The effect of policy response to the COVID-19 pandemic on GDP growth, an analysis with variations over time

El efecto de las políticas de respuesta a la pandemia de COVID-19 en el crecimiento del PIB, un análisis con variaciones en el tiempo

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Abstract

The study is aimed at exploring the effect of three policies, social distancing, economic support to households and business, and vaccination on GDP, adopted by governments to mitigate the effects of the of COVID-19 pandemic. The analysis applies a data set scoping from the first quarter of 2020 to the third quarter of 2021 across OECD countries. The methodology incorporates interactive time dummy variables to capture variations of the effects over time; in addition, control factors comprising social, medical, demographic, besides health service sufficiency are incorporated in the analysis to disentangle the effect of policy response variables. The result indicates that the impact of policies can vary over time and hence, it is important the governments conduct strategies to keep effectiveness of the policies.

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Keywords: GDP growth; interactive dummies; OECD countries; COVID-19

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Resumen

El estudio tiene como objetivo explorar el efecto de tres políticas, distanciamiento social, el apoyo económico a los hogares y las empresas, y la vacunación sobre el PIB, adoptadas por los gobiernos para mitigar los efectos de la pandemia de COVID-19. El análisis aplica un conjunto de datos que abarca desde el primer trimestre de 2020 hasta el tercer trimestre de 2021 en los países de la OCDE. La metodología incorpora variables dummy de tiempo interactivas para capturar variaciones de los efectos a lo largo del tiempo; adicionalmente, en el análisis se incorporan factores de control que comprenden factores sociales, médicos, demográficos, además de la suficiencia de los servicios de salud, para desentrañar el efecto de las variables de las políticas de respuesta. El resultado indica que los efectos de las políticas pueden variar con el tiempo y, por lo tanto, es importante que los gobiernos lleven a cabo estrategias para mantener la efectividad de las políticas.

Código JEL: C51, F43, H12
Palabras clave: Crecimiento del PIB; variables dummy interactivas; países de la OECD; COVID-19

Introduction

The coronavirus disease (COVID-19) that was first detected in China in December 2019, has spread throughout the world over 2020 and 2021 causing a global distress. As a measure to stop the spread of the virus, nations took confinement actions through lockdowns in schools, public places, workplaces, tourist sites and in multiple economic and social activities that were considered non-priority for the maintenance of the essential daily life. As of mid-august 2021 around 209 million cases of the virus have been confirmed and have accrued around 4.39 million deaths (Worldometer, 2021).

The global social distancing caused a severe economic fallout in most of the countries, mainly in the second quarter of 2020; in countries such as India, United Kingdom, México, France, Italy and South Africa the economy fell by more than 17% in the period in relation to the previous year; the economy of the OECD countries fell by 11.6% in average (OECD, 2021). The early studies were aimed at simulating or forecasting the potential impact of the pandemic on gross domestic product, using different methodologies, and considering the lockdown as a main determinant of the economic decline. Maliszewska, et al. (2020) and Beckman, et al. (2021) applied computable general equilibrium models to simulate the impact of COVID-19 on relevant economic variables including GDP in a global scope; Jena, et al. (2021) performed an artificial neuronal network model to forecast the fall of GDP in the second quarter of 2020 on major economies.

As the pandemic continued over time, there was more data availability to conduct parametric analysis; in this respect, the studies incorporated time series and panel data to explore the effect of relevant

variables on the GDP in the context of the pandemic. KÖnig and Winkler (2021) analysed the impact of mandatory social distancing imposed by lockdown policies and voluntary social distancing triggered by fatality rates on GDP growth in the first three quarters of 2020 for a sample of 42 countries, conducting OLS and IV methods, and found and important role for the fatality rates, while the lockdown stringency is the more important driver of growth. Fernández-Villaverde and Jones (2020) studied the macroeconomic outcomes of the pandemic using data at the country level, individual US States and key cities throughout the world, they conduct descriptive analysis and OLS regressions and found substantial heterogeneity in outcomes, which opens the need to explore multivariate determinants of the economic performance during the pandemic.

