

**EXECUTIVE  
BOARD  
MEETING**

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September 16, 2020

To: Members of the Executive Board

From: The Secretary

Subject: **October 2020 World Economic Outlook—Analytical Chapter 2 and Online Annex**

Board Action: Executive Directors' **consideration** (Formal)

Tentative Board Date: **Wednesday, September 30, 2020**

Publication: Yes, it is intended that the full set of the World Economic Outlook documents will be released to the public at the time of the World Economic Outlook press conference, tentatively scheduled for **Tuesday, October 13, 2020.**

The analytical chapters will be made available to the public on the IMF website in advance of the publication of the full document.

Questions: Mr. Sandri, RES (ext. 37698)  
Mr. Grigoli, RES (ext. 34804)

Additional Information: The paper will be revised for publication in light of the Executive Board discussion. If Executive Directors have additional comments, they should notify Mr. Sandri and Mr. Grigoli by **5:30 p.m. on Friday, September 25, 2020.**



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*To contain the coronavirus (COVID-19) and protect susceptible populations, most countries imposed stringent lockdown measures in the first half of 2020. Meanwhile, economic activity contracted dramatically on a global scale. This chapter aims to dissect the nature of the economic crisis in the first seven months of the pandemic. It finds that the adoption of lockdowns was an important factor in the recession, but voluntary social distancing in response to rising infections also contributed very substantially to the economic contraction. Therefore, although easing lockdowns can lead to a partial recovery, economic activity is likely to remain subdued until health risks abate. Meanwhile, countries should protect the most vulnerable and find ways to support economic activity compatible with social distancing, for example, by reducing contact intensity in the workplace and enhancing work from home where possible. The chapter also provides new evidence on the uneven effects of lockdowns, which are found to have a larger impact on the mobility of women and younger cohorts. This calls for targeted policy action to prevent a widening of inequality. Finally, the analysis shows that lockdowns can substantially reduce COVID-19 infections, especially if they are introduced early in a country's epidemic and are sufficiently tight. Thus, despite involving short-term economic costs, lockdowns may pave the way to a faster recovery by containing the spread of the virus and reducing the need for voluntary social distancing over time, possibly having positive overall effects on the economy. This remains an important area for future research as new data become available.<sup>1</sup>*

## Introduction

The coronavirus (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, closing schools and business activities and sometimes even preventing people from leaving their homes, except for essential reasons. Meanwhile, economic activity has contracted dramatically, as discussed in Chapter 1. No country was spared, with GDP declining sharply in advanced, emerging, and low-income countries.

This chapter's first goal is to shed light on the extent to which the economic contraction was driven by the adoption of government lockdowns instead of by people voluntarily reducing social interactions for fear of contracting or spreading the virus. This issue is important to understand retrospectively the nature of the recession and to provide insights into the strength of the upcoming recovery. If lockdowns were largely responsible for the economic contraction, it would be reasonable to expect a quick economic rebound when lockdowns are lifted. But if voluntary social distancing played a predominant role, then economic activity would likely remain subdued until health risks recede.

The analysis starts by examining the cross-country association between lockdowns and economic activity across a broad sample of countries. It finds that countries that endured more stringent lockdowns experienced larger growth declines relative to pre-COVID-19 forecasts, even after controlling for the state of the local epidemic. The chapter then assesses the impact of lockdowns using high-frequency proxies for economic activity, namely mobility indicators

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<sup>1</sup>The authors of this chapter are Francesca Caselli, Francesco Grigoli (co-lead), Weicheng Lian, and Damiano Sandri (co-lead), with support from Jungjin Lee and Xiaohui Sun. The chapter benefited from insightful comments by Yuriy Gorodnichenko and internal seminar participants.

provided by Google and job postings provided by the website Indeed.<sup>2</sup> Regression results show that lockdowns have a considerable negative effect on economic activity. Nonetheless, voluntary social distancing in response to rising COVID-19 infections can also have strong detrimental effects on the economy. In fact, the analysis suggests that lockdowns and voluntary social distancing played a near comparable role in driving the economic recession. The contribution of voluntary distancing in reducing mobility 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.

Looking at the recovery path ahead, the importance of voluntary social distancing as a contributing factor to the downturn suggests that lifting lockdowns is unlikely to rapidly bring economic activity back to potential if health risks remain. This is true especially if lockdowns are lifted when infections are still relatively high because, in those cases, the impact on mobility appears more modest. Further tempering the expectations of a quick economic rebound, the analysis documents that easing lockdowns tends to have a positive effect on mobility, but the impact is weaker than that of tightening lockdowns. These findings suggest that economies will continue to operate below potential while health risks persist, even if lockdowns are lifted. Therefore, policymakers should be wary of removing policy support too quickly and consider ways to protect the most vulnerable and support economic activity consistent with social distancing. These may include measures to reduce contact intensity and make the workplace safer, for example by promoting contactless payments; facilitate a gradual reallocation of resources toward less-contact-intensive sectors; and enhance work from home, for example, by improving internet connectivity and supporting investment in information technology.

