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Assessing the effectiveness of international government responses to the COVID-19 pandemic☆

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ABSTRACT

This paper examines the effectiveness of non-pharmaceutical measures adopted by governments to control the evolution of the COVID-19 pandemic. Using a Panel VAR model for the OECD countries, we test for Granger causality between the 7-day cumulative incidence, mortality rate, and government response indexes. Granger-type statistics reveal evidence that the evolution of the COVID-19 pandemic influenced the measures taken by governments. However, limited or nonexistent evidence supports the reverse situation. This suggests that government measures were not highly effective in controlling the pandemic. While not implying total ineffectiveness, our results indicate a considerable lack of efficacy, emphasizing a lesson for governments to learn from and correct in preparation for similar events in the future.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has become one of the most important events of the 21st century so far. Since March 11th, 2020, when the World Health Organization (WHO) declared the pandemic situation, its outbreak has led to serious human losses (by June 2022, 534 million cases and 6.31 million deaths had been recorded worldwide) and has also generated one of the largest economic crises known to date. According to the World Bank Data,[4] the worldwide Gross Domestic Product decreased by 3.4% in 2020 while that of the Eurozone decreased by 6.4%. Brodeur et al. (2021) and Bloom et al. (2022) present an interesting perspective on the economic consequences of COVID-19, comparing it with other modern infectious diseases. It should also be pointed out that the pandemic has had a significant social impact in many areas, affecting all segments of the population but being particularly detrimental to the most disadvantaged groups, as noted by Bhattacharya (2020). The situation continues to evolve and some of the problems related to the pandemic have not yet fully emerged.

Faced with this avalanche of health and socio-economic effects, governments were forced to take quick measures to control the pandemic. State and local governments imposed a wide array of restrictions on activity, easing or tightening them as the transmission evolved. Moreover, these restrictions were quite similar in all European countries, as reported by Alfano et al. (2022b).[5] Some of the restrictions included stay-at-home requirements, the closing of schools and workplaces, shutting down international traffic, and limits on the size of public gatherings. Other more long-term measures encouraged the use of pharmaceutical interventions. The Oxford COVID-19 Government Response Tracker (OxCGRT) provides a systematic method of tracking government responses to COVID-19 across countries (Hale et al., 2020 and Hale et al., 2023). It classifies measures aimed at containing the pandemic into three main dimensions: containment and closure policies, health system policies, and vaccination policies. The analysis of all these measures has become the focus of a number of recent papers. The conclusions that can be drawn from these studies are varied and often contradictory.

Much of this research has focused on the analysis of the social and health implications of certain specific measures. In this regard, we can

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[4] https://www.worldbank.org/en/publication/global-economic-prospects (2022)
[5] We should note that these authors consider the first wave of COVID-19. Consequently, the sample size is shorter than the one used here.

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cite the paper by Alfano and Ercolano (2020), who state that lockdown measures were effective in reducing the number of new cases in the countries that implemented them, and their subsequent paper Alfano and Ercolano (2022b) in which they draw a similar conclusion for school closures. Elgin et al. (2020) focused on the economic policies adopted by national governments, whilst Brauner et al. (2021) studied the effectiveness of non-pharmaceutical interventions for a sample of 41 countries. Alfano (2021) examined the relevance of the work ethics in the containment of COVID-19 for a sample of 30 European countries. Despite the interest of these articles, they offer a partial view on the effects of the different measures adopted during the pandemic. We consider that it is not possible to analyze the effect of an isolated measure. Rather, it is better to have an overall view of the decisions taken in order to measure the real effectiveness of the response of governments. This could be done by summarizing the different actions in a single measure or index.

In fact, the development of the above mentioned indexes has been another important line of work in the analysis of the implications of governmental actions during the pandemic. The indexes elaborated by the Oxford COVID-19 Government Response Tracker are obtained by combining the evolution of some indicators of the measures taken by different governments into a single measure and are used to describe the variation in public responses. Among the different works that use this type of index for a wide group of countries, we can highlight those of Liu et al. (2021), Alfano et al. (2021), Alfano et al. (2022a), Sun et al. (2022), and Caselli et al. (2022). These works show that lockdown policies that restricted internal movement substantially reduced COVID-19 cases, especially when they were introduced early in a country's epidemic. However, these results have been questioned by many scholars who find that there is no clear negative correlation between the degree of lockdown and fatalities due to the COVID-19 pandemic. This is the case of Chaudry et al. (2020) or Bjørnskov (2021), amongst others, who consider a large sample of international countries. The reviews of the literature by Allen (2022) or Herby et al. (2022) show that the evidence fails to confirm that lockdowns had a significant effect in reducing COVID-19 mortality.

Today, it remains an open question whether lockdowns have had a large, significant effect on containing the pandemic. Moreover, they have imposed enormous economic and social costs where they have been adopted, reducing economic activity, raising unemployment, reducing schooling and undermining liberal democracy. As a consequence, their use as a pandemic policy instrument is clearly questioned, given the great socioeconomic cost.[6]

The origin of the controversy about the results of governmental actions during the pandemic may reside in the methodologies applied to date. Most of the work has focused on the search for correlations, but not on causality analysis. This is a fundamental question in this framework, given that the direction of the causality provides information on the consequences of the decision taken by governments on the evolution of the pandemic. Therefore, it seems quite interesting to apply the causality concept developed by Granger (1969) in this scenario.[7] Following this author, a variable X is said to cause (or Granger-cause) a variable Y if it can be shown that those values of X provide statistically significant information about the future values of Y. Most often, this is done by using a vector autoregressive model (VAR) and testing whether the lagged estimates of the variable X are significantly different from 0. In this context, an analysis of the causality between the measures taken by the government and the mortality rate may provide additional information to help clarify whether these measures are effective or not.

Against this background, we should note that this study aims to fill this gap by analyzing the effectiveness of the measures adopted by different governments to control the evolution of the COVID-19 pandemic by testing the null hypothesis of non-causality. To that end, we will estimate a panel VAR which includes two variables that can capture the evolution of the pandemic, namely the 7-day cumulative incidence and the death rate, and an index of the response of governments that collects systematic information on policy measures that governments have taken to tackle the pandemic.

The rest of the paper is organized as follows. Section 2 provides a discussion on the data and explains the methodology applied. The main results are reported in Section 3 and discussed and analyzed in Section 4. The main conclusions are presented in Section 5.

2. Data and methods

2.1. Database

The variables considered in this analysis are the following: the 7 day cumulative incidence (CI7) of the pandemic, the mortality rate (MR), and an index that reflects the response of governments. CI7 and MR have been obtained from the database organized by Johns Hopkins University.[8]

In order to measure the response of governments to the pandemic, we have employed a set of indexes compiled by the Oxford COVID-19 Government Response Tracker (OxCGRT) that provides a systematic set of cross-national, longitudinal measures of government responses. OxCGRT calculates simple indices that combine information to provide an overall measure of the intensity of government response in a particular domain. This response is measured by the following set of indicators: (C1) School Closing, (C2) Workplace closing, (C3) Cancel public events, (C4) Restrictions on gathering size, (C5) Close public transport, (C6) Stay at home requirements, (C7) Restrictions on internal movement, (C8) Restrictions on international travel, (E1) Income Support, (E2) Debt/contract relief for households, (E3) Fiscal measures, (E4) Giving international support, (H1) Public information campaign, (H2) Testing policy, (H3) Contact tracing, (H4) Emergency investment in healthcare, (H5) Investment in Covid-19 vaccines, (H6) Facial coverings, (H7) Vaccination policy, (H8) Protection of elderly people, and (M1) Other responses. These indicators are later employed to elaborate different indexes.