The ongoing pandemic has caused several adverse effects on different sectors of the economy. On the one hand, health services tend to be saturated with care for people affected by the virus, while other health services and care for regular diseases have been neglected; on the other hand, the lockdown and social distancing has affected both demand and supply of services and goods, as a result, many businesses have had to close, and many jobs have also been lost. In response to the COVID-19 pandemic, countries have adopted fiscal responses to provide resources to strengthen health services and to protect firms and jobs. The measures have been diverse, and the resources have varied from country to country. In this respect the five OECD countries which have directed more additional resources, in proportion to their GDP, to mitigate collateral effects of the pandemic, as of march 2021 are USA (25.5 percent), New Zealand (21.3 percent), United Kingdom (16.3 percent), Australia (16.2 percent) and Japan (15.9 percent). In contrast, countries like Turkey (1.9 percent) and Mexico (0.7 percent) have not exceeded 2.0 percent of their GDP in fiscal support to face the pandemic (IMF, 2021).

The fiscal policy response to the disease and its effect on health, employment, firms, and economic growth has been an emerging topic in the relevant literature. In this respect, Almalki (2021) pointed out that effectively responding to COVID-19 requires a significant adjustment in the governments' budgets while adapting new methods of how services are delivered. DeWit, et al. (2020) showed that massive fiscal stimulus package to protect public health and stabilise incomes in Japan protect both public health and essential services, while also promoting resilience and sustainability.

The spread of the disease fostered global efforts and research to develop vaccines as an attempt to stop the pandemic and to mitigate the effects of the virus on the population. The collaboration between universities, laboratories and governments rendered results since many countries progressed in clinical trials; as a result, the vaccination started in December 2020. By late august 2021, about 30 percent of the world population have received at least one dose of the COVID-19 vaccine; at least 10 countries have managed to fully vaccinate more than 70 percent of their population, in percentage descending order they are Malta, Singapore, United Arab Emirates, Iceland, Portugal, Qatar, Uruguay, Denmark, Chile and

Belgium; however, the global distribution has been uneven, as only 1.6 percent of people in low-income countries have received at least one dose (OWD, 2021).

The effect that vaccination can have on the reduction of deaths and new contagion cases has become a topic of major concern, but also the effect that can exert on restoring GDP growth or improving economic conditions, assuming that vaccinated populations can gradually abandon social distancing and lockdown. In this respect, Wang, et al. (2021) developed a Markov decision tree to explore the economic evaluation in response to mass vaccination against COVI-19; they built a cost-utility ratio of vaccines and showed that one dollar invested in vaccine would have form USD $13 to USD $28 in return, depending on the Vaccine brand. Khalfaoui, et al. (2021) studied the time-varying connectedness between the COVID-19 vaccination and the stock market returns and the economy; they found that the vaccination has a positive and significant influence on S&P 500 returns at the majority of business cycle frequencies; they concluded that the US government intervention with the vaccination strategy may lead to the recovery of the stock market as well as the whole economy.

Throughout the pandemic, governments have adopted policy measures to protect the population and to mitigate the effects on the economy, deserve highlighting lockdown and social distancing, fiscal support and vaccination. Despite the progress in the literature related to the effect of COVID-19 on the countries´ economy, it has barely been analysed the effect of policies adopted by governments, to counteract the pandemic and its repercussions, on economic growth. Moreover, the study of the determinants of changes in GDP during the course of the pandemic requires the incorporation of different variables to have a broader understanding on the issue. In this context, this paper is aimed at exploring the effect of factors directly associated to policy response of governments, to mitigate the effect of the pandemic, on economic growth, such as social distancing and lockdown, fiscal support, and vaccination rate. In addition, control factors comprising socials, medicals, demographics, and health service sufficiency are included in the equation to disentangle the effect of policy response variables.

This study is relevant to analyse the impact that policies adopted by governments have had on economic growth and the effectiveness of such policies, to have elements to suggest courses of action and identify policy implications. It is conducted across OECD countries comprising data from January 2020 to the second week of July 2021. The information is analysed through panel data

The structure of the paper is as follows, section 2 provides the discussion of the theoretical background, section 3 comments on the methodology applied in the study, section 4 analyses the outcome obtained form the methodology, and section 5 provides summary of the results, conclusions and policy implications

Theoretical background

In this section, it is performed a discussion on theories and hypothesis that explain the effect of government policies, conducted to mitigate health and economic repercussions of the pandemic, on economic growth.

