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Protecting Lives and Livelihoods with Early and Tight Lockdowns

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Abstract

Using high-frequency proxies for economic activity over a large sample of countries, we show that the economic crisis during the first seven months of the COVID-19 pandemic was only partly due to government lockdowns. Economic activity also contracted because of voluntary social distancing in response to higher infections. We also show that lockdowns can substantially reduce COVID-19 infections, especially if they are introduced early in a country's epidemic. Despite involving short-term economic costs, lockdowns may thus pave the way to a faster recovery by containing the spread of the virus and reducing voluntary social distancing. Finally, we document that lockdowns entail decreasing marginal economic costs but increasing marginal benefits in reducing infections. This suggests that tight short-lived lockdowns are preferable to mild prolonged measures.

Keywords: COVID-19, infections, lockdown, mobility, voluntary social distancing.

JEL Codes: E1, I1, H0.

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1 Introduction

The COVID-19 pandemic has raised unprecedented health challenges on a global scale. To contain the spread of the virus, most countries have resorted to stringent lockdown measures during the first few months of the pandemic, for example closing schools and business activities and sometimes even preventing people from leaving their homes, except for essential reasons. The recent resurgence of COVID-19 cases in many countries sparked a renewed debate about the desirability of new lockdown measures. Before vaccines and treatments become widely available, non-pharmaceutical interventions remain key to slow the spread of the COVID-19 pandemic and relieve pressure from the health systems. Lockdowns, however, impart considerable short-term economic damage. It is then critical to gain insights as to what type of lockdowns provide the best economic and epidemiological outcomes.

In this paper, we first document that lockdowns were not the only factor driving the decline in economic activity during the first seven months of the COVID-19 pandemic. The fear of contracting and spreading the virus also led people to refrain from various types of economic activities that involved social interactions, which in turn took a severe toll on economic activity. Second, we assess the effectiveness of lockdowns in containing infections, which in turn affect people's decisions to engage in social interactions. Finally, by examining the economic and epidemiological outcomes of early and late lockdowns as well as tight and mild ones, we offer a novel perspective on the costs and benefits associated with these measures.

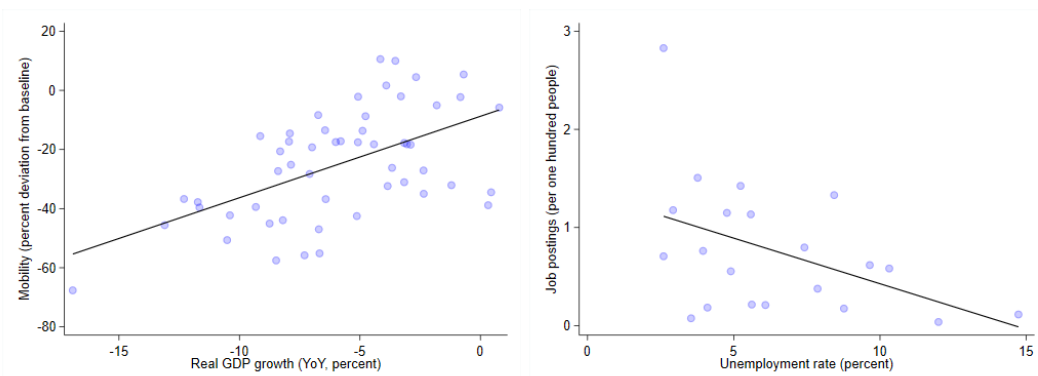
The literature provides conflicting evidence on the role of lockdowns and voluntary social distancing. Some papers find that lockdowns have a severe impact on the economy. Using customized survey data, Coibion et al. (2020) document that lockdowns accounted for much of the decline in employment and consumer spending in the US during the first months of the country's epidemic. Beland et al. (2020) and Gupta et al. (2020) use data from the US Current Population Survey and also find that stay-at-home orders led to large increases in unemployment. Analyzing transaction level data from bank accounts, Baker et al. (2020) find that consumer spending dropped twice as much in US states that issued shelter-in-place orders. Evidence about the severe impact of lockdowns extends to studies beyond the US. For example, Carvalho et al. (2020) exploit high-frequency transaction data in Spain to show that expenditures fell sharply in conjunction with the national lockdown. Similarly, Chronopoulos et al. (2020) use transaction level data showing that consumer spending declined in line with lockdown measures in the UK.

Other papers argue instead that voluntary social distancing was the key driver of the economic contraction. Combining high-frequency data from payroll and financial firms in the US, Chetty et al. (2020) find that spending and employment fell before state-at-home orders and that re-openings had modest effects on economic activity. Goolsbee and Syverson (2020) analyze customers' visits to businesses located nearby but that faced different lockdown restrictions because belonging to different counties. They conclude that the drop in economic activity was mostly due to people voluntarily reducing visits in line with rising COVID-19 deaths. Baek et al. (2020), Bartik et al. (2020), Forsythe et al. (2020) and Rojas et al. (2020) also find that lockdown restrictions had a modest impact on the US labor market. Chen et al. (2020) document that lockdowns in Europe did not have systematic effects on electricity consumption and Maloney and Taskin (2020) find that in most countries the decline in mobility was related to rising infections rather than to lockdowns. The importance of voluntary social distancing is also attested by the economic contractions in countries that did not adopt stringent lockdowns, such as South Korea and Sweden (Andersen et al., 2020; Aum et al., 2020; Born et al., 2020).

Using data for the first seven months of the pandemic, we assess the impact of lockdowns and voluntary social distancing in a large set of countries including advanced, emerging, and low-income ones. To exploit time variation in the data, the analysis uses two high-frequency proxies for economic activity, namely mobility indicators provided by Google and job openings advertised on the website Indeed.[1] As shown in Figure 1, the collapse in mobility over the first six months of 2020 correlates well with the decline in real GDP growth (panel 1a). Similarly, job postings display a tight negative correlation with unemployment rates over the same period (panel 1b). These correlations indicate that mobility and job postings serve as good high-frequency proxies of economic activity.

Figure 1: High-Frequency Proxies of Economic Activity for the First Semester of 2020

(a) Mobility and real GDP growth (b) Job postings and unemployment rate



Notes: Mobility and job postings are computed as the daily average over the first semester of 2020. Real GDP growth for the first semester of 2020 is computed with respect to the first semester of 2019. The unemployment rate is computed as the average of the monthly unemployment rate over the first semester of 2020.

Identifying the causal impact of lockdowns is a challenging task primarily because government measures were imposed in response to epidemiological developments, which in turn affect the economy. To alleviate this concern, the econometric specifications examine the effects of lockdowns while controlling for the stage of the epidemic. Specifically, we use local projections to regress the mobility index over the stringency of lockdowns and the number of COVID-19 infections. By controlling for COVID-19 infections, the regression framework can also shed light on the extent of voluntary social distancing. The response of mobility to rising infections should indeed capture how people change behavior when health risks become more severe. To strengthen identification, the regressions are

[1] Google Community Mobility Reports provides information on daily attendance rates at various locations relative to pre-crisis levels. Data are available at the national level for a large set of advanced, emerging, and developing economies. For various countries, mobility information is also available at the sub-national level. Indeed provides information about daily job postings in 22 countries, disaggregated by employment sector. See Appendix A for more details.

also estimated using sub-national data, focusing on regions less affected by COVID-19 in countries that adopted national lockdowns. The identification assumption is based on the observation that national lockdowns were often imposed in response to localized outbreaks and were thus largely exogenous to the conditions prevailing in regions with low infections.