The basic index is the Stringency Index (SI, hereafter) which is a comprehensive measure based on the evolution of 9 indicators: C1-C8 and H1. There is a second index, called the Containment and Health Index (CHI, hereafter), based on the behavior of the following 14 indicators: C1-C8, H1-H3 and H6-H8. CHI includes the information related to the lockdown policies that primarily restricted people's behavior contained in the Stringency Index and combines it with measures such as the testing policy and contact tracing, short term investment in healthcare, as well investments in vaccines. Finally, there is a third index, called the Government Response Index (GRI). This is the most general one and is derived from a set of 16 indicators, covering containment and closure policies (C1-C8), economic policies (E1-E2), and health system policies (H1-H3 and H6-H8).[9]

These three indexes quantify the intensity of government response and range from 0 to 100. The closer to 100, the more stringent the government response to the COVID-19 pandemic. Further details on these three indexes can be found in Petherick et al. (2020) and Hale et al. (2021). Finally, we should note that the GRI encompasses the remaining indexes, offering a more comprehensive view of the evolution of government responses compared to the other indexes. Consequently, our

[6] In this regard, we can cite Dergiades et al. (2022).

[7] We are aware of some papers where the use of the Granger causality methodology is criticized. See Stokes and Purdon (2017) and Barnett et al. (2018) in this regard. However, we consider that this is the best procedure in a framework such the one considered in this paper.

[8] The data were collected from the webpage https://coronavirus.jhu.edu/

[9] More details on the elaboration of this index can be found in https://www.bsg.ox.ac.uk/research/covid-19-government-response-tracker

primary focus throughout the paper will center on the GRI. Nevertheless, we will also include the results obtained with the other two indexes for the purpose of comparison.

We have considered the 38 OECD countries. This dataset represents a relatively homogeneous group of countries. Nevertheless, we will also consider the case of the EU countries included in the sample in order to analyze the robustness of the obtained results. We should also note that the sample covers the weekly data from March 22nd, 2020 to August 29th, 2021. The data are thus previous to the appearance of the Omicron variant. The daily data have been transformed into weekly in order to smooth the variability of the data, remove the influence of some lack of data, and avoid the existence of possible measurement errors.

Once we have defined the database, a brief descriptive analysis seems to be in order. To that end, we have included in the Appendix Tables A1-A5, which present some sample statistics, such as the initial and the final values, the maximum value, and the values of the 3 quartiles. An analysis of these tables offers us some interesting insights.

Let us first consider the case of the CI7, presented in Table A1. The maximum values range from Belgium and Portugal, exceeding 1200 cases per million inhabitants, to Australia, Korea, and New Zealand, which are below 50. Similarly, the highest median values exceed 175 cases per million inhabitants (The Netherlands), while the lowest medians are not greater than 10 (Korea, Australia, and New Zealand). Despite this relatively wide range, the coefficient of variation for the different statistics presented in this table is not notably large, consistently remaining below 100, except for the statistics associated with the lowest values of the distribution (initial and minimum values).

Table A2 reflects the case of the number of deaths. We can see that Chile, Colombia and Mexico present median values greater than 4 deaths per million inhabitants, whilst those for Australia, New Zealand and Iceland are very low. Similarly, the range of variation for the Q3 values goes from Czechia and Hungary, which exhibit values greater than 10, to the cases of Australia, New Zealand, Iceland and Korea, which exhibit values lower than 0.1.

The analysis of the evolution of the government responses is reflected in Tables A3-A5. Focusing on the case of GRI, we can see that Chile present the highest median value (83), whilst Sweden, Estonia, and New Zealand show figures lower than 45. If we consider the Q3 case, we can observe that Sweden and Mexico exhibit values lower than 50, whilst Austria, Greece, Ireland and Chile present figures greater than 80. We should also note that the coefficient of variation of the different statistics presented in Table A3 is lower than those shown in Tables A1 and A2. Consequently, the dispersion in the measures adopted by the governments seems to be lower than that of the pandemic variables.

The case of the CHI is quite similar to the GRI. However, we can appreciate some differences for Q3. In this case, we can see that the highest values are for Chile, Greece and Colombia, which take values over 80, whilst New Zealand and Estonia show the lowest values (<50). We can also observe that the coefficient of variation of the statistics is quite similar to that observed for the GRI.

The SI presents some small differences with respect to the preceding indexes. We can see that New Zealand exhibits very low Q1 and median values. Even the values for Q3 are lower than 50. By contrast, Chile presents very high values. For instance, the Q1, Q2 and Q3 values are 78, 79 and 82, respectively.

The results of this initial descriptive analysis reveal interesting insights. There is more dispersion in the pandemic variables than in the indexes measuring government responses,[10] suggesting the potential inefficiency of governments to control the evolution of the pandemic. In any event, this is not the best procedure for studying the relationship between these variables. Rather, we consider the estimation of a Panel VAR as a much more appropriate econometric technique. The results obtained are presented in the next section.

[10] The relatively short dispersion may also indicate that countries adopted very similar measures to control the pandemic, as noted by Alfano et al. (2022).

2.2. Methodology

The aim of the paper is to analyze the Granger causality between the two measures of the evolution of the COVID-19 pandemic (confirmed cases and death rate) and the government responses to it, measured by the GRI index presented in the previous section. To that end, the use of time series analysis offers an excellent framework to carry out this study. More precisely, we want to estimate a Panel VAR and, subsequently, test the null hypothesis of Granger causality. The estimation of the panel VAR requires the variables employed to be stationary. We will take advantage of the advances on panel unit root inference to do this, although the selection of the most appropriate statistic depends on the possible existence of cross-sectional dependence.

The following subsections present the set of statistics that will be employed, all of them aimed to guarantee the appropriateness of the panel VAR estimation.

2.2.1. Testing for cross-sectional dependence

We first need to analyze the possible presence of cross-sectional dependence to determine the most appropriate panel data unit root tests. If the null hypothesis of no cross-sectional dependence is not rejected, then the statistics proposed by Im et al. (2003) can be used. However, the existence of cross-sectional dependence distorts the behavior of these statistics and, consequently, it must be taken into account.

There are various statistics to test for cross-sectional dependence. The most commonly used is the one in Pesaran (2015), which is defined as follows:

$$CD_P = \sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{\rho}_{ij} \quad \xrightarrow{As} N(0,1)$$

With $\widehat{\rho}_{ij}$ being the pair-wise correlation coefficient.