As for social distancing, in an assessment of the economic and health costs of COVID and policy responses to COVID Kaplan, et al. (2020), based on preliminary analysis, suggest a trade-off between economic activity and public health. If true, it is expected the pandemic´s effects on GDP to be inversely correlated with a country´s COVID deaths per capita; that is to say, countries enacting stronger social distancing suffer fewer deaths but also see larger decreases in GDP. However, by testing the hypothesis using cross-sectional country-level data as of November 2020 for 20 countries both developed and developing and performing a simple regression line they found an opposite relationship, in which mortality rate and GDP loss are in fact positively correlated. They also argue that Countries that were able to control the pandemic better and earlier suffered less economically; or example, China, South Korea, and Germany performed better than Spain, United Kingdom and France.

By conducting further analysis, they found differences between and within countries, and identify four factors that may explain the diversity of effects of social distancing on mortality and the economy. These factors are one climatic, because colder temperature is likely to contribute to higher fatality rates; two demographics, the first is population density as it affects social distancing, and the second is average age, since older individuals benefit from reduced mortality risk, in contrast, younger individuals bear much of the cost of unemployment; and finally one timing factor, in the sense that early exposure rates to the infection reduces benefits of learning-by-doing, and early strict social distancing has proved to have better results on mortality risk (Kaplan, et al. 2020).

Another theoretical explanation concerning the decision to conduct social distancing policy, the level of strictness and the likely impact on the economy can be provided by the political economy literature. Their corresponding models emphasise that politicians are aimed at attaining and sustaining power and therefore, they prefer policy outcomes favouring their donors and voters in the short-run, subject to informational, technological, political and economic constraints, and regardless the longer-term repercussions. In this context, the United States response to the COVID-19 pandemic in President Trump's government was not supported on strict social distancing, as there was concern that heavy restrictions would damage the economy and his chances for re-election, and the United States showed one of the highest mortality rates in the world. The policy of Brazil and Mexico to face the virus mirrors that of the United States, both set priority to popularity, and both have high rates of fatalities (Alesina and Rosenthal, 1995; Kaplan, et al. 2020).

The impact of lockdown and social distancing policies on economic growth is negative in the short-run and the intensity varies depending on climatic, demographic or timing factors and on political decisions. However, over the longer-run, countries that conduct sound social distancing policies, combined with other factors, can have faster economic recuperation, or higher economic growth in relative terms than other countries. This is the case of China, Turkey and Korea, which have recovered pre-pandemic GDP per capita by late 2020 or early 2021.

The COVID-19 crisis caused a disruption of production and supply chains and eventually a sharp fall of aggregate supply, while the loss of employment and the drop in income and consumption collapsed aggregate demand. To face this situation, governments' countries launched fiscal support measures; deserve highlighting transfers to individuals and households to avoid deterioration of welfare, tax relief and tax credits to small business or specific economic sectors to reduce tax burden, and economic support to firms and wage subsidies to assist wages payment and to retain employment (Makin and Layton, 2021).

A theoretical explanation for government intervention by implementing emergency fiscal policy measures during the COIVD-19 crisis can be taken from Keynesian economics theory. It postulates expansionary fiscal policy by means of government expenditure on infrastructure, unemployment benefits, and education to boost consumption and increase aggregate demand, as well as transfer programs to low-income families as redistributive solutions to poverty (Keynes, 1936). The fiscal response to face the pandemic in the nature of old-style Keynesian stimulus was the provision of income transfers paid to households and individuals, cash handouts to encourage household spending (Makin and Layton, 2021) and transfers to families affected by the crisis to mitigate welfare deterioration, in turn all these measures are consistent with the demand side approach.

The policy response to the crisis comprising fiscal support to small firms and specific economic sectors and wage subsidies was aimed to protect employment, but also to keep supply of goods and services and supply chains; hence, it is more associated to the supply side approach and differs from the Keynesian approach.

Governments' fiscal response across countries to mitigate the fall of both aggregate demand and aggregate supply leads to the increase in not only budget deficits but also public debt. Between the third quarter of 2019 and the third quarter of 2020, global debt, comprising household, non-financial corporates and government debt, increased from 252.7 trillion USD dollars to 272.7 trillion US dollars, an upturn of 20 trillion in debt in the period, equivalent to a rise in the debt-to-GDP ratio of 7.9 percent. In the same period, developed markets group increased in 8.0 percent and emerging markets group in 7.7 percent, the former represents 72 percent of the global debt. The financial panorama is unlikely to improve in the

short-run, due to falling income, combined with high pandemic relief measures cost, resulting in increasing debt and public budget deficit (World Economic Forum, 2021).