Our results show that both lockdowns and voluntary social distancing in response to rising COVID-19 infections can have strong detrimental effects on the economy. Lockdowns and voluntary social distancing played a comparable roles in driving the drop in mobility across our full set of countries. Similar results are obtained using job postings. Yet, there is significant heterogeneity across countries. The contribution of voluntary distancing was stronger in advanced economies, where people can work from home more easily and sustain periods of temporary unemployment because of personal savings and government benefits. Lockdowns played instead a much stronger role in low-income countries where people do not have the financial means to temporarily refrain from economic activities.

Looking at the recovery path ahead, the importance of voluntary social distancing in the recession suggests that lifting lockdowns is not enough to ensure a strong and sustained recovery if health risks remain. This is true especially if lockdowns are lifted while infections are still elevated because the analysis finds that the impact on mobility is significantly smaller in that case. We document that easing lockdowns tends to have a positive effect on mobility but the impact is weaker than that of tightening lockdowns, further tempering the expectations that there would be a quick economic rebound simply through easing lockdowns. These findings suggest that economies will continue to operate below potential as long as health risks persist and should caution policymakers against lifting lockdowns prematurely.

Using a similar empirical framework to the one employed for the analysis of mobility and job postings, the paper also documents that lockdowns can substantially reduce infections.[2] The results are robust to using sub-national data to strengthen identification. The effects of lockdowns on COVID-19 cases tend to materialize a few weeks after the introduction of lockdowns, consistent with the incubation period of the virus and testing times. This underscores the importance of rapid intervention. Indeed, the analysis shows that lockdowns are particularly effective in curbing infections if they are introduced at an early stage of a country's epidemic, consistent with the the findings of Demirgüç-Kunt et al. (2020).

The fact that lockdowns can reduce infections but impose short-term economic costs is often used to argue that lockdowns involve a trade-off between saving lives and protecting livelihoods. However, the findings in the paper that infections also severely depress economic activity through voluntary social distancing calls for a re-assessment of this narrative. By bringing infections under control, lockdowns may pave the way to a faster economic recovery as people feel more comfortable to resume normal activities. In other words, the short-term economic costs of lockdowns could be compensated through higher future economic activity, possibly leading to a positive overall effect on

[2]This is line with growing empirical evidence on the diffusion of COVID-19 (Chernozhukov et al., 2020; Dave et al., 2020; Friedson et al., 2020; Glaeser et al., 2020, Fang et al., 2020, Imai et al., 2020, Jinjarak et al., 2020; Yilmazkuday, 2020). The literature also documents the importance of face masks and testing to contain the virus (Chernozhukov et al., 2020; Gapen et al., 2020). Using quasi-experimental variation for France, Adda (2016) documents that school closures have a pronounced effects on the incidence of influenza.

the economy.[3] This remains a crucial area for future research as the pandemic progresses and more data become available making it possible to assess the medium-term consequences of lockdowns.

Finally, the paper examines whether lockdowns involve non-linear effects on mobility and infections. We find evidence that more stringent lockdowns have decreasing marginal costs in restricting mobility and thus they likely entail progressively smaller damages to the economy. On the contrary, lockdowns display increasing marginal benefits in reducing infections. This implies that, to reduce infections by a certain amount at the lowest short-run economic cost, more stringent shorter-lived lockdowns could be preferable to mild prolonged measures.

The paper is organized as follows. Section 2 presents an assessment of the economic impact of lockdowns and voluntary social distancing relying on high-frequency proxies of economic activity. Section 3 examines the effect of lockdowns on COVID-19 infections. Section 4 explores the non-linear effects of lockdowns on mobility and infections. Section 5 concludes.

2 Lockdowns and Voluntary Social Distancing

In this section we examine the economic impact of lockdowns and voluntary social distancing using high-frequency data. Specifically, we rely on two types of data to proxy for economic activity, both of which are available at daily frequency. First, we use mobility data provided by Google, which reports the attendance rate at various locations relative to pre-crisis levels.[4] These data have the key advantages of covering a large set of countries and being available also at the subnational level. Second, we corroborate the analysis of mobility using job posting data reported by Indeed, an online job search engine. Indeed data are available for fewer countries but capture labor market conditions more directly.

2.1 Impact on Mobility

Assessing the impact of lockdowns on mobility is a challenging task since the decision to deploy lockdowns is not random. Cross-country identification is precluded by omitted variable concerns because the introduction of lockdowns can reflect time-invariant country characteristics that also affect economic outcomes. For example, countries with higher social capital may not require stringent lockdowns—as people take greater precautions against infecting others—and could also better withstand the economic impact of the crisis. When using time variation in the data, the main challenge is that the adoption of lockdowns depends on the stage of the epidemic. For example, governments are more likely to impose lockdowns when health risks become more acute. At that time, people tend to voluntarily reduce social interactions because they fear being infected or infecting others. This may generate a spurious correlation between the introduction of lockdowns and the reduction in mobility.

[3] Correia et al. (2020) argue that lockdowns during the 1918 Flu Pandemic were associated with better medium-term economic outcomes.

[4] Data are based on cell phones' locations for people that own smart phones and accept to share location data with Google. A drawback of this data is that, since this category of people may have characteristics that differ from the broader population (e.g., relative to income level, age, and access to internet, among others), the mobility indices may not be fully representative of the entire country, especially in poorer countries where fewer people have smart phones.

To alleviate endogeneity concerns, the analysis relies on panel regressions that control for country fixed-effects and the stage of the country's epidemic. More specifically, we assess the dynamic response of mobility to lockdowns using the following local projection regressions (Jordà, 2005):

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h ln\Delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} + \sum_{p=1}^{P} \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (1)$$

The variable $mob_{i,t+h}$ denotes the level of mobility for country i at time $t+h$, with h being the horizon;[5] $ln\Delta cases_{i,t-p}$ is the log of daily COVID-19 cases, which is used to track the stage of the pandemic, with p being the lag length; and $lock_{i,t-p}$ is an index measuring the stringency of lockdowns.[6] The specification also features lags of the dependent variable to account for pre-existing trends, and country and time fixed effects to control for country characteristics and global factors. The estimation includes a week worth of lags.[7] Standard errors are clustered at the country level. The sample of analysis includes 128 countries between early February and mid-July, 2020.

Our identification assumption is that by controlling for the stage of the pandemic (proxied by daily cases) and country fixed effects, the coefficient δ_0^h should isolate the impact of lockdowns. At the same time, for a given level of lockdown stringency, the coefficient β_0^h should reveal the extent of voluntary social distancing, capturing the responsiveness of mobility to rising infections. Finally, to control for the persistence of the stringency index and of the number of COVID-19 cases, we include lags of both variables.

To address endogeneity concerns further, we validate our findings using an alternative identification strategy that takes advantage of the sub-national disaggregation of the Google mobility data. This is based on the observation that various countries imposed lockdowns on a *national* scale in reaction to *localized* outbreaks. For example, in Italy—one of the first countries severely hit by the pandemic after China—the government imposed a national lockdown in early March even though most of the infections were concentrated in Lombardy. In these countries, the adoption of national lockdowns was largely exogenous to the conditions prevailing in those regions that had few COVID-19 infections. This provides an opportunity to considerably strengthen identification by analyzing the effects of national lockdowns on the mobility in regions less affected by COVID-19.