2.2.2. Testing panel data unit root tests

If we can prove the existence of cross-sectional dependence, as can be expected, then we should employ panel data unit root statistics that take it into account. We have several possibilities, but the one developed by Pesaran (2007) seems to be a good choice. This author extends the standard statistic by including some extra regressors that take into account the cross-sectional dependence. More precisely, the statistic is obtained by estimating the following equation:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0}^{p} d_{ij}\Delta\overline{y}_{t-j} + \sum_{j=0}^{p}\delta_{ij}\Delta y_{i,t-j} + \varepsilon_{it}$$

where y_{it} reflects the vector of the variables included in the analysis and a_i contains the deterministic elements. We should note that this regression extends the individual augmented Dickey-Fuller regressions with the cross-sectional means of the lagged levels and the first difference of the variables under analysis, capturing the effect of the non-observable factors. In order to test the null hypothesis H_o:b_i=0 (i=1,2,.,N) versus the alternative that H_A: b_i <0 for some (i=1,2,…,m), with m<N, Pesaran (2007) defines the following statistic:

$CIPS = \sum_{i=1}^{N} t_i$, with $t_i = \widehat{b}_i / \widehat{\sigma}_{\widehat{b}_i}$

The critical values are reported in Pesaran (2007). This author also designs a truncated version (CIPS*) of this statistic that removes the influence of extreme values. The threshold values and the critical values of this alternative version are also presented in the cited paper.

2.2.3. Panel VAR estimation and testing for Granger causality

After proving the absence of unit roots, we can then estimate a panel VAR. This model is an interesting extension of the standard VAR first introduced by Sims (1980). The panel VAR can be stated as follows:

$$Y_{it} = Y_{it\text{-}1} A_1 + Y_{it\text{-}2} A_2 + \ldots + Y_{it\text{-}p} A_p + X_{it} B + u_i + e_{it} \quad (1)$$

.

i=1,2,…N, t = 1,2, … T, where Y_{it} is a (1xk) vector of dependent variables, X_{it} is a (1xℓ) vector of exogenous explanatory variables, u_i is a (1xk) vector of dependent variable-specific panel fixed effects, and e_{it} is a (1xk) vector of idiosyncratic errors, such as $E(e_{it})=0$, $E(e_{it}'e_{it})=\Sigma$, and $E(e_{it}'e_{is})=0$ for all t>s. Finally, A_j (j=1,2,…p) is a kxk matrix of parameters, whilst B is a ℓxk matrix of parameters.

The estimation of this model is not straightforward, given that the presence of lagged dependent variables makes the standard methods (ordinary least squares, for instance) biased, as Nickel (1981) noted. Then, we should employ alternative methods to obtain estimators with good properties. To obtain consistent and efficient estimates under this condition, Arellano and Bond (1991) developed a generalized method of moment (GMM), which was later improved by the refinement of Blundell and Bond (1998), who developed the system-generalized method of moment (System-GMM). This uses the lagged differences of the dependent variable as instruments for equations in levels and also includes the lagged levels of the dependent variable as instruments for equations in first differences.[11]

Once we have estimated the system of equations, causality inference is straightforward. Following Granger (1969), testing for Granger causality[12] implies analyzing the hypothesis that all coefficients on the lag of variable m are jointly zero in the equation for variable n. This can be accomplished by conducting Wald tests using GMM estimation of the matrix A and its corresponding covariance matrix.

Finally, panel VAR analysis is carried out by selecting the optimal lag order in both the panel VAR specification and moment condition. To that end, we have considered the results of Andrews and Lu (2001) who proposed an optimal moment and model selection criteria (MMSC) for GMM models based on Hansen's (1982) J statistic of overidentifying restrictions. This statistic is analogous to various commonly used maximum likelihood-based model-selection criteria, namely, the Akaike information criteria (AIC), developed in Akaike (1969), and the Bayesian information criteria (BIC) proposed in Schwarz (1978). As we will see later, this procedure has led us to select two lags in all the considered cases.

3. Results

3.1. Cross-sectional dependence tests

The results of the cross-sectional dependence tests are presented in Table 1. As one can observe, the null hypothesis of no cross-sectional correlation is rejected by using the statistic proposed in Pesaran (2015).

This result has consequences in the subsequent steps, given that we should apply panel data unit root tests that take into account this fact, as is the case of the statistics proposed by Pesaran (2007) and presented in the methodological section.

3.2. Panel data unit root tests

The results of the panel data unit root tests are presented in Table 2. According to the analysis, the evidence against the null hypothesis of unit root is overwhelming. Consequently, we cannot consider that the variables are first-order integrated and the use of cointegration techniques is not appropriate, contrary to what was observed in Yang et al. (2021). To understand the differences, we should take into account that the samples differ in the number of countries, the type of data employed and, especially, the sample size. Sample size is of particular importance, given that we should note that all the variables will tend to decline at the end of the pandemic, all of them moving towards 0. Therefore, we cannot consider these variables are I(1), although their behavior can be similar to this type of variable for some periods of time. However, they should hopefully be considered as I(0) in the long-run, due to their reversion towards 0.

The results obtained are very relevant given that they determine the econometric tools that should be employed. Since no evidence in favor of the presence of unit roots has been found, then "standard" econometric techniques can be used. In our case, we have opted for the use of the panel VAR approach.

Table 1
Cross-Sectional dependence tests.

Variable	CD
Panel I. OECD countries	
SI	106.71***
CHI	92.55***
GRI	90.38***
CI7	83.62***
MR	79.18***
Panel II. EU countries	
SI	94.17***
CHI	86.31***
GRI	83.06***
CI7	74.86***
MR	71.56***

This table presents the values of the CD statistic designed in Pesaran (2015) for testing the null hypothesis of weak cross-sectional independence. The statistic asymptotically goes towards a standard N(0,1) distribution. Panels I and II consider the 38 OECD countries and the EU countries included in the sample, respectively.
*** means 1% rejection.

Table 2
Panel data unit root tests.

Variables	CIPS*
Panel I. OECD countries	
SI	-3.19***
CHI	-3.14***
GRI	-3.21***
CI7	-3.63***
MR	-4.12***
Panel II. EU countries	
SI	-3.10***
CHI	-3.27***
GRI	-3.31***
CI7	-4.03***
MR	-4.23***

This table presents the CIPS* statistic developed in Pesaran (2007) for testing the panel data unit root null hypothesis, when the specification includes an intercept and a deterministic trend. The number of lags has been selected by following a general to particular strategy based on the use of a Wald statistic to test the joint significance of the parameters of the augmented lags, using a maximum lag of 5.
Panels I and II consider the 38 OECD countries and the EU countries included in the sample, respectively.
*** means 1% rejection.

[11] See Abrigo and Love (2016) in this regard.

[12] We should note that testing for Granger-causality implies solely analyzing the predictive capacity of the variable X on variable Y, without any philosophical connotations.

3.3. Panel VAR and testing for Granger causality

Panel I of Table 3 presents the results of the estimation of model (1) with $Y_{it}=(GRI_{it}, CI7_{it}, MR_{it})$, considering that the application of the statistics for selecting the appropriate number of lags suggests p=3 and where the inclusion of the matrix X_{it} of exogenous variables is discarded. The analysis of this table provides a number of very interesting insights. If we begin by considering the CI7 equation, we can observe that the only estimations that are statistically different from 0 are the CI7 lags, whilst the lags of MR and GRI are not. Moreover, the estimation of the parameter of the CI7 lags reveals the existence of a very high amount of persistence in this variable, although this variable is not integrated. As a consequence, the reversion towards the expected values of this variable is very slow.

