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Carrot and stick: Economic support and stringency policies in response to COVID-19

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ABSTRACT

To address the economic losses caused by the COVID-19 pandemic, countries have implemented, together with policies aimed at stopping the spread of the virus, a mixture of fiscal and monetary measures. This work investigates the effect of containment policies and economic support measures on economic growth in the short run, investigating a time window of six quarters in a cross country perspective. Our results confirm the existence of a negative effect of stringency measures on GDP; we also detect a positive effect from economic support measures. Moreover, looking at the interaction between these two kinds of interventions, our findings suggest that up to a relatively low level of stringency policies, economic support measures are able to positively counterbalance the negative impact of containment and closure policies. When the level of closures became more severe, however, the economic support measures that countries adopt are not able to completely recoup, in the short run, the economic losses due to stringency policies. Results suggest that in order to have a positive net effect, policymakers should take into account the level of stringency measures implemented before investing in economic support.

1. Introduction

Since the beginning of the COVID-19 pandemic, which struck Europe severely in March 2020, several studies have analyzed the effects of containment measures and the pandemic itself on the world economy (Al-Awadhi et al., 2020; Fernandes, 2020). Scholars have observed that, compared to previous global crises, the current outbreak derives from both demand and supply shocks, which reinforce each other (Eichenbaum et al., 2020). As pointed out by Borio (2020), the economic crisis caused by the COVID-19 pandemic is the result of “a policy to tackle a health emergency through containment measures” (p. 181), which sent the global economy into hibernation. The same author underlines that the consequences of this crisis in terms of output and employment “have been even sharper than those experienced during the Great Depression” (p. 181), and detects three main characteristics that make the crisis “unique”. These are: i) the fact that it is truly exogenous; ii) its uncertainty; and iii) its global impact. The uniqueness of the COVID-19 crisis can also be observed if we look at policy responses (Borio, 2020). National governments have implemented sets of policies and complex strategies based on allocating massive public funding to mitigate dramatic economic losses. The scale of the efforts to restore and support economic activities is considerable, with high-income economies committing as much as 10% of their GDP (Cirera et al., 2021). Nonetheless, the effectiveness of this strategy appears uncertain at the very least, due to the unprecedented features of the COVID-19 crisis. While it appears reasonable to assume that, ceteris paribus, the short-term economic losses might have been higher if fiscal and monetary policies to support the economy had been more limited (Deb et al., 2020), further issues are related to the typology of policies adopted and their integration within each national mix. A central concern raised by scholars is that in a simultaneous supply and demand crisis, in a situation where consumers have health concerns, traditional macroeconomic tools may have reduced capacity to positively affect employment, as well as other economic outcomes (Chetty et al., 2020).

A further issue is the economic result of contextual implementation of containment and mitigation policies. While this has certainly driven exceptional policy interventions and economic efforts, it leads to doubts regarding the breakdown of national strategies. Considering the severity and length of the health crisis and consequent economic outbreak, addressing this issue appears to be greatly important both for advancing

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research and for guiding policymakers in the foreseeable future.

This paper address the main points of the issue in two ways: on the one hand it explores the relation between containment and mitigation policies, with the aim of understanding to what degree the former were compensated for by the latter; on the other hand, it investigates the economic effects of mitigation policies, giving specific attention to economic growth.

Previous studies, which focus on various features of national responses and take different approaches, seem to agree that government responses have largely varied depending on the country, according to institutional factors, fiscal space, and income level (Costa-Filho and Neto, 2020; Loayza & Pennings, 2020; Pepinsky, 2020).

Nevertheless, to the best of our knowledge little evidence has been provided so far regarding the effectiveness of economic mitigation policies (Cirera et al., 2021).

The aim of the present paper is to deepen our knowledge of this policy heterogeneity by investigating the effects of containment and economic measures on economic growth in a set of 38 countries, and examining how the pair of measures interacts.