Formally, we re-estimate equation (1) using data for 422 subnational regions in 15 G20 countries that adopted national lockdowns. For each country, we exclude the region with the largest number of COVID-19 cases and any region that had more than 20 percent of the country's total cases. The regression thus analyzes the mobility response in those regions less affected by the virus for which the national lockdown was an exogenous event triggered by conditions elsewhere in the country.

[5]The mobility index used in the analysis is constructed as the average of the mobility indices for groceries and pharmacies, parks, retails and recreation, transit stations, and workplaces. In the case of China, the mobility index is based on data from Baidu.

[6]We employ the lockdown stringency index provided by the University of Oxford's Coronavirus Government Response Tracker. This index is a simple average of nine sub-indicators capturing school closures, workplace closures, cancellations of public events, gatherings restrictions, public transportation closures, stay-at-home requirements, restrictions on internal movement, controls on international traveling, and public information campaigns. Since we want to measure the impact of *actual* restrictions, we re-construct the index excluding public information campaigns as they aim to promote voluntary social distancing. The results, however, are similar when public information campaigns are included in the index.

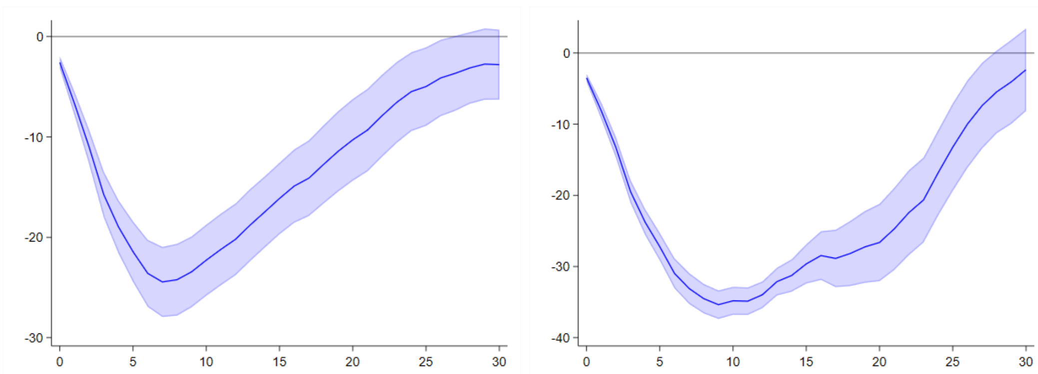
[7]A richer lag structure does not affect the results.

Figure 2 shows the impact on mobility from a full lockdown that includes all measures used by governments during the pandemic. Panels 2a and 2b display the results from the national and subnational regressions, respectively. We see that in both cases a full lockdown leads to a very significant decline in mobility. When using national level data, the impact reaches about 25 percent after a week and then mobility starts to resume gradually as the lockdown tightening dissipates.[8] The estimates based on subnational data corroborate the negative effect of lockdowns on mobility. The shape of the mobility response is remarkably similar to the one obtained with national data. The impact is modestly larger and more persistent, possibly reflecting differences in the sample coverage.

Figure 2: Impact of a Full Lockdown on Mobility
(Percent)

(a) National data

(b) Subnational data



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

As discussed, lockdowns are not the only contributing factor to the decline in mobility during the pandemic. People also voluntarily reduce exposure to each other as infections increase and they fear becoming sick. Aum et al. (2020), Goolsbee and Syverson (2020), and Maloney and Taskin (2020) document indeed that mobility has been tightly correlated to the spread of COVID-19 even after controlling for government lockdowns, especially in advanced economies. In line with this literature, the regression framework provides estimates that can shed light on the strength of voluntary social distancing by capturing the response of mobility to rising COVID-19 infections for a given lockdown stringency.[9] Figure 3 presents the estimates of the strength of voluntary social distancing by capturing the response of mobility to rising COVID-19 infections for a given

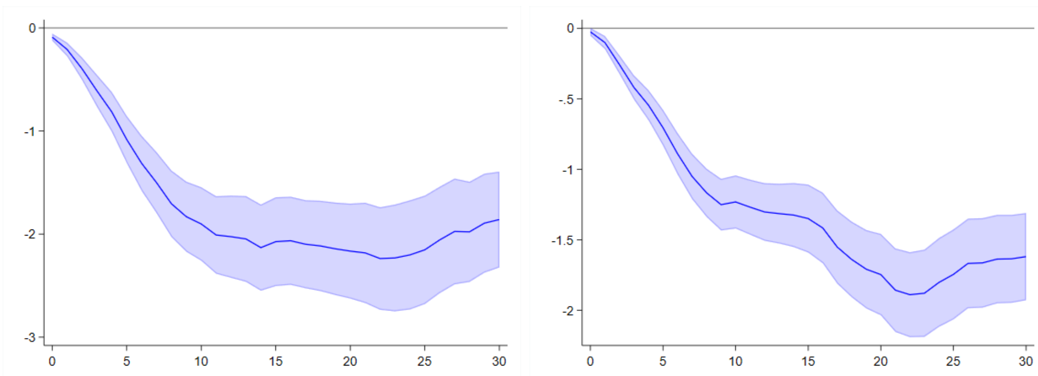
[8]Results are robust to controlling for COVID-19 deaths instead of cases; using sub-indicators of mobility provided by Google; controlling for testing, contact tracing, and public information campaigns; and testing for possible cross-country heterogeneity in the mobility response depending on population density and indicators of governance and social capital.

[9]Besides reacting to the spread of COVID-19, people may opt to voluntarily self distance also in response to other factors, such as public health announcements, news about celebrities being infected, or even the adoption of government lockdowns. As such, the analysis may underestimate the true extent of voluntary social distancing. Also, as shown by Adda (2016), higher mobility and economic activity might lead to faster spread of viral diseases, generating some reverse causality between the outcome variables and COVID-19 infections. The dynamic structure of the estimation should alleviate this endogeneity concern.

lockdown stringency. Using national data, panel 3a shows that an increase in COVID-19 cases has a considerable negative effect on mobility. A doubling of daily COVID-19 cases leads to a contraction in mobility by about 2 percent.[10] Panel 3b shows the impact of COVID-19 on mobility using subnational data. The results are in line with the ones obtained at the national level: a doubling of COVID-19 cases leads to a contraction in mobility of 1.7 percent after 30 days.

Figure 3: Impact of Voluntary Social Distancing on Mobility
(Impact of a doubling in daily COVID-19 cases, percent)

(a) National data (b) Subnational data



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

The national and subnational results thus convey a consistent message. Both lockdowns and voluntary social distancing in response to rising infections can severely reduce mobility. To gain further insights into the relative importance of these two factors, we calculate the contributions of lockdowns and voluntary social distancing in driving the decline in mobility during the first three months of each country's epidemic. The effect of lockdowns and voluntary distancing are likely to differ across countries depending on the stage of development. For example, in mode advanced countries people can more easily opt for voluntary social distancing thanks to the prevalence of teleworking, the presence of contactless delivery services, the amount of personal savings to sustain periods of temporary unemployment, etc. To capture some of these nuances, we amend the specification in equation (1) allowing the impact of lockdowns and rising COVID-19 cases to vary between

[10]The results are robust to controlling for COVID-19 deaths instead of cases.