A theoretical explanation through which public debt can affect economic growth is provided by the classical loanable funds doctrine. According to this approach, higher public debt, as a result of increasing budget deficit, increases the demand for funds and hence, turns up interest rate, ceteris paribus, which discourage private investment, inhibits the increase of capital stock and eventually constrains economic growth. When high public debt is the result of unproductive public deficit, it can affect business and household confidence and creates uncertainty in the economy. This process also harms investments and growth. In this respect, there is macroeconomic inconsistency in the Keynesian approach justifying fiscal deficit when it is unproductive. If public debt and budget deficit fund productive public investment in infrastructure and human capital, they are able to foster economic growth with a longer-time perspective; in contrast, if they fund unproductive investment, they might be able to foster economic relief in the short-run, but in a longer-time perspective can harm growth, due to uncertainty, higher interest rates and decreasing investment (Makin and Layton, 2021).

The loss of employment, falling households' income, and the risk of businesses closure, mainly as a result of lockdown and social distancing policies, in the view of many governments, justified opportune and significant economic support of emergency to households, to protect income of the families, and also to firms and sectors, to protect employment and businesses permanence. However, this public expenditure could be deemed unproductive, which in the longer run can jeopardise economic growth or lessen it.

Gründler, et al. (2021) formulate a theory proposing that crisis experience influences preferences towards COVID-19 vaccination and the speed of vaccination during the initial phase when vaccination became available. In their approach, their argument behind experienced-based learning is that people living in countries with previous crisis experience are more likely to acquire more accurate perceptions about the excess of payoff of the newly developed COVID-19 vaccines than people living in countries that have not much previous crisis experience. The potential to expend resources is constrained by the government budget, which in turn is determined by the corresponding wealth of the country. In short, their theory suggests that country i's progress in vaccination V_i depends on its wealthiness W_i, health expenditure H_i, and the extent of crisis experience in the past C_i. In their view, early vaccination progress against COVID-19 suggests that countries with crisis experience have managed the COVID-19 crisis in a more acceptable way than countries with less crisis experience, for instance EU countries. Those countries untroubled by crisis for a long time can learn from the current pandemic crisis, and may conduct investments in crisis management infrastructure and crisis prevention (Gründler, et al., 2021).

McCartney, et al. (2021) argue that community immunity could require around two-thirds of the population to be vaccinated and point out the bilateral deals between wealthier countries, which have secured quantities of vaccines to cover their entire population, while developing countries have limited access. In this sense, the recovery will be further prolonged due to the disparities to COVID-19 universal vaccination of global city population. Vaccination will create immunity, and in turn it allows economic recovery, however economic recovery also depends on economic resilience, and it is through it that social and community resilience emerge. In countries with pre-existing serious socioeconomic crisis, in a context of unemployment, inflation, recession, external debt and poverty, the COVID-19 has become a crisis embedded in another crisis. The notion of resilience has been conceptualised more commonly within an economic framework, comprising business environment, governance and financial arrangements, and labour market conditions (McCartney, et al. 2021).

With the above in mind, the effect of vaccination on GDP recovery might be diverse across countries and even marginal or slow in some economies because it is subject to previous crisis experience, the proportion of population immunized in a country but also the disparities to universal vaccination, and the economic resilience of a country and its pre-existing economic condition before the COVID-19 crisis.

Within this theoretical context, three hypotheses are formulated:

H1: The impact of lockdown and social distancing policies on economic growth is negative in the short-run; over the longer-run the impact becomes diverse.

H2: Fiscal support, has a positive relationship with GDP growth because mitigates adverse effects on the economy in the short-run; however, in the longer-run the relationship is negative because higher public expenditure jeopardises economic growth or lessens it.

H3: The effect of vaccination on GDP recovery is positive but diverse over time because it is subject to different factors.

Methodological approach

The analysis comprises the construction of a panel data set involving 44 OECD countries and daily data from January 26th 2020 to July 11th 2021, in total 533 observations in time. The range of time vary in the country sample because the observations start in different dates, depending on the time in which the pandemic reached in the countries.

