BANK OF ALBANIA

THE ECONOMIC EFFECTS OF COVID-19

Bledar Hoda

DISCUSSION PAPER 01 (02) 2023

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NOTES

The thoughts and opinions expressed in this report are those of the authors only and do not reflect the views and opinions of the Bank of Albania.

CONTENT

ABSTRACT

In the absence of a treatment or a vaccine, the economic fallout due to a pandemic is undisputable either due to the spread of the pandemic and lives lost or due to the lockdowns imposed to limit the spread. Stricter lockdowns have much greater economic impact in the short term, but may have the benefit of limiting the spread of the infection. This study looks at '*the direct impact of lockdowns on economic activity based on a panel set of industrial production and unemployment data*'. The findings suggest that based on the scales of the lockdown measures established during the first wave, raising the bar of the lockdowns by any 10 percentage point may cause a decline of the industrial production by 5% in any month. The analysis goes further in addressing '*how this impact varies across industries and across various groups of labor force*' to shed light on the impact of Covid-19 on the labor market and various industries.

I. INTRODUCTION

The Covid-19 pandemic has caught the world by surprise with no health protocol good enough to put it under control. The critical mechanism to mitigate its health consequences for the society has been social distancing and lockdown measures. A clear motivation to undertake such harsh measures in the initial months has been the uncertainty regarding the rate of infection and the lack of an effective protocol to treat it. These uncertainties have pushed the governments to maintain a very tough policy response in the initial phase of the pandemic as a preemptive measure to contain the spread. Governments around the world have deliberately shut down the economy and social life for days or weeks and continued to maintain a degree of social distancing depending on the state of the pandemic. The drastic shut-down in spring would reduce the infection rate to e level that would allow the spread to die out. Instead, the quick lockdown and the following partial stringency measures have managed to gain time towards vaccine development. Due to these measures the number of infected people is also at a much lower number compared to the last pandemic in 1917-1918, assuming the Covid-19 spreads at a similar pace as Spanish flu had done.

However, these drastic measures have disrupted the economic activity. Compared to the last similar pandemic almost a century ago, the Spanish flu in 1917-1918, the balance of the impact in this current pandemic weighs much strongly on the economy due to the lockdown measures. The lockdown strategy expectedly would allow to reignite the engines of the economy within a short period of time once the pandemic would show signs of die out. Several months into the pandemic now, it has become obvious that getting rid of the virus, returning back to normal life and restarting the economy to limit the cost of lockdowns hasn't been that easy. The unusually high social and economic costs so far have raised questions regarding the effectiveness of lockdown measures.

The plan in this study is to evaluate the economic consequences of the pandemic, in particular the effects of the lockdown measures. Drawing on experiences from the impact of the Spanish flu in 1917-

1918, there are at least two aspects of the impact of Covid-19 in economic activity. First, the longer the pandemic lasts the greater the long-term impact that follows from the associated reduction in labor supply and from the structural changes in business environment and trade. While there is no definite number of deaths worldwide due to Spanish flu, an estimate in 48 countries goes to around 40 million lives or 2.1% of world population, while the total number worldwide goes above 50 million lives lost (Barro, Ursúa, & Weng, 2020). In addition, the pandemic is thought to have lasted until 1920, with pockets of spread in localities few years afterwards. As the world had lived with the pandemic for about three years (1918-1920) the business environment should had changed. In principle, those that are unemployed during a pandemic may end up being unfit for a job a few years later, while many businesses could fail due to shifts in business and consumer trends during a long pandemic. The immediate implication for the current pandemic is that, the long term effects for the current Covid-19 pandemic are difficult to assess amidst the pandemic.

Second, the immediate impact of the pandemic is caused by the stringency measures driven by the necessity to contain the spread of the virus, rather than the death rate. The impact takes the form of a short-term disruption in economic activity associated with a sharp decline in aggregate demand, in production and in services. When the virus is no longer a threat, either due to containment measures and vaccines or due to natural crowd immunization, the economy is hopefully expected to follow a V-shaped return to a more stable growth path. In the aftermath, there are more than one way how the economy rebounds. The economy may restart at the pre-pandemic path and keep growing at the earlier rate of growth. In this case the structure of the economy, the business environment and the labor force may not be affected by the disruption while the cost of the pandemic is borne primarily by the sharp increase in public and/or private debt. Alternatively, the economy may see only a partial recovery. The various reasons why it may not recover the losses during the economic shut down may depend on (i) the severity of the structural impairment in the business structure, in trade links and in labor force due to the pandemic and (ii) the length of the disruption. Both factors may lead to structural unemployment and below-potential economic growth while partial recovery taking longer the more severe and lengthy the pandemic.

The focus in this work is limited to addressing only the short-term costs of the lockdown measures on economic activity and labor markets. The first question addressed is 'what are the economic effects of preventive measures taken to restrain the spread of Covid-19 pandemic, based on the impact of lockdowns on industrial production index and unemployment rate. The second question is "*how the economic activity across industries and unemployment among various groups of labor force respond to different degrees of lockdowns*". Given the short period covered and the short time series dimension of the lockdown indicators I employ a panel set of economic data mostly available from Eurostat, for most European countries, with few data for most developed economies added from OECD database. Economic data for a handful of other countries are recovered from IMF database or from the statistical offices of individual countries.

With the data for European economies as the main source of input in mind, I make a short review of some of the characteristics of European economies in sections 2, with a focus on the Central Eastern and Southeastern European Economies (CESEE) which have similar economic foundations like Albania. The review aims at providing a comparative perspective of the Albanian economy to the other economies. Furthermore, in the second part of section 2 I provide a survey of academic papers on the costs of a pandemics. Data and methodology are discussed in detail in section 3, results are summarized in section 4 and I conclude with a summary of key findings.

II. THE ECONOMIC EFFECTS OF COVID-19

II.1 Which channels does the Pandemic affect most?

There are various ways in which this health crisis will shape the economy and social life once it is over. The literature helps to identify several channels through which this pandemic will exercise its impact (OECD, 2020). In particular, for emerging and developing economies some sectors may be more important than others. Summarizing the key channels through which the pandemic may strongly influence the economies of developing countries provides a comparative view of where how the countries might come out from this pandemic.

Domestic demand. The stringency measures imposed on countries will lead to a decline in aggregate demand as manufacturing and services are shut down and as employment and income fall. Even those households with high incomes will limit the purchases of goods that require personal contact. The higher uncertainty regarding future income and the reduced probability of remaining employed will call for increased precautionary savings at the cost of lowering demand for goods and services by high income groups. By extrapolating future trend from the currently depressed demand and uncertainty about the pandemic, the entrepreneurs may further cut down on any type of investment amplifying the impact on aggregate demand. While economic measures aiming to support the affected business sectors and the households losing jobs may alleviate the overall impact. Still, these measures cannot account for the full impact of the shut-down of the economies. While it is still early to get data on overall GDP, monthly data manufacturing or industrial production may hint at the immediate impact.

Aggregate supply. The increase in the number of unemployed will be initially a temporary feature. The longer it takes for the pandemic to disappear the higher the number of businesses that will not be able to reset or restart right after the opening of the economy and even long after the pandemic ends. Some of the unemployed during the pandemic may remain so for a long time and shift from temporary unemployed due to the pandemic to structurally unemployed. In a similar way capital utilization may remain below its long term trend as the structure of the economy may change fundamentally. Some sectors are more vulnerable than the others to the disruptions while different measures may affect various sectors at varying degrees. In the long-term it is not clear upfront how productivity in the economy will be affected from these disruptions. Employment figures will provide an early proxy for the GDP gap in addition to industrial production.

Public and private Investment. Aggregate investments are expected to see a sharp decline due to the stringency measures across countries. First, the private domestic investments will see a decline as economic and social activity has been restricted in the first half and the last quarter of the year. Low aggregate demand and high uncertainty will keep private (domestic) investment below potential in both advanced and developing economies. Uncertainty will weigh as a factor long after the restrictions are eased even though fiscal transfers keep supporting aggregate demand.

Second, public investments are critically limited by a combination of factors. A shortfall in fiscal revenues due to restrictions in economic activity jeopardizes the ability to finance public investments. In many economies with existing high public debt there are legitimate concerns regarding the costs of further raising the public debt. In addition, in developing economies public investment can be constrained by the limited capacity to finance expanded fiscal deficits beyond the gap generated by the shortfall in fiscal revenues. Concessional financing seems to help address some of the issues in many developing economies while unconventional monetary policy, framed as quantitative easing, plays that role in advanced economies.

A third component of aggregate investment is the expected decline in foreign direct investments (FDIs). FDIs are particularly critical for developing countries as they are a significant source of financing the economy and a source of technological progress and productivity. The relatively longer time it may take to resume investment financed by FDI implies a potentially stronger impact of the Covid-19 pandemic in productivity and in potential growth rates in the medium term.

