Macroeconomic Impacts of the Covid-19 Pandemic in Some European Union Countries[1]

A Counterfactual Analysis

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Abstract

The aim of this paper is to analyze the macroeconomic impacts of the Covid-19 pandemic in the European Union (27 countries) and, particularly, in four of its economies – Germany, Spain, Italy and Portugal. For this purpose, a counterfactual analysis was conducted based on an ARIMA forecasting model through which the behavior of a set of macroeconomic variables (Gross Domestic Product, public debt, inflation rate, public deficit, and unemployment rate) is examined in the context of the Covid-19 pandemic against a hypothetical scenario without pandemic. In general, the results point to a significantly better performance of all variables in the four countries and in the European Union if the Covid-19 pandemic had not existed. In a scenario without the Covid-19 pandemic, all countries would have achieved higher product levels, showing, however, relatively weaker economic growth rates when compared to the pandemic situation, namely in 2021 and 2022. The results also point to budget surpluses in Germany and Portugal, in 2020, 2021 and 2022, as well as a sharp reduction (over 20 percentage points) in Spanish public debt. In 2021 and 2022, there is also a lower inflationary pressure for the European Union, Germany, Spain and Italy, after a very sharp rise in prices in 2020. Regarding the labor market, with the exception of Germany and European Union, where the unemployment rate would be relatively higher, especially in 2022, the remaining countries would register lower unemployment rates.

Keywords: ARIMA, Counterfactual, Covid-19 pandemic, macroeconomic impacts.

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1. Introduction

The outbreak of SARS-CoV-2, also known as Covid-19, was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 after being initially reported in December 2019 in Wuhan – China's seventh largest city – following its rapid widespread. Not only was the WHO deeply concerned both by the alarming levels of transmissibility and severity, but also by some degree of inaction, calling the attention of countries to take political and economic action to contain the new coronavirus.

Although it might seem too early to talk about the economics of the Covid-19 pandemic, the "*Coronanomics*" as termed by Eichengreen (2020), it remains pertinent to analyze its macroeconomic impacts due to the damage caused by the direct and indirect economic effects across countries, and in the European Union (EU)[4]. The Covid-19 pandemic forced the European countries to lock down borders, preventing normal flows of goods, capital and services. Moreover, businesses and production shut down temporarily, causing enormous endogenous negative shocks on both supply and demand, with potential devastating effects for the economies. In addition to dire health consequences, the pandemic is a massive and far-reaching economic cost burden for all EU countries, leading many into recession and possibly economic depression.

Under such circumstances, the aim of this research is to provide an overall understanding of the macroeconomic effects of the Covid-19 pandemic in some EU countries – Germany, Spain, Italy and Portugal –, as well as in the EU (27 countries). With this purpose in mind, we conducted a counterfactual analysis, i.e., comparing the behavior of a set of macroeconomic variables (Gross Domestic Product (GDP), public debt, inflation rate, public deficit, and unemployment rate) in two distinct contexts, with and without the Covid-19 pandemic.

There are three main reasons for choosing these countries: i) number of confirmed cases of the disease in the first three waves of the Covid-19 pandemic; ii) highest vaccination rate of their population, and iii) fiscal space to react to the pandemic. In the case of reason i), we think that Spain and Italy are two good examples of the situation. Portugal is the best explanatory example of reason ii), and Germany fits perfectly well into argument iii). Naturally, the EU-27 is a benchmark, aimed to carry out a comparative analysis of the macroeconomic impacts of the Covid-19 pandemic for the EU as a whole.

The counterfactual analysis is developed from an ARIMA (Autoregressive Integrated Moving Average) forecasting model. It allows us to predict, with a high degree of exactitude, the expected values of the macroeconomic variables for the years 2020, 2021 and 2022, based on a linear combination of past values, had the pandemic situation not occurred.

With some exceptions, the results point to a better performance of all the variables in the four EU countries and in the EU-27 had the Covid-19 pandemic not existed. In a counterfactual scenario without the pandemic, all countries would have achieved higher product levels, also showing significantly lower levels of public debt, inflation, public deficit and unemployment. More specifically, Germany and Portugal would have had budget surplus, and the latter would have recorded relatively higher inflationary pressure when compared to the situation in a pandemic context. It is also worth mentioning the sharp reduction by more than twenty percentage points of the Spanish public debt, and the increase by about three percentage points

[4] As indirect effects we have chosen, e.g., the reduction of health care in non-Covid-19 diseases that can have negative effects on labour productivity and on the GDP.

of the unemployment rate in the EU-27. This outcome is completely in counter-cycle with the unemployment downward trend observed in the four countries.

These results are in line with further studies carried out to other EU economies (see, e.g. Albu et al., 2020 or Radulescu et al., 2020, both dedicated to the analysis of the economic impacts of the pandemic in Romania; Sanfelici, 2020, for an analysis of the Italian response to the Covid-19 crisis, Pedauga et al., 2021, who study the economic effects of the disease in the Spanish economy; Silva and Duarte, 2021, for the case of Portugal and the rest of the euro area that analyze the macroeconomic consequences of a labor supply shock in the context of the infectious coronavirus disease outbreak). They are also consistent with the outcomes of several works developed for regions outside Europe (see, e.g., Altig et al., 2020, for the USA and UK, before and during the Covid-19 pandemic; Padhan and Prabheesh, 2021, who explore the effects of the pandemic and propose potential policy guidelines to mitigate its economic consequences; Chan, 2022, studies the impacts therefore in China). Our main results are still analogous to those obtained for countries on the African continent (see, e.g., Adam et al., 2020; Alon, 2020; Ataguba, 2020; Farayibi and Asongu, 2020), which is not at all surprising given the global nature of the disease and the current economic globalization.

However, to the best of our knowledge, a counterfactual analysis based on autoregressive methods and focused on macroeconomic variables has never been carried out before for such a large sample of EU countries that included simultaneously an analysis of the EU-27. We believe that this study is an important contribution to the literature on the subject, namely from the prospective point of view of the economic policies to be adopted in a pandemic and non-pandemic context, since both scenarios are considered in our study.