To the best of our knowledge, so far only a few studies have moved in this direction. Baldwin and Di Mauro (2020) have provided a detailed review of emerging policies. Some scholars have explored country heterogeneity in comprehensive projects of policy monitoring (Cheng et al., 2020; Elgin et al., 2020; Hale et al., 2020a; Siddik, 2020), while others have tried to analyze the effectiveness of mitigation policies on a global scale (Cirera et al., 2021; Didier et al., 2021). By means of a quantitative cross country analysis, the present study contributes to the cited literature that focuses on the effects of containment policies and economic support measures on economic growth in the short run. More precisely, using data on economic growth extracted from the Organization for Economic Co-operation and Development (OECD) and data on stringency policies from the Oxford-COVID-19 Government Response Tracker (Ox-CGRT), this paper tries to address the following research questions:

RQ1. Do containment policies have an impact on economic growth?

RQ2. To what extent are economic support measures able to mitigate the negative impact of containment policies?

The rest of the paper is organized as follows. In the next section we discuss the relevant literature, and Section 3 introduces the data and methodology used in the empirical analysis. In Section 4 we comment our main results and perform some robustness checks, while the last section concludes the paper.

2. Literature review

Following the outbreak of the COVID-19 pandemic, a growing number of scholars have tried to address various issues related to the measures adopted by national governments. However, compared to studies that focus on the efficacy (and its determinants) of containment measures, namely non-pharmaceutical interventions (NPIs) (Alfano & Ercolano, 2021; Alfano, 2022; Alfano, Cicatiello, & Ercolano, 2021; Bargain & Aminjonov, 2020; Chan et al., 2020), the contributions aimed at analyzing the efficacy of economic measures remain limited (Chetty et al., 2020; Granja et al., 2020), surprisingly, given the sizable financial commitment to policies aimed at fighting COVID-19. Taking different approaches and focuses, the literature offers several case studies. Berardi et al. (2020) analyze the impact of a variety of policies carried out in Italy between January and August 2020 on health and non-health outcomes, finding a significant effect on financial market and trade flows. Granja et al. (2020), by analyzing a specific business support program carried out in the US between April and June 2020, detect only a moderate effect on employment in the short and medium term.

Some researchers have focused specifically on the distributional effects of government economic interventions. Among them, Kozeniauskas et al. (2020), using survey and administrative data on Portuguese firms between April and July 2020, observe that while firms with higher productivity experienced smaller declines in sale and employment rates, these were also the companies that were less reliant on government support policies. Focusing on Italy, Gallo and Raitano (2020) find that the economic costs of pandemic and containment measures are not equally distributed among income levels and that government policies have mitigated the worsening of income distribution. Hur (2020), comparing the effects of two measures that aim to keep people at home in the USA, observes that “stay at home subsidies” had a greater effect on death reduction and on average welfare loss.

Other studies have focused on the effects on the tourism sector and on financial markets. In regard to the latter, Ashraf (2020) observes that income support packages result in positive market returns. As regards tourism, meanwhile, in a study that uses the COVID-19 Economic Stimulus Index (CESI) developed by Elgin et al. (2020) as its main dependent variable, as well as two other variables (fiscal stimulus package as a percentage of GDP, and the interest rate cut as a percentage), Khalid et al. (2021) observe that the size of stimulus packages is positively associated with the size of the tourism sector.

Cirera et al. (2021) attempt to categorize the considerable variety of policies deployed by various countries. By analyzing data on 120,000 firms across 60 countries between April and September 2020, the authors identify three principal categories: debt finance support, employment cost support, and tax support.

Didier et al. (2021) meanwhile identify two principal groups of policies: one aimed at adapting the institutional framework in order to address the specificities of the pandemic, and another aimed at providing credit to firms. In turn, the latter can be divided into monetary and regulatory policies on the one hand, and policies aimed at transferring risk to government on the other. Two other studies on policy monitoring have made progress in the exploration of the heterogeneity of economic measures. Elgin et al. (2020) review the economic measures adopted by 166 countries over the first weeks of the pandemic, and by means of a Principal Component Analysis and an OLS regression study the cross-country differences in government responses, shedding some light on the determinants of initial government responses. In more detail, this study shows that the size of the economic stimulus is positively correlated with GDP per capita and population age. In a similar vein, Siddik (2020) measures the extent of economic stimulus implemented in 168 countries between June and September 2020. By using the Euclidean distance method, the study tries to systematize the variety of economic measures adopted by national countries, observing that GDP, health expenditure and government stringency on containment measures are, among other things, significantly correlated with a country’s economic stimulus.