The results of the estimation of the MR equation are somewhat different. The lags of the MR variable are statistically different to 0 and also denote a large amount of persistence. We can also observe that the estimations of some lags of the CI7 variable are different from 0. By contrast, the lags of the GRI variable are not statistically different from 0. This implies that the evolution of the CI7 is very important for understanding that of the MR, whilst the effect of the GRI is not statistically different from 0, as occurred in the CI7 equation.

The results of the GRI equation are also very interesting. The lags of this variable are statistically different from 0 and, even more relevant, they once more show a great amount of persistence. We can also appreciate a significant impact of the lags of the CI7 and MR on the evolution of the GRI variable. Then, it seems that the response of governments depended on the evolution of the pandemic, and the worse the pandemic evolution, the more restrictive the measures taken by governments.

To assess the robustness of our findings, we extended our analysis the EU countries within the sample, as detailed in panel II of Table 3. Furthermore, we explored the impact of the Stringency Index (SI) and the Containment and Health Index (CHI) on the dynamics of COVID-19 variables. It is worth noting that these latter indexes focus more specifically on containment and closure policies, providing an alternative perspective to the broader Government Response Index (GRI). The Panel VAR estimations for these scenarios are presented in Appendix B, with Table B1 covering the SI and Table B2 addressing the CHI. The conclusions drawn from the analysis of these additional tables closely align with those in Table 3, underscoring a substantial degree of persistence in the variables and limited influence of government measures on the evolution of COVID-19 variables.

Once we have estimated the Panel VAR, we can use it to employ the statistics proposed by Granger (1969) and test for the null hypothesis of Granger non-causality, as presented in Table 4. Let us first focus on the case of the GRI, which is the most general one and thus provides a more comprehensive perspective on the measures that governments implemented to combat COVID-19. The results in Panel A of Table 4 unequivocally reject the null hypothesis of Granger non-causality from CI7 to MR for all three groups of countries considered. This rejection remains robust when analyzing Granger causality from CI7 to GRI. However, when assessing the impact of GRI on COVID-19 variables, we cannot reject the null hypothesis of Granger non-causality. Consequently, we should conclude that Granger causality between GRI and pandemic variables is not supported by the data.

The panels B and C of Table 4 present the results of those cases where the government responses are measured using SI and CHI. We can see that CI7 maintains its influence over the other variables, whilst the evidence against the null hypothesis of Granger non-causality between MR

Table 3
Panel VAR estimation.

Lag Var.\Equation	CI7	MR	GRI
	Panel I. OECD countries		
L.CI7	1.54***	0.006***	0.006***
	(0.05)	(0.0005)	(0.001)
L2.CI7	-0.63***	-0.004***	-0.005***
	(0.04)	(0.0005)	(0.001)
L.MR	-1.11	1.34***	-0.005
	(2.31)	(0.05)	(0.06)
L2.MR	2.71	-0.44***	0.03
	(1.87)	(0.04)	(0.06)
L.GRI	0.41	0.008	1.08***
	(0.42)	(0.007)	(0.03)
L2.GRI	-0.73*	-0.002	-0.13***
	(0.42)	(0.0007)	(0.03)
	Panel II. EU countries		
L.CI7	1.53***	0.006***	0.005***
	(0.06)	(0.0005)	(0.001) **
L2.CI7	-0.61***	-0.005***	-0.003
	(0.05)	(0.0006)	(0.001)
L.MR	-3.57**	1.40***	-0.04
	(1.76)	(0.06)	(0.07)
L2.MR	3.35**	-0.48***	0.09
	(1.56)	(0.05)	(0.06)
L.GRI	1.15*	-0.003	1.02***
	(0.65)	(0.01)	(0.03)
L2.GRI	-1.13**	0.008	-0.15***
	(0.56)	(0.01)	(0.03)

This table reflects the estimation of the model (1) when the specification includes the variables CI7, MR and GRI in levels. The values in parenthesis are the estimations of the standard errors of the different estimators. Panel I includes the 38 OECD countries, whilst panel II only considers the EU countries included in the sample.
L means the lag operator.
***, ** and * mean 1%, 5% and 10% rejection, respectively.

Table 4
Granger Causality. Panel VAR in levels.

Equation\excluded var.	CI7	MR	GM
Panel A. GM=GRI			
Panel I. OECD Countries			
CI7	-	6.74**	3.82
MR	150.60***	-	3.50
GM	25.40***	1.45	
Panel II. EU countries			
CI7	-	4.65*	4.26
MR	116.43***	-	0.69
GM	20.37***	6.15**	
Panel B. GM=SI			
Panel I. OECD Countries			
CI7	-	7.54**	6.40**
MR	149.13***	-	3.06
GM	26.42***	0.04	
Panel II. EU countries			
CI7	-	8.14**	4.32
MR	112.19***	-	1.05
GM	26.54***	3.00	
Panel C. GM=CHI			
Panel I. OECD Countries			
CI7	-	6.82**	5.51*
MR	145.05***	-	2.31
GM	26.13***	1.59	
Panel II. EU countries			
CI7	-	5.04*	4.92*
MR	110.58***	-	0.51
GM	22.43***	6.41**	

This table presents the Wald-type tests for testing the null hypothesis of Granger non-causality, obtained after the estimation of different Panel VARs for the variables in levels. The first column reflects the equation of the system, whilst the first row is associated to the excluded lags.
CI7, MR, and GM represent the 7-day cumulative incidence, the mortality rate, and a variable measuring the government responses to COVID-19. In the latter case, we have considered the three indexes presented in the paper: GRI, SI, and CHI, associated with Panel A, Panel B, and Panel C, respectively. Panel I displays the results for the 38 OECD countries, while Panel II concentrates on EU countries included in the sample.
***, ** and * mean 1%, 5% and 10% rejection, respectively.

and CI7 slightly increases. Importantly, there are somewhat relevant changes in the Granger causality analysis between CHI and SI and the pandemic variables and our results offer some evidence against the Granger non-causality null hypothesis, although this is only strong for the SI in the OECD countries.

However, we should consider the findings of Blundell and Bond (1998), who demonstrate that the use of highly persistent variables may adversely affect the estimation of the Panel VAR and, consequently, the analysis of the Granger non-causality hypothesis. To mitigate the potential impact of employing near-integrated variables, we have repeated the analysis assuming the presence of a unit root in the variables. Therefore, we estimated the Panel VAR with the variables transformed into their corresponding first differences. This additional analysis allows us to better appreciate the robustness of the Granger non-causality inference previously carried out. The results of this new analysis are presented in Table 5, where we observe that the rejection of the Granger non-causality null hypothesis persists when considering the relationship from CI7 to the variables measuring government responses. In contrast, the evidence against this hypothesis disappears when considering the opposite case. Therefore, doubts about the capacity of government measures to control the evolution of the pandemic persist.