The remainder of this work is organized as follows. Section 2 briefly examines the general context of the Covid-19 pandemic in the EU countries. Section 3 describes the data and presents a preliminary analysis of the behavior of the variables. Section 4 is dedicated to the counterfactual analysis of the macroeconomic effects of the Covid-19 pandemic, presenting the methodology and the main results of the empirical study. Finally, section 5 draws some conclusions.

2. The Covid-19 Pandemic in the European Union Countries

The Covid-19 pandemic is, first of all, a disease and a public health matter. Table 1 shows the number of cases and deaths in the EU-27 and in the four countries studied. The disease spread across Europe in the first quarter of 2020; Italy, Portugal and Spain recorded the highest number of cases per million inhabitants in 2020 among the countries analyzed. In 2020, the death toll was highest in Italy and Spain, above the EU-27 average. In 2021, the number of cases increased in all countries considered, as well as in the EU-27. The number of deaths per million of inhabitants decreased in Italy and Spain, the two countries where mortality Covid-19 was the worst in 2020. In Germany, Portugal and the EU-27 the number of deaths per million inhabitants increased in 2021.

Table 1: Number of Cases of Covid-19 and Reported Deaths

		EU-27	Germany	Spain	Italy	Portugal
Total of cases	2020	15853348	1783390	2015318	2209100	432358
	2021	37314081	5228298	3913084	3419735	853760
Cases per million people	2020	35441	21444	42578	37040	41993
	2021	83417	62865	82672	57338	82922
Total of deaths	2020	402834	43952	54914	79360	7226
	2021	493209	66844	34212	57815	11177
Deaths per million people	2020	901	528	1160	1331	702
	2021	1103	804	723	969	1086

Source: European Centre for Disease Prevention and Control and author's own calculations.

The treatment and control of the disease represents a burden on national health systems. Table 2 shows health care expenditure (as a % of GDP and per inhabitant) in each of these countries and the EU-27 in 2019. At the time this paper was written there were no data available on the pandemic period that followed.

Table 2: Health Care Expenditure

	EU-27	Germany	Spain	Italy	Portugal
Health care expenditure (% of GDP)	9.92	11.70	9.13	8.67	9.53
Health care expenditure (euro per inhabitant)	3102.05	4855.33	2411.68	2599.22	1982.5

Source: Eurostat.

As it can be observed, in 2019, Germany health care expenditure, as a % of GDP and per inhabitant, are higher than in EU-27. The two countries that were most affected by the first wave of the pandemic, Italy and Spain, recorded the lowest expenditure as a % of GDP. Portugal is the country with the lowest expenditure per inhabitant. It is expected that health care expenditure may have increased significantly in response to the Covid-19 pandemic. Unfortunately, with the exception of Portugal, where it is possible to obtain forecast data for 2021 – health care expenditure equal to 10.12% of GDP, and health care expenditure per inhabitant equal to €1989.1 –, the absence of data for the other countries, does not allow us to verify this. Even so, the counterfactual analysis that we intend to carry out will certainly help us to empirically confirm this reality.

The vaccination process, crucial to control the disease and its spread among the population, started in Europe in December 2020. The EU member states implemented a common strategy to approve and buy Covid-19 vaccines and to facilitate the supply of protective and medical equipment. Table 3 shows the key figures of the vaccination process, in 2021, in EU-27 and in the four countries considered in this work.

Table 3: Vaccination Process (2021)

		EU-27	Germany	Spain	Italy	Portugal
Total doses	Week 12	71,636,748	13,248,382	7,695,843	9,570,850	1,738,445
	Week 26	386,076,404	78,181,753	44,517,117	53,751,404	9,318,147
	Week 40	576,827,903	109,239,051	70,992,542	85,705,664	16,174,152
	Week 52	741,793,966	149,863,127	79,590,105	110,001,548	19,679,347
Uptake of at least one dose (%)	Week 12	11.3	11.2	10.7	11.0	11.9
	Week 26	52.6	57.3	56.5	58.5	56.6
	Week 40	68.0	68.7	80.0	76.2	87.5
	Week 52	72.8	74.2	84.1	80.5	90.4
Uptake full vaccination (%)	Week 12	4.7	4.8	5.6	5.0	4.9
	Week 26	35.7	39.2	40.4	33.7	36.8
	Week 40	63.2	65.3	73.3	69.3	80.5
	Week 52	68.5	71.2	75.2	74.3	82.6

Source: European Centre for Disease Prevention and Control.

As expected, over time, Covid-19 vaccination rates grew. However, there are differences between countries, Portugal achieving the highest record in terms of the proportion of the population with at least one dose of the vaccine and the proportion of the population fully vaccinated (in spite of the low rate of health expenditure per inhabitant). Spain has the second-best record, followed closely by Italy and Germany, slightly behind. The EU-27, compared with these four countries, has the worst vaccination record.

The first reactions and spending decisions to fight against the Covid-19 pandemic and to support households and companies were essentially taken by countries. The previous section of this work refers to the literature that describes the reaction of some of these countries. However, on April 9, 2020, the EU established an instrument (€540 billion) providing temporary support to mitigate unemployment risks in an emergency (SURE) to help workers, businesses and member states (see the European Council Website for more details on this and other measures). They also agreed, on July 21, 2020, on a i) €750 billion recovery effort, Next Generation EU, to help the EU tackle the crisis caused by the pandemic and, ii) a 2021-2027 long-term EU budget of €1,074.3 billion to support investment in the digital and green transitions and resilience. The first recovery and resilience plan of Portugal was submitted in April 2021. The European Commission has issued positive assessments of the recovery and resilience plans of our four countries in June 2021.

The European Central Bank (ECB) initiated, in March 2020, the pandemic emergency purchase program (PEPP), totaling €1,850 billion, with the aim to lower borrowing costs and increase lending in the euro area. The ECB also carried out four Pandemic Emergency Longer-Term Refinancing Operations (PELTRO) in 2021 to serve as a liquidity backstop to the euro area banking system and to preserve the smooth functioning of money market, among other measures (see the ECB Website for more details on these and other measures).