From the perspective of economic theory, the uniqueness of the COVID-19 crisis in terms of economic impact and policy responses raises an interesting question: is short-term economic growth during this period linked only to the extraordinary measures taken during the pandemic, or are there also other structural drivers operating independently? It is well known that the literature on economic growth identifies different determinants able to influence countries’ paths in terms of economic outcomes.

The literature has used exogenous models to explain the differences in growth rates of GDP, on the basis of capital accumulation. From the key equilibrium suggested by Harrod (1939) and Domar (1947) to the steady state growth path observed by Solow (1956), some distinctions have emerged over time, based mainly on the nature and existence of a natural convergence process among countries.

In order to overcome certain limitations of exogenous models, such as the nature of and role played by other factors such as innovation, technological change and human capital, some scholars have proposed endogenous models (Rebelo, 1991; Romer, 1990). The most recent contributions have pointed out that economic growth is also linked to
the consumption of public goods, like education, which are able to influence human capital accumulation, or public health policies that are able to affect individual and collective outcomes, which are a starting condition for the full activation of market forces.

In this context, the COVID-19 crisis has been an interesting case study. Governments adopted NPIs to contain the spread of the virus, with different intensities over time, but following similar regional trends (Alfano et al., 2022). On the one hand, these measures may have sent markets into hibernation, with negative economic consequences. On the other hand, they also helped to guarantee the possibility of restarting economic activities once the virus was brought under control. If we look at the economic support measures, while these were a considerable cost for public finances, they were also the most obvious policy instruments to keep alive most economic activities over the period in which containment measures (NPIs) had forced them to shut down. It may thus be useful to shed some light on the net effect that both measures (NPIs and economic support measures) had on economic growth, via a quantitative empirical analysis.

3. Methodology and data

The previous literature suggests that the best empirical strategy to model the impact on GDP growth of the set of policies adopted to deal with COVID-19 in a sample of different countries is the use of so-called fixed effects estimations. Indeed, it is widely recognized in the econometric literature that fixed effects models have an advantage over random effects models when analyzing panel data. This is the case because these models control for all level 2 characteristics, whether measured or unmeasured, as long as they are time-invariant (Allison, 2009; Halaby, 2004; Woolridge, 2010). This characteristic becomes especially important when working in a cross country perspective, which makes it particularly difficult to control for some determinants in a ceteris paribus condition. In this respect, the possibility of controlling for all time-invariant characteristics (such as the different demographic compositions of different countries, different work ethics, and more generally all the characteristics that do not change over the timespan analyzed) is especially important. Using fixed effects, the empirical estimation implicitly controls for all the variables that are not included in the regression and which do not change in the timespan analyzed, and which may influence GDP growth. In that sense, the GDP growth in our model is not only explained by the explanatory variables, but also, of course, by all the country-level time-invariant variables that are implicitly accounted for in the model.

More precisely, in order to test our hypothesis empirically, we modeled the impact of stringency and economic measures on GDP growth through the following equation:

\[
GDP_{ct} = \alpha + \beta_1 \text{Cases}_{ct} + \beta_2 \text{Str}_{ct} + \beta_3 \text{Eco}_{ct} + \beta_4 \text{GDPpc}_{ct} + \varepsilon \tag{1}
\]

where GDP_{ct} represents gross domestic product growth in country c at time t (quarters), and is modeled as a function of Cases, Str, Eco and GDPpc. The first variable is a measure of the severity of the epidemic in each country c for each time t; the second and third are proxies of, respectively, the stringency measures and policies to support the economy in place in each country c for each time t. In this way we can estimate, respectively in \( \beta_1 \) and in \( \beta_2 \), the average impact on GDP growth of the average stringency and economic measures taken each t.

In order to estimate this equation empirically, we gathered data from a number of sources. First, we collected data regarding GDP growth from the OECD. Its dataset offers complete data on GDP growth (expenditure approach, seasonally adjusted data) for 38 different economies \(^1\) in six quarters starting from the first quarter of 2020. With these data we operationalize GDP in two ways: as growth with respect to the previous quarter (GDPGrq), and with respect to the same quarter of the previous year (GDPGpy). We thus expect to be able to capture both the relative and absolute effects of the policies, i.e., with respect to the current GDP trend, and in comparison with a pre-COVID-19 scenario. While a measure of economic growth is to be taken with caution, due to the obvious changes in the scenario, we believe it remains a noteworthy variable, and an interesting robustness test of our results.