Exports of goods. Exports will decline in many economies, not simply due to the decline in global demand but also due to limited economic activity even if demand were to remain stable. The stringency measures reduce the capacity of firms to fully utilize labor and capital up to the potential. Even once some of the stringency measures are lifted, a prolonged effect will hit exports due to the plunge in aggregate demand in economies where these exports are heading to. The plunge in aggregate demand in Euro area will hit the export sector of Central Eastern and Southeastern European Economies (CESEE) whose exports sector is integrated into the EU or global supply chains. The impact is likely stronger in countries with manufacturing sectors integrated in global supply chains and where these sectors account for a significant part of the employed labor force. In most of the EU members, including some CESEE countries that have joined after 2004, the exports sector accounts for 30%-90% of GDP. Among EU candidate countries only Serbia and North Macedonia are in this group of countries. While among other non-EU members, Albania, Kosovo and Montenegro, have exports of goods account for less than 10% of GDP.

Tourism sector. The pandemic has hit the tourism industry hardest particularly in those touristic destinations where the infection rate has remained high during the summer, following the first wave in spring. As the number of cases infected with Covid-19 has increased for host countries relying on revenues from tourism, international travel towards those destinations has been restricted by governments in home countries. Tourism receipts account for a significant share of GDP in several economies of the region. Among EU members or candidate countries, economies in the region, including Albania, rely on touristic receipts varying around 15-25% of GDP to support aggregate demand while in more advanced countries of the EU they account for less than 5% of GDP (Graph 1).

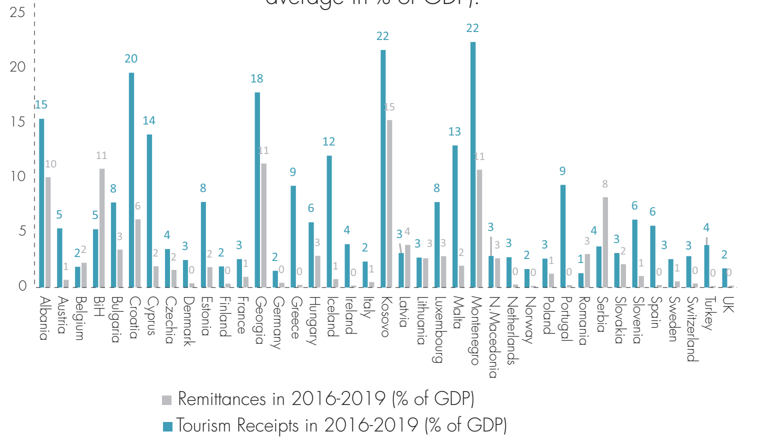
Chart 1. The groups of countries with a high and low share of Exports of goods in % of GDP prior to Covid-19 pandemic.

50% - 100%	30% - 50%	20% - 30%	10% - 20%	0% - 10%
Belgium	Austria	BiH	Cyprus	Albania
Czechia	Bulgaria	Croatia	Greece	Kosovo
Hungary	Denmark	Finland		Montenegro
Ireland	Estonia	France		
Lithuania	Germany	Georgia		
Netherlands	Latvia	Iceland		
Slovakia	Luxembourg	Italy		
Slovenia	N.Macedonia	Malta		
	Poland	Norway		
	Serbia	Portugal		
	Sweden	Romania		
	Switzerland	Spain		
		Turkey		

**Average data over 2016-2019. Data for EU members, (potential) candidates and associated countries.*
Source: World Bank

Remittances. Some of the developing economies rely on a steady flow of income from remittances to support consumption or investments. Among non-EU countries, the Balkan economies seem to rely the most on remittances accounting for more than 10% of GDP, except for Serbia's remittances that make up for around 8-9% of GDP. This source of income is expected to contract due to the spike in unemployment in EU member economies where the providers of these remittances have settled or due to restrictions in international travelling. Across EU members only some economies that have accessed the union after 2004 have remittances between 3-6% of GDP, while in the rest of the EU economies remittances are less than 2%.

Chart 1 Tourism Receipts and Remittances prior to Covid-19 (2016-2019 average in % of GDP).



Source: World Bank.

The contribution of both remittances and tourism sector of the economies in the western Balkan countries ranges between 20-40% of respective GDP. Of these countries only Croatia is an EU member. These two sources of income account for a slightly lower but still significant share on some other member or candidate countries in south of EU.

Chart 2. The groups of countries with a high and low share of receipts from Tourism and Remittances in % of GDP prior to Covid-19 pandemic.

30%-40%	20% - 30%	10% - 20%	5% - 10%	0% - 5%
Kosovo	Albania	BiH	Austria	Belgium
Montenegro	Croatia	Bulgaria	Czech Rep.	Denmark
	Georgia	Cyprus	Estonia	Finland
		Iceland	Greece	France
		Luxembourg	Hungary	Germany
		Malta	Latvia	Ireland
		Serbia	Lithuania	Italy
			North Macedonia	Netherlands
			Portugal	Norway
			Slovakia	Poland
			Slovenia	Romania
			Spain	Sweden
				Switzerland
				Turkey
				UK

**Average data over 2016-2019. Data for EU members, (potential) candidates and associated countries.*
Source: World Bank

II.2 Literature Survey on the Economic Effects of the Pandemics

There are two strands of literature that help to shed light on the impact of the current pandemic on economic activity. **The first is the group of papers that analyze the impact of the past pandemics, particularly of the Spanish flu in 1918 and the second is a sequence of recent papers and reports analyzing the impact of the ongoing pandemic.** The advantages of looking at the first set of studies is that series of economic indicators affected by the pandemic are available for the whole cycle of the pandemic and afterwards. That helps shed light on the medium to long term effects of the pandemic. The disadvantage is that the data particularly on measures and policies are not of a very good quality and as detailed as the data for the current pandemic.

The opposite is true for the second set of studies, the ones focusing on Covid-19. The data on measures and policies are more detailed but the set of economic data is not, primarily due to delays in publications and the uncertainty regarding the end of the pandemic itself.

Another distinction worth discussing in this literatures is among the studies that look at short term effects of the pandemics relative to long-term ones. The death rate has been relatively high in past pandemics. The 1918 flu had a death rate of around 2.1% of world population according to some estimates (Barro, Ursúa, & Weng, 2020). With such high death rates there is a need to evaluate the impact of exogenous shocks on population (labor force) on the medium-term growth rates of income per capita. Theoretical models may be ambiguous about these effects. Different assumptions on the capital and labor share on the production function as well as on the impact on savings rate yield different results. The AK growth model delivers positive growth rates of income per capita following a negative shock in population due to the high share of capital per capita on aggregate income. The neoclassical growth model assumes diminishing marginal returns to capital.

The following surveyed literature, while hardly claiming to be exhaustive, sheds some light on the economic impact of the pandemics by emphasizing those two distinctions.

- Studies analyzing the long-term effects of earlier pandemics

A very recent study Barro etal (2020) measure the impact of lockdown measures, like school closing, prohibition of public gathering and stay-at-home measures on the number of deaths, and in turn measure how the number of lives lost affected the economy. It is not a direct measure of lockdown measures on economy. Barro etal (2020) find that the decline by 2.1% of the population due to 1918-1920 flu deaths in 48 countries (or 92 % of the world) led to a decline in GDP and consumption of 6% and 8 % respectively.

McKibbin and Fernando (2020) investigate pandemic scenarios of various sizes in a computable general equilibrium framework by adjusting epidemiological information to formulate macroeconomic shocks. The simulations suggest that for a pandemic scenario that in the first year leads to 236 thousand deaths in US, out of around 15 million worldwide, the GDP gap from its potential vary around 2-3% in US and other large economies (table 10, pp 139). Only in a severe scenario with 1.06 million deaths in US (out of 68.3 million worldwide) would the US economy see a GDP loss of around 8.4%.

In an earlier paper the authors' calculations suggest that only in a severe scenario, where 142 million lives are lost, can the GDP decline by around 12.6% (McKibbin & Sidorenko, 2006)[1]. In a mild case of the pandemic with 1.4 million deaths worldwide, GDP would be 0.8 percentage points lower than its potential. For developing economies GDP losses can go much higher. In addition, preventing exchange rate depreciations exacerbates the impact in developing economies.

Lee & McKibbin (2004) suggest that the economic costs of an epidemic like SARS in 2003 to the world economy could reach as high as 40 billion US dollars if it hits only once and 54 billion US

[1] *10.7% is the equivalent of the 4.4 trillion USD loss in nominal GDP units of the time.*

Mild scenario: WORLD	*1.4 million lives*	*0.8% (330bio USD) GDP*
Ultra scenario: WORLD	*142.2 million lives*	*12.6% (4.4 trn USD) GDP*

dollars if it recurs. A persistent shock causes losses not only through the direct impact on unemployed but also due to loss of investment and reduced spending associated with higher uncertainty.

The long term effects of the pandemic do not include the human capital costs that is argued will take the form of lower skill value once a business is lost due to the pandemic or lockdown (Eichengreen, 2020).

Looking at the long term effects, Brainerd & Siegler (2003) assess the impact of Spanish flu on per capita income growth 10 years after the pandemic across US states. They find that states with higher death rates had a higher growth rates of income per capita 10 years later. The findings in this paper is unique in lending support to the theoretical assumptions underlying a production function of the AK style with constant returns to scale and the potential for a positive effect of exogenous population declines.

- Studies analyzing the short-term effects of earlier pandemics

Country studies based on the 1918 flu provide different estimates of GDP losses. One of the most recent studies (Ludvigson, Ma, & Ng, 2020) estimate the economic cost of disasters across US states over the past 40 years and simulate potential effects of Covid-19 by calibrating the shock-based evidence in the first half of the year. They find that a short-lived pandemic can reduce the industrial production by 11.8% and raise unemployment in US by around 60 million in service industry[2].