The overall results presented in this section raise doubts about the effectiveness of government responses in controlling the spread of COVID-19. However, we should note that the absence of a counterfactual scenario makes it impossible to definitively determine how the pandemic variables would have behaved without government measures. In any event, our results robustly suggest that the evolution of the pandemic seemed to dictate the course of these responses, portraying governments more as followers than leaders. This implies a limited ability to anticipate and influence the trajectory of the pandemic, prompting questions about the adequacy of the health policies adopted by governments during this period.

Table 5
Granger Causality. Panel VAR for the first differenced variables.

Equation\excluded var.	CI7	MR	GM
Panel A. GM=GRI			
Panel I. OECD Countries			
CI7	-	28.21***	0.03
MR	174.51***	-	0.53
GM	17.21***	1.93	-
Panel II. EU countries			
CI7	-	21.22***	0.08
MR	155.49**	-	0.02
GM	9.64***	0.98	-
Panel B. GM=SI			
Panel I. OECD Countries			
CI7	-	27.93***	0.03
MR	168.51***	-	0.88
GM	20.38***	11.10**	-
Panel II. EU countries			
CI7	-	21.20**	0.29
MR	151.98***	-	0.13
GM	12.32***	6.62**	-
Panel C. GM=CHI			
Panel I. OECD Countries			
CI7	-	29.26**	0.01
MR	171.58***	-	0.68
GM	17.30***	3.21*	-
Panel II. EU countries			
CI7	-	23.75***	0.10
MR	154.82***	-	0.002
GM	9.10**	1.78	-

This table presents the Wald-type tests for testing the null hypothesis of Granger non-causality, obtained after the estimation of different panel VARs for the first differenced variables. The first column reflects the equation of the system, whilst the first row is associated to the excluded lags.
CI7, MR, and GM represent the 7-day cumulative incidence, the mortality rate, and a variable measuring the government responses to COVID-19. In the latter case, we have considered the three indexes presented in the paper: GRI, SI, and CHI, associated with Panel A, Panel B, and Panel C, respectively. Panel I displays the results for the 38 OECD countries, while Panel II concentrates on EU countries included in the sample.
***, ** and * mean 1%, 5% and 10% rejection, respectively.

4. Discussion

The main insight that emerges from our results is the very well-known fact that correlation does not mean causality. We have previously reported on some papers where a strong correlation is found between government responses and the evolution of the COVID-19 pandemic. However, these papers do not explicitly test for causality, except for Yang et al. (2021). Our results reveal that causality from government responses to the pandemic evolution is very limited. By contrast, there exists robust evidence in the reverse direction.

In any case, it is important to note that the results obtained do not imply that the measures taken were useless, particularly the containment and closure policies included in SI and CHI, as they contributed to controlling the epidemiological situation, especially at the beginning of the pandemic. This observation aligns with findings from Alfano and Ercolano (2020), (2022a) for a sample of international countries, Alfano et al. (2021) in Italy, and Rees et al. (2022) in Canada. Furthermore, our results do not present the counterfactual situation, making it impossible to determine what would have occurred if these lockdown measures had not been implemented, as mentioned earlier.

However, we should recognize that the results presented in these papers show that governments may have exhibited some degree of overreaction, as Pingle (2022) notes. Some other authors, such as Frijter et al. (2021) and Chaudhuri (2022), also support this point. Therefore, it is possible that less severe restrictions would have been as effective as those taken and with less damaging socio-economic consequences. The lockdown measures adopted in all countries have led to far-reaching social and economic changes, resulting in economic crisis and recession, a reduced workforce across all economic sectors, social distancing, self-isolation, an increase in poverty, hunger, and inequalities, as Schippers et al. (2022) note.

In any event, we cannot consider that government responses were inadequate, especially if we bear in mind the initial uncertainty about the behavior of the virus. However, our results do question their effectiveness. Some factors, such as inappropriate behavior by some members of the public, the inadequate use of facemasks, and the existence of a certain disdain for citizens' compliance with the regulations, could help to explain this lack of effectiveness. Some previous papers also suggest this. For instance, Alfano et al. (2022a) study a sample of 34 countries and show that corruption in politicians and public officials is directly correlated to the COVID-19 cases, perhaps connecting the mistrust of the public with the lack of effectiveness in the application of the previously mentioned measures. Park et al. (2021) study the case of South Korea and conclude that an improvement in individual preventive measures by the public might have reduced the need for more restrictive measures, such as quarantine, isolation, or contact screening. A similar conclusion is reached by Huang et al. (2022) for the USA case. Similarly, Spiliopulos (2022) concludes that the maximum effectiveness of non-pharmaceutical restrictions is attainable with interventions associated with lower values of the GRI. These papers, and others like those of Haug et al. (2020), BenDavid et al. (2021) and Vickers et al. (2022), suggest that governments might have overreacted to the evolution of the pandemic in the sense that more severe restrictions were not significantly more effective than less restrictive policies.

Therefore, we consider that adopting very severe measures has a very high economic and social cost, and public policies should take this into consideration in order to improve the effectiveness of their implementation in the event that a situation similar to that of the COVID-19 pandemic would have to be faced. The best antidote to that end is the continuous evaluation of these public policies.

5. Conclusions

This paper analyzes the effectiveness of government responses to the outbreak of the COVID-19 pandemic in a sample comprising the 38 OECD countries. For this purpose, a Panel VAR has been estimated that includes as variables the 7-day cumulative incidence, mortality rate, and a measure of the responses of governments to the pandemic. These measures are based on the set of indicators compiled by the Oxford COVID-19 Government Response Tracker at the Blavatnik School of Government. This institution publishes the Government Response index that provides very useful information to assess the evolution of the different decisions taken by governments, but also the Stringency Index and the Commitment and Health index, which consider a lower number of indicators. The sample used covers weekly data from March 22nd, 2020 to August 29th, 2021, which reflects the evolution of the pandemic before the arrival of the omicron variant and the mass vaccination of individuals. Based on the estimation of the aforementioned panel VAR, we have tested the null hypothesis of Granger non-causality to determine the direction of the relationship between the variables included in the VAR specification.

The results obtained show that, first, the pandemic variables (MR and CI7) are very persistent, but not integrated. Therefore, they have a very slow reversion towards their natural value, which in the long term should tend to 0. Secondly, the existence of Granger causality between these two variables is observed. There is also evidence of Granger causality from these variables to the three indexes that measure the government responses, which indicates that decisions were taken based on their evolution. However, the clear evidence that these government responses caused changes in the evolution of the pandemic is limited. The evidence against the null hypothesis of Granger non-causality is only solid for the SI case, when we consider the total sample. Apart from this case, the evidence against this null hypothesis is very weak. This result can be partially explained by the aforementioned persistence of MR and CI7, but it also suggests a certain ineffectiveness of the government measures.

The overall conclusion is that the measures of government responses were of very limited effectiveness. However, we should interpret this with some caution as the results do not prejudge the adequacy of the responses. These policies were among the best that could have been applied, especially in the initial situation, given the dramatic epidemiological circumstances and the absence of pharmaceutical solutions, which have played a crucial role in this regard. However, it can be deduced from our results that the responses may have generated a certain degree of overreaction. Additionally, it seems that the way in which these measures were applied may not have been the most appropriate. These lessons have to be taken into account in the, hopefully unlikely, event that governments are faced with situations similar to those that led to the outbreak of the COVID-19 pandemic.