Cases is operationalized as the average number of COVID-19 cases per country c in each quarter of 2020 t. We computed this variable, which is labelled AvCasespc, with data from the Oxford COVID-19 Government Response Tracker dataset (henceforth OxCGRT, Hale et al., 2020a). This is a public dataset compiled by a cross-disciplinary Oxford University team of academics and students from different parts of the world, using several sources. It is led by the Blavatnik School of Government (Hale et al., 2020b). We have used the latest version available at the time of writing, namely the 17 February 2022 edition. This offers a country-by-country daily estimation of COVID-19 cases. In order to avoid biases due to population, following the most recent literature on the theme (Alfano, 2022; Alfano & Ercolano, 2022), we have transformed the variable into per capita terms, and computed AvCasespc, the operationalization of Cases/i in Eq. (1). This variable is the per capita mean number of COVID-19 cases for each country c, divided by the population of country c (data from the World Bank dataset in 2019).

From the same source we also computed two other variables. The first, Str, is a measure of the different policies implemented in order to fight COVID-19 in each country c for each day t. It is operationalized through the average value for the quarter of the Oxford Stringency Index offered by Hale et al. (2020a), a daily measure of the non-pharmaceutical interventions in place in each country. It is calculated as the sum of several different sub-indexes, then rescaled as a single variable on a 0–100 base. This index takes into account workplace closures, cancellations of public events, restrictions on the size of gatherings, closures of public transportation, home confinement orders, and restrictions on internal and international travel. We expect this variable to be negative, since stringency measures should reduce GDP growth, as they are a disincentive to consume.

Second, we computed Eco, the per country and quarter average of another index offered by Hale et al. (2020a), which focuses on economic policy. Once again, this is calculated as the sum of four different sub-indexes (Income support, Debt/Contract relief for households, Fiscal measures, and Providing support to other countries), which are rescaled as a single variable on a 0–100 base. We expect this variable to be positive, since economic support should increase GDP growth.

One may wonder why we do not lag the dependent variable GDP, since it is possible to argue that Str and Eco at time t should affect GDP at time t + 1. As a matter of fact, in these kinds of models the outcome variable is usually lagged, to allow the policy to have an effect. We believe that this is not the optimal strategy in our case. In our data, the proxies of stringency and economic support are available on a daily basis (Hale et al., 2020a). Therefore, in order not to lose too much information, we computed the quarterly average for it, so as to have it at the same t as the other variables. Accordingly, Str is a policy that is continuously implemented over each quarter, rather than a policy

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1 These countries are: Austria, Belgium, Bulgaria, Canada, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, United Kingdom, and the United States of America.
enforced at the end of it. It is thus easily imaginable that this policy has a continuous effect, rather than an effect at the later time. It is hard to believe that the level of consumption in \(t\) (which of course would affect GDP) is not affected by the level of stringency measures implemented in \(t\). We therefore consider the lag structure that we adopted to be appropriate. Moreover, a functional form of the model with a lagged dependent variable would make necessary a dynamic panel controlling for endogeneity, which is impossible in our case, given the scarcity of data.

Finally, working once again from OECD data, we gather data for GDPpc, the Gross Domestic Product per capita, expressed in current prices, and current Purchasing Power Parity (PPP), seasonally adjusted, for each quarter. More affluent countries are likely to respond more efficiently to the crisis, and it is possible to argue that economic measures in these countries may benefit from more extensive resources. Furthermore, the pre-crisis growth rate average might pick up information about countries’ growth paths (Solow, 1956). Therefore, it makes sense to control for countries’ wealth.

In this way, we build a balanced panel dataset with 38 countries observed for six quarters, starting from the first quarter of 2020, giving a total of 228 observations. Summary statistics about these variables are presented in Table 1, and a heat map to compare the main variables used in the model at a glance is presented in Fig. 1. Moreover, in order to inspect the association between the variables used in the estimations from a bivariate perspective, Table 2 presents the correlation matrix.