Eichenbaum etal (2020) investigate the trade-off between optimal policy and epidemics in an epidemiology model. They show that stringency measures may reduce infection rates from 4.7% to 2.5% of population while amplifying the magnitude of recession from 7% to 22% of GDP. The stringency policies reduce death toll from 0.4% to 0.26% of population. While the results are subject to sensitive assumptions, they provide an indicative reference for the cost of stringency measures.

[2] *By a short-lived pandemic the authors assume a period close to 6 months.*

Average rates across unit mask the real impact depending on the intensity of the pandemic. Data on the impact of deaths due to the 1918 Spanish flu on several economic and financial indicators across US states show that the 1918 flu eradicated about 18% of manufacturing output in US (Correia, Luck, & Verner, 2020). It also reduced employment in manufacturing by around 23%. Carillo and Jappelli (2020) report that the difference in terms of 'GDP per capita growth' lost between the region with highest mortality rate and the one with the lowest mortality during 1918 flu in Italy was around 6.5%. They also report that it took around 3 years to for the impact to fade away. A full recovery of regions with the highest intensity in Denmark, calculated to have seen annual income growth of about 3.75 percentage points, would take about 2-3 years. A one standard deviation increase in the 1918 flu intensity costs 1.25 percentage points of annual income growth (Dahl, Hansen, & Jensen, 2020).

The potential economic costs of the pandemic for some of the core founders of EU, Belgium, France, Netherlands and UK, indicate also a large variation cross countries or regions. Keogh-Brown etal (2010) report that for UK these costs can range from 0.37-4.85% of GDP depending on the scale of the pandemic from mild to severe. Their simulations yield similar results for the other countries.

Ma etal (2020) study the impact of epidemics that occurred between 1968 and 2016 on GDP growth, international trade and GDP components in a panel of countries affected by epidemics. The study includes countries which were not affected to control for the impact of the epidemic. They conclude that GDP growth falls by 3 percentage points in affected countries in the year of the outbreak, but it could take up to 5 years for GDP to reach its pre-crisis level. International trade declines by 19% during the year of the epidemic.

Forecasts for the current pandemic also show large variation depending on the assumption regarding the half-life of the pandemic. Arnold etal (2006) calculate that in a mild pandemic similar to ones in 1957 or 1968, associated with about 100,000 deaths out of 75 million infections, they expect to cost the US economy about

1% of GDP. In the severe case, with 2 million deaths out of 90 million infections, the cost in terms of GDP would be 4.25%. These calculations are only based on two scenarios build to resemble past pandemics.

- Studies analyzing the short-term effects of Covid-19

A number of reports by national or international organizations warn that the world economy will be in recession during 2020. Earlier reports forecasted decline in GDP among largest economies in the range of 3-6%. A comprehensive Congressional Research Service (CRS) Report that updates US Congress members regarding impact of Covid-19 concludes that the pandemic may cost the world economy 3.0 to 6.0 of GDP in 2020 based on growth forecasts made by OECD, IMF and World Bank (CRS, 2020). In addition, global trade may fall by 13% to 32%, all depending on how the pandemic unfolds in the remaining part of the year. Similarly, early in the spring, BIS forecasted that the cost of Covid-19 to be around 4% of world GDP for 2020, with larger economies taking a harder hit (Boissay & Rungcharoenkitkul, 2020). Forecasts by EBRD yield similar growth numbers. The GDP in regions covered by EBRD is projected to contract by an average 3.5 per cent, assuming lockdown measures will remain relaxed in the second half of the year (EBRD, 2020). They also warn that the 2019 levels of income per capita may take some years to be attained in some regions.

More recent studies look at various aspects of the current pandemic, including the impact on the economy. Working papers investigate the economic impact of Covid-19 with preliminary data and predict sharp decline in economic activity at global level. Deb etal (2020) look at the impact of stringency measures on economic activity by quantifying the daily decline of Nitrogen Dioxide (NO2) emissions in Jan-May interval due to containment and stringency measures for 62 countries. They report that over a 30-day period the decline in NO2 emissions is consistent with a 15% decline in industrial production. They also find that the measure had a strong impact on flights, energy consumption, maritime trade and retail sales.

Coibion etal (2020) investigate how stringency measures affect macroeconomics expectations using survey data. The respondents in their survey expected unemployment to go up by 11% in the current year and that the downturn would be persistent in the following 3-5 years.

II.2.1 Methodological approaches

The study of macroeconomic effects of the current pandemic is challenging due to several factors. First, the frequency of an event at this scale is low and rare. The most recent pandemic that had a similar impact on the lives of the populations across the globe has occurred during the years 1918-1920. Second, in cases when a pandemic of a similar scale has been identified, data frequency and quality turns to be an obstacle in capturing the short term impact of the pandemic on the economy. In particular, the severity of the pandemic during the Spanish flu overlaps with the loss of lives due to the First World War. Proper assessment of the scale of the pandemic becomes difficult due to this overlapping. Third, unlike in any other earlier pandemics, the economic costs of Covid-19 may not be particularly due to the high frequency of infections or lives lost but rather due to the stay-at-home and social distancing measures implemented to slow the spread of the infection. This last factor, is a characteristic quite relevant of the current pandemic, though similar measures have been requested during the Spanish influenza, although at a much smaller scale. A survey of the methodologies employed to analyze the economic effects of the pandemics emphasizes the critical role of these challenges (Table 1).

Various authors employ a few approaches to overcome these challenges. A bird's eye view of the methodologies employed shows that the most common is the panel regression with control variables is the most common as long as the data allow for it. Most authors employ control variables in panel regression in order to identify the causal effect of the spread of the pandemic on the economic variables. Since during the past pandemic the role of non-medical measures like social distancing and stay-at-home orders is very limited or not available in data form, most papers surveyed employ a measure of the spread of infections in an economy as an independent variable. Social distancing measures are not taken into account in most studies. As there is no causal effect between the key independent variable and the control variables, the panel regression with control variables for the impact of other factors is a common approach to capture the impact of the pandemic on the economy.

A second approach is the scenario analysis in computable general equilibrium models (CGE). Looking at the impact of pandemics on economy from a different angle, in addition to regressions, provides alternative benchmarks to the size of the potential impact of a pandemic. Only recently the estimates from these two approaches have been complemented by local projection (LP) methods. LP is an alternative method of generating impulse responses of Y variable due to a shock in X variable by employing a regression method.

Across the studies, mostly address the impact of the pandemic, measured by number of infections or number of lives lost, on economic variables. In one recent study, Deb etal (2020) measure the impact of containment measures on indirect indicators of economic activity like carbon dioxide emissions, flights, energy consumption, maritime trade and mobility by employing local projection (LP) method to generate impulse responses. To control for the endogeneity of the state of pandemic, they include the number of infections and number of deaths on the day before the implementation of a containment measure (lockdown or other social distancing measures). The large number of observations at daily frequency is critical for the implementation of such a rich regression.

Table 1. Summary of studies and methodologies

	Method	Event
Barro etal (2020)	Panel Regression w/ controls.	1918 Influenza
McKibbin and Fernando (2020)	DSGE/CGE	Simulations on Covid-19
McKibbin and Sidorenko (2006)	DSGE/CGE	Simulations on SARS 2003
Lee and McKibbin (2004)	C-Cubed CGE	Simulations SARS
Brainerd and Siegler (2003)	Panel Regression w/ controls	1918 Influenza; US states
Ludvigson, Ma & Ng (2020)	3-variable VAR	
Eichenbaum, Rebelo, Trabandt (2020)	SIR-macro GE model	
Correia, Luck and Verner (2020)	Panel Regression w/ Instruments	1918 flu; US states
Carillo and Jappelli (2020)	Panel Regression (incl.lags)	1918 flu; Italian Regions
Dahl, Hansen and Jensen (2020)	Panel Regression (Diff-in-Diff)	1918 Influenza; 76 Danish municipalities/ annually
Keogh-Brown etal (2010)	Multi-sector GE model	2003 Sars; UK, Fr, Be, Netherland
Ma etal (2020)	1) Local Projection 2) Panel Regressions with control variables	Flu 1968, SARS 2003, H1N1 2009, MERS 2012, Ebola 2014, Zika 2016.
Arnold etal (2006)	Scenarios based on past pandemics	US
Deb etal (2020)	Local Projections (X=Lives)	Covid-19; *NO2* Flights, Energy - 57 Countries
Coibion, Gorodnichenko, Weber (2020)	Panel Regression of Survey data	Covid-19
Boissay and Rungcharoenkitkul (2020)	BIS Report based on review	
EBRD (2020)	Official Reports	
CRS (2020)	Official Reports	

III. DATA AND THE METHODOLOGY

III.I Data

Industrial Production (IP) data for manufacturing or total industry come from Eurostat for EU member countries, candidate and associated ones. Data for North American countries, BRIC countries, a few Latin countries and Asian larger economies come from OECD database.

Then I get total industry IP data for 5 countries from IMF database and use them as proxy for the IP data in manufacturing sector. For some countries data from national statistics institutes of that particular country were used to fill up the missing recent observations in OECD database. The IP series is available for a total of 55 countries.