The Covid-19 pandemic crisis generated disruptions in economic activity, output loss and unemployment which are important to assess. However, this is a new type of shock and the economies have different socio-economic features from the past. Therefore, comparing its macroeconomic adverse effects with other past crises can lead to misleading outcomes

(Donadelli et al., 2021). The growing number of infected people and the combination of policy measures (lockdown, quarantine, testing) to "flatten the curve" are studied in order to capture the impact of the outbreak and to predict the macroeconomic effects of the pandemic (Chan, 2022 for the case of China; Ng, 2020 for the USA case). In the following sections we proceed to the counterfactual analysis based on ARIMA forecasting model.

3. Data and Preliminary Analysis

The data was collected during the months of November and December 2021 from AMECO online macroeconomic database[5] of the European Commission's Directorate General for Economic and Financial Affairs. The site compiles annual frequency data for a large number of macroeconomic variables. We used time series data for five macroeconomic variables: Gross Domestic Product (GDP), public debt, inflation rate, public deficit, and unemployment rate. Table 4 shows a description of the variables.

Table 4: Description of Variables

Variable	Description
GDP	Gross Domestic Product at constant market prices, Mrd EURO
Debt	Gross Public Debt as a percentage of GDP (UDGG/OVGD)
Inf_CPIH	Inflation rate by Harmonized Consumer Price Index (ZCPIH)
Deficit	Public Deficit as a percentage of GDP (UBLG/OVGD)
U	Unemployment rate, total (percentage of civilian labor force)

Source: AMECO.

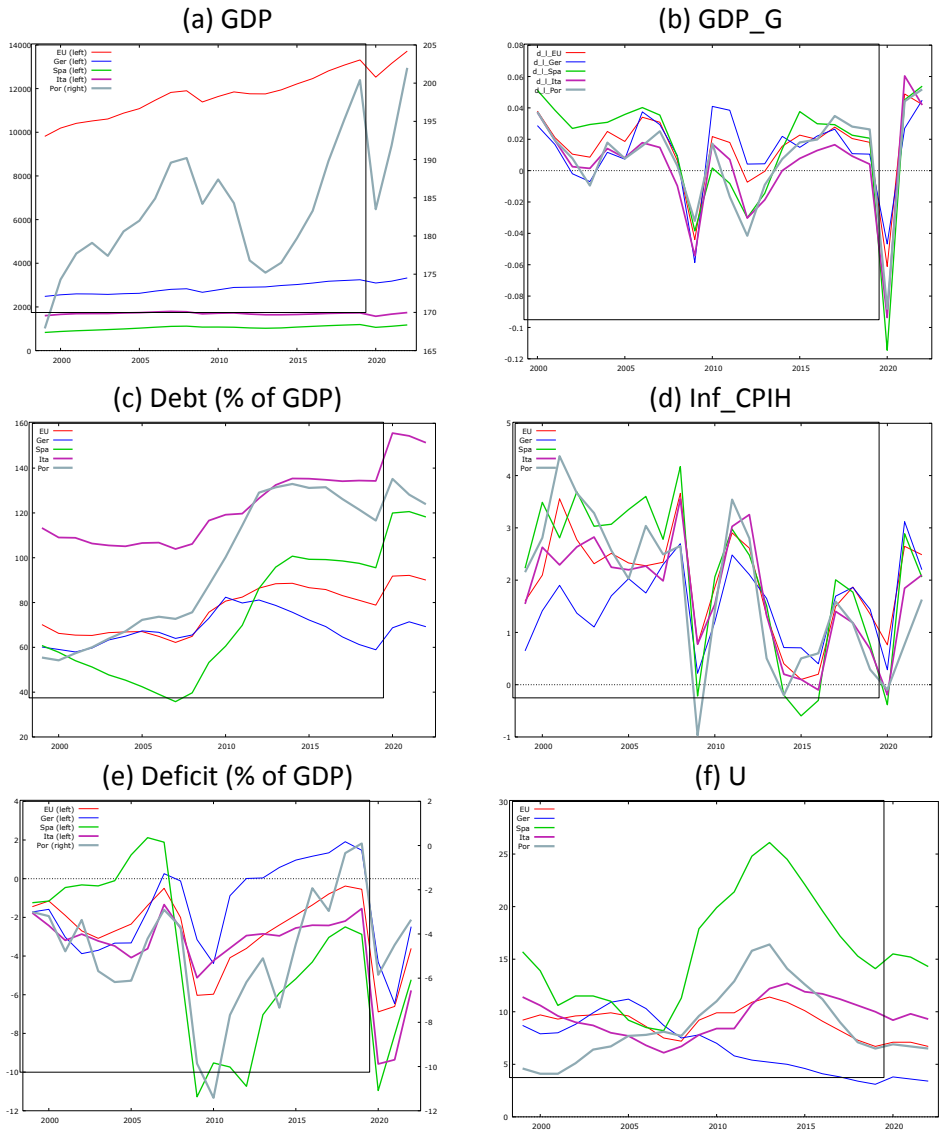
The sample covers the period from 1999 (the official launch of the European single currency) to 2022. This means that the values of the series of variables for the years 2021 and 2022 are AMECO's forecast values.

For each of these five macroeconomic variables, data were selected for the EU-27 and also for four of its economies – Germany, Spain, Italy and Portugal. As we said before, the choice of the countries was essentially determined by three main reasons: i) number of confirmed cases of the disease in the first three waves of the Covid-19 pandemic – Spain and Italy are two good examples of the situation; ii) highest vaccination rate of their population – Portugal is the best explanatory example, and iii) financial availability to react to the pandemic – Germany fits perfectly well into this argument. Naturally, the EU-27 is a benchmark, aimed to carry out a comparative analysis of the macroeconomic impacts of the Covid-19 pandemic for the European Union as a whole.

Figure 1 presents the macroeconomic performance of the variables in each of the four selected countries, as well as in the EU-27. In case of GDP, for a better perception of its dynamics, its growth rate (GDP_G) was also represented, measured as the logarithmic rate of change of each country's GDP. Our empirical results and figures were all obtained using Gretl 2021d software.

[5] See https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/macro-economic-database-ameco/ameco-database_en.

Figure 1: Macroeconomic Behavior (1999-2022)



Source: Authors, using the research database.