The chapter also contributes to the growing empirical evidence on the uneven effects of the crisis, with particularly acute impacts on more economically vulnerable people. Using novel mobility data provided by Vodafone for some European countries, the analysis shows that lockdowns tend to have a larger effect on women's mobility than on men's, especially at the time of school closures.<sup>3</sup> This suggests that women carry a disproportionate burden in caring for children, which may jeopardize their employment opportunities. Vodafone data also show that lockdowns tend to have a stronger impact on the mobility of younger cohorts who are economically more vulnerable because they generally rely on labor income and have less stable jobs. Thus, targeted policy intervention is needed to protect the employment prospects of women and younger cohorts and prevent a widening of income inequality.

Finally, the chapter finds that lockdowns can reduce infections substantially. The effects of lockdowns on confirmed COVID-19 cases tend to materialize after a few weeks of delay, given the incubation period of the virus and testing times. This underscores the importance of early intervention, also because lockdowns are particularly effective in curbing infections if they are

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<sup>2</sup>Google Community Mobility Reports provide information on daily attendance rates at various locations relative to precrisis levels. Data are available at a national level for a large set of advanced, emerging, and developing economies. For various countries, mobility information is also available at a subnational level. Data can be downloaded at <https://www.google.com/covid19/mobility/>. The job site Indeed provided the IMF with anonymized information about daily job postings in 23 countries, disaggregated by employment sectors.

<sup>3</sup>Vodafone data have been provided for the analysis in anonymized format through a confidential agreement.

introduced early in the stage of a country's epidemic. The analysis also suggests that lockdowns must be sufficiently stringent to reduce infections significantly.

The effectiveness of lockdowns in reducing infections suggests that lockdowns may pave the way to a faster economic recovery if they succeed in containing the epidemic and thus limit the extent of voluntary social distancing. Therefore, the short-term economic costs of lockdowns could be compensated by stronger medium-term growth, possibly leading to positive overall effects on the economy. This is an important area for future research. Meanwhile, policymakers should also pursue alternative ways to contain infections that may involve lower short-term economic costs than lockdowns, such as expanding testing and contact tracing, promoting the use of face masks, and encouraging work from home. As the understanding of the virus transmission improves, countries may also be able to deploy targeted measures rather than blunt lockdowns, for example by focusing on protecting vulnerable people and restricting large indoor gatherings.

The analysis contributes to a rapidly growing literature on the pandemic and the effects of lockdowns, which is reviewed in Box 2.1. The understanding of the crisis is still evolving—some papers detect considerable effects of lockdowns while others emphasize the role of voluntary social distancing. The literature also documents the pandemic's uneven effect on vulnerable segments of the population and provides evidence on the effectiveness of lockdowns and face masks in containing infections.

### Cross-Country Evidence on Lockdowns and Economic Activity

The analysis starts by presenting cross-country evidence on the association between lockdowns and economic activity over a sample of up to 52 advanced, emerging, and developing economies. Panel 1 of Figure 2.1 shows the correlation between the stringency of lockdowns during the first half of 2020 and the decline in GDP relative to pre-pandemic forecasts.<sup>4</sup> The figure illustrates that countries that implemented more stringent lockdowns experienced sharper GDP contractions.

Panel 2 of Figure 2.1 shows that the negative association between lockdowns and economic activity is robust to using other indicators besides GDP. For example, more stringent lockdowns are associated with lower consumption, investment, industrial production, retail sales, Purchasing Managers' Indexes for the manufacturing and service sectors, and higher unemployment rates.<sup>5</sup> These correlations persist with and without controlling for the strength of each country's epidemic based on the total number of confirmed COVID-19 cases scaled by population.

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<sup>4</sup>The analysis uses a lockdown stringency index that averages several sub-indicators—school closures, workplace closures, cancellations of public events, restrictions on gatherings, public transportation closures, stay-at-home requirements, restrictions on internal movement, controls on international travel—provided by the University of Oxford's Coronavirus Government Response Tracker.