Labor market data on monthly basis are available for about 40 countries and come from the Eurostat and OECD database. The Eurostat Labor data is used as a primary source while additional countries not in the Eurostat's database are added to the list from the OECD database. Employment across industries measured is in thousands of persons only available on quarterly basis for 44 countries based on the same sources, Eurostat and OECD.

The unemployment data for total unemployment and the unemployment rate based on gender and age groups are provided for a set of 39 or 40 countries. For all the monthly labor market data I define the monthly change of unemployment rate across various labor force cohorts

$$\Delta UNr\_z_{j,t} = UNr\_z_{j,t} - UNr\_z_{j,t-1} \quad (1.1)$$
$$\text{where} \quad \forall z = total, under25, above25, male, female$$

where '*z*' stands for (1) total labor force (2) labor force aged between 15-25 years old (3) labor force aged between 25-64 years old (4) male labor force and (5) female labor force.

Chart 3. Industrial production and labor market data.

	Description	Frequency	Unit	Nr. of countries
	Industrial Production data			
ΔIP_t	Monthly percentage change of Industrial Production (sa).	M	(in %)	55
	Labor Market data			
UNr_t	Unemployment rate.	M	(in %)	40
UN_15_t	Unemployment rate of under 25 year olds (15-25 years old).	M	(in %)	40
UN_25_t	Unemployment rate of above 25 years old (25-64 years old).	M	(in %)	40
$UN\_T\_m_t$	Unemployment rate across MALE cohort.	M	(in %)	39
$UN\_T\_f_t$	Unemployment rate across FEMALE cohort.	M	(in %)	39
	Labor Market data across sectors			
EMP_i_t	Number of employed persons in industry 'i':	Q	('000 persons)	44

M: Monthly; Q: Quarterly
Source: Eurostat, OECD, IMF

Following that definition, the $UNr\_age\_gap_t$ is the difference between *"monthly change in unemployment rate of those 15-25 years old" and the "monthly change in unemployment rate of those 25-64 years old"*.

$$UNr\_age\_gap_{j,t} = \Delta UN\_25_{j,t} - \Delta UN\_15_{j,t} \qquad (1.2)$$

Similarly, $UNr\_sex\_gap_t$ is the difference between "*monthly change in unemployment rate across the male cohort*" and the "*monthly change in unemployment rate across the female cohort*".

$$UNr\_sex\_gap_{j,t} = \Delta UN\_T\_m_{j,t} - \Delta UN\_T\_f_{j,t} \qquad (1.3)$$

To infer about the impact of lockdown across industries, I obtain data on the number of employed persons in each industry *'agriculture', 'construction', 'manufacturing', 'services'* and '*total*' based on Eurostat data for a set of 44 countries at quarterly frequency. I define the growth of the number of employed persons in each industry $\Delta EMPgrowth_{j,t}$ as the difference between log *employment in industry* j at time t and $t\text{-}1$.

$$\Delta EMPgrowth\_i_{j,t} = log(EMP\_i_{j,t}) - log(EMP\_i_{j,t-1}) \qquad (1.4)$$
$$\forall i = \text{agriculture, construction, manufacturing, services, total}$$

The ultimate interest is on the growth differential of industry i, $\Delta EMPgrowthDF\_i_{j,t}$, defined as the residual difference between employment growth in any i industry and the employment growth in total economy.

$$\Delta EMPgrowthDF\_i_{j,t} = \Delta EMPgrowth\_i_{j,t} - \Delta EMPgrowth\_i_{total,t} \qquad (1.5)$$
$$\forall i = \text{agriculture, construction, manufacturing, services}$$

Finally, data on lockdown, on infection rates and on economic support of respective governments shown in Chart 4 are available from *Oxford Covid Policy Tracker*.

The data indicated in the chart are available on daily bases on a scale 0-1 and can change only at 0.05 increments. As a results, at daily frequency each variable is a discrete one. The data are further averaged on monthly basis to get an indicator at monthly frequency. By doing so a new non-discrete series is obtained that can take any value on the continuum 0 to 1. Since monthly changes are used in the regression, they can easily interpreted as tightening of the lockdown (or economic support) conditions measured in percentage points and can take any values from 0% to 100%, which are sensible values for a monthly percentage change.

$$DB\_Stringency_{j,t} = Stringency\_index_{j,t} - Stringency\_index_{j,t-1} \qquad (1.6)$$
$$\Delta L_{j,t} = L_{j,t} - L_{j,t-1}$$

where $Stringency\_index_{j,t}$ or $L_{j,t}$ is the monthly lockdown stringency index that takes values in the continuum 0 to 1 due to averaging from daily to monthly frequency, and $DB\_Stringency_{j,t}$ is the monthly change of the lockdown tightening/loosening measured in percentage points. Monthly changes for other indicators of economic support are calculated in the same way.

The data used in this study cover the period Dec 2019 – June 2020 at monthly frequency, accounting for 7 observations for each country. One exception is data for employment across industries which is available only at quarterly frequency and includes 3 observations, 2019q4-2020q2, for each cross-section. Stringency data are also averaged at quarterly frequency in that special case.

The reason I use such a short series is to focus only on the impact of lockdown, which takes values different from zero only starting from December 2019. By leaving out earlier observations, I focus on the impact of the stringency index as the key factor to affect the economic activity indicator, IP or unemployment, and emphasize joint behavior of variables along the cross section rather than along the time series dimension. Any other effect along the time series dimension is either shown as prt of the error in the regression or captured by an AR term included to check how strong the impact of non-lockdown related factors are.

Chart 4. Data on the degree of lockdown, on economic support, on infection rates.

	Description	Frequency	Unit	Nr. of countries
$L_{j,t}$	Stringency index: shows the degree of lockdown in country '*j*' on a continuum scale of 0-1.	M.avg	(in %)	170
$SG_{j,t}$	An index showing economic support by government in country '*j*' on a continuum scale of 0-1.	M.avg	(in %)	170
$SI_{j,t}$	An index showing economic support in the form of '*Income Support*' by government in country '*j*' on a continuum scale of 0-1.	M.avg	(in %)	170
$SD_{j,t}$	An index showing economic support in the form of '*Debt Relief*' by government in country '*j*' on a continuum scale of 0-1.	M.avg	(in %)	170
$C_{j,t}$	Number of infected persons per 1 million population in country '*j*'.	M.avg	(persons per 1 million)	170

D: Daily; M.avg: Monthly average
Source: Oxford Covid Policy Tracker.

III.2 Model Specification

III.2.1 Economic activity

How is the economic activity affected by the lockdown? To address the question, I obtain two key indicators of economic activity, industrial production and unemployment rate and specify similar equations to estimate the impact of lockdown on economic activity, using either indicator.

- The effect of lockdown on industrial production.

In the first stage I estimate the impact of the lockdown on industrial production as in equation (2.1). Following Barro etal (2020), I regress industrial production (first difference) to the lockdown index at time t and at $t-1$ as in equation (2.2). The interpretation is that should the coefficient β be negative and significant then the impact of the lockdown will more persistent.

$$\Delta IP_{j,t} = \beta_{j,0} + \beta_{j,1}\,\Delta L_{j,t} + \varepsilon_{j,t} \quad (2.1)$$
$$\Delta IP_{j,t} = \beta_{j,0} + \beta_{1}\,\Delta L_{j,t} + \beta 2\,\Delta L_{j,t-1} + \varepsilon_{j,t} \quad (2.2)$$
$$\Delta IP_{j,t} = \beta_{j,0} + \beta 1\,\Delta L_{j,t} + \gamma 1\, S_{j,t} + \varepsilon_{j,t} \qquad \forall S_{j,t} = SG_{j,t}, SI_{j,t}, SD_{j,t} \quad (3.1\text{-}3.3)$$

To check the impact of economic support programs by the governments I add an additional regressor to the equation (2.1). The extra regressor is either of the three indicators of government economic support (see Chart 4):

- the overall index of government economic support $SG_{j,t}$,
- the index of government economic support in the form of income $SI_{j,t}$, or
- the index of government economic support in the form of debt relief $SD_{j,t}$.

For the sake of robustness, I check how the results change when the lag of the dependent variable is included in the form of an autoregressive term AR(1) and report those results.

- The effect of lockdown on unemployment.

A similar approach is followed in setting up the regression equation to obtain an estimate of the impact of lockdown on the change in unemployment rate in equation (4.1). Inclusion of the first lag of the independent variable, change in lockdown index, is aimed at checking whether the impact is persistent or not (eq. 4.2).

$$\Delta UN_{j,t}=\beta_{j,0}+\beta_{j,1}\Delta L_{j,t}+\gamma_{j,1}\Delta C_{j,t}^{world}+\varepsilon_{j,t} \qquad (4.1)$$

$$\Delta UN_{j,t}=\beta_{j,0}+\beta_{j,1}\Delta L_{j,t}+\beta_{j,2}\Delta L_{j,t-1}+\gamma_{j,1}\Delta C_{j,t}^{world}+\varepsilon_{j,t} \qquad (4.2)$$

In both equations, the change in the state of the pandemic at a global level, $\Delta C_{j,t}^{world}$, is included in the regression. The term $\Delta C_{j,t}^{world}$ is the change in the average number of infections per 1 million population across all countries of the sample. IT is a proxy for the state of the pandemic at global level. The advantage of this variable is that it is not endogenous to the spread of the pandemic in any country and helps improve the estimation of the $\beta_{j,1}$ and $\beta_{j,2}$ coefficients in eq (4.1) and (4.2).