### 4. Results and robustness check

Our main results are presented in Table 3. All the coefficients were estimated through an F-GLS model with fixed effects, with standard errors clustered at country level. Column 3.1 in Table 3 shows the estimates that use the GDP growth rate with respect to the previous quarter as dependent variables (GDPGrpq), while column 3.2 shows the regression estimates using the GDP growth rate with respect to the same quarter of the previous year (GDPGrpy).

It is worth noting that AvCasespc appears to be, ceteris paribus, positively correlated with the percentage of GDP growth with respect to the previous quarter. This is probably due to the fact that the countries most severely affected by the pandemic are, on average, also characterized by a higher level of economic activities. Richer countries are also those most exposed to international openness, which may be a possible driver of virus transmission (Alfano & Ercolano, 2020).

If we look at our variables of interest it can be seen that the stringency variable shows negative coefficients in both models reported in Table 3. These coefficients are also statistically significant at 99%. As expected, in the short run, the higher the level of stringency adopted by government policies, the lower the capacity to restart economic growth. These results probably also depend on the fact that a higher level of the stringency index is often characterized by a general spread of closures of economic activities. But it is important to note that, ceteris paribus, the economic support index shows a positive and significant coefficient. This means that economic measures to balance the impact of lockdown and other containment policies are effective at mitigating the negative impact of such measures. Nevertheless, it is also important to note the different magnitude of the coefficients between the stringency and economic variables. In general, despite the fact that economic support is able to positively affect economic growth, the negative impact of stringency shows a greater magnitude in the short run. Finally, in order to check for the presence of multicollinearity among our regressors, a Variance Inflation Factor (VIF) test has been performed. Results presented in Table 4 do not detect multicollinearity in our models.

A possible weakness of the analysis presented so far is that we have proxied the severity of the unfolding of the pandemic via the number of average cases in a quarter. This may be an operationalization that in some cases misses the point, since it is sub-optimal in proxying the effective situation, given that the mean is an index that is strongly attracted to extreme values. For this reason, we decided to replicate the analysis using the maximum number of cases (MaxCasespc) in the quarter as a proxy of the severity of the pandemic. The results, presented in Table 5, are consistent with our main findings, and suggest that these are robust.

We also believe that it is worthwhile to test the combined effect of these two policies. Indeed, the severity of stringency may influence consumption, and thus GDP, in the presence of economic support policies as well. There are accordingly reasons to believe that the effects of the former and the latter on GDP are (also) intertwined. To test the relationship between the two, we slightly amend Eq. (1) to allow an interaction term between the two proxies of the policies. We thus obtain Eq. (2), as follows:

\[
GDP_{ct} = \alpha + \beta_1 \text{Cases}_{ct} + \beta_2 \text{Str}_{ct} + \beta_3 \text{Eco}_{ct} + \beta_4 \text{Str}_{ct} \times \text{Eco}_{ct} + \epsilon
\]

(2)

In this way, by computing the marginal effect, we may derive the effect of Eco on GDP at different levels of Str. This is precisely what we present analytically in Table 6, and graphically in Fig. 2 (for growth with respect to the previous quarter GDPGrpq). More specifically, if we look at Fig. 2, it is interesting to note that up to a lower level of stringency (20 points), economic support is able to generate a positive effect on the GDP