<sup>5</sup>Data for GDP, consumption, and investment refer to the first half of 2020. For the other indicators that are available at monthly frequency, the analysis considers the first three months after the first 100 confirmed COVID-19 cases in each country to compare economic outcomes during the same phase of a country's epidemic. See Online Annex 2.2 for additional details. All annexes are available at [www.imf.org/en/Publications/WEQ](http://www.imf.org/en/Publications/WEQ)

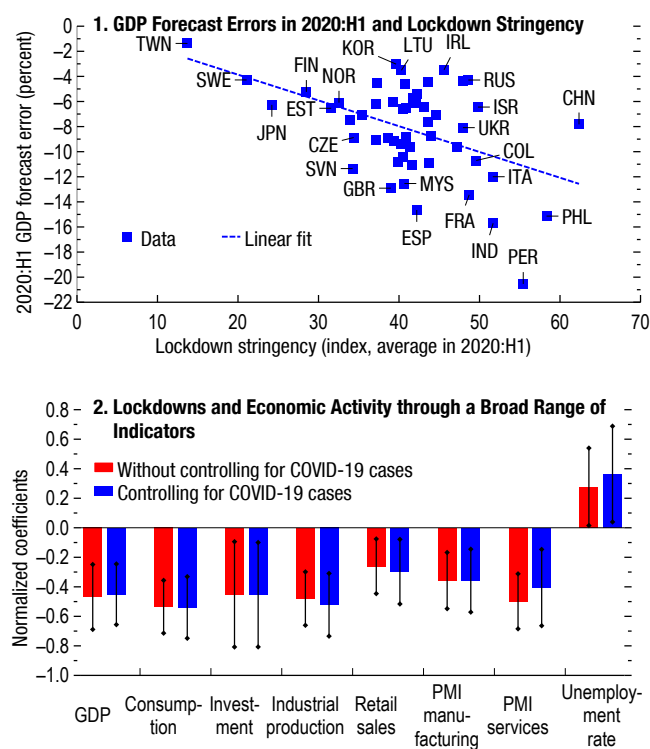
Figure 2.1 thus provides suggestive evidence that lockdowns tend to have a negative short-term economic impact. Nonetheless, these findings should be interpreted with caution given omitted variable concerns that affect cross-country analyses and endogeneity concerns about lockdowns. The decision to deploy lockdowns is indeed not random; rather, it may 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. This may generate a spurious negative correlation between the stringency of lockdowns and economic activity. To strengthen identification by controlling for such time-invariant country characteristics, the next section reexamines the economic impact of lockdowns using time-series variation in high-frequency data.

## Assessing the Impact of Lockdowns Using High-Frequency Data

Two types of daily data are used to proxy for economic activity at high frequency. First, the analysis uses mobility data provided by Google, which reports the attendance rate at various locations relative to pre-crisis levels.<sup>6</sup> These data have the key advantages of covering a large set of countries and being available also at the subnational level. The findings based on mobility data will be corroborated 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.

**Figure 2.1. Lockdowns and Economic Activity**

More stringent lockdowns are correlated with sharper economic contractions.



Sources: Haver Analytics; Oxford Coronavirus Government Response Tracker; World Economic Outlook (WEO) database; and IMF staff calculations.

Note: Panel 1: The GDP forecast errors are defined as the deviations from January 2020 WEO projections for the first half of 2020 (2020:H1). Online Annex Table 2.1.2 provides the full list of countries. Panel 2: For GDP, consumption and investment, the analysis uses data for 2020:H1. For the other indicators that are available at monthly frequency, the analysis considers the first three months after COVID-19 cases reach 100 in a country. The regressions control for the logarithm of the COVID-19 cases normalized by population in 2019. Normalized coefficients reported on the vertical axis show the impact of a one-standard-deviation increase in the lockdown index on each economic variable, normalized by its own standard deviation. Standard deviations are based on the cross-country variation in the sample. The vertical lines refer to 90 percent confidence bands. See Online Appendix 2.2 for additional details. PMI = purchasing managers' index. Data labels use International Organization for Standardization (ISO) country codes.

<sup>6</sup>Data are based on cell phone locations for people who own smart phones and accept sharing location data with Google. Because this category of people may have characteristics that differ from the broader population—for example, income level, age, or access to internet—the mobility indexes may not be fully representative of the entire country, especially in poorer countries where fewer people have smart phones.