As a further check of the robustness of the results I estimate both equations (4.1) and (4.2) with:

- an additional AR(1) term for both equations (4.1) and (4.2), and
- with cross section fixed effects (available).

III.2.2. Labor market across industries and social groups.

Monthly labor market data availability across various social groups predetermine the type of regression that is possible to estimate in each case of this subsection. In one special case, employment across industries measured in thousands of persons is only available at quarterly frequency. Therefore, to address how the lockdown might have affected individual industries of an economy I transform lockdown data at quarterly frequency.

- The effect of lockdown on employment across industries.

Data on employment across industries are available at quarterly frequency. To get an estimate of how the lockdown affects employment growth in different industries I obtain the difference in growth employment in each industry relative to employment growth in the whole economy. Should the impact of the lockdown on industry 'i' be of the same size as in the overall economy then, the residual difference should not be explained by the lockdown factor. I regress the growth differential on lockdown factor of the current period, (5.1), or on the lagged lockdown factor as in (5.2). A significant coefficient would lend support to the hypothesis that the lockdown affects the industry differently and the sign of $\beta_{j,1}$ would show the weakness/strength of the impact.

$$\Delta EMPgrowthDF\_i_{j,t} = \beta_{j,0} + \beta 1 \Delta L_{j,t} + \varepsilon_{j,t} \quad (5.1)$$
$$\Delta EMPgrowthDF\_i_{j,t} = \beta_{j,0} + \beta 2 \Delta L_{j,t-1} + \varepsilon_{j,t} \quad (5.1a)$$
$$\Delta EMPgrowthDF\_i_{j,t} = \beta_{j,0} + \beta 1 \Delta L_{j,t} + \beta 2 \Delta L_{j,t-1} + \varepsilon_{j,t} \quad (5.2)$$
$$\forall i = agriculture, construction, manufacturing, services$$

where, 'a' stands for agricultural industry, 'c' for construction, 'm' for manufacturing and 's' for service industry.

- The effect of lockdown on unemployment across younger and older labor force.

Monthly changes of unemployment rates across age groups 15-25 years old ($\Delta UNr\_15_{j,t}$) and 25-64 years old ($\Delta UNr\_25_{j,t}$) are available as shown in data section. The regression equation to be estimated in (6.1-6.1a) provide estimates of the impact of the lockdown on unemployment across different age groups. Should the lockdown have the same impact on unemployment of any of these two groups, young and old labor force, then the gap between the two groups should not be explained by the lockdown index, therefore $\beta_{j,1}$ and $\beta_{j,2}$ coefficients should not be significant in the following equations.

$$\Delta UN\_age\_gap_{j,t} = \beta_{j,0} + \beta_1 \Delta L_{j,t} + \gamma_1 \Delta C_{j,t}^{world} + \varepsilon_{j,t} \tag{6.1}$$
$$\Delta UN\_age\_gap_{j,t} = \beta_{j,0} + \beta_1 \Delta L_{j,t-1}) + \gamma_1 C_{j,t}^{world} + \varepsilon_{j,t} \tag{6.1a}$$
$$\Delta UN\_age\_gap_{j,t} = \beta_{j,0} + \beta_1 \Delta L_{j,t} + \beta_2 \Delta L_{j,t-1} + \gamma_1 \Delta C_{j,t}^{world} + \varepsilon_{j,t} \tag{6.2}$$

For robustness, in (6.1a) the lagged lockdown variable $(\Delta L_{j,t-1})$ replaces the independent variable at time 't' to see if one month accounts for a time gap of the effect to show up. Adding the lagged independent variable to the regression as shown in (6.2) allows to check whether both coefficients, β_1 and β_2, are statistically significant indicating a rather more persistent effect. For reference, the three respective regressions are shown.

- The effect of lockdown on unemployment across male and female cohorts.

Similarly, monthly changes of unemployment rates among males $(\Delta UNr\_m_{j,t})$ and females $(\Delta UNr\_f_{j,t})$ are calculated. I replicate the same regressions with differences in unemployment rates between two gender groups, male and female, $\Delta UN\_sex\_gap_{j,t}$ as dependent variables. Should the monthly change of the lockdown index have the same impact on the two gender variables, then the gap between the two unemployment rate (growths) based on gender, $\Delta UN\_sex\_gap_{j,t}$, should not be explained by changes in the lockdown. In these regressions I include the cross-country average of spread of infections (per million of population) as a measure of the spread of the pandemic at global level to obtain normal errors.

$$\Delta UN\_sex\_gap_{j,t} = \beta_{j,0} + \beta_{j,1} \Delta L_{j,t} + \gamma_{j,1} \Delta C_{j,t}^{world} + \varepsilon_{j,t} \tag{7.1}$$
$$\Delta UN\_sex\_gap_{j,t} = \beta_{j,0} + \beta_{j,1} \Delta L_{j,t-1} + \gamma_{j,1} C_{j,t}^{world} + \varepsilon_{j,t} \tag{7.1a}$$
$$\Delta UN\_sex\_gap_{j,t} = \beta_{j,0} + \beta_{j,1} \Delta L_{j,t} + \beta_{j,2} \Delta L_{j,t-1} + \gamma_{j,1} \Delta C_{j,t}^{world} + \varepsilon_{j,t} \tag{7.2}$$

As in the previous subsection, adding the lagged independent variable to the base regression is a quick way to check for a persistent effect of lockdown on unemployment gap across males and females. For robustness, in (7.1a) the lagged lockdown variable $(\Delta L_{j,t-1})$ replaces the lockdown variable at 't' to account for a time gap of the effect to show up. For reference, the three respective regressions are shown.

Finally, for each set of equations (6.1) - (6.1a) and (7.1) - (7.1a) I obtain results for cases when:

- an additional AR(1) term is included in the regression, and
- cross section fixed effects are included.

III.3 Methodology

To assess the impact of lockdowns on any economic indicator Y_t of the economy, it would be convenient to simply regress that indicator on a variable, or a vector of variables that measures lockdown, say L_t and get an estimate of the parameter vector β_t.

It is clear that the stricter the lockdown the sharper the impact on the economic indicator Y_t. On the other hand the economic activity indicator, measured by GDP or unemployment rate, will depend on the expected severity of the pandemic (conditional on any degree of lockdowns L_t) which is not observed. Hence, economic activity will be a function of, among other factors, the lockdown measures which in return are a function of the expected spread of the pandemic conditional on the lockdown measures.

$$Y_{j,t} = f(L_{j,t}, E_t(C_{j,t+1} | L_{j,t})) \qquad f'(L_{j,t})<0, f'(E_t(C_{j,t+1}) | L_{j,t}))<0 \qquad (8.1)$$
$$Y_{j,t} = f(L_{j,t}, C_{j,t}) \qquad f'(L_{j,t})<0, \; f'(C_{j,t})<0$$

where, L_t is an index of the lockdown, called stringency index and $C_{j,t}$ $E_t(C_{j,t+1}|L_{j,t})$ is the expected scale of the pandemic severity which cannot be observed.

At the same time, the scale of the imposed lockdown will depend on the expected severity of the pandemic conditional on no lockdown and on an exogenous policy parameter, α.

$$L_{j,t}=\alpha_{j,0}+\alpha_{j,1}*E_t\,(C_{j,t+1}|L_{j,t}=0)+\vartheta_{j,t} \qquad \alpha_{j,1}>0 \text{ and } \vartheta_{j,t}\sim N(0,\sigma_{\vartheta j}^2) \qquad (8.2)$$

The higher the absolute value of the exogenous parameter, $|\alpha_{j,1}|$ the tougher the stance the authorities may take on it. Therefore, plugging equation (8.2) into (8.1) one gets

$$Y_{j,t}=f([\alpha_{j,0}+\alpha_{j,1}*E_t\,(C_{j,t+1}\,|L_{j,t}=0)],C_{j,t}) \qquad (8.3)$$
$$f'(E_t\,(C_{j,t+1})\,|L_{-j,t}=0))<0, \qquad f'(C_{j,t})<0$$

One clear problem is that we cannot observe the severity of the expected pandemic conditional on any degree of lockdown, $E_t\,(C_{j,t+1}\,|L_{j,t})$, including the case when no lockdown is imposed, $E_t\,(C_{j,t+1}\,|L_{j,t}=0)$. Substituting the actual number of infected people, $C_{j,t'}$ for the expected scale of the pandemic and regressing $Y_{j,t}$ on actual number of cases to obtain residuals u_t introduces measurement errors in those residuals. Measurement errors $E_t\,(C_{j,t+1}\,|L_{j,t})$ - C_t would be part of residuals u_t and therefore violate a key moment condition, $E_t\,(C_{j,t},u_{j,t})=0$ for the OLS estimates to be consistent.

Similarly, strong correlation between $E_t\,(C_{j,t+1}\,|L_{j,t})$ and $C_{j,t'}$ therefore between $L_{j,t}$ and $C_{j,t'}$ introduces similar problems when regressing $Y_{j,t}$ on $L_{j,t}$.