### Table 1

| Label          | Variable                                                                 | Obs  | Mean     | Sample | Std. dev. | Min  | Max  | Observations |
|---------------|---------------------------------------------------------------------------|------|----------|--------|-----------|------|------|--------------|
| GDPGrpq       | Percentage GDP growth (expenditure approach, seasonally adjusted) with respect to the previous quarter | 228  | .1560774 | overall | 6.235102  | -19.44948 | 18.61955 | N – 228      |
|               |                                                                           |      | between  |        | .6723257  | -9.165206 | 3.460203 | 136.282      |
|               |                                                                           |      | within   |        | .6199553  | -19.53777 | 18.80405 | T – 6        |
| GDPGrpy       | Percentage GDP growth (expenditure approach, seasonally adjusted) with respect to the same quarter of the previous year | 228  | .9131957 | overall | 7.968412  | 21.50187  | 24.64187  | N – 228      |
|               |                                                                           |      | between  |        | 2.346309  | -4.980887 | 9.211203 | 98.98034    |
|               |                                                                           |      | within   |        | 7.641633  | -19.16452 | 26.68885 | T – 6        |
| MaxCasespc    | Max number of COVID-19 cases per capita in the country during the quarter | 228  | .0274575 | overall | .0344581  | 9.526076  | 1562636    | N – 228      |
|               |                                                                           |      | between  |        | .0152127  | .0003874  | .0625494  | 136.282      |
|               |                                                                           |      | within   |        | .0310005  | -.0047819 | 1211717  | T – 6        |
| AvCasespc     | Average number of COVID-19 cases per capita in the country during the quarter | 228  | .0219298 | overall | .0304703  | 7.00e-07  | .1259627   | N – 228      |
|               |                                                                           |      | between  |        | .012235   | .0003433  | .0509077  | 136.282      |
|               |                                                                           |      | within   |        | .0297961  | -.0281372 | 1251272   | T – 6        |
| Str           | Average for the quarter of Oxford Stringency Index for each country        | 228  | .5219367 | overall | 19.50188  | 6.848531  | 87.23168   | N – 228      |
|               |                                                                           |      | between  |        | 7.883489  | 22.80092  | 68.19232  | T – 6        |
|               |                                                                           |      | within   |        | 17.9412   | 3.77785   | 84.70768   | T – 6        |
| Eco           | Average for the quarter of Oxford Economic Policy Index for each country   | 228  | .5863764 | overall | 29.257    | 0         | 100        | N – 228      |
|               |                                                                           |      | between  |        | 15.32568  | 23.35974  | 85.57692  | T – 6        |
|               |                                                                           |      | within   |        | 20.2547   | -13.63362 | 103.7583   | T – 6        |
| GDPpc         | Gross Domestic Product per capita (current prices, current purchasing power parity, seasonally adjusted) | 228  | .46036   | overall | 20.73711  | 12.07277  | 128.6493   | N – 228      |
|               |                                                                           |      | between  |        | 20.79615  | 14.01102  | 121.0704   | 136.282      |
|               |                                                                           |      | within   |        | 2659.665  | 35.59493  | 58871.3    | T – 6        |
growth rate with respect to the previous quarter. However, starting from 50 points of the stringency index, the economic support measures do not seem to be sufficient for the growth rate to recover completely. Economic support measures are able to completely restore the negative impact of containment measures up to a certain level. But when such policies became more intense, the closure of economic activities and the relative negative effects on economic growth in the short run prevail over economic support measures.

**Fig. 1.** Heat maps of the average of the main variables in the countries included in the sample.

**Table 2**
Correlation matrix.

|         | GDPGrpq | GDPGrpy | MaxCasespc | AvCasespc | Str  | Eco  | GDPpc |
|---------|---------|---------|------------|-----------|------|------|-------|
| GDPGrpq | 1.0000  |         |            |           |      |      |       |
| GDPGrpy | 0.4233  | 1.0000  |            |           |      |      |       |
| MaxCasespc | 0.1645 | 0.5208  | 1.0000     |           |      |      |       |
| AvCasespc | 0.1559 | 0.5706  | 0.9790     | 1.0000    |      |      |       |
| Str     | -0.1052 | -0.1643 | 0.3812     | 0.3407    | 1.0000 |      |       |
| Eco     | 0.1219  | -0.0234 | 0.2633     | 0.2407    | 0.5998 | 1.0000 |       |
| GDPpc   | 0.1145  | 0.2335  | 0.1525     | 0.1573    | -0.0472 | 0.1031 | 1.0000 |

|         | GDPGrpq | GDPGrpy | MaxCasespc | AvCasespc | Str  | Eco  | GDPpc |
|---------|---------|---------|------------|-----------|------|------|-------|
| GDPGrpq | 1.0000  |         |            |           |      |      |       |
| GDPGrpy | 0.4233  | 1.0000  |            |           |      |      |       |
| MaxCasespc | 0.1645 | 0.5208  | 1.0000     |           |      |      |       |
| AvCasespc | 0.1559 | 0.5706  | 0.9790     | 1.0000    |      |      |       |
| Str     | -0.1052 | -0.1643 | 0.3812     | 0.3407    | 1.0000 |      |       |
| Eco     | 0.1219  | -0.0234 | 0.2633     | 0.2407    | 0.5998 | 1.0000 |       |
| GDPpc   | 0.1145  | 0.2335  | 0.1525     | 0.1573    | -0.0472 | 0.1031 | 1.0000 |