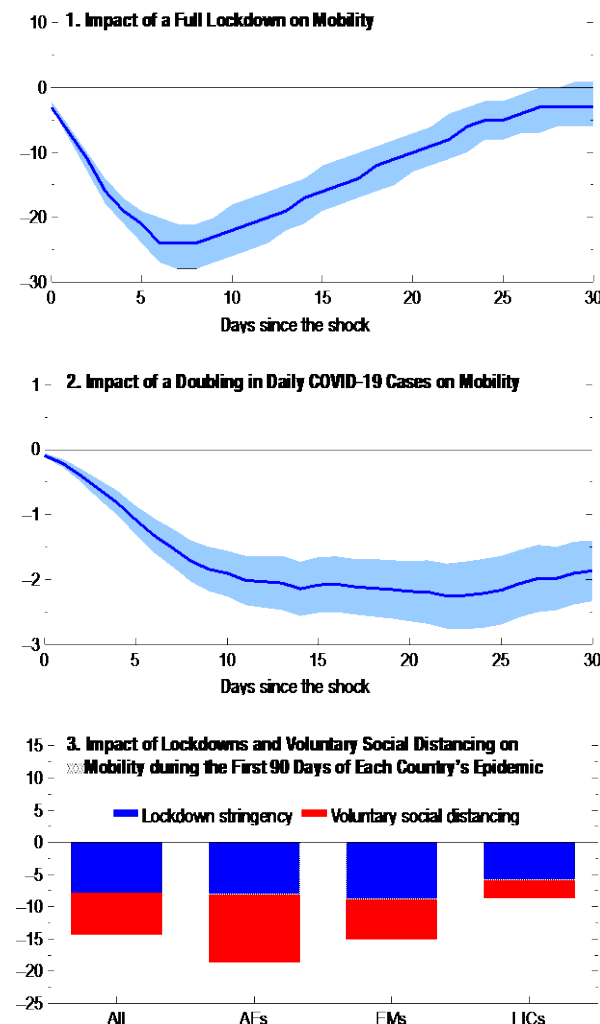
## Lockdowns and Mobility

To assess the impact of lockdowns on mobility, the analysis uses local projections that include country fixed effects and time dummies to control for time-invariant country characteristics and global shocks, respectively. It is important to note that lockdowns are endogenous policy choices that depend on the stage of the epidemic and the degree of mobility. For example, governments are more likely to impose lockdowns when health risks become more acute. At the same time, people tend to reduce mobility because they fear contracting the virus, independent of lockdowns. This may lead to a spurious negative correlation between lockdowns and mobility. To alleviate these endogeneity concerns, the regression framework controls for the number of COVID-19 cases and includes lags of the mobility indicator. In other words, the empirical analysis tries to measure the impact on mobility from a lockdown tightening at a given stage of the country's epidemic. Online Annex 2.3 provides additional details.

The regression is estimated using national-level data for 128 countries. Panel 1 of Figure 2.2 shows that lockdowns tend to have a statistically significant negative effect on mobility. A full lockdown that includes all measures that governments have used during the pandemic—for example, school closures, travel restrictions, business closures, and stay-at-home requirements—tends to generate a reduction in mobility of about 25 percent within a week. Mobility starts to resume gradually after that as the lockdown tightening shock dissipates, as illustrated in Online Annex 2.3.<sup>7</sup>

**Figure 2.2. The Impact of Lockdowns and Voluntary Social Distancing on Mobility (Percent)**

Lockdowns and voluntary social distancing have a substantial negative impact on mobility.



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level. In panel 3, the first 90 days of the epidemic vary across countries as they are counted since the first COVID-19 case in each country. See Online Annex 2.1 for data sources and country coverage. AEs = advanced economies; EMs = emerging markets; LICs = low-income countries.

<sup>7</sup>Online Annex 2.3 also shows that the 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 accounting for possible cross-country heterogeneity in the mobility response depending on population density and indicators of governance and social capital.



To address endogeneity concerns further, the impact of lockdowns is also estimated using subnational data. The analysis considers 15 Group of Twenty countries that imposed national lockdowns in response to severe localized outbreaks and examines the impact on mobility in regions with a relatively low number of COVID-19 cases. This approach strengthens the identification because the adoption of the national lockdown was largely exogenous for regions less affected by the epidemic. As reported in Online Annex 2.3, the results confirm that lockdowns tend to have a strong negative impact on mobility. These findings are robust to controlling for COVID-19 cases at both the regional and national level.

However, lockdowns are not the only contributing factor to the decline in mobility. During a pandemic, people also voluntarily reduce exposure to each other as infections increase and they fear becoming sick. Several papers document this aspect by showing that mobility has been tightly correlated with the spread of COVID-19, even after controlling for government lockdowns, especially in advanced economies (Aum, Lee, and Shin 2020; Goolsbee and Syverson 2020; Maloney and Taskin 2020). In line with this literature, the regression framework used in the analysis 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.<sup>8</sup> Panel 2 of Figure 2.2 shows that an increase in COVID-19 cases tends to have a considerable negative effect on mobility. A doubling of daily cases leads to a contraction in mobility by about 2 percent.