Employing instrumental variables or GMM when regressing the indicator $Y_{j,t}$ on the actual number of cases or on the index of lockdown is necessary to obtain efficient estimates of the impact of the pandemic or of the lockdown on the economic indicator. The GMM methodology employs instruments to sterilize the estimated coefficients from reverse causality effects. The validity of instruments is judged based on the J-statistics.

Since we are more interested on the impact of the policy indicator, index of lockdown, on the economic activity I regress $Y_{j,t}$ on lockdown indicator $L_{j,t'}$ and include the actual and past state of the pandemic in the set of instrument to get efficient estimates of parameters. I use GMM to address the issue of increasing number of instruments needed to improve the estimates of parameter $\beta_{j,1}$ in (8.4) and the Sargan J-statistics to test for over-identifying restrictions of instrumental variables. J-statistics follows a Chi-square distribution with degrees of freedom depending on the number of over-identifying restrictions.

I include data related to the spread of the pandemic as instruments that are best related to the scale of the lockdown. The presence of lags of independent variable neither changes nor helps with the results as there are only 6 observations of the lockdown index along the time dimension and any lags will just require addition of zero's prior to the first six months of 2020 or shortening of the estimation sample.

IV. RESULTS

IV.1 The effect on economic activity

Results in appendix provide a summary of all results where industrial product is the dependent variable. In these charts referred to in this section, the independent variables '*Db_Stringency*' and '*Db_Ec.Support*' are the monthly changes in lockdown and government economic support indices, respectively, scaled on a range from 0 to 1. Zero implies no restrictions at all while 1 indicates total lockdown. Total lockdown is quite e comparative definition, though it is the same definition for all the countries. For comparison those countries that saw the stringent lockdowns during the first wave of the pandemic in the spring, reached a scale of 0.85-0.95 on a scale of 0 to 1. Given this reference, any 10 percentage points tightening of lockdown stringency index implies the same degree of lockdown for all countries.

- The effect on industrial production.

- The estimates in Chart 6 indicate the estimated coefficient $\hat{\beta}_1$ in all equations (2.1 -2.2) and (3.1-3.3) is in the range of -0.5 to -0.6. Based on the interpretation of lockdown indices in the data section, a 10% tightening of lockdown conditions in any month, for example from 0 to 0.1, will lead to a decline of industrial production by 5-6% in that particular month.

- The second result is the estimate of coefficient on the one-month lagged lockdown index change, $\hat{\beta}_2$, shown in third and fourth columns of the chart, referring to equation (2.2). The $\hat{\beta}_2$ estimate is negative (-0.0837). While it is significant at 10% interval only when an AR term is not included, it would be a measure of the persistency of the lockdown impact on the industrial production in the following month.

- Results from equations (3.1-3.3) of the same chart show that the government economic programs like income support, debt relief or a joint combination of these two do not have a significant impact on industrial production. The results should not come as a surprise since income support policies affect the aggregate consumption while debt relief provide a financial relief to the companies while their operations depend on the degree of lockdown in short term.
  It remains to be seen if and how financial assistance in the form of debt relief might have an impact on industrial production in the long run due to a hypothetically higher post-pandemic survival rate of firms benefitting from any form of financial assistance. That may require further accumulation of data along the time series dimension.

Table 1. The effect of lockdown on industrial production.

	Sign & Significance of $\hat{\beta}$ and $\hat{\gamma}$ coefficients				
Independent variable	$\hat{\beta}$ on $\Delta L_{j,}$	$\hat{\beta}$ on $\Delta L_{j,t-1}$	$\hat{\gamma}$ on $\Delta SG_{j,t}$	$\hat{\gamma}$ on $\Delta SI_{j,t}$	$\hat{\gamma}$ on $\Delta SD_{j,t}$
Eq 2.1: $\Delta L_{j,t}$ only	(-)				
Eq.2.2: $\Delta L_{j,t}$ and $\Delta L_{j,t-1}$	(-)	(-)			
Eq 3.1: $\Delta L_{j,t}$ and $\Delta SG_{j,t}$	(-)		Not signif		
Eq 3.2: $\Delta L_{j,t}$ and $\Delta SI_{j,t}$	(-)			Not signif	
Eq 3.3: $\Delta L_{j,t}$ and $\Delta SD_{j,t}$	(-)				Not signif

(*) When not specified the coefficient is significant at 5% interval. $\Delta SG_{j,t}$ general economic support; $\Delta SI_{j,t}$ income support; $\Delta SD_{j,t}$ debt relief; Results hold for cases when regressions include an AR term and for cases when they do not. No values in shaded area.

- The effect on unemployment.

Estimation results for equations (4.1-4.2) with monthly change in unemployment rate as the dependent variable are provided in Chart 7 of the Appendix.

- The $\hat{\beta}_1$ estimate turns around 0.005 – 0.008 in those regressions estimated with no fixed effects[3]. For such a small magnitude of the estimated coefficient, the impact of lockdown on unemployment seems limited. The variable 'average number of infected cases per million of population' is included in the regression. The significance of the estimated coefficient can potentially be explained by either a psychological effect of the pandemic at world level or by the expectation that given an increase in the spread of the virus worldwide, employers might be reluctant to rehire or prone to let employees leave their jobs.
  Another reason for the small magnitude of the $\hat{\beta}_1$ coefficient, an estimate of the impact of the lockdown on unemployment rate, can be the government policies with furlough schemes that allow firms to keep their employees on the payroll while the government finances their salaries. As such schemes have been increasingly applied in EU and developed economies, which make up for the largest share of the sample in this study, the magnitude of the $\hat{\beta}_1$ coefficient is diminished by these schemes.

- The inclusion of the lagged independent variable, lockdown stringency index, in the regression yields a significant $\hat{\beta}_2$ coefficient only in the regression with an AR term included. This holds even for the case when fixed effects are included. Given the limited impact on the short term (small $\hat{\beta}_1$ estimate) it may be more reasonable to imply that the long term effect of the lockdown is even smaller or non-significant.

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[3] *When cross section fixed effects are included the estimate turns slightly higher at the range 0.006-0.011.*

IV.2 The effect on labor markets across Industries and social groups?

This section provides a summary of the effect of lockdown on employment in different industries and on the unemployment rates across age and gender groups.

- The effect on employment across industries.

The data showing economic activity across industries are employment in

- agricultural and fishing industry denoted by 'a',
- construction industry (c),
- manufacturing (m), and
- service industry (s).

In equation (1.5) of 'Data' section I provide a definition of 'the employment growth in industry 'i' relative to the employment growth in the whole economy'. Regression results for equations (5.1 – 5.2), with 'relative employment growth in the i-th industry' as the dependent variable, are summarized in Chart 8 of the appendix.

As I have already seen that the magnitude of the impact of the lockdown on the labor market data is diminished due to various government schemes that limit its impact, I am focusing on the sign of the impact in these regressions.

Regressions results in equation (5.1) and (5.1a) of Chart 8 provide the same result, that is the lockdown has a positive effect on the 'relative employment growth in the agricultural and manufacturing sectors' but a negative effect on 'construction and services sectors'. Regression results with lockdown index and its lag both as independent variables confirm the negative impact of lockdown on 'relative employment growth' in the construction and services sectors.

The estimate of in equation (5.2) is not significant in any of the equations, therefore there is no evidence of a persistent effect. Based on these results, the simple interpretation is that the lockdown affects more intensely the construction and services sectors.

Table 2. The effect of lockdown on 'Employment growth' across different sectors.

	Sign & Significance of $\hat{\beta}$ coefficients of $\Delta L_{j,t}$ / $\Delta L_{j,t-1}$			
Independent variable	Industry a	Industry c	Industry M	Industry s
Eq 5.1 : $\Delta L_{j,t}$ only	(+)	(-)	(+)	(-)
Eq.5.1a: $\Delta L_{j,t-1}$ only	(+)	(-)	(+)	(-)
Eq.5.2 : $\Delta L_{j,t}$ and $\Delta L_{j,t-1}$	NOT Signif.	(-)	NOT Signif.	(-)

(*) 'a' for agriculture; 'c' stands for construction; 'm' for manufacturing; 's' for services. Coefficient are significant when not indicated. Results hold for all cases, whether AR term included or not.

- The effect on unemployment across age groups.

The dependent variable in the equations reported in this section (6.1, 6.1a and 6.2) is the 'gap in unemployment rate change of young employees relative to that of OLD ones' and is defined in definition (1.2) of data section III.1.

The main hypothesis is that should the lockdown affect both age groups with the same magnitude, the difference between the unemployment rate changes of the two groups should not be explained by the lockdown index. I am focusing only on the 'significance' and the 'sign' of the $\hat{\beta}_1$ and $\hat{\beta}_2$ coefficients here, not their magnitudes. Results from Chart 9 of the appendix show that both coefficients are significant and greater than zero in any of the equations as summarized in Table 2. Two key results emerge.

- First, the unemployment across the younger employees, aged 15-25, is more intensely affected by the lockdown, and
- second, the effects may be persistent even after the lockdown is lifted.

Table 3. The effect of lockdown on unemployment across age groups.