**Table 3**
GDP Growth with respect to the same quarter of previous year – F-GLS FE.

|         | (3.1) GDPGrpy | (3.2) GDPGrpq |
|---------|---------------|---------------|
| AvCasespc | 155.1*** | -41.74* |
| (6.66) | (6.66) |
| Str | -0.204*** | -0.118*** |
| (– 7.18) | (– 5.85) |
| Eco | 0.0588*** | 0.114*** |
| (4.05) | (3.38) |
| GDPpc | 0.00304*** | 0.00047*** |
| (3.96) | (3.72) |
| Constant | -44.67*** | -66.96*** |
| (– 3.60) | (– 3.52) |
| Observations | 228 | 228 |

* t statistics in parentheses, S.E. clustered at country level. ** p < 0.1, *** p < 0.05, **** p < 0.01.

**Table 4**
Variance Inflation Factor (VIF) test.

|         | VIF | 1/VIF |
|---------|-----|-------|
| AvCasespc | 1.17 | 0.853513 |
| Str     | 1.72 | 0.580144 |
| Eco     | 1.61 | 0.622749 |
| GDPpc   | 1.06 | 0.939571 |
| Mean VIF | 1.39 | 1.39 |

growth rate with respect to the previous quarter. However, starting from 50 points of the stringency index, the economic support measures do not seem to be sufficient for the growth rate to recover completely. Economic support measures are able to completely restore the negative impact of containment measures up to a certain level. But when such policies became more intense, the closure of economic activities and the relative negative effects on economic growth in the short run prevail over economic support measures.
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Table 5
Robustness check – Max cases – F-GLS FE.

|            | (3.1)       | (3.2)       |
|------------|-------------|-------------|
| GDPGrpy    |             |             |
| MaxCasespc | 133.8***    | -33.43      |
|            | (6.32)      | (- 1.34)    |
| Str        | -0.214***   | -0.117**    |
|            | (- 7.03)    | (- 3.23)    |
| Eco        | 0.0606*     | 0.114**     |
|            | (4.15)      | (5.44)      |
| GDPpc      | 0.00107***  | 0.00144***  |
|            | (3.98)      | (3.46)      |
| Constant   | -46.03**    | -65.70***   |
|            | (- 3.61)    | (- 3.27)    |
| Observations | 228       | 228         |

$t$ statistics in parentheses, S.E. clustered at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6
Marginal effects of interaction model – F-GLS FE.

|            | (4.1)       | (4.2)       |
|------------|-------------|-------------|
| GDPGrpy    |             |             |
| AvCasespc  | 155.1***    | -39.88*     |
|            | (6.57)      | (-1.75)     |
| Str        | -0.204***   | -0.146***   |
|            | (- 6.35)    | (- 5.07)    |
| Eco        | 0.0586***   | 0.0926***   |
|            | (3.65)      | (3.73)      |
| GDPpc      | 0.00107***  | 0.00144***  |
|            | (3.98)      | (3.46)      |
| Constant   | -46.03**    | -65.70***   |
|            | (- 3.61)    | (- 3.27)    |
| Observations | 228       | 228         |

Marginal effects; $t$ statistics in parentheses. (d) for discrete change of dummy variable from 0 to 1. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Fig. 3. Predictive margins of Eco on GDPGrpq for observations under and over the median of Str.

Fig. 2. Marginal effects of Eco on GDPGrpq for different levels of Str.

Furthermore, one may wonder whether the effect of economic support on GDP growth differs due to stringency in a non-linear way. In order to see whether the stringency level of the NPIs play a different role in the effect of economic support on GDP growth depending on their level, we estimated the impact of Eco at different levels on GDPGrpq in the subsample of observations under and over the median value of Str (57.461). Our results, presented in Fig. 3, show that while economic support over 50 has a positive impact on GDPGrpq in the sample under the median of Str, no level of economic support has any positive effect on GDP growth in the subsample over the median value of stringency. Once again, this suggests that economic support has no positive economic impact once highly stringent measures are in place.