Three main explanatory variables are incorporated in the analysis; they are proxies of public policy respond to the crisis of COVID-19. The first is the stringency index (*stringen*), it is a composite measure built from nine response indicators including workplace closures, school closures and travel bans, rescaled to a value from 0 to 100 (100 = strictest). If policies vary at the subnational level, the index is

presented as the response level of the strictest sub-region, the source is Our World in Data (2021). The variable is a proxy of lockdown and social distancing policy and it is incorporated in the equation to tests hypothesis H1. The second is the fiscal support (*fiscalsup*) expressed as a percentage of the GDP, the variable summarises key fiscal measures governments have taken in selected economies in response to the COVID-19 pandemic, the source is IMF (2021). The variable is applied to test hypothesis H2. The third is government intervention through vaccination against COVID-19 strategy, to proxy this policy response two indicators are incorporated in the equation, the log of the number of people who received at least one vaccine dose per hundred (*vaccine*), and the log of the number of people who received all doses prescribed by the vaccination protocol (*vaccineful*), the source is Our World in Data (2021). The variable is incorporated in the equation to test hypothesis H3.

The dependent variable is the percentage GDP variation in relation to previous year (*gdpgrowth*), it is presented quarterly, and the source is OECD (2021). The study also incorporates a set of control variables, it includes: two proxies to measure the intensity of the pandemic, the log of new deaths attributed to COVID-19 per million people (*newdeaths*), and the log of the number of COVID-19 patients in hospital on a given day per million people (*patients*); two demographic variables, population density (*density*), presented as the number of people divided by land area, measured in square kilometres, most recent year available, and the share of the population that is 65 years and older (*65&older*), most recent year available. The control variables also include pre-existing social crisis, represented by the share of population living in extreme poverty (*poverty*), most recent year available since 2010; pre-existing medical conditions or comorbidity among the population, represented by diabetes prevalence (*diabetes*) as a percentage of population aged 20 to 79, in 2017; pre-existing medical infrastructure measured by hospital beds per thousand people (*hospbeds*), most recent year available since 2010, the source for the control variables is Our World in Data (2021).

Descriptive statistics of the variables in the dataset are presented in Table 1

Table 1
Descriptive statistics of the variables

Variables	Obs	Mean	Std. Dev.	Min	Max
Explanatory variables					
stringen	22,331	59.090	19.148	0.000	100.000
fiscalsup	15,788	6.870	5.005	0.200	25.500
vaccineful	5,921	1.524	1.728	-4.605	4.252
vaccine	6,564	2.179	1.670	-4.605	4.352
Control variables					

newdeaths	16,431	0.180	1.683	-6.908	4.013
patientes	11,243	4.145	1.607	-4.200	7.170
density	22,664	137.584	138.871	3.202	527.967
65&older	22,664	15.831	5.153	5.319	27.049
poverty	17,504	2.175	4.690	0.100	21.200
diabetes	22,664	6.706	2.219	3.280	13.060
hospbeds	22,664	4.290	2.663	0.530	13.050

Source: Own computation

The econometric approach starts with a general regression equation model as follows:

$$\text{gdpvar}_{it} = \alpha + \sum_{k=1}^{n} \beta_k X_{kit} + \sum_{k=1}^{n} \delta_k Z_{kit} + u_{it}$$

(1)

where gdpvar or the dependent variable Y is the GDP variation in percentage in relation to the same period in previous year, X is a vector of explanatory variables (string, fiscalsup, vaccine and vaccineful) as outlined before. Z is a vector of control variables comprising two proxies to measure the intensity of the pandemic (newdeaths and patientes), two demographic variables (density and 65&older), a pre-existing social crisis variable (poverty), a pre-existing medical conditions variable or comorbidity among the population (diabetes), and a pre-existing medical infrastructure variable (hospbeds), as outlined before. The error term u is assumed to satisfy white-noise assumptions, in other words, it is independently and identically distributed with zero mean, constant variance σ^2 and serially uncorrelated, which is denoted $u \sim I.I.D\ (0,\sigma^2)$. The parameter α represents the intercept, the subscripts k, i and t indicate variable, country and time respectively.