	Sign & Significance of $\hat{\beta}$ coefficients	
Independent variable	$\hat{\beta}$ on $\Delta L_{j,t}$	$\hat{\beta}$ on $\Delta L_{j,t}$
Eq 6.1: $\Delta L_{j,t}$ only	(+)	
Eq.6.1a: $\Delta L_{j,t-1}$ only		(+)
Eq.6.2 $\Delta L_{j,t}$ and $\Delta L_{j,t-1}$	(+)	(+)

(*) Results hold for both cases, when regressions does include an AR term and when they don't. No coefficient in shadow areas.

- The effect on unemployment across gender groups.

The dependent variable in the regressions specified to measure the effect of lockdown across gender groups is the 'gap in unemployment rate change of male labor force relative to female cohort' and is defined in (1.3) of data section III.1. Results for equations (7.1, 7.1a and 7.2) are reported in Chart 10 of the appendix.

A significant and positive estimate of $\hat{\beta}_1$ and $\hat{\beta}_2$ in these regressions would imply that unemployment among men is more intensely affected by the lockdown. The estimates for the lockdown at time 't' or/and 't-1' are not significant, except in the case of equation (5.1) without an AR term, where the $\hat{\beta}_1$ estimate is negative and significant.

The mixed results call for a cautious interpretation. On one side the adjusted R-squared of all the regressions, except (5.1) without AR term, is close to zero which may indicate an issue with equation specification, while the set of instruments are similar across the different equations. If that is a legitimate cause of concern then, the results from (5.1) without AR term may be a better representation of the lockdown on unemployment across different gender cohorts.

The negative sign of the $\hat{\beta}_1$ coefficient in (5.1) indicates that lockdown has a weaker impact on unemployment among men relative to unemployment among women.

Table 4. The effect of lockdown on unemployment across age groups.

	Sign & Significance of $\hat{\beta}$ coefficients	
Independent variable	$\hat{\beta}$ on $\Delta L_{j,t}$	$\hat{\beta}$ on $\Delta L_{j,t-1}$
Eq 7.1: $\Delta L_{j,t}$ only	(-) NOT Signif. w/ AR term (-) Signif. w/out AR term	
Eq.7.1a: $\Delta L_{j,t-1}$ only		(-) NOT Signif.
Eq.7.2: $\Delta L_{j,t}$ and $\Delta L_{j,t-1}$	(+) NOT Signif.	(-) NOT Signif.

(*) Results hold for cases when regressions include an AR term and for cases when they do not. No coefficient in shady areas.

V. FINAL REMARKS

Following the first wave of the Covid-19 pandemic there has been a discussion regarding the merits of the lockdowns as an approach to curb the spread of the infections. On one side, temporary lockdowns are seen as the only means for the pandemic not to get out of control in the absence of treatments and vaccines. On the other hand, there should be a critical point in terms of how long the economy can be kept shut down, at which the costs of the lockdown far outweigh the benefits. At the extreme case, it is claimed that maintaining a lockdown for quite too long will cause more damage to the society than the pandemic itself.

The study looks at the direct immediate effect of lockdowns on economic activity and labor markets. These immediate effects may miss a critical part of the effects that take a longer-term horizon to materialize. The estimates about these immediate effects provide a comparative benchmark in weighing the cost of the lockdowns relative to the benefits in terms of curbing the spread of the infections.

The findings suggest that based on the scales of the lockdown measures established during the first wave, raising the bar of the lockdowns by any 10 percentage point may cause a decline of the industrial production by 5% in any month. Income support measures are expected to have an impact on consumption and aggregate demand while debt relief measures may take time to show up in firm survival rate. Yet, based on the current data available for this study an impact of these economic support measures on IP could did not turn significant based on these tests.

The magnitude of the impact of lockdowns on unemployment rate seems very low, although statistically significant. One explanation is that furlough schemes supported by public deficits may be muting the impact.

The impact of lockdowns may differ across industries and various social groups. Estimates show closing the economy may affect more the employment in construction and services industries while employment in agricultural and manufacturing may suffer relatively less.

Furthermore, unemployment among youngsters can go up faster than unemployment among older population due to lockdown measures. Results distinguishing between unemployment among men and women are rather mixed. The hypothesis that females may be more prone to lose their jobs then men is the more likely scenario.

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APPENDIX

Chart 5. Data source for Industrial Production.

Eurostat	OECD	IMF database
34 (countries)	12 (countries)	7 (countries)
Belgium	Canada	Paraguay
Bulgaria	Colombia	Israel
Czechia	Costa Rica	Mongolia
Denmark	Japan	Senegal
Germany	Korea	Ukraine
Estonia	India *	Argentina *
Ireland	Mexico	Vietnam *
Greece	United States	
Spain	Brazil	
France	Chile	
Croatia	Russia	
Italy	South Africa	
Cyprus		
Latvia		
Lithuania		
Luxembourg		
Hungary		
Malta		
Netherlands		
Austria		
Poland		
Portugal		
Romania		
Slovenia		
Slovakia		
Finland		
Sweden		
United Kingdom		
Norway		
Switzerland		
Montenegro		
North Macedonia		
Serbia		
Turkey		

* *Data from national statistics website of each country were used to complete the series with missing values.*

** *IMF data is only for total industry*

Chart 6. Results from regressing industrial production growth on lockdown index.

Dependent variable	IP growth									
	Eq. (2.1)	Eq. (2.1)	Eq. (2.2)	Eq. (2.2)	Eq. (3.1)	Eq. (3.1)	Eq. (3.2)	Eq. (3.2)	Eq. (3.3)	Eq. (3.3)
	w/ AR term		w/ AR term		w/ AR term		w/ AR term		w/ AR term	
Db_Stringency	-0.5780*	-0.5785*	-0.5992*	-0.5386*	-0.5646*	-0.5871*	-0.5105*	-0.5638*	-0.4941*	-0.5688*
t-stat	(-12.1651)	(-12.4924)	(-14.6458)	(-14.6940)	(-6.2622)	(-6.7741)	(-6.8351)	(-7.4120)	(-5.2721)	(-6.4239)
Db_Stringency(-1)			-0.0415*	-0.0837*						
t-stat			(-1.5709)	(-1.6949)						
					Ec.Support	Ec.Support	Inc.Support	Inc.Support	Debt Relief	Debt.Relief
DB_Ec.Support					-0.0351	-0.0256	-0.0511	-0.0320	-0.1638*	-0.0394
t-stat					(-0.4211)	(-0.4125)	(-0.9506)	(-0.6908)	(-1.7030)	(-0.5925)
AR(1)	-0.0945		-0.0517		-0.0611		-0.0718		0.0722	
t-stat	(-1.4254)		(-0.8424)		(-0.7123)		(-0.9921)		(0.7648)	
Adj. R-squared	0.5450	0.5334	0.5447	0.5410	0.5565	0.5447	0.5918	0.5664	0.5302	0.5457
Durbin-Watson	2.2735	2.3861	2.2712	2.3086	2.2788	2.3343	2.2635	2.3289	2.3972	2.3380
Prob(J-statistic)	0.1484	0.1362	0.2108	0.1710	0.0860	0.1153	0.1066	0.1225	0.0002	0.1116
Instrument rank	7	4	8	4	6	5	8	5	7	5
Hist (prob)	0.1729	0.1902	0.0569	0.0830	0.1220	0.0978	0.3286	0.1718	0.0200	0.1380
Nr. of obs	357	357	357	357	357	357	357	357	357	357
Nr of Countries	51	51	51	51	51	51	51	51	51	51
Instrument 1	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	Da10_cases(-1)
Instrument 2	cases(-2)	cases(-2)	cases(-2)	cases	cases(-2)	cases(-2)	cases(-2)	cases(-2)	cases(-2)	Da10_cases(-2)
Instrument 3	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport		EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)
Instrument 4	ContainHlth(-1)			ContainHlth(-1)			ContainHlth(-1)	ContainHlth(-1)	ContainHlth(-1)	

"Stringency" stands for monthly change of "lockdown index". "Ec.Support" is the monthly change of "economic support index".
"Inc.Support' and "Debt_Relief" are the monthly changes in "income support index" and in "debt relief index" components of 'Ec.support index'.
For t-values above 1.96 and 1.66 the estimated coefficient is significant at 5% and 10%, respectively.

Chart 7. Results from regressing 'change in unemployment rate' on lockdown index.