Notes: "GDP_G" is the GDP Growth, measured as the logarithmic rate of change in each country's GDP. The values of the variables for the years 2021 and 2022 are forecast based on AMECO. Countries are represented using the following abbreviations and colors: European Union (EU) - red; Germany (Ger) - blue; Spain (Spa) - green; Italy (Ita) – purple, and Portugal (Por) - grey, increasing the thickness of the line in this order.

The graphical analysis of the series allows us to see that the Covid-19 pandemic had a very negative and immediate effect on the macroeconomic behavior of the four EU countries, as well as of the EU-27. For all the variables, a strong change in their trend can be observed, with particular emphasis on the sharp drop registered in the GDP growth rate of all countries. Due to the pandemic shock, European economies experienced in 2020 negative growth rates in their product, reversing the good performance they were registering once the international financial crisis of 2011-13 was over. In 2020, the GDP of Spain fell more than 10%, followed by Italy and Portugal, with negative growth rates of around 9% and 8.5%, respectively. Germany is no exception, showing a 4.6% reduction in its product, slightly below the EU-27 rate, with a drop of the GDP of approximately 6%.

The official forecasts of the European Commission's Directorate General for Economic and Financial Affairs expected the four European economies and the EU-27 to recover from the crisis situation in 2021, and to deteriorate again in 2022, although positive output growth rates are expected.

As a direct consequence of GDP decline, largely explained by the temporary production shut down, the successive confinements of the population, and the disruptions observed in international value chains to which the pandemic gave rise, it is not surprising that the unemployment and the inflation rates also performed worse. With the surprising exception of Italy, which managed to keep up the downward trend in the unemployment rate since 2014, the immediate effects of the pandemic caused unemployment to rise in the other countries. Standing out negatively, we can mention the performance of the Spanish economy with the unemployment rate approaching 16%. Regarding the inflation rate, at first it can be said that there was a deflationary trend, mainly explained by the negative demand shock. However, more recently, there may be a pressure for rising prices. This is a result of the scarcity of raw materials and the growing demand for equipment and consumer goods directly related to the economic and political action taken to fight against the Covid-19 pandemic.

Finally, with regard to public finances, both public deficit and public debt registered a significant deterioration in their performance, once again as an immediate consequence of the political actions to overcome the pandemic. Particularly noteworthy is the very strong increase in the Spanish public deficit, which rapidly rose from -2.9% in 2019 to -11% in 2020, as well as in the Italian economy, which sees its public deficit increase significantly, from -1.5% in 2019 to -9.6% in 2020. Public debt of both countries also deteriorated significantly: Spain from 95.5% to 120%, and Italy from 134.3% to 155.6%, in addition to Portugal, whose gross public debt increased from 116.6% to 135.2% of GDP. Germany's performance is also worth mentioning. It was the only country in 2019 whose public debt was below 60% of GDP, and after the Covid-19 pandemic this variable increased to 68.7% of GDP. As can be seen from the analysis of Figure 1, this situation is expected to be reversed in 2022 only, despite the possibility of the 2022 values being considerably higher than before the pandemic.

In this context, we propose that once the pandemic has passed, European public decision-makers proceed with economic policies that promote the balance of public accounts, benefiting from the exceptional financial aid package created within the scope of institutional solidarity recently achieved by the EU within the framework of the so-called Recovery and Resilience Plan. Without balanced public accounts, Europe will have trouble fostering economic growth capable of reversing future shocks of this nature and avoiding a crisis situation again.

The counterfactual prospective analysis that follows will certainly help us to better understand the need to conduct this type of economic policies.

4. Counterfactual Analysis

Once the data has been described and the behavior of the selected variables analyzed, the question that arises is how to measure the macroeconomic impacts of something (in our case the Covid-19 pandemic) that now hypothetically we assume has not occurred, when in reality it did happened. We do this by forecasting the values of the variables for 2020, 2021 and 2022 had the pandemic not taken place. Then, we compare its dynamics with the actual behavior of the variables in the pandemic context. In other words, we analyze the macroeconomic effects of the Covid-19 pandemic starting from a counterfactual analysis. We assume that the pandemic did not occur, therefore the variables continue to perform in the same way since the beginning of the sample period. In this context, the relevant period of data analysis to develop our counterfactual research will be from 1999 to 2019.

Table 5 shows, for the period 1999-2019, some descriptive statistics of the variables.

The forecasting of data will be done using an ARIMA (Autoregressive Integrated Moving Average) model for each variable. The following section briefly describes this methodology[6].

4.1. Methodology

As previously mentioned, the methodology used to conduct the counterfactual analysis was an ARIMA forecasting model through which the behavior of a set of macroeconomic variables (GDP, public debt, inflation rate, public deficit, and unemployment rate) is examined in the context of the Covid-19 pandemic against a hypothetical situation without pandemic.

The choice of this forecasting model stems from the fact that it is a powerful tool when the intention is to forecast based on the past values of the variables. Under such circumstances, we will briefly explain how the ARIMA process works, thus justifying our choice.

[6] In the description of the methodology we follow closely Bento and Duarte (2020).

Table 5: Descriptive Statistics (1999-2019)