Finally, we would like to remark that this study could benefit from two complementary analyses. The first is related to the period of time considered, suggesting that a time-varying analysis could provide more evidence against the null hypothesis of Granger non-causality, especially during the earliest stages of the pandemic. Additionally, it is likely that the effectiveness of government measures has varied across countries. Therefore, studying specific cases could help us to better understand how government measures influenced the evolution of pandemic variables. Both aspects are left for future research, as they require different econometric approaches to that employed in this paper.

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Declarations of interest

none.

Data Availability

Data will be made available on request.

Appendix A

Table A1
Descriptive Statistics. Variable: CI7

	ini	last	max	min	σ	Q1	Q2	Q3
Australia	3.39	36.60	36.60	0.19	6.31	0.43	0.65	3.47
Austria	26.88	138.62	771.66	2.99	169.45	15.09	72.61	220.79
Belgium	18.92	171.27	1431.38	7.81	234.50	49.57	144.60	211.10
Canada	3.39	74.01	227.12	3.39	66.25	16.06	46.66	118.69
Chile	2.47	31.65	372.67	2.47	109.13	75.41	111.17	249.56
Colombia	0.33	51.59	578.15	0.33	143.98	70.01	153.07	249.42
Costa Rica	1.61	399.98	466.33	1.02	124.57	69.09	172.01	232.32
Czechia	7.54	17.59	1150.89	4.45	368.66	15.92	47.22	593.46
Denmark	16.28	165.90	567.00	2.82	113.31	24.77	85.45	155.73
Estonia	22.35	236.04	1103.64	0.66	269.27	15.61	49.84	328.83
Finland	7.80	107.50	137.53	0.80	37.26	11.86	36.13	63.76
France	17.51	291.45	747.16	6.40	177.18	37.13	171.69	302.67
Germany	22.00	105.64	283.27	3.81	87.72	13.73	47.40	160.22
Greece	4.12	312.53	312.53	0.62	101.54	7.70	60.10	191.28
Hungary	0.88	11.57	910.22	0.60	226.22	4.51	36.77	201.08
Iceland	98.31	229.19	332.61	0.48	84.14	4.99	18.40	42.81
Ireland	12.80	364.93	1003.56	1.61	176.34	38.04	83.25	144.82
Israel	7.29	921.92	924.84	1.52	259.73	23.96	110.31	341.47
Italy	62.71	107.63	567.60	3.25	147.20	20.76	81.84	234.08
Japan	0.33	180.41	180.41	0.29	32.03	3.99	10.13	23.06
Latvia	5.54	82.11	496.71	0.52	160.14	4.51	50.58	282.00
Lithuania	2.23	213.45	1077.00	0.92	267.78	10.90	89.59	327.93
Luxembourg	81.30	111.04	1059.09	4.92	247.33	67.61	151.66	275.15
Mexico	0.17	128.69	141.66	0.17	33.88	25.60	40.32	62.02
Netherlands	16.52	155.03	660.59	3.33	184.98	38.63	175.90	371.19

(*continued on next page*)

Table A1 (*continued*)

	ini	last	max	min	σ	Q1	Q2	Q3
New Zealand	0.93	9.72	14.78	0.00	2.52	0.37	0.62	0.96
Norway	27.25	171.10	171.10	1.35	44.53	14.59	43.30	79.45
Poland	1.19	5.40	742.93	1.19	197.43	8.52	18.67	226.57
Portugal	10.43	225.66	1227.21	10.43	252.49	34.37	64.81	250.81
Slovakia	2.60	16.27	518.59	0.21	169.90	5.16	22.01	277.84
Slovenia	14.66	179.36	854.35	0.28	273.38	13.99	84.80	427.87
Korea	2.03	34.49	35.09	0.17	9.11	1.43	7.68	11.62
Spain	44.26	202.55	765.24	6.56	173.31	84.96	149.15	241.14
Sweden	11.73	92.89	634.93	11.73	206.74	40.12	89.36	389.61
Switzerland	57.32	293.92	930.81	1.86	197.36	25.88	97.86	215.73
Turkey	0.62	225.90	676.35	0.62	151.99	18.18	64.35	158.81
United Kingdom	10.40	494.57	849.33	6.90	205.21	30.43	76.33	315.15
United States	6.28	461.73	712.13	6.28	183.42	85.60	159.32	249.42
CV	138.4	94.5	59.2	110.4	56.6	90.9	67.6	59.2

Columns ini, last, max, min, σ, Q1, Q2, Q3 reflect the initial value, the last value, the maximum value, the minimum value, the 1st quartile, the 2nd quartile (median) and the 3rd quartile, respectively. The last row presents the cross-sectional coefficient of variation for each one of the descriptive statistics.

Table A2
Descriptive Statistics. Variable: Mort.

	ini	last	max	min	σ	Q1	Q2	Q3
Australia	0.02	0.09	0.72	0.00	0.16	0.00	0.01	0.06
Austria	0.09	0.21	12.00	0.02	3.08	0.16	0.74	2.99
Belgium	0.37	0.51	26.77	0.10	5.48	0.43	2.30	4.25
Canada	0.04	0.55	4.90	0.04	1.28	0.26	0.83	1.97
Chile	0.00	1.87	9.99	0.00	2.15	2.16	3.36	4.90
Colombia	0.00	1.85	12.51	0.00	3.29	2.31	3.64	6.19
Costa Rica	0.02	3.19	5.96	0.00	1.48	0.79	2.02	2.89
Czechia	0.00	0.17	19.74	0.00	6.59	0.16	0.87	11.44
Denmark	0.17	0.26	5.39	0.01	1.25	0.12	0.29	0.89
Estonia	0.00	0.63	8.55	0.00	2.48	0.06	0.52	3.31
Finland	0.01	0.23	2.12	0.00	0.38	0.06	0.22	0.53
France	0.59	1.89	13.56	0.13	3.00	0.59	2.24	5.15
Germany	0.08	0.24	10.26	0.04	2.61	0.18	1.05	2.65
Greece	0.09	2.92	9.58	0.01	2.75	0.24	1.21	4.23
Hungary	0.03	0.16	26.88	0.00	7.57	0.16	1.13	10.10
Iceland	0.12	0.48	3.03	0.00	0.48	0.00	0.00	0.07
Ireland	0.05	0.49	11.19	0.00	2.81	0.26	0.86	1.96
Israel	0.01	2.87	6.83	0.01	1.56	0.21	1.01	2.18
Italy	6.06	0.79	13.00	0.10	3.82	0.38	2.73	7.15
Japan	0.02	0.30	0.86	0.00	0.23	0.05	0.13	0.36
Latvia	0.00	0.35	11.18	0.00	3.22	0.10	0.62	4.40
Lithuania	0.00	2.47	16.86	0.00	4.31	0.17	0.89	4.29
Luxembourg	0.84	0.16	10.90	0.00	2.92	0.16	1.11	3.58
Mexico	0.00	5.46	9.92	0.00	2.15	2.09	3.64	4.79
Netherlands	0.67	0.54	8.58	0.02	2.11	0.25	1.26	3.48
New Zealand	0.00	0.00	0.22	0.00	0.04	0.00	0.00	0.00
Norway	0.13	0.07	1.41	0.00	0.32	0.05	0.13	0.40
Poland	0.01	0.08	14.45	0.01	4.32	0.30	0.69	7.19
Portugal	0.08	1.08	26.46	0.08	5.50	0.33	1.07	2.80
Slovakia	0.00	0.03	18.07	0.00	6.09	0.04	0.24	7.44
Slovenia	0.06	0.55	24.06	0.00	6.27	0.20	0.95	3.82
Korea	0.08	0.18	0.43	0.00	0.09	0.03	0.06	0.09
Spain	2.50	2.53	17.75	0.01	3.60	0.84	2.37	4.85
Sweden	0.40	0.21	11.32	0.02	2.91	0.27	1.69	4.27
Switzerland	0.94	0.39	11.24	0.01	3.45	0.15	0.59	3.12
Turkey	0.01	2.63	4.12	0.01	1.00	0.51	0.85	1.80
United Kingdom	0.32	1.58	17.83	0.11	4.65	0.31	1.29	6.10
United States	0.11	3.56	10.19	0.11	2.50	1.98	2.71	5.02
CV	286.4	117.4	67.3	168.4	69.4	144.8	85.9	72.8