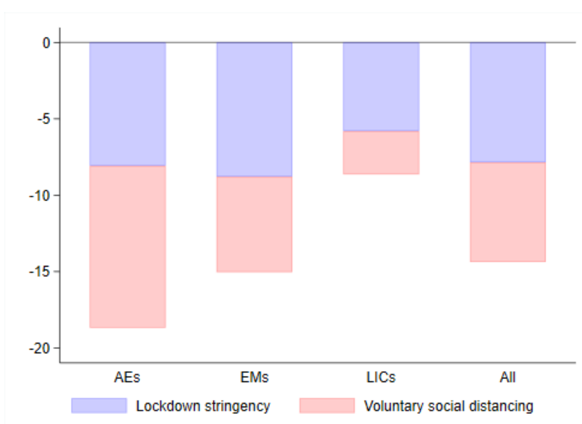
advanced, emerging, and low-income countries:

$$
\begin{aligned}
mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h ln\Delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} \\
+AE_i \times \Big(\sum_{p=0}^{P} \beta_p^{h,AE} ln\delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^{h,AE} lock_{i,t-p} \Big) \\
+EM_i \times \Big(\sum_{p=0}^{P} \beta_p^{h,EM} ln\Delta cases_{i,t-p} + \sum_{p=0} P\delta_p^{h,EM} lock_{i,t-p} \Big) \\
+ \sum_{p=1}^{P} \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \qquad (2)
\end{aligned}
$$

The variables AE_i and EM_i are dummies that denote advanced economies and emerging markets, respectively, with low-income countries being the omitted category. Thus, the impact of lockdowns on mobility for advanced economies can be obtained as $\delta_0^h + \delta_0^{h,AE}$, for emerging markets as $\delta_0^h + \delta_0^{h,EM}$, and for low-income countries as δ_0^h.

We then compute the contributions of lockdowns and voluntary social distancing to the decline in mobility during the first three months of each country's epidemic. To obtain such contributions, we multiply the average coefficient on lockdown stringency (log of daily COVID-19 cases) over the 30-day local projection horizon by the average value of lockdown stringency (log of daily COVID-19 cases) for each country during the first three months of the epidemic. With respect to the average coefficient, we rely on the estimates of equation (2), which differentiates countries between advanced economies, emerging markets, and low-income countries. Finally, we compute the country group-specific averages.

Figure 4: Contributions to the Mobility Decline
(Percent)



Notes: The bars denote the cross-country averages of the contributions of lockdowns and voluntary social distancing, computed using the coefficients on lockdowns and the log of daily COVID-19 cases multiplied by the average of the corresponding variables for each country group during the first three months of each country's epidemic.

Figure 4 illustrates the contributions of lockdowns and voluntary social distancing in reducing mobility across country groups. Both lockdowns and voluntary social distancing had a large impact on mobility, playing a roughly similar role across the full set of countries. The contribution of voluntary social distancing was significantly stronger in advanced economies, likely because people can work from home more easily and can even afford to stop working temporarily by relying on personal savings and social security benefits. On the contrary, voluntary social distancing was quite limited in low-income countries where the drop in mobility was mostly due to lockdowns.

2.1.1 Informing the Recovery

The importance of voluntary social distancing in reducing mobility has important implications for the upcoming recovery. It suggests that lifting lockdowns can only lead to a partial rebound in economic activity if health risks persist because mobility is likely to remain compressed by voluntary social distancing. To shed further light on this issue, we examine if the effect of lockdowns depends on the stage of the country's epidemic. We do so by modifying the regression framework in equation (1) to allow for an interaction term between the lockdown stringency index and the number of daily COVID-19 cases:

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h ln\Delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} + \sum_{p=0}^{P} \gamma_p^h ln\Delta cases_{i,t-p} \times lock_{i,t-p} + \sum_{p=1}^{P} \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (3)$$

where γ_0^h reveals the differential effect of a lockdown conditional on a given number of daily cases. In some cases people might be scrutinizing the spread of the virus at the global level rather than at the national level. To account for that, we also estimate equation (3) by interacting the lockdown stringency index with the number of daily cases in the world.

The results confirm that the effects of lockdowns depend on the state of the pandemic. Panel 5a of Figure 5 shows that the impact of lockdowns is smaller when national infections are relatively high, i.e. when people are voluntarily refraining from social interactions because they fear contracting the virus. The results in panel 5b corroborate these findings showing that lockdowns have a weaker impact on mobility when global cases are high, suggesting that people's behavior is also affected by global health developments.[11] These findings warn against lifting lockdowns prematurely in the hope of jump-starting economic activity. If health risks remain acute, people are unlikely to sharply resume mobility just because lockdown measures have been eased.

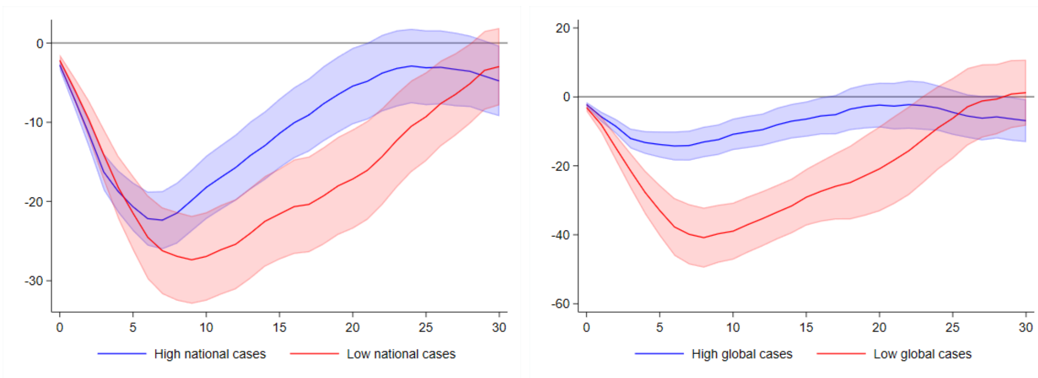
Additional evidence against expecting a sharp mobility boost just from easing lockdowns is provided by examining asymmetric effects depending on whether lockdowns are eased or tightened. To explore this issue, we modify the specification in equation (1) to allow for an interaction term between the lockdown stringency index and a dummy variable identifying periods in which restrictions

[11] The difference between the effects of lockdowns with high and low cases, which corresponds to the interaction term in the regression, is statistically significant both when interacting lockdown stringency with national and global cases.

Figure 5: Impact of a Full Lockdown on Mobility Conditional on the Stage of the Pandemic (Percent)

(a) Impact of a Full Lockdown on Mobility, Under Low and High National COVID-19 Cases

(b) Impact of a Full Lockdown on Mobility, Under Low and High Global COVID-19 Cases



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

were eased:

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h ln\Delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p}$$
$$+ \sum_{p=0}^{P} \phi_p^h D_{i,t}^+ \times lock_{i,t-p} + \sum_{p=0}^{p} \theta_p^h D_{i,t}^+ + \sum_{p=1}^{P} \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (4)$$

where $D_{i,t}^+$ is a dummy that takes value one if the seven-day moving average of the change in lockdown stringency is positive and zero otherwise.[12] The impact of lifting restrictions on mobility is given by $\delta_0^h + \phi_0^h$.