	Mean	Median	Min.	Max.	Std. Dv.	C.V.	Skn.	Exc. K.
EU								
GDP	11567	11757	9812.4	13313	939.17	0.0811	-0.0132	-0.6451
GDP_G	0.0152	0.0192	-0.0439	0.0379	0.0177	1.1625	-1.9188	4.3500
Debt	75.105	75.659	62.197	88.596	9.4950	0.1264	0.1022	-1.6514
Inf_CPIH	1.9215	2.0950	0.1001	3.6613	0.9937	0.5171	-0.2446	-0.5585
Deficit	-2.3434	-2.0082	-6.0311	-0.3805	1.5826	0.6753	-1.0096	0.4981
U	9.2333	9.6000	6.7000	11.400	1.2615	0.1366	-0.4386	-0.4844
Ger								
GDP	2823.9	2805.9	2483.3	3245.0	233.06	0.0825	0.3608	-1.0523
GDP_G	0.0133	0.0132	-0.0586	0.0409	0.0215	1.6147	-1.7429	4.2789
Debt	67.893	65.521	57.938	82.382	7.8806	0.1160	0.5315	-1.0044
Inf_CPIH	1.4942	1.6495	0.2188	2.6966	0.6798	0.4549	-0.2118	-0.7567
Deficit	-1.0955	-0.8798	-4.3792	1.9122	2.0396	1.8617	-0.1423	-1.4122
U	7.0048	7.5000	3.1000	11.200	2.5268	0.3607	0.0423	-1.1916
Spa								
GDP	1040.7	1070.2	831.60	1193.8	95.044	0.0913	-0.5708	-0.3287
GDP_G	0.0180	0.0280	-0.0384	0.0512	0.0243	1.3488	-0.9997	0.0226
Debt	68.117	60.520	35.769	100.70	24.343	0.3573	0.2307	-1.5962
Inf_CPIH	2.1180	2.4768	-0.5964	4.1714	1.4518	0.6854	-0.6502	-0.7851
Deficit	-3.5771	-2.8769	-11.278	2.1219	4.1644	1.1642	-0.4968	-0.9009
U	15.919	15.300	8.2000	26.100	5.6561	0.3553	0.3353	-1.1302
Ita								
GDP	1700.8	1699.4	1599.7	1795.1	47.722	0.0280	0.0395	-0.2257
GDP_G	0.0038	0.0079	-0.0542	0.0371	0.0198	5.1687	-1.3652	2.1321
Debt	118.77	116.60	103.90	135.37	12.637	0.1063	0.2450	-1.6512
Inf_CPIH	1.7884	1.9860	-0.1000	3.5510	1.0542	0.5894	-0.2238	-0.9203
Deficit	-2.9223	-2.8660	-5.1227	-1.3376	0.91190	0.3120	-0.4309	0.1096
U	9.5333	9.6000	6.1000	12.700	1.9635	0.2059	-0.0870	-1.1710
Por								
GDP	182.69	182.00	167.90	200.40	7.5992	0.0415	0.4325	0.0178
GDP_G	0.0088	0.0165	-0.0415	0.0374	0.0211	2.3912	-0.9282	0.1419
Debt	94.053	87.799	54.206	132.93	30.497	0.3242	0.0717	-1.6868
Inf_CPIH	1.9193	2.1521	-0.9698	4.3716	1.4122	0.7357	-0.2910	-0.7880
Deficit	-4.7753	-4.4519	-11.414	0.0932	2.8196	0.5904	-0.5075	0.1527
U	8.9762	7.8000	4.1000	16.400	3.7047	0.4127	0.5621	-0.7152

Source: Authors, using the research database.
Notes: “Min.” is the minimum. “Max.” is the maximum. “Std. Dv.” is the standard deviation. “C.V.” is the coefficient of variation. “Skn.” is the skewness. “Exc. K.” is the excess Kurtosis.

The name ARIMA comes from the acronym Auto Regressive Integrated Moving Average. Forecasts based on the autoregressive (AR) method are a linear combination of past values. An order regression *p*, or AR (p), can be written as follows:

$$y_t = c + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \cdots + \varphi_p y_{t-p} + \varepsilon_t, \quad (1)$$

where ε_t is a white noise. By white noise we mean that the errors do not have autocorrelation, or that the errors are not dependent on the past values. The second component of the ARIMA process is called the Moving Average (MA). This process uses, through a linear combination, past errors to predict future values. A MA process of order *q*, or MA (q), will take the form:

$$y_t = c + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} \quad (2)$$

As in the AR process, in the case of the Moving Average process the error term ε_t is also white noise, i.e. not dependent on its past values. The combination of the autoregressive process and the moving average process gives rise to the new process named ARIMA. The component "I", which stands for integrated, is the number of differentiations (d) that the model needs for the variables to be stationary. By stationarity it is understood that regardless of the time interval of the series that we choose, it maintains its characteristics.

In this context, forecasting through the ARIMA process requires the fulfilment of the stationarity condition. In a stylized way, for a series to be stationary it needs to meet three conditions over time:

i) Constant average:

$$\forall_t, E(Z_t) = \mu, \quad (3)$$

ii) Constant variance:

$$\forall_t, V(Z_t) = \sigma_Z^2, \quad (4)$$

iii) The same auto covariance function over time:

$$\forall_t, \forall_S, \forall_K, E[(Z_t - \mu)(Z_{t-K} - \mu)] = E[(Z_S - \mu)(Z_{S-K} - \mu)] = f(K) \quad (5)$$

Complying with equations (3), (4) and (5) is the same as saying that it has the same characteristics over time.

In the case of our set of macroeconomic variables, the stationarity condition is no exception. In order to verify whether our series of variables are stationarity, we opted to apply two tests, which allows greater robustness in the analysis. These tests include the traditional unit root Augmented Dickey-Fuller (ADF) test, whose null hypothesis is the existence of a unit root (Dickey and Fuller, 1979), and the stationary test of Kwiatkowski-Phillips-Schmidt-Shin (KPSS test), with null hypothesis of the series being stationary (Kwiatkowski et al., 1992).

The main results obtained by applying this methodology are presented in the following section.

4.2. Results

According to the methodology described above, we began to study the stationarity feature of the variables applying the ADF and KPSS tests. Table 6 shows the results of these unit root and stationary tests to each of the variables.

As can be observed, depending on the country and the variable in question, the results in terms of stationarity analysis are very diverse, and it is not possible to identify similar behavioral patterns between countries or variables. The exception is the inflation rate that, in all countries, is I(0). There is a predominance of I(0) variables and it is also possible to identify several cases in which the order of integration of the variables is equal to one or even equal to two, that is, in which the variables need one or two differentiations to become stationary. This is the case, for example, of Germany's public deficit, that is I(2), or the unemployment rate in Portugal, with this variable being I(1).

Eventually, the most surprising result in terms of stationary analysis of the series is the fact that a country like Italy, often characterized by some economic and political instability, presents all the variables I(0). Equally unexpected is the fact that the public deficit in Germany is I(2). This can be explained by the fact that during the period of analysis the country oscillated several times between budget deficit and surplus, causing persistent fluctuations in the behavior of the series, thus making it I(2).