See caption to Table A1.

Table A3
Descriptive Statistics. Variable: GRI

	ini	last	max	min	σ	Q1	Q2	Q3
Australia	35.86	42.24	67.71	35.86	8.42	53.12	58.78	64.90
Austria	64.14	78.01	83.96	64.14	5.88	70.29	73.59	80.83
Belgium	55.73	63.31	74.56	55.73	4.48	61.45	64.35	65.62
Canada	53.43	71.67	71.88	53.43	4.80	64.21	69.08	70.42
Chile	35.57	83.70	87.55	35.57	16.74	62.40	82.96	86.04
Colombia	40.40	67.29	74.90	40.40	8.55	61.72	65.21	67.29
Costa Rica	44.34	61.70	66.98	44.34	3.61	57.08	57.97	58.96
Czechia	64.06	57.83	75.62	50.52	6.80	55.00	58.33	61.56
Denmark	53.05	58.81	63.13	39.58	8.02	53.05	54.57	60.45

(continued on next page)

Table A3 (*continued*)

	ini	last	max	min	σ	Q1	Q2	Q3
Estonia	39.65	50.00	66.25	30.21	13.21	34.90	40.32	52.32
Finland	54.46	56.35	56.35	45.31	3.57	53.39	54.76	56.35
France	72.81	62.98	72.81	53.79	5.63	62.24	66.36	68.44
Germany	45.16	68.63	69.97	45.16	5.45	63.22	67.29	68.39
Greece	37.65	72.71	87.92	37.65	11.55	64.11	73.65	81.04
Hungary	54.98	56.25	71.46	38.02	13.18	39.58	54.98	69.79
Iceland	56.10	54.17	71.77	46.35	5.90	54.17	57.81	61.53
Ireland	37.50	70.94	85.00	37.50	10.07	66.65	67.81	81.21
Israel	64.29	65.10	70.83	44.79	7.38	57.44	65.10	65.10
Italy	67.71	77.44	81.78	64.06	4.91	72.33	77.49	79.12
Japan	40.10	56.67	61.51	40.10	4.26	56.25	56.67	58.96
Latvia	51.78	59.38	59.38	38.02	8.91	40.10	51.78	58.75
Lithuania	52.67	61.85	67.60	50.52	4.76	53.39	55.21	60.31
Luxembourg	66.81	59.38	66.81	42.63	6.23	46.87	57.29	59.69
Mexico	7.66	47.76	63.02	7.66	10.04	45.37	47.76	48.85
Netherlands	47.47	65.73	69.90	45.81	8.53	51.30	55.73	66.44
New Zealand	36.46	37.92	90.97	36.46	19.91	37.92	39.17	77.60
Norway	38.84	60.71	67.29	35.94	10.03	51.74	55.71	62.53
Poland	38.91	63.02	68.33	38.91	7.21	53.12	53.12	65.89
Portugal	59.38	70.62	78.60	59.38	5.35	65.27	69.66	71.46
Slovakia	57.36	61.68	81.82	50.78	11.12	55.25	57.36	77.40
Slovenia	56.92	61.04	78.30	41.46	10.98	46.67	55.52	62.60
Korea	57.00	59.48	64.17	51.86	2.80	59.48	60.42	62.50
Spain	52.57	65.99	68.13	52.57	5.31	56.51	58.59	67.16
Sweden	49.18	37.81	52.92	34.17	4.19	37.81	40.94	44.06
Switzerland	53.80	56.35	62.55	51.56	3.66	52.40	54.69	56.35
Turkey	40.99	76.15	81.88	36.98	13.76	50.37	61.04	73.54
United Kingdom	28.50	68.80	75.91	28.50	10.23	57.59	62.94	68.02
United States	49.85	59.30	65.62	49.85	4.02	55.43	58.85	62.64
CV	25.8	16.5	12.5	24.2	49.7	16.4	15.8	14.0

See caption to Table A1.

Table A4
Descriptive Statistics. Variable: CHI

	ini	last	max	min	σ	Q1	Q2	Q3
Australia	38.95	74.17	75.53	38.95	7.73	57.80	62.50	68.29
Austria	63.10	69.43	82.62	43.45	13.19	53.31	69.31	78.86
Belgium	54.76	61.90	75.12	51.49	5.05	59.46	62.76	64.74
Canada	53.15	66.24	73.21	53.15	4.81	61.61	64.50	71.24
Chile	40.65	72.08	85.77	40.65	6.91	72.92	75.30	80.18
Colombia	40.05	59.82	84.52	40.05	10.63	58.33	71.01	80.95
Costa Rica	49.15	61.67	69.40	49.15	4.11	54.86	56.96	61.43
Czechia	69.64	47.02	83.81	38.69	14.36	46.75	61.36	71.58
Denmark	55.27	56.55	68.57	41.33	6.91	51.09	56.55	60.72
Estonia	36.39	38.35	62.11	32.14	9.54	35.71	42.26	48.95
Finland	55.10	50.30	58.93	33.33	7.78	40.11	51.19	53.69
France	68.92	72.32	75.65	46.43	8.15	55.02	64.88	70.07
Germany	46.26	68.79	75.12	46.26	6.66	59.20	66.14	71.55
Greece	41.75	68.68	90.00	41.75	11.36	60.31	66.07	80.23
Hungary	57.74	39.88	76.31	39.29	11.48	46.51	57.44	68.33
Iceland	54.93	51.79	69.52	38.69	5.78	48.56	51.67	55.95
Ireland	39.29	62.50	83.81	39.29	11.34	62.40	67.33	75.34
Israel	66.33	63.69	87.43	41.11	12.36	57.97	68.28	72.22
Italy	72.79	67.86	85.42	62.50	6.54	66.96	75.04	79.05
Japan	38.69	51.85	56.01	33.33	6.57	39.01	45.24	50.48
Latvia	50.26	45.83	58.63	39.20	4.51	49.11	53.01	55.36
Lithuania	57.14	52.38	72.33	30.95	12.20	48.36	57.10	65.30
Luxembourg	64.12	51.79	70.71	38.18	7.23	51.43	58.27	60.83
Mexico	8.76	64.88	68.45	8.76	8.38	52.26	60.71	62.50
Netherlands	49.66	54.17	72.50	41.44	8.95	51.49	60.71	65.83
New Zealand	37.07	91.51	91.51	29.76	16.00	31.70	34.05	45.96
Norway	42.09	54.76	71.55	33.76	11.89	39.69	55.06	61.29
Poland	43.20	46.43	72.11	30.06	12.13	46.43	60.55	67.28
Portugal	59.18	61.90	81.16	55.65	7.17	59.06	65.73	70.49
Slovakia	60.46	43.75	81.01	43.45	13.16	47.98	66.70	75.60
Slovenia	60.97	43.81	80.36	40.24	13.15	49.11	59.69	72.67
Korea	62.08	64.29	76.19	49.11	6.49	52.68	59.89	64.94
Spain	53.19	54.46	71.31	42.56	5.94	55.06	62.43	64.80
Sweden	54.17	43.21	87.50	39.64	16.45	44.04	51.19	73.25
Switzerland	57.14	53.57	66.77	39.88	6.53	50.30	57.14	60.92
Turkey	46.85	42.26	86.43	42.26	9.35	62.62	65.48	72.85
United Kingdom	25.17	51.79	81.67	25.17	9.16	60.65	62.56	67.37
United States	56.97	61.90	70.24	55.95	3.38	62.56	64.88	66.67
CV	25.3	19.8	11.8	23.3	37.4	16.7	14.0	13.2