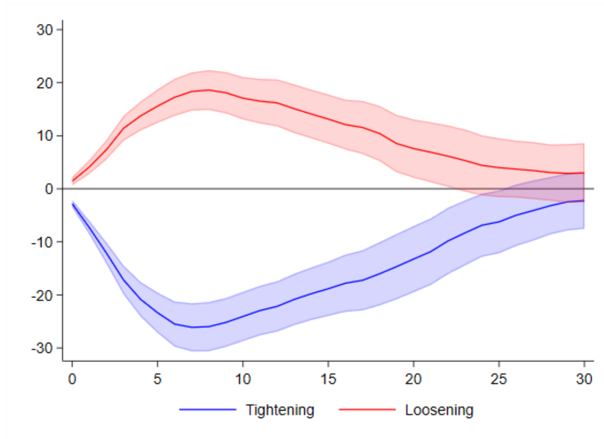
The results in Figure 6 show that tightening and loosening lockdowns have asymmetric effects on mobility. While the introduction of a full lockdown leads to decline in in mobility of about 26 percent one week after the tightening, lifting restrictions boosts mobility only by about 18 percent over the same period, with the difference being statistically significant. This should temper the expectations of a sharp economic rebound from simply easing lockdowns if the virus continues to spread at a constant pace.

2.2 Impact on Job Postings

In the previous section, we found that both lockdowns and voluntary social distancing played a very substantial role in reducing mobility. We now show that similar results are obtained when analyzing job postings data provided by Indeed. We re-estimate the panel regression in equation (1) substituting the level of mobility with the log of the number of job postings. The sample includes

[12] All periods without a change in stringency following a tightening (loosening) are considered a tightening (loosening) period.

Figure 6: Asymmetric Impact of Lockdown Tightening and Loosening
(Percent)



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

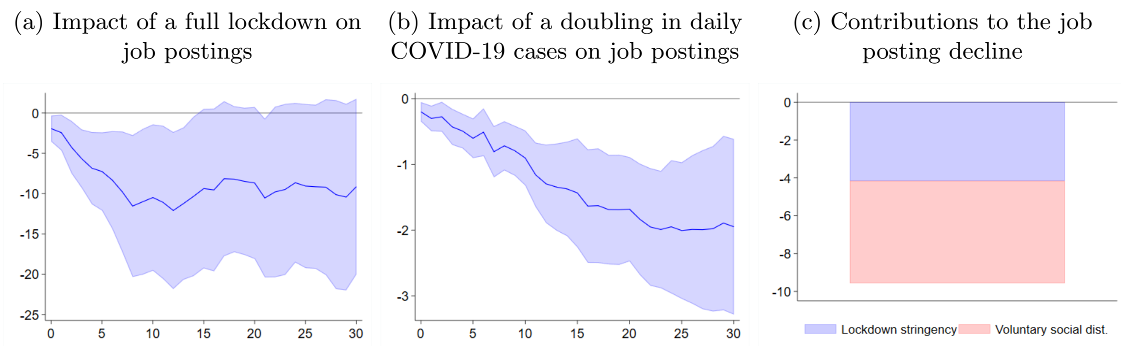
daily data for 22 countries from January 1 to June 28, 2020. In line with the analysis of mobility, the specification includes seven lags of the dependent and independent variables, and country and time fixed effects to control for time invariant country characteristics and global factors.

Figure 7 shows that both lockdowns and voluntary social distancing have negative and significant effects on job postings. In panel 7a, a full lockdown is associated with a decline in job postings of about 12 percent two weeks after the introduction of the lockdown. In panel 7b, a doubling COVID-19 cases leads to a 2 percent decline in job postings after 30 days. Using these estimates, we can compute the contributions of lockdowns and voluntary social distancing in reducing job postings during the first three months of each country's epidemic. Panel 7c shows that both lockdowns and voluntary social distancing were important factors behind the drop in job postings. The contribution of voluntary social distancing was relatively stronger. This is consistent with the results based on mobility data since the Indeed sample includes primarily advanced economies.

To shed further light on the role played by lockdowns and voluntary social distancing, we examine job postings data differentiated by sector of employment. In particular, we compare the dynamics of job postings in contact-intensive sectors (food, hospitality, and personal care) to that of less-contact intensive ones (manufacturing) around the adoption of stay-at-home orders. Panel 8a of Figure 8 presents a binned scatter plot where each dot represents the mean of the job postings in a given sector using 20 equally sized bins. The stock of job postings is normalized to 100 forty days before the introduction of stay-at-home orders and time zero denotes the introduction of stay-at-home orders.

For each sector, we select the date of the first decline in job postings that is larger than one standard deviation of the job posting series. These dates are shown in the chart using vertical dashed lines. We observe that job postings in contact-intensive sectors started to decline between

Figure 7: Impact of Lockdowns and Voluntary Social Distancing on Job Postings (Percent)



Notes: The x-axes in panels 7a and 7b denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level. The bars in panel 7c denote the cross-country averages of the contributions of lockdowns and voluntary social distancing, computed using the coefficients on lockdowns and the log of daily COVID-19 cases multiplied by the average of the corresponding variables during the first three months of each country's epidemic.

1 and 2 weeks before the introduction of stay-at-home orders. This highlights the importance of voluntary social distancing as people started to avoid contact-intensive activities even before the adoption of lockdowns. Conversely, the decline of job postings in the manufacturing sector broadly coincided with the introduction of stay-at-home orders, suggesting that in less-contact intensive sectors lockdowns have been the driving force behind the decline in activity.

Panel 8b considers the job postings dynamics when lockdowns were eased. Lifting restrictions led only to a marginal recovery in job postings. This corroborates our earlier findings based on mobility data warning against expecting a sudden economic rebound from merely easing lockdown measures.

3 Lockdowns and COVID-19 Infections

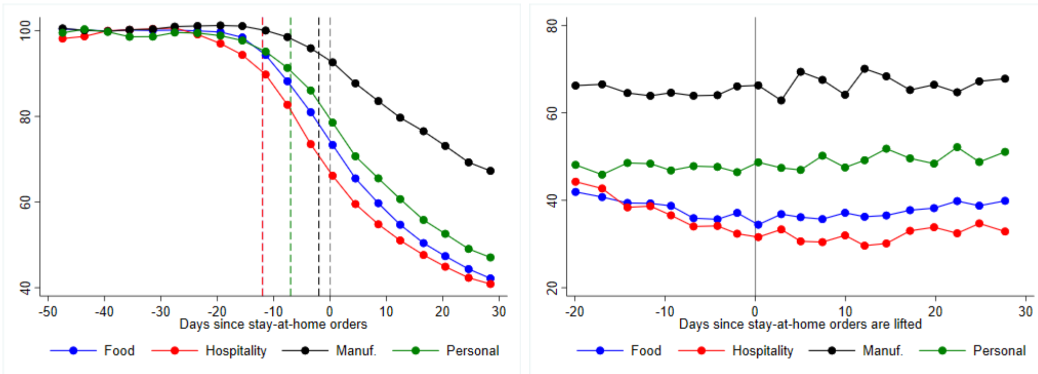
After having examined the economic effects of lockdowns, we now turn to the question of whether these tools can succeed in their intended goal of curbing infections. To address this issue, we estimate the following local projections:

$$lncases_{i,t+h} - lncases_{i,t-1} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h X_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} + \sum_{p=1}^{P} \rho_p^h \Delta lncases_{i,t-p}$$
$$+trend_i^h + trend_i^{2,h} + \varepsilon_{i,t+h} \quad (5)$$

where $X_{i,t-p}$ is a vector of controls including the average temperature and humidity in the country (Adda, 2016, for instance, finds that higher temperatures reduce the spread of influenza and other viral diseases), as well as indicators for whether widespread testing and contact tracing policies are in place; and $trend_i^h$ and $trend_i^{2,h}$ are country-specific linear and quadratic trends. The sample

Figure 8: Job Postings by Sector around Stay-at-Home Orders
(Index)

(a) Job postings around state-at-home orders (b) Job postings around reopenings



Notes: The figure reports the binned scatter plots showing the evolution over time of the 7-day moving average of job postings in each sector, where the x-axes variables are divided into 20 equal-sized bins. The series are orthogonalized with respect to day-of-week and country fixed effects. The vertical grey dash line in panel 8a denotes the day in which stay-at-home orders were introduced and the other vertical dash lines correspond to the first decline in job postings larger than one standard deviation for each sector. The vertical grey dash line in panel 8b denotes the day in which state-at-home orders were lifted. The sample in both panels includes countries that introduced national stay-at-home orders according to the Oxford Coronavirus Government Response Tracker.

includes 89 countries based on data availability.