Table 6: Unit Root and Stationary Tests

	ADF				KPSS			
	Level		First Difference		Level		First Difference	
	C	T	C	NC	C	T	C	T
EU								
GDP	-0.517	-1.822	-3.587**	-2.581**	0.766***	0.098	0.119	0.119
GDP_G	-3.689**	-3.538*	---	---	0.135	0.119	---	---
Debt	-1.813	-1.858	-2.332	-2.321**	0.583**	0.102	0.147	0.147*
Inf_CPIH	-2.495	-4.09***	---	---	0.438*	0.082	---	---
Deficit	-2.942**	-2.892	---	---	0.142	0.135*	---	---
U	-2.787*	-2.577	---	---	0.104	0.093	---	---
Ger								
GDP	2.057	-2.395	-4.57***	0.415	0.781***	0.145*	0.115	0.059
GDP_G	-4.71***	-3.675**	---	---	0.080	0.058	---	---
Debt	-1.835	-5.72***	---	---	0.285	0.164**	---	---
Inf_CPIH	-3.83***	-7.97***	---	---	0.109	0.094	---	---
Deficit	1.877	24.270	14.587	1.285	0.589**	0.091	0.098	0.060
Δ_Deficit	---	---	-2.711*	-2.88***	---	---	0.067	0.063
U	-0.120	-11.1***	---	---	0.655**	0.131*	---	---
Spa								
GDP	-2.128	-2.335	-2.085	-1.825*	0.621**	0.129*	0.180	0.135*
GDP_G	-2.149	-1.930	-4.02***	-4.14***	0.224	0.141*	0.150	0.071
Debt	-1.657	-6.86***	---	---	0.587**	0.148*	---	---
Inf_CPIH	-2.366	-16.7***	---	---	0.538**	0.079	---	---
Deficit	-1.941	18.751	15.572	-2.98***	0.304	0.118	0.117	0.093
U	-2.023	-3.320*	---	---	0.373*	0.107	---	---
Ita								
GDP	-4.31***	-3.373*	---	---	0.125	0.129*	---	---
GDP_G	-3.633**	-3.451*	---	---	0.211	0.145*	---	---
Debt	-1.542	-51.4***	---	---	0.667**	0.143*	---	---
Inf_CPIH	-2.380	-3.603*	---	---	0.469*	0.096	---	---
Deficit	-3.173**	0.235	---	---	0.194	0.150*	---	---
U	-2.972**	-1.178	---	---	0.282	0.145*	---	---
Por								
GDP	-2.574*	-2.159	---	---	0.357	0.098	---	---
GDP_G	-2.833*	-2.785	---	---	0.149	0.149*	---	---
Debt	-2.063	-5.10***	---	---	0.713***	0.102	---	---
Inf_CPIH	-1.042	-4.62***	---	---	0.558**	0.051	---	---
Deficit	-1.544	-1.628	-3.84***	-3.93***	0.182	0.162**	0.215	0.058
U	-2.300	-1.699	-1.880	-1.927*	0.418*	0.145*	0.284	0.126*

Source: Authors, using the research database.

Notes: The number of lags included in the test regressions was chosen according to the AIC criterion. "T" identifies tests run with a constant and a trend. "C" identifies tests run with only a constant. "NC" identifies tests run without a deterministic term. "Δ" identifies the first difference of the series. The null hypothesis of the ADF test is the existence of a unit root, while for KPSS under the null the series is (trend-) stationarity. Significance at 1%, 5% and 10% levels are denoted by "***", "**" and "*", respectively.

After analyzing the stationarity characteristics of the variables, the next step is to select the most appropriate ARIMA model. For this purpose, the minimum value of the Schwarz information criterion was considered, also known as the BIC criterion. The results of this analysis are summarized in Table 7.

Table 7: Parameters of the ARIMA Forecasting Model

	ARIMA Model Selection (AR, d, MA) Schwarz information criterion (BIC)				
	EU	Ger	Spa	Ita	Por
GDP	(0,1,0) 271.4071	(0,1,0) 222.2880	(1,1,0) 183.3419	(1,0,1) 214.6939	(2,0,0) 127.0910
GDP_G	(2,0,2) -90.78946	(2,0,2) -87.53355	(2,1,2) -81.28415	(2,0,2) -86.58697	(2,0,2) -84.39305
Debt	(0,1,1) 104.7056	(2,0,0) 118.6196	(2,0,0) 130.2543	(2,0,2) 120.4199	(2,0,0) 131.2994
Inf_CPIH	(1,0,0) 62.25456	(0,0,1) 49.01470	(1,0,0) 77.83393	(1,0,0) 64.66730	(0,0,1) 75.90161
Deficit	(0,0,2) 64.67468	(2,2,1) 73.59247	(0,1,1) 93.67269	(0,0,1) 52.32580	(0,1,0) 92.22704
U	(2,0,1) 48.86576	(2,0,1) 51.10911	(2,0,0) 95.87369	(2,0,1) 53.11702	(1,1,0) 69.18722

Source: Authors, using the research database.

As can be seen, the analysis of the minimum value of the Schwarz information criterion pointed to the choice of different types of ARIMA forecasting models for each of the countries and each of the variables. In fact, there is no pattern that can be said to be common to all of them.

Finally, based on these ARIMA models, we forecast the values of the variables for the years 2020, 2021 and 2022 ("without the Covid-19 Pandemic" scenario), and then compare its dynamics with the effective behavior of the variables in the pandemic context ("with the Covid-19 Pandemic"). The ARIMA models (or ARMA, if the series is I(0)) are estimated using the Kalman filter (exact maximum likelihood). The standard errors are based on Hessian. The forecast is automatic with out-of-sample dynamics. The results of this counterfactual research are presented in Table 8.

