры жесткой экономии, применяемые в странах в указанный период, классифицированные по влиянию на производительность труда). Данные были агрегированы с использованием значений численности населения для каждой страны и нормализованы с помощью метода логарифмической нормализации. Также используется многомерная регрессия, экзогенными переменными которой являются все виды деятельности, входящие в NACE REV 2, вносящие вклад в национальный ВВП, и эндогенной переменной – составной индекс загрязнения (основанный на показателях загрязнения воздуха и воды). Контрольные переменные, использованные в многомерной регрессии, те же, что и описанные ниже. Результаты показывают, что DGP снизился на 16,26 % с четвертого квартала 2019 года по второй квартал 2020 года и на 5,86 % с аналогичного периода прошлого года по второй квартал текущего года, что обусловлено мерами жесткой экономии, принятыми для того, чтобы остановить распространение SARS-COV-2, особенно теми, которые предусматривают закрытие нетривиальных видов деятельности или закрытие всего сектора. Установлено также 30 % улучшения качества воздуха (с точки зрения присутствия частиц) во время блокирования COVID-19 в Европе, что оказало положительное влияние даже после приостановки локализации, и общее улучшение качества воды на 32 % с 2018 по 2020 год. В работе представлена моральная проблема: COVID-19 забрал или спас много жизней благодаря снижению загрязнения воздуха, учитывая, что уровень смертности от COVID-19 составляет 1,4 % [40], а уровень смертности от загрязнения воздуха составлял 7,6 % в 2016 году [18], до улучшения качества воздуха?

Ключевые слова: загрязнение, COVID-19, меры жесткой экономии, ВВП.