The expected effect of the explanatory variables is commented as follows: The stringency index is expected to have a negative sign because the social distancing and lockdown policy reduces economic activity; in contrast, fiscal support is expected to have a positive sign because it mitigates adverse effects on household and individual income, business activities and employment. The vaccination variables are expected to have positive sign, because as the vaccination strategy progresses, the population are more protected against contagious or adverse effects of the virus, which creates the pre-condition to lessen lockdown and social distancing and to re-establish economic activity.

As for the control variables, the two proxies to measure the intensity of the pandemic are expected to enter the equation with negative sign because an increase in new deaths attributed to COVID-19 pandemic and the number of COVID-19 patients in hospital can deter economic activity. The two

demographic variables are expected to have negative sign since the higher the population density the higher the probability to suffer contagious; in addition, the larger the proportion of population that is 65 years and older the more is the vulnerability of the population to the virus, therefore, both population density and older population create more vulnerability during pandemic, which inhibits economic activity. Extreme poverty is expected to enter the equation with negative sign as the virus is likely to spread faster in poor population and hence, there are more affectations in the economy. Comorbidity, as diabetes, increases vulnerability in the population and therefore, creates the conditions to reduces economic growth. Finally, hospital beds per thousand are expected to have a positive sign because more medical infrastructure creates stronger conditions to face the pandemic and reduces adverse effects on the economy.

The estimations start with the standard ordinary-least-squares method (OLS) pooling or combining all the observations, and assuming that α is constant across countries and over time. The output obtained from the OLS specification is presented in Table 2, Column 1.

To explore the effect of the explanatory variables and their performance over time, the study disaggregates the slopes by quarter. To do so, interactive or differential slope dummy variables for each explanatory variable should be available. To construct the interactive dummies, what we have to do is multiply each of the quarter dichotomous time dummy variables TDVt by each of the explanatory variables Xit. In total, 21 new variables will be created, and each new interactive dummy variable will be applied to estimate a slope coefficient for a variable X in quarter t[1] Columns 2, 3 and 4 in Table 2 present the differential slope coefficients for stringency index, fiscal support, and fully vaccinated indicator variables respectively.

Table 2
The effects of policy respond to COVID-19 and control variables on GDP growth

Variable	Coefficient (1)		Interactive variables disaggregated coefficients by quarter			
		Qtr	stringen (2)		fissup (2)	vaccineful (3)
Explanatory variables						
		20Q1	-0.029	*		
		20Q2	-0.001			
		20Q3	0.091	*		
Stringen	-0.266 *	20Q4	0.065	*		
		21Q1	-0.101	*		
		21Q2	-0.054	*		
		21Q3	-0.037	*		

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[1] For previous applications of interactive dummy variables to desegregate slop coefficients see Paredes-Gómez et al. (2021).

			20Q1	0.104	*		
			20Q2	-1.031	*		
			20Q3	-0.206	*		
Fiscalsup	0.864	*	20Q4	-0.073	*		
			21Q1	0.129	*		
			21Q2	0.718	*		
			21Q3	0.741	*		
			20Q1			-0.244	*
			20Q2			0.512	*
			20Q3			0.565	*
Vaccineful	0.651	*	20Q4			0.327	*
			21Q1			0.248	*
			21Q2			0.041	*
			21Q3			-0.056	**
Vaccine	0.071						
Control variables							
Newdeaths	-1.455	*					
Patients	-0.856	*					
Density	-0.028	*					
65&older	2.590	*					
Poverty	-3.998	*					
Diabetes	-0.906	*					
Hospbeds	1.016	*					
Constant	-24.433	*					

Source: own computation with information from Our World in Data (2021), OECD (2021) and IMF (2021).
Notes: The dependent variable is GDP growth in percentage variation in relation to previous year. * Statistically significant at 1 percent, statistically significant at 10 percent.

Comments on the results

The stringency index variable enters the aggregated equation with a negative and statistically significant coefficient, it is consistent with the expected negative effect on GDP growth, an increase of one point of the stringency index reduces GDP by 0.266 percentage points. When the slope is disaggregated by quarter in Column 2, we observe that as the time passes the slope is more negative, but with decreasing magnitude, which indicates that longer periods of strict stringency affect more the economy in relative terms compere to early periods of stringency. H1 is satisfied to the extent that the impact of lockdown and social distancing policies on economic growth is negative in the short-run, as the first and second quarter (2020 quarters 1 and 2) coefficients are negative and statistically significant; however, over longer periods the impact does not seem diverse, because the last three quarters of the sample (2021 quarters 1, 2, 3) have negative and statistically significant coefficients with larger but decreasing magnitude, which confirms that in further periods the effect of stringency on growth can be more adverse.