As done for the analysis of mobility, to improve the identification we re-run equation 5 using subnational data for 339 units in 15 G20 countries. The sample excludes subnational units with the largest number of cases per country and those that had more than 20 percent of the country's total COVID-19 cases. It thus focuses on regions with fewer cases for which the adoption of national lockdowns was largely an exogenous event. The subnational regressions exclude the controls $X_{i,t-p}$ since they are not available at the subnational level.

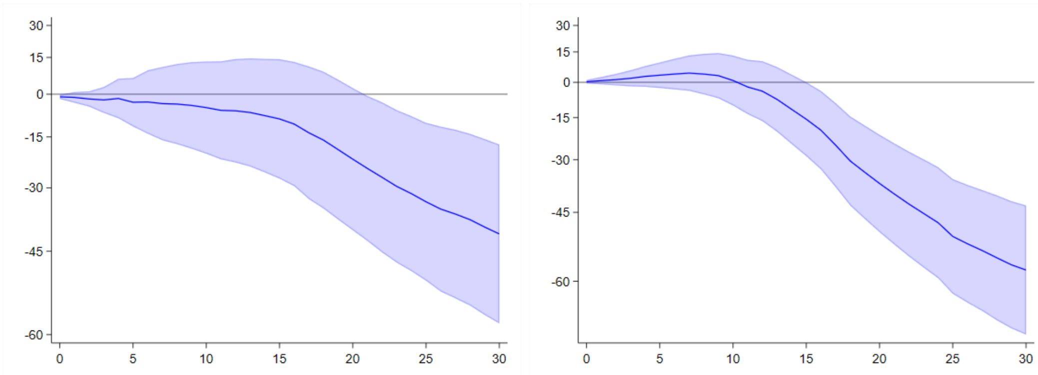
Figure 9 presents the results of the impact of lockdowns on COVID-19 infections. Using national level data, panel 9a shows that a full lockdown leads to a large reduction in cumulated infections, equal to about 40 percent after 30 days. The results based on subnational data in panel 9b point to an even larger effect, reducing infections by about 58 percent after 30 days.

Figure 9 also shows that the effects of lockdowns on confirmed COVID-19 cases tend to materialize with a delay of at least two weeks. This is consistent with the incubation period of the virus and the time required for testing. Acknowledging this delayed effect is important to guide people's expectations about the effectiveness of lockdowns. Furthermore, it points to the need to adopt lockdowns before infection rates increase too rapidly.

The benefits of adopting lockdowns early can also be seen by comparing the epidemiological outcomes of countries that adopted measures at different times. We differentiate countries between early and late adopters using two alternative criteria. First, we consider the number of days that passed from the first case to when lockdown measures reached their maximum stringency. As shown in panel 10a of Figure 10, there is a considerable cross-country heterogeneity. Half of the countries

Figure 9: Impact of a Full Lockdown on COVID-19 Infections
(Percent)

(a) National data (b) Subnational data



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

reached their maximum lockdown stringency within a month but some waited up to four months. Second, we differentiate countries based on the number of weekly cases at the time in which the maximum lockdown stringency was reached. Panel 10b shows that virtually all countries reached the maximum stringency before daily cases reached 0.1 cases per thousand people.

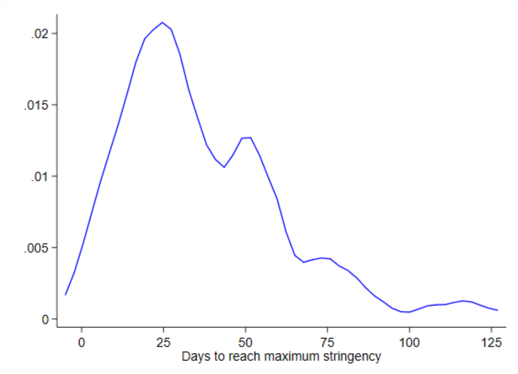
The analysis then compares the epidemiological outcomes of early and late lockdown adopters 90 days after the first COVID-19 case, splitting the country sample with respect to the median of the distributions in panels 10a and 10b. Panel 10c shows the evolution of infections since the first COVID-19 case, differentiating countries by the number of days passed from the first case to the time that authorities adopted the most stringent lockdown measures. Countries that imposed lockdowns faster experienced better epidemiological outcomes. The differences are even more striking if the sample is split with respect to the number of COVID-19 cases at the time of lockdowns as in panel 10d. Countries that adopted lockdowns when COVID-19 cases were still low witnessed considerably fewer infections during the first three months of the epidemic relative to countries that introduced lockdowns when cases were already high.

4 Nonlinear Effects of Lockdowns

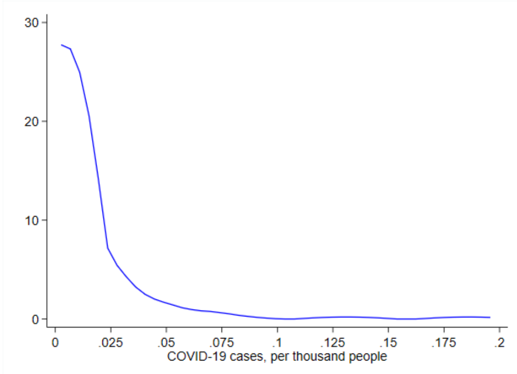
So far, we used a lockdown stringency index that combines a broad range of underlying measures. These includes for example travel restrictions, school and workplace closures, and stay-at-home orders, among others. Disentangling the effects of these measures is an arduous task because they are highly correlated, as countries often introduced them in rapid succession to contain infections. Furthermore, countries have generally followed a similar sequence, from restrictions on international travel to stay-at-home orders as illustrated in Figure 11. A regression specification that features all the lockdown measures as independent variables would thus capture the marginal effect of each

Figure 10: The Importance of Speed and Timing of Lockdowns

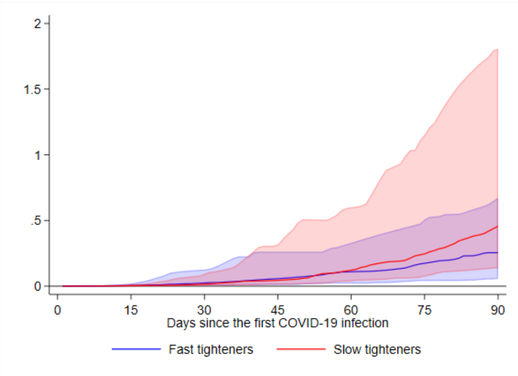
(a) Cross-country distribution of the speed of lockdowns
(Density)