Table 8: Effective and Forecast Values with and without the Covid-19 Pandemic

	Effective/Forecast Values "With the Covid-19 Pandemic"			Forecast Values "Without the Covid-19			
	2020	2021p	2022p	2020	2021	2022	
EU							
GDP	12523.3	13150.4	13717.2	13488.0	13663.1	13838.1	↗↗↗
GDP_G	-0.06	0.05	0.04	0.02	0.01	0.01	↗↘↘
Debt	91.8	92.1	90.0	77.5	77.8	78.0	↘↘↘
Inf_CPIH	0.8	2.6	2.5	1.6	1.8	1.8	↗↘↘
Deficit/Surplus	-6.9	-6.6	-3.6	-1.4	-2.1	-2.3	↘↘↘
U	7.1	7.1	6.7	7.4	8.6	9.9	↗↗↗
Ger							
GDP	3096.7	3181.4	3327.5	3283.1	3321.2	3359.3	↗↗↗
GDP_G	-0.05	0.03	0.05	0.00	0.01	0.01	↗↘↘
Debt	68.7	71.4	69.2	58.9	60.2	62.0	↘↘↘
Inf_CPIH	0.3	3.1	2.2	1.5	1.5	1.5	↗↘↘
Deficit/Surplus	-4.3	-6.5	-2.5	1.6	2.5	3.4	↘↘↘
U	3.8	3.6	3.4	3.2	3.5	3.8	↘↘↗
Spa							
GDP	1064.6	1113.8	1175.4	1216.7	1238.7	1260.1	↗↗↗
GDP_G	-0.11	0.05	0.06	0.01	0.02	0.02	↗↘↘
Debt	120.0	120.6	118.2	92.2	87.9	83.3	↘↘↘
Inf_CPIH	-0.4	2.9	2.1	1.5	1.8	1.9	↗↘↘
Deficit/Surplus	-11.0	-8.1	-5.2	-2.5	-2.6	-2.7	↘↘↘
U	15.5	15.2	14.3	13.6	13.7	14.1	↘↘↘
Ita							
GDP	1573.2	1671.1	1742.5	1720.5	1709.8	1703.3	↗↗↘
GDP_G	-0.09	0.06	0.04	0.00	-0.01	-0.01	↗↘↘
Debt	155.6	154.4	151.4	132.3	129.5	126.4	↘↘↘
Inf_CPIH	-0.2	1.8	2.1	1.2	1.5	1.6	↗↘↘
Deficit/Surplus	-9.6	-9.4	-5.8	-2.2	-2.9	-2.9	↘↘↘
U	9.2	9.8	9.3	9.1	8.3	7.6	↘↘↘
Por							
GDP	183.5	191.8	202	200.9	198.6	195.0	↗↗↘
GDP_G	-0.09	0.05	0.05	0.02	-0.01	-0.02	↗↘↘
Debt	135.2	128.2	123.9	111.2	105.6	100.1	↘↘↘
Inf_CPIH	-0.1	0.8	1.6	1.3	1.9	1.9	↗↗↗
Deficit/Surplus	-5.8	-4.5	-3.4	0.2	0.4	0.6	↘↘↘
U	6.9	6.7	6.5	6.1	5.9	5.7	↘↘↘

Source: Authors, using the research database.

Notes: "p" identifies a forecast value by AMECO. Upward ↗ (downward ↘) oriented arrows indicate that, in the hypothetical absence of Covid-19 pandemic, forecast values for the variables would be higher (lower) than the effective/forecast values observed in the pandemic context for the corresponding years.

The analysis of the context "with the Covid-19 Pandemic" against a hypothetical situation "without the Covid-19 Pandemic" allows us to draw the following conclusions:

i) In general, the macroeconomic variables would have performed significantly better in the four countries and in the EU-27 had the Covid-19 pandemic not existed. In this sense, in counterfactual terms, it can be said that the Covid-19 pandemic was directly and indirectly responsible for the deterioration of the macroeconomic performance of all countries. In a scenario without the Covid-19 pandemic, all countries would have achieved higher GDP levels, showing, however, relatively weaker economic growth rates when compared to the pandemic situation, namely in 2021 and 2022. This is naturally explained by the strong drops in the product at the beginning of the pandemic.

ii) If the Covid-19 pandemic had not existed in a first moment (year 2020), the inflation rate would have been under greater upward pressure, with this dynamic being reversed in the two subsequent years. The exception is Portugal, whose forecasts point to consecutive increase in prices over the three years of our counterfactual analysis. All of the countries and the EU-27 would live in a context of low inflation (never above 2%), without any of them having observed a situation of deflation, unlike what happened in 2020 in Spain, Italy and Portugal with the Covid-19 pandemic.

iii) As expected, the greatest impact of the pandemic was on public finances. The demand and supply shocks it caused required from the EU countries an enormous financial effort to fight against the disease, namely in national health systems. This reality cruelly demonstrates the urgent need to restructure many of its services and the demand for new investments. Also, the lock-downs and temporary shut-downs of various productive activities, required an additional financial effort supported by the social protection systems. In a non-pandemic context, our forecasts point precisely to a better performance of all countries in terms of public debt and public deficit during the three years of counterfactual analysis. The budget surpluses in Germany and Portugal, in 2020, 2021 and 2022, as well as in the sharp reduction (over 20 percentage points) in the Spanish public debt are a clear indication of that. Considering that Spain and Portugal recently received international financial assistance to avoid bankruptcy, this result is very interesting. It reveals the eventual success of the fiscal policies followed since then, which, unfortunately, the emergence of the Covid-19 pandemic came to interrupt.

iv) In the absence of the Covid-19 pandemic, the labor market would have functioned without major disruptions, with the unemployment rate in the four EU countries following a downward trajectory. There would be only a slight increase in the German unemployment rate in 2022, which could be explained by the weak economic growth forecast for Germany in the same year. The biggest exception to this better performance forecasts of the unemployment rate in a non-pandemic context is the result obtained for the EU as a whole. In fact, our counterfactual analysis shows an increase in the EU-27 unemployment rate had the pandemic not existed, which is surprising given what we said earlier about the good performance of the other macroeconomic variables. We cannot ignore that even without a pandemic, in many European countries the labor markets encounter structural issues that make them more fragile and exposed to international competition, namely wage rigidity, low productivity and low rates of youth employment, e.g., in sectors producing high added value goods.

Despite considering these results very interesting from the economic point of view and its political implications, they should nevertheless be taken with some caution since they were

obtained from a hypothetical counterfactual scenario, which could also be questionable due to the possible use of other alternative forecasting methods.