The coefficient of the fiscal support variable enters the aggregated equation with positive and statistically significant sign, a rise of one point as a percentage of the GDP in fiscal support turns up GDP

by 0.864 percentage points, the result is in keeping with the expected sign. When the variable on fiscal support is disaggregated in Column 3, the coefficients from the second to the fourth quarter (2020 quarter 2, 3, 4) are negative and statistically significant, and the coefficients of the last three quarters (2021 quarter 1, 2, 3) in the sample turn positive and remain statistically significant. This finding indicates that in an early stage, the fiscal support does not reverse the negative impact of the pandemic on the economy, in contrast, it seems to reduce GDP; however, overt longer periods the fiscal support mitigates the adverse effect of the pandemic on the economy and even increases GDP progressively. According to the results, H2 does not hold, because in the short-run fiscal support reduces economic growth instead of increasing it; and in the longer-run it improves the economy instead of lessening it.

The analysis incorporates two proxies of vaccination, the first represents people vaccinated per hundred, and the second represents people fully vaccinated per hundred. The former is not statistically significant and the latter is positive and statistically significant. Hence, the vaccination strategy can achieve positive results in the economy only when individuals receive the full vaccination scheme. An increase of one percent of fully vaccinated people rises the GDP by 0.651 percentage points, this result is consistent with the expected direction of the effect, but only considering fully vaccinated individuals. When the coefficient of the variable on fully vaccinated people is disaggregated, it is statistically significant in all the quarters, but it is negative in the first quarter; it might happen because in an early period the vaccination was only experimental with ambiguous results. From the second to the sixth quarter (2020 quarter 2 to 2021 quarter 2) the coefficient turns positive but shows a decreasing magnitude, and in the last quarter (2021 quarter 3) it turns negative.

The result suggests that as the time passes the positive effect of the vaccination strategy tends to diminish, and even it can become adverse in later periods. This finding also suggests that the vaccination strategy has to be continues and permanent and has to be implemented in a full scheme to avoid a declining positive effects or even adverse effects in the longer-run. To some extent H3 holds because the effect of the vaccination strategy is positive but tends to be unstable or diverse in later periods because has diminishing results or even negative effects in further periods.

The econometric results, in relation to the control variables, provide the following relevant points. The trade off between economic activity and public health, measured by the intensity of the pandemic, proposed by Kaplan, et al. (2020), in which countries enacting shallow social distancing suffer more deaths but also see less affectations in GDP, is not captured in the analysis. The outcome shows that a rise in the pandemic intensity, represented by an increase in the variable on new deaths attributed to the pandemic or an increase in the variable on COVID-19 patients in hospital on a given day, is associated to more affectations in GDP. Both the variable on new deaths and on patients in hospital enter the equation with negative sign and a coefficient statistically significant. The coefficients show that an increase of one

percent in new death per million, reduces GDP by 1.46 percentual points, while an increase of one percent of patients in hospital on a given day per million drops GDP by 0.856 percentual points. The result suggests that a policy of superficial lock down and social distancing with more risk of deaths or COVID-19 patients will not be compensated with more economic growth in relative terms, in contrast, it results in a reduction of GDP. This outcome is consistent with the expected sign.

With respect to the demographic variables the analysis finds that population density is associated to less economic growth, as it was expected, the increase of one person more per square kilometres is associated to a drop of 0.028 percentage points in GDP. What is striking is that the variable on the proportion of population that is 65 years and older enters the analysis with a positive and statistically significant coefficient, which was not originally expected, a rise of one percentage point in this proportion increases the GDP by 2.59 percentage points. This outcome can be explained because the countries with more developed economies have a higher proportion of elderly population, and they are also economies that had sharp falls in GDP in an initial stage of the pandemic, due to the strict lockdown and social distancing imposed by their governments, however in subsequent periods, they have shown a rapid recovery process in their GDP.