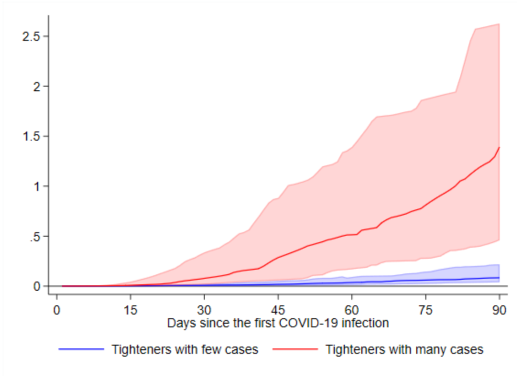
(b) Cross-country distribution of the timing of lockdowns
(Density)



(c) Infections since the start of the countries' epidemics for fast and slow tighteners
(Per thousand people)



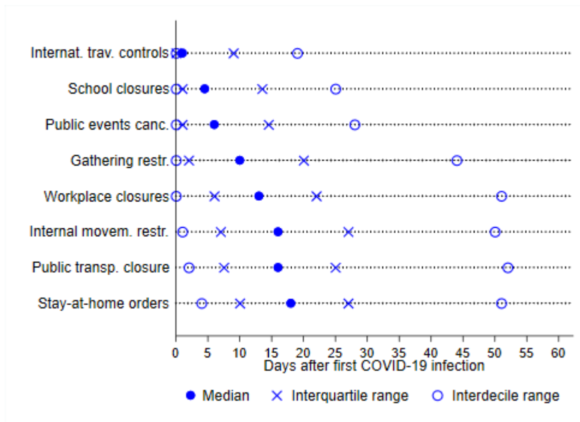
(d) Infections since the start of the countries' epidemics for tighteners with few and many COVID-19 cases
(Per thousand people)



Notes: In panels 10c and 10d, the lines denote the medians and the shaded areas correspond to the interquartile ranges. In panel 10c, countries are split based on the cross-country median value of the distribution in panel 10a; in panel 10d, countries are split based on the cross-country median value of the distribution in panel 10b.

measure conditional on those that have been adopted beforehand. This underestimates the importance of measures that are adopted at a later stage. For example, stay-at-home orders are generally found to have a modest impact on mobility because various other measures are already in place.[13]

Figure 11: Sequencing of Lockdown Measures



Notes: The blue dots denote the cross-country median number of days since the first COVID-19 case and the day in which each lockdown measure was introduced, the blue crosses denote the interquartile ranges, and the empty circles denote the interdecile ranges.

An analytically sounder approach is to examine whether further tightening of lockdown measures continues to have similar economic and epidemiological effects. This can inform policymakers on whether it is best to rely on protracted mild lockdowns or to opt for more stringent measures. To examine nonlinearities in the effects of lockdowns on mobility, we add the quadratic term of the lockdown stringency to equation (1):

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h ln\Delta cases_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} + \sum_{p=0}^{P} \omega_p^h lock_{i,t-p}^2$$
$$+ \sum_{p=1}^{P} \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (6)$$

[13] For example, replacing the lockdown stringency index in equation (1) with the (rescaled) indices for each individual lockdown measure would produce results for which measures that are introduced later (e.g., stay-at-home orders or transportation restrictions) display a smaller impact on mobility, while the measures that are introduced first (e.g., international movement restrictions or school closures) are associated with a larger impact. In the case of infections, while the point estimates are negative, the confidence intervals include the zero for most of the measures. Results are available upon request. Another approach could be to allow for interaction terms across all measures to better capture the impact on mobility of a given measure conditional on the others being in place or not. However, the regression becomes cumbersome and the results are inconclusive.

and we do the same for infections modifying equation (5) as follows:

$$lncases_{i,t+h} - lncases_{i,t-1} = \alpha_i^h + \tau_t^h + \sum_{p=0}^{P} \beta_p^h X_{i,t-p} + \sum_{p=0}^{P} \delta_p^h lock_{i,t-p} + \sum_{p=0}^{P} \omega_p^h lock_{i,t-p}^2 + \sum_{p=1}^{P} \rho_p^h \Delta lncases_{i,t-p} + trend_i^h + trend_i^{2,h} + \varepsilon_{i,t+h} \quad (7)$$

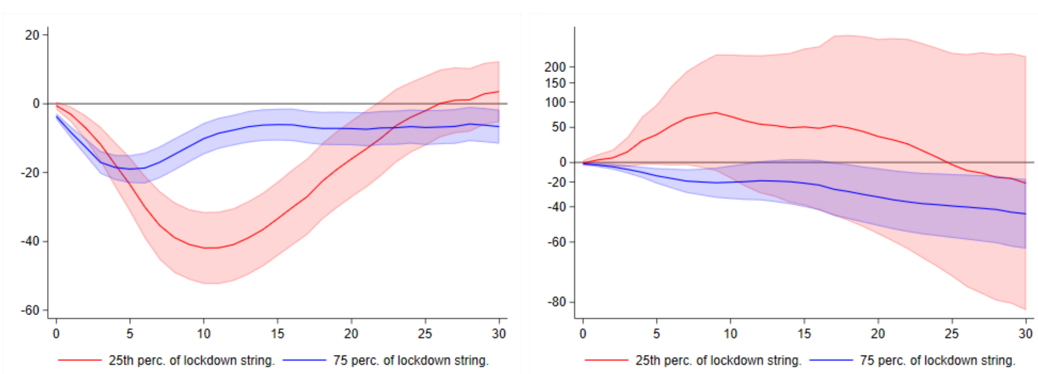
The results in panel 12a of Figure 12 suggest that lockdowns have decreasing marginal effects on mobility. Introducing additional measures when the lockdown stringency index is already elevated has a weaker impact on mobility compared to introducing them when the lockdown stringency is low. For example, stay-at-home orders may have only a modest negative impact on economic activity if governments have already imposed workplace closures. Formally, these findings reflect that the quadratic term in equation (6) is positive and statistically significant at various horizons.

While lockdowns have decreasing marginal effects on mobility, panel 12b shows that they have increasing marginal effects on infections. Lockdown measures are effective in reducing COVID-19 cases only if they are sufficiently stringent. A possible interpretation is that preventing only a few instances of personal contacts—such as by closing schools alone—is not enough to significantly reduce community spread. More stringent measures—such as workplace closures or stay-at-home orders—are needed to effectively bring the virus under control. The quadratic term in equation (7) is negative and statistically significant at various horizons.

Taken together, these results suggest that to achieve a given reduction in infections, policymakers may want to opt for stringent lockdowns over a shorter period rather than resort to prolonged mild lockdowns. Tighter lockdowns appear indeed to entail only modest additional economic costs while leading to a considerably stronger decline in infections.

Figure 12: Nonlinear Effects of Lockdowns
(Percent)

(a) Impact on mobility (b) Impact on infections



Notes: The x-axes denote the number of days, the lines denote the point estimates, and the shaded areas correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

5 Conclusions

This paper documents that lockdowns and voluntary social distancing have both played a crucial role in reducing economic activity during the first phase of the COVID-19 pandemic. Relying on high frequency proxies for economic activity—such as mobility and job posting data—and employing identification strategies based on national and subnational data, we provide consistent evidence on the negative impact of lockdowns. Despite lockdowns have negative economic effects, letting infections grow uncontrolled can also have dire economic consequences. This is because voluntary social distancing in response to rising COVID-19 infections can have severe detrimental effects on the economy.