Dependent variable	Change in Unemployment rate				Change in Unemployment rate			
		No Fixed Effects			w/ Fixed Effects			
	Eq. (4.1)	Eq. (4.1)	Eq. (4.2)	Eq. (4.2)	Eq. (4.1)	Eq. (4.1)	Eq. (4.1)	Eq. (4.1)
	w/ AR term		w/ AR term		w/ AR term		w/ AR term	
Db_Stringency	0.0078 **	0.0048 **	0.0054**	0.0050**	0.0094**	0.0073**	0.0055**	0.0112**
t-stat	(3.1426)	(3.2682)	(3.5223)	(3.2885)	(3.9358)	(3.6136)	(3.9016)	(3.2916)
Db_Stringency(-1)			0.0066**	0.0016			0.0066**	0.0008
t-stat			(4.3608)	(0.6077)			(3.9789)	(0.2481)
D(DA10_CasesWrld)	0.0414*	0.0370*	0.0170*	0.0392*	0.0405*	0.0274*	0.0169*	0.0338*
t-stat	(6.1974)	(8.3436)	(3.6510)	(4.9278)	(8.0360)	(5.7237)	(3.5486)	(3.7338)
AR(1)	0.1776		0.2465*		-0.0064		0.0732	
t-stat	(2.5973)		(3.8119)		(-0.0934)		(1.1186)	
Adj.R-squared	0.3309	0.3402	0.4227	0.3515	0.4625	0.0000	0.4447	0.4391
Durbin-Watson	2.1113	1.7888	2.0704	1.7616	2.1087	0.0000	2.0635	2.1251
Prob(J-statistic)	0.7231	0.2012	0.6619	0.10	0.1617	0.0051	0.5783	0.6145
Instrument rank	5	5	9	7	43	0.502798	46	43
Hist (prob)	0.1209	0.1299	0.0012	0.3464	0.8283	0.3231	0.1800	0.3464
Nr. of obs	273	273	273	273	273	273	273	273
Nr of Countries	39	39	39	39	39	39	39	39
Instrument 1		cases		cases(-1)		cases		
Instrument 2	cases(-1)	cases(-1)	cases(-1)	EcSupport(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)
Instrument 3				ContainHlth(-1)				cases(-2)
Instrument 4			EcSupport	ContainHlth(-0)			EcSupport	EcSupport(-1)
Instrument 5		ContainHlth(-1)	ContainHlth	StringencyWRld(-1)		ContainHlth(-1)	ContainHlth	ContainHlth(-1)
Instrument 6		StringencyWRld(-1)	UN_chng(-1)					

For t-values above 1.96 and 1.66 the estimated coefficient is significant at 5% and 10%, respectively.

Chart 8. Results from regressing gap in 'quarterly employment growth' on industry 'i' relative to 'economy-wide emp. growth' on lockdown index.

Dependent variable	Employment growth differential in industry 'i' relative to economy-wide one				(EMPgrow_ith sector - EMPgrow_total)							
		Eq. (5.1)				Eq. (5.1a)				Eq. (5.2)		
Industry type 'i' (*)	a	c	m	s	a	c	m	s	a	c	m	S
Db_Stringency	0.0047**	-0.0062**	0.0009	-0.0008**					0.009561	-0.0150**	-0.00138	-0.0014**
t-stat	(2.2096)	(-6.4741)	(1.1050)	(-3.7837)					(0.3624)	(-1.9591)	(-1.0983)	(-6.1597)
Db_Stringency(-1)					0.0396**	-0.0214**	0.0027**	-0.0021**	-0.0043	0.0195	0.0054	0.0001
t-stat					(3.8673)	(-11.1019)	(3.0788)	(-4.4888)	(-0.0588)	(1.1261)	(1.5279)	(0.2084)
AR(1)	-0.7400**	-0.2226**	-0.3495**	-0.2635**	-0.5582**	-0.2062**	-0.3273**	-0.3383**	-0.7631**	-0.2932**	-0.3378**	-0.2006**
t-stat	(-32.1310)	(-2.4556)	(-3.3547)	(-2.8455)	(-5.1780)	(-2.6334)	(-3.8216)	(-3.5231)	(-58.3194)	(-2.5004)	(-3.1181)	(-2.0937)
Adj.R-squared	0.864	0.208	0.101	0.187	0.46	0.49	0.13	0.19	0.993	0.122	0.120	0.609
Durbin-Watson	1.530	1.932	1.814	2.035	1.518	1.819	1.904	2.129	1.368	2.030	1.843	2.053
Prob(J-statistic)	0.154	0.251	0.270	0.185	0.224	0.126	0.189	0.120	0.223	0.250	0.173	0.243
Instrument rank	6	7	7	6	5	7	6	5	7	6	7	6
Hist (prob)	0.152	0.291	0.144	0.116	0.61	0.206	0.202	0.096	0.167	0.343	0.143	0.124
Nr. of obs	123	123	120	123	126	123	123	123	123	123	120	123
Nr of Countries	44	44	43	44	44	44	44	44	44	44	43	44
Instrument 1	cases	cases	cases	cases	cases	cases	cases		cases	cases	cases	Cases
Instrument 2		cases(-1)	cases(-1)	cases(-1)		cases(-1)	cases(-1)			cases(-1)	cases(-1)	
Instrument 3												
Instrument 4	ContainHlth(-1)	ContainHlth(-1)	ContainHlth(-1)			ContainHlth	ContainHlth(-1)	ContainHlth	ContainHlth(-1)		ContainHlth	ContainHlth
Instrument 5	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport	EcSupport(-1)	EcSupport		EcSupport	EcSupport(-1)			
Instrument 6												

** Industry type: Letters 'a', 'c', 'm' and 's' stand for industry type agriculture, construction, manufacturing and services respectively.*
For t-values above 1.96 and 1.66 the estimated coefficient is significant at 5% (*) and 10% (**), respectively.

Chart 9. Results from regressing "GAP in unemployment rate change across YOUNG cohort relative to that of OLDER one" on lockdown index (eq.6.1-6.2)

Dependent variable	UNr_age_gap: GAP in unemployment rate change across YOUNG cohort relative to that of OLDER one					
	Eq. (6.1)	Eq. (6.1)	Eq. (6.1a)	Eq. (6.1a)	Eq. (6.2)	Eq. (6.2)
	w/ AR term		w/ AR term		w/ AR term	
Db_Stringency	0.0282**	0.0107**			0.0109**	0.0106**
t-stat	(4.0874)	(2.3671)			(3.7767)	(3.6492)
Db_Stringency(-1)			0.0195**	0.0153**	0.0139**	0.0126**
t-stat			(4.2894)	(2.5436)	(3.2485)	(2.3284)
D(DA10_CasesWrld)	0.1115**	0.0664**	0.0275**	0.0612**	0.0485**	0.0471**
t-stat	(5.2860)	(6.8565)	(3.1063)	(4.0286)	(4.1159)	(3.3142)
AR(1)	0.1785		0.0981		0.1294	
t-stat	(2.5850)		(1.8834)		(2.1972)	
Adj. R-squared	0.190722	0.272758	0.354567	0.419512	0.352442	0.325034
Durbin-Watson	2.136758	1.851777	2.105039	1.79788	2.089229	1.849543
Prob(J-statistic)	0.109223	0.165468	0.081989	0.238873	0.165142	0.112683
Instrument rank	5	5	10	4	9	7
Hist (prob)	0.6259	0.3622	0.1160	0.9089	0.5741	0.4541
Nr. of obs	260	260	261	261	260	260
Nr of Countries	38	38	39	39	38	38
Instrument 1		cases	cases	cases	cases	Da10_cases
Instrument 2	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	Da10_cases(-1)
Instrument 3			EcSupport(-1)			
Instrument 4		EcSupport	EcSupport(-2)	EcSupport(-1)	EcSupport	Db_EcSupport
Instrument 5			ContainHlth(-1)		ContainHlth	ContainHlth
Instrument 6		d(casesWrld(-1))	d(casesWrld(-1))		d(casesWrld(-1))	d(casesWrld(-1))
Instrument 7			ContainHlth(-2)			ContainHlth(-1)

** For a definition of "the GAP in unemployment rate change across young cohort' relative to that of older ones" see definition in equation (1.2).*
For t-values above 1.96 and 1.66 the estimated coefficient is significant at 5% (*) and 10% (**), respectively.

Chart 10. Results from regressing "GAP in unemployment rate change across MALE cohort relative to that of FEMALE one" on lockdown index (eq.7.1-7.2)

Dependent variable	UNr_sex_gap: GAP in unemployment rate change across MALE cohort relative to that of FEMALE one					
	Eq. (7.1)	Eq. (7.1)	Eq. (7.1a)	Eq. (7.1a)	Eq. (7.2)	Eq. (7.2)
	w/ AR term		w/ AR term		w/ AR term	
Db_Stringency	-0.0022	-0.0127**			0.0007	0.0005
t-stat	(-1.1363)	(-9.8538)			(0.3379)	(0.2330)
Db_Stringency(-1)			-0.0010	-0.0006	-0.0009	-0.0007
t-stat			(-0.7922)	(-0.4909)	(-0.7907)	(-0.6395)
AR(1)	-0.1190*		-0.1249*		-0.1166*	
t-stat	(-1.8823)		(-1.9554)		(-1.8036)	
Adj. R-squared	0.009983	0.237504	0.008831	-0.002619	0.001147	-0.008219
Durbin-Watson	2.103216	2.176251	2.102313	2.148521	2.089084	2.118593
Prob(J-statistic)	0.114407	0.227651	0.192763	0.19448	0.210197	0.210575
Instrument rank	5	3	6	4	7	5
Hist (prob)	0.801891	0.138015	0.575387	0.373579	0.72159	0.51014
Nr. of obs	266	266	267	267	266	266
Nr of Countries	38	38	39	39	38	38
Instrument 1			cases	Cases	cases	Da10_cases
Instrument 2	cases(-1)	cases(-1)	cases(-1)	cases(-1)	cases(-1)	Da10_cases(-1)
Instrument 3						
Instrument 4	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	EcSupport(-1)	Db_EcSupport(-1)
Instrument 5						
Instrument 6						

** For a definition of "GAP in unemployment rate change across MALE cohort relative to that of FEMALE one" see definition in equation (1.3).*
For t-values above 1.96 and 1.66 the estimated coefficient is significant at 5% (*) and 10% (**) , respective

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