The variable on pre-existing social crisis, represented by the share of population living in extreme poverty, has a negative and statistically significant coefficient. This result was already expected because pre-existing social difficulties create preconditions for vulnerability and reduce community resilience; moreover, the pandemic is likely to spread faster in conditions of poverty and vulnerability. An increase of one percentage point in the proportion of population living in extreme poverty is associated to a drop in GDP of nearly 4 percentage points during the pandemic.

Pre-existing medical conditions, represented by diabetes prevalence and pre-existing medical infrastructure, represented by a measure of hospital beds, have statistically significant coefficients with negative and positive sign respectively, as was originally expected. An increase of one percentage point in the proportion of population aged 20 to 79 with a diabetes diagnostic reduces economic growth of GDP by 0.906 percentage points, while an increase of one unit in the number of hospitality beds per thousand people increases economic growth of GDP by 1.016 percentage points.

Summary of the results, conclusions and policy implications

Through strict measures of social distancing and lockdown one would expect a reduction in deaths or new COVID-19 patients, but a more drastic affectation of the economy. However, this has not been the overall experience during the pandemic, countries implementing strong stringency measures are also likely to have significant deaths in the population and sharp falls in GDP parallelly. This is the case of countries

like Mexico, Italy, or France. The results also indicate that as time passes during a period of seven quarters, the adverse effects of stringency on the economy reaches a pick and then declines but remains higher than in early periods.

The main implication of this is that countries can not keep long periods of strict lockdown and social distancing, because gradually obtain more affectation in their economies, which might result unsustainable in the longer-run. In contrast, they should find alternative measures to protect their population and to gradually return to economic activity and lessen stringency. These measures can be the use of face mask, massive vaccination campaigns and application of COVID-testing, contact tracing, and sufficient medical infrastructure and attention in terms of availability of treatments, oxygen, hospital beds, and health workers protection.

The fiscal support to families and small business can be counterproductive in the longer run due to increasing fiscal imbalance and public debt, which inhibits the growth of the economy. However, the outcome of the study indicates that at least during a period of seven quarters, fiscal support does not slow down the economy in the longer-run, in contrast, during the last three quarters the fiscal support gradually increases the benefits on the economy. Hence, fiscal support reduces affectation in the GDP and accelerates its recuperation. Countries that did not issue income support to families and business have had a slower recuperation of employment and GDP, and in recent months have faced less economic growth; moreover, they have increased during the pandemic the proportion of population living in poverty, this is specifically the case of Mexico. Nevertheless, countries have to be cautious in the provision of economic stimulus by avoiding fiscal imbalance that might jeopardise the economy in further periods.

The main implication of this is that countries should set up and maintain a contingency fund that allows them to provide financial support to families and small businesses for periods of one year or more, in pandemic episodes, without having to incur fiscal deficit and severe indebtedness. This will mitigate the fall in GDP, employment and poverty, and will accelerate the recovery of the economy in the long-term.

The immunity created by vaccination can have a positive effect on GDP, but the intensity of the recovery in the economy is subject to the proportion of population immunized within a country but also to the disparities to COVID-19 universal vaccination of global population, moreover, it depends on pre-existing socioeconomic crisis in the country or region. Hence, despite vaccination, the pandemic cycles may resurface, due to global mobility of people, and medical and socioeconomic disparities among the global population. The results point out that in an early-stage vaccination benefits GDP but as time passes the effect declines and in the last quarter it might turn to not significant or even negative, this outcome confirms that the effect of vaccination might depend on other factors that jeopardise its effectivity.

The main policy implication can be stated in three strategies. The first is that the population within a country have to be immunised as much as possible through the application of the vaccine, the second concerns to the universal application worldwide to avoid COVID-19 transmission across countries, and the third is that governments have to attend pre-existing socioeconomic and medical crisis to strength resilience. This final action not only potentializes the effect of vaccination, but also the effect of economic support to families and business; furthermore, it allows to lift the lockdown and return to economic activity faster.

The contribution of this study to the relevant literature is that it tests the effect of three main strategies to face the COVID-19 pandemic (stringency, economic support to families and business and vaccination) on GDP, which have being adopted by governments to overcome the economic crisis that the pandemic has left to in its wake. In addition, the database and the methodological strategy allows to explore the variations the effects can have over time, to be prices, over a period of seven quarters once the pandemic burst. The results provide new insights to adopt policies that mitigate or reverse the adverse effects of pandemic episodes on the economy.

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