We also find that lockdowns are powerful instruments to reduce infections, especially if they are introduced early in a country's epidemic and are sufficiently tight. Furthermore, the analysis suggests that lockdowns impose decreasing marginal costs on economic activity as they become more stringent. Therefore, policymakers may want to lean towards adopting tight lockdowns rapidly when infections increase rather than rely on protracted mild measures.

The effectiveness of lockdowns in reducing infections coupled with the finding that rising infections can considerably harm economic activity provide an important new perspective on the overall costs of lockdowns. The prevailing narrative often portrays lockdowns as involving a trade-off between saving lives and supporting the economy. This characterization neglects that, despite imposing short-term economic costs, lockdowns may lead to a faster economic recovery by containing the virus and reducing voluntary social distancing. More research is warranted as the pandemic progresses to provide a fuller assessment of the overall economic effects of lockdowns.

Meanwhile, policymakers should also look for alternative ways to contain infections that may entail even lower short-run economic costs. These include expanding contact tracing, promoting the use of face masks, and encouraging working from home. As the understanding of the virus transmission improves, countries may also be able to use targeted lockdown measures more effectively, for example by limiting large indoor gatherings and better protecting vulnerable people. These remain important areas for future research.

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Appendix A. Data Sources and Country Coverage

Table A.1 lists the data sources used in the analysis. The country coverage for the different sections of the analysis is reported in Table A.2, with the selection of countries being driven by data availability. For the analysis relying on high-frequency indicators, the sample includes 22 countries when job postings are used and 128 countries when mobility is used. When we employ subnational data on mobility, the sample consists of 422 units for 15 G20 countries. Finally, the analysis of infections is based on a sample of 89 countries for which information on temperature, humidity, testing, and contact tracing is available. At the subnational level, the sample consists of 373 units for G20 15 countries.

Table A.1: Data Sources

Indicator	Source
Contact tracing	Oxford COVID-19 Government Response Tracker
COVID-19 cases	Oxford COVID-19 Government Response Tracker
Humidity	Air Quality Open Data Platform
Lockdown stringency index	Oxford COVID-19 Government Response Tracker
Mobility	Google Community Mobility Reports, Baidu for China
Stock of job postings	Indeed
Temperature	Air Quality Open Data Platform
Testing	Oxford COVID-19 Government Response Tracker

Table A.2: Country Coverage

Country	Samples	Country	Samples	Country	Samples
Afghanistan	*Mn, In*	Iraq	*Mn, In*	Guatemala	*Mn, In*
Algeria	*In*	Ireland	*Mn, In, Jp*	Guinea	*In*
Angola	*Mn*	Israel	*Mn, In*	Haiti	*Mn*
Argentina	*Mn, Ms, In, Is*	Italy	*Mn, Ms, In, Is, Jp*	Honduras	*Mn*
Aruba	*Mn*	Jamaica	*Mn*	Hong Kong SAR	*Mn, In, Jp*
Australia	*Mn, Ms, In, Is, Jp*	Japan	*Mn, Ms, In, Is, Jp*	Hungary	*Mn, In*
Austria	*Mn, In, Jp*	Jordan	*Mn, In*	Iceland	*In*
Bahrain	*Mn, In*	Kazakhstan	*Mn, In*	India	*Mn, Ms, In, Is*
Bangladesh	*Mn, In*	Kenya	*Mn*	Indonesia	*Mn, Ms, In, Is*
Barbados	*Mn*	Korea	*Mn, In*	Iran	*In*
Belarus	*Mn*	Kosovo	*In*	Puerto Rico	*Mn*
Belgium	*Mn, In, Jp*	Kuwait	*Mn, In*	Qatar	*Mn*
Belize	*Mn*	Kyrgyz Republic	*Mn, In*	Romania	*Mn, In*
Benin	*Mn*	Lao P.D.R.	*Mn, In*	Russia	*Mn, In*
Bolivia	*Mn, In*	Latvia	*Mn*	Rwanda	*Mn*
Bosnia and Herzegovina	*Mn, In*	Lebanon	*Mn*	Saudi Arabia	*Mn, Ms, In, Is*
Botswana	*Mn*	Libya	*Mn*	Senegal	*Mn*
Brazil	*Mn, Ms, In, Is, Jp*	Lithuania	*Mn, In*	Serbia	*Mn, In*
Bulgaria	*Mn, In*	Luxembourg	*Mn*	Singapore	*Mn, In, Jp*
Burkina Faso	*Mn*	Macao SAR	*In*	Slovak Republic	*Mn, In*
Cambodia	*Mn*	Malaysia	*Mn, In*	Slovenia	*Mn*
Cameroon	*Mn*	Mali	*Mn, In*	South Africa	*Mn, Ms, In, Is*
Canada	*Mn, Ms, In, Is, Jp*	Mauritius	*Mn*	Spain	*Mn, In, Jp*
Chile	*Mn, In*	Mexico	*Mn, Ms, In, Is, Jp*	Sri Lanka	*Mn, In*
China	*Mn, Ms, In, Is*	Moldova	*Mn*	Sweden	*Mn, In, Jp*
Colombia	*Mn, In*	Mongolia	*Mn, In*	Switzerland	*Mn, In, Jp*
Costa Rica	*Mn, In*	Morocco	*Mn*	Taiwan Province of China	*Mn*
Croatia	*Mn, In*	Mozambique	*Mn*	Tajikistan	*Mn, In*
Czech Republic	*Mn, In*	Myanmar	*Mn, In*	Tanzania	*Mn*
Côte d'Ivoire	*Mn, In*	Namibia	*Mn*	Thailand	*Mn, In*
Cyprus	*In*	Nepal	*Mn, In*	Togo	*Mn*
Denmark	*Mn, In*	Netherlands	*Mn, In, Jp*	Trinidad and Tobago	*Mn*
Dominican Republic	*Mn*	New Zealand	*Mn, In, Jp*	Turkey	*Mn, In*
Ecuador	*Mn, In*	Nicaragua	*Mn*	Uganda	*Mn, In*
Egypt	*Mn*	Niger	*Mn*	Ukraine	*Mn, In*
El Salvador	*Mn, In*	Nigeria	*Mn*	United Arab Emirates	*Mn, In, Jp*
Estonia	*Mn, In*	Norway	*Mn, In*	United Kingdom	*Mn, Ms, In, Is, Jp*
Ethiopia	*In*	Oman	*Mn*	United States	*Mn, In, Jp*
Fiji	*Mn*	Pakistan	*Mn, In*	Uruguay	*Mn*
Finland	*Mn, In*	Panama	*Mn*	Uzbekistan	*In*
France	*Mn, Ms, In, Is, Jp*	Papua New Guinea	*Mn*	Venezuela	*Mn*
Gabon	*Mn*	Paraguay	*Mn*	Vietnam	*Mn, In*
Georgia	*Mn, In*	Peru	*Mn, In*	Yemen	*Mn*
Germany	*Mn, Ms, In, Is, Jp*	Philippines	*Mn, In*	Zambia	*Mn*
Ghana	*Mn, In*	Poland	*Mn, In, Jp*	Zimbabwe	*Mn*
Greece	*Mn, In*	Portugal	*Mn, In*		

Notes: *Mn* = national-level regressions of mobility; *Ms* = subnational-level regressions of mobility; *In* = national-level regressions of infections; *Is* = subnational-level regressions of infections; *Jp* = job postings.