See caption to Table A1.

Table A5
Descriptive Statistics. Variable: SI

	ini	last	max	min	σ	Q1	Q2	Q3
Australia	40	72	75	37	10	57	67	70
Austria	81	58	82	36	16	49	66	76
Belgium	70	47	81	47	10	51	60	63
Canada	60	66	75	59	5	67	71	74
Chile	52	63	88	52	7	78	79	82
Colombia	50	51	91	42	13	65	79	87
Costa Rica	62	55	78	55	7	56	61	72
Czechia	80	27	82	27	18	38	55	73
Denmark	70	39	72	38	10	50	57	65
Estonia	49	26	78	23	14	35	42	56
Finland	66	38	71	32	11	38	48	52
France	84	67	88	44	14	49	64	75
Germany	56	61	85	50	10	60	68	77
Greece	65	66	89	42	14	58	67	82
Hungary	68	25	80	25	16	49	64	72
Iceland	52	42	66	27	8	40	44	51
Ireland	48	48	91	39	17	54	72	84
Israel	78	56	92	24	18	53	63	78
Italy	84	56	94	47	9	68	72	80
Japan	41	52	55	26	8	34	45	49
Latvia	59	42	69	32	9	42	54	57
Lithuania	81	32	84	26	19	30	51	67
Luxembourg	79	38	80	26	12	42	48	56
Mexico	4	67	82	4	15	47	71	72
Netherlands	61	42	82	32	15	51	65	75
New Zealand	43	96	96	22	24	22	22	42
Norway	62	39	80	32	14	41	56	68
Poland	57	39	87	23	17	43	63	75
Portugal	72	53	86	53	8	62	65	72
Slovakia	75	35	84	30	17	39	60	72
Slovenia	65	35	90	26	19	40	55	76
Korea	60	51	82	37	8	50	53	58
Spain	71	48	85	41	11	61	68	71
Sweden	68	32	100	27	26	34	47	89
Switzerland	69	41	73	29	11	43	51	60
Turkey	58	32	87	32	12	61	66	72
United Kingdom	35	44	88	35	13	61	68	78
United States	63	56	75	47	8	58	67	72
CV	25.7	30.9	10.6	32.3	36.2	24.2	19.0	15.6

See caption to Table A1.

Table B1
Panel VAR estimation. SI

Lag Var.\Equation	CI7	MR	SI
	Panel I. Total sample		
L.CI7	1.53***	0.006***	0.01***
	(0.05)	(0.0005)	(0.002)
L2. CI7	-0.63***	-0.004***	-0.006***
	(0.04)	(0.0005)	(0.002)
L.MR	-0.22	1.34***	0.02
	(2.58)	(0.05)	(0.13)
L2. MR	2.22	-0.45***	-0.007
	(2.04)	(0.04)	(0.11)
L.SI	0.32	0.004	1.05***
	(0.25)	(0.004)	(0.03)
L2. SI	-0.53**	-0.0008	-0.12***
	(0.24)	(0.004)	(0.03)
	Panel II. EU countries		
L.CI7	1.52***	0.006***	0.008***
	(0.06)	(0.0005)	(0.002)
L2. CI7	-0.60***	-0.005***	-0.005***
	(0.05)	(0.0006)	(0.002)
L.MR	-4.70**	1.43***	0.04
	(1.82)	(0.06)	(0.09)
L2. MR	4.61***	-0.51***	0.02
	(1.62)	(0.05)	(0.09)
L.SI	0.63	0.004	1.03***
	(0.44)	(0.007)	(0.03)
L2. SI	-0.79**	0.004	-0.15***
	(0.39)	(0.007)	(0.03)

This table reflects the estimation of the model (1) when the specification includes the variables CI7, MR and SI in levels. The values in parenthesis are the estimations of the standard errors of the different estimators. Panel I includes the 38 OECD countries, whilst the results of panel II are related

to the EU countries included in the sample.
L means the lag operator.

Table B2
Panel VAR estimation. CHI.

Lag Var.\Equation	CI7	MR	CHI
	Panel I. OECD countries		
L.CI7	1.53***	0.006***	0.007***
	(0.05)	(0.0005)	(0.001)
L2.CI7	-0.63***	-0.004***	-0.005***
	(0.04)	(0.0005)	(0.001)
L.MR	-0.87	1.34***	-0.01
	(2.58)	(0.05)	(0.07)
L2.MR	2.58	-0.44***	0.04
	(2.05)	(0.04)	(0.06)
L.CHI	0.55	0.006	1.08***
	(0.36)	(0.006)	(0.02)
L2.CHI	-0.78**	-0.002	-0.13***
	(0.34)	(0.006)	(0.03)
	Panel II. EU countries		
L.CI7	1.52***	0.006***	0.005***
	(0.06)	(0.0006)	(0.001)
L2.CI7	-0.60***	-0.005***	-0.003***
	(0.05)	(0.0006)	(0.001)
L.MR	-3.65**	1.41***	-0.005
	(1.79)	(0.06)	(0.07)
L2.MR	3.59**	-0.48***	0.07
	(1.60)	(0.05)	(0.06)
L.CHI	1.16*	-0.001	1.04***
	(0.65)	(0.01)	(0.04)
L2.CHI	-1.25**	0.006	-0.15***
	(0.56)	(0.01)	(0.03)

This table reflects the estimation of the model (1) when the specification includes the variables CI7, MR and CHI in levels. The values in parenthesis are the estimations of the standard errors of the different estimators. Panel I includes the 38 OECD countries, whilst the results of panel II are related to the EU countries included in the sample.
L means the lag operator.

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