Finally, we considered whether this relationship could vary at different levels of welfare. Richer societies can shrink their expenditure more than is the case with poorer societies, where expenditure is already closer to the lower bound given by the subsistence level, a threshold beyond which an economy cannot be reduced. In order to test this hypothesis, we ran the regression for two different subsamples composed of the observations over and under the median value of GDPpc. Our results, presented in Table 7 with respect to the estimation of Eq. (1), and Figs. 4 and 5 for the marginal effects of the estimation of Eq. (2), suggest that in our sample the effect of GDPpc does not play a significant role in the relationship we have explained, which is very similar regardless of the level of welfare. It is important in this regard, however, to highlight that our sample is composed of relatively rich countries. Indeed, the average GDPpc in our sample is $46,036.58, with the lowest to $12,072.7, a value higher than the world average, which was $10,926 in 2020 (Macrotrends). Therefore, this lack of differences once the sample has been segmented according to level of welfare may be due to the composition of the sample, and is a finding that must be interpreted with caution, especially with regard to its external validity.

5. Lessons learned

The emergency triggered by the COVID-19 pandemic has pushed national governments all over the world to implement containment policies aimed at reducing the spread of the virus. These kinds of policies, which have mainly been characterized by lockdown measures and “social distancing”, are very important as a means to ease the strain on health services by slowing down the outbreak (Hamzelou, 2020). Nevertheless, despite the benefits for health systems generated by these measures, there are notable social and economic costs correlated with

Table 7
Robustness check – subsamples under and over the GDPpc median – F-GLS FE.

|            | (5.1)       | (5.2)       |
|------------|-------------|-------------|
| GDPGrpy    |             |             |
| AvCasespc  | 120.1***    | 177.2***    |
|            | (3.75)      | (4.97)      |
| Str        | -0.185***   | -0.180***   |
|            | (- 6.37)    | (- 3.51)    |
| Eco        | 0.0598***   | 0.0507*     |
|            | (3.84)      | (2.05)      |
| GDPpc      | 0.00204***  | 0.000610*** |
|            | (5.69)      | (3.12)      |
| Constant   | -62.55***   | -34.22**    |
|            | (- 5.25)    | (- 2.81)    |
| Observations | 114        | 114         |

$t$ statistics in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. 
in our analysis, the economies of countries with more stringent measures.

This result could be triggered by the market “hibernation” (Didier et al., 2021) that occurred when stringent became higher. In other words, it is important to consider that NPIs and economic support measures may exhibit their effects at different time lags. This means that, over the period considered in our analysis, the economies of countries with more stringent measures could have been more severely damaged, and it is therefore possible that these countries required greater economic support measures to maintain previous levels of welfare.

While this study contributes to the literature with these novel findings, it is important to highlight that it has some limitations. The most considerable of these is that, since it is a cross country analysis, in spite of the well-known benefits that brings in terms of generalization (and thus of external validity) of the results, the estimated coefficients have to be interpreted as an average effect among very different countries. Thus, these estimates should be applied with caution to specific cases, remaining mindful of the process that led to our results.

Moreover, it is important to remember that this study is by its nature exploratory, analyzing data about an event whose effects continue to unfold. It is therefore important to treat it with caution, and bear in mind that we are presenting estimations about a short period due to the availability of data. It is worth noting that from a long run perspective, the interaction between stringency measures and economic mitigation policies could reveal further insights. These two kinds of measures may exhibit their effects, both in terms of socio-economic costs and benefits, at different lags of time, which may last well over the six quarters we could include in our analysis. It would be interesting, especially in a long run perspective, to extend the results of the present paper about the interaction between NPIs and economic support measures, investigating the existence of an optimal mixture that leads to the best possible trade-off between spreading COVID-19 and damaging the economy. Finally, future studies may also focus on making these findings more robust by analyzing a longer period, plugging in the qualitative differences among the several stringency measures or, once more data become available, estimating more precise effects in single countries or within a given geographical area.

Declarations of interest
None.

Appendix 1. Countries included in the analysis
Austria, Belgium, Bulgaria, Canada, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Romania, Russia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States of America.

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