5. Conclusion

In this paper we have analyzed the macroeconomic impacts of the Covid-19 pandemic in the EU-27 and, more particularly, in four of its economies (Germany, Spain, Italy and Portugal). For this purpose, a counterfactual analysis was conducted based on an ARIMA forecasting model through which the behavior of the GDP, public debt, inflation rate, public deficit, and unemployment rate of these economies was examined in the context of the Covid-19 pandemic against a hypothetical scenario without a pandemic.

Several studies have been developed on this topic. Even so, we believe that the results obtained in our study are indeed very interesting, namely because they may help frame future economic policies, whether in a similar context of pandemic crisis, or in a more favorable context in which there is no public health crisis.

It was found that the pandemic crisis, due to its direct or indirect effects on the functioning of economies, was strongly responsible for a slowdown in economic growth, the general rise in prices, a relatively significant increase in the unemployment rate, but above all significant worsening of the public finances of the European economies. If the Covid-19 pandemic had not occurred, all of these variables would have performed better, highlighting the decline in public deficits and public debt, which would certainly leave more room for public decision-makers to pursue more expansionary economic policies when they are actually needed, that is, in periods of economic crisis and recession.

In short, if for some "superior or natural order" the Covid-19 pandemic had not happened, in addition to the thousands of human lives that could have been saved, the economic health of the European Union countries would have been relatively better, which would have certainly resulted in greater welfare.

References

Adam, C.; Henstridge, M. and S. Lee (2020), "After the lockdown: macroeconomic adjustment to the COVID-19 pandemic in sub-Saharan Africa", *Oxford Review of Economic Policy*, Vol. 36, No. S1, pp. 338-358.

Albu, L.; Preda, C.; Lupu, R.; Dobrota, C.; Calin, G. and C. Boghicevici (2020), "Estimates of Dynamics of the Covid-19 Pandemic and of its Impacts on the Economy", *Romanian Journal of Economic Forecasting*, Vo. 23, No. 2, pp. 5-17.

Alon, T; Kim, M.; Lagakos, D. and M. VanVuren (2020), "How Should Policy Responses to the Covid-19 Pandemic Differ in the Developing World?", NBER, Working Paper 27273, May.

Altig, D.; Baker, S.; Barrero, J. M.; Bloom, N.; Bunn, P.; Chen, S.; Davis, S.; Leather, J.; Meyer, B.; Mihaylov, E.; Mizen, P.; Parker, N.; Renault, T.; Smietanka, P. and G. Thwaites (2020), "Economic uncertainty before and during the COVID-19 pandemic", *Journal of Public Economics*, Vol. 191.

Ataguba, J. (2020), "COVID-19 Pandemic, a War to be Won: Understanding its Economic Implications for Africa", *Applied Health Economics and Health Policy*, Vol. 18, pp. 325-328.

Bento, J. A. and A. P. Duarte (2020), "Brexit: An Exploratory Analysis of the Macroeconomic Effects on the British Economy", *Scientific Annals of Economics and Business*, Vol. 67, SI, pp. 1-17.

Chan, Y. T. (2022), "The macroeconomic impacts of the COVID-19 pandemic: A SIR-DSGE model approach", *China Economic Review*, Vol. 71.

Dickey, D. and W. Fuller (1979), "Distribution of the Estimators for Time Series Regressions with a Unit Root", *Journal of the American Statistical Association*, Vol. 74, pp. 427-31.

Donadelli, M.; Ferranna, L.; Gufler, I. and A. Paradiso (2021), "Using past epidemics to estimate the macroeconomic implications of COVID-19: A bad idea!", *Structural Change and Economic Dynamics*, Vol. 57, pp. 214–224.

ECB Website. Accessed in January 4, 2022 at https://www.ecb.europa.eu/home/search/coronavirus/html/index.en.html.

Eichengreen, B. (2020), "Coronanomics 101: which policy tools will contain the economic threat of COVID-19?", World Economic Forum (in collaboration with Project Syndicate), March 12, 2020. Accessed in December 23, 2021 at https://www.weforum.org/agenda/2020/03/coronavirus-economics/

European Council Website. Accessed in January 4, 2022 at https://www.consilium.europa.eu/en/topics/covid-19/.

Farayibi, A. and S. Asongu (2020), "The Economic Consequences of the Covid-19 Pandemic in Nigeria", EXCAS Working Paper, No. 42.

Kwiatkowski, D., Phillips, P., Schmidt, P. and Y. J. Shin (1992), "Testing the Null Hypothesis of Stationary Against the Alternative of a Unit Root: How Sure Are We That Economic Time Series have a Unit Root?", *Journal of Econometrics*, Vol. 54, pp. 159-78.

Ng, W. L. (2020), "To lockdown? When to peak? Will there be an end? A macroeconomic analysis on COVID-19 epidemic in the United States", *Journal of Macroeconomics*, Vol. 65, 103230.

Padhan, R. and K.P. Prabheesh (2021), "The economics of COVID-19 pandemic: A survey", *Economic Analysis and Policy*, Vol. 70, pp. 220-237.

Pedauga, L.; Sáez, F. and B. L. Delgado-Márquez (2021), "Macroeconomic lockdown and SMEs: the impact of the COVID-19 pandemic in Spain", *Small Business Economics*.

Radulescu, C.; Ladaru, G-R.; Burlacu, S.; Constantin, F.; Ioanas, C. and L. Petre (2021), "Impact of the COVID-19 Pandemic on the Romanian Labor Market", *Sustainability*, Vol. 13, No. 271, pp. 1-23.

Sanfelici, M. (2020), "The Italian Response to the COVID-19 Crisis: Lessons Learned and Future Direction in Social Development", *The International Journal of Community and Social Development*, Vol. 2, No.2, pp. 191-210.

Silva, N. B. and A. P. Duarte (2021), "Essential and Non-essential Goods: A Dynamic Stochastic General Equilibrium Modeling of the Infectious Disease Coronavirus (COVID-19) Outbreak", Springer Books, in: José Caetano, Isabel Vieira and António Caleiro (ed.), New Challenges for the Eurozone Governance, pp. 171-185.