To gain further insights into the relative importance of lockdowns and voluntary social distancing tied to rising COVID-19 cases, panel 3 of Figure 2.2 shows their contribution in reducing mobility during the first three months of each country's epidemic. Both lockdowns and voluntary social distancing had a large impact on mobility, playing a roughly similar role in emerging markets. The contribution of voluntary social distancing was smaller in low-income countries and larger in advanced economies. These differences likely reflect that people in more economically developed countries can work from home more easily and can even afford to stop working temporarily by relying on personal savings or social security benefits. Conversely, people in low-income countries are often unable to opt for voluntary social distancing as they do not have the financial means to cope with a temporary income loss. This underscores the importance of international support to ensure that low-income countries have budgetary room for expanding safety nets.

The large contribution of voluntary social distancing in reducing mobility suggests that lifting lockdowns can lead to only a partial rebound in economic activity if health risks persist. In line with this implication, panel 1 in Figure 2.3 shows that the impact of lockdowns on mobility is smaller when infections are relatively high. A likely reason is that people feel uncomfortable with resuming mobility when lockdowns are lifted if they still perceive a considerable risk of contracting or spreading the virus. This insight warns against lifting lockdowns prematurely in

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<sup>8</sup>Besides reacting to the spread of COVID-19, people may voluntarily opt for social distancing also in response to other factors, such as announcements by public health officials, news about celebrities being infected, or even the adoption of government lockdowns. Therefore, the analysis may underestimate the extent of voluntary social distancing. The results are robust to controlling for COVID-19 deaths instead of cases. Normalizing COVID-19 cases or deaths by population is irrelevant, given that the regressions include country fixed effects and population does not vary during the period of analysis.

hope of jumpstarting economic activity. Panel 2 of Figure 2.3 provides additional evidence against expecting a sharp economic recovery just from easing lockdowns. It shows that easing lockdowns tends to have a positive effect on mobility but the magnitude is weaker compared with the impact from a lockdown tightening. As documented in Online Annex 2.3, this difference is statistically significant.

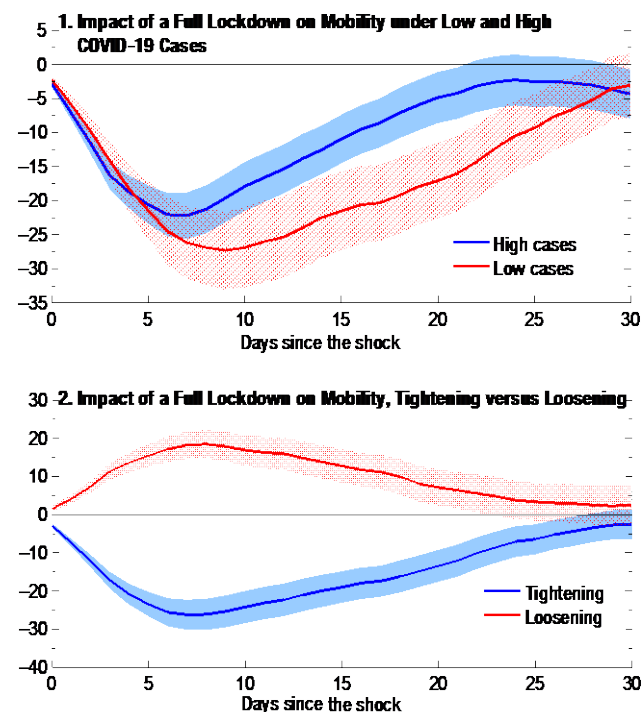
The importance of voluntary social distancing coupled with the modest boost to mobility from easing lockdowns suggest that economies will likely operate below potential as long as health concerns persist.<sup>9</sup> A first implication is that policymakers should be wary of removing policy support too hastily to avoid precipitating a further downturn and should continue to protect the most vulnerable through social safety net spending. Second, it is important to find ways to support economic activity consistent with persistent social distancing. These may include measures to reduce contact intensity and make the workplace safer—for example by promoting contactless payments—and facilitate the reallocation of resources toward less-contact-intensive sectors. Policymakers should also enhance working from home, for example by improving internet access and supporting firm investment in information technology, which, as shown in Box 2.2, can protect employment during the pandemic.

### Lockdowns and Job Postings

The importance of lockdowns and voluntary social distancing in the ongoing crisis can also be examined using the daily number of job postings provided by Indeed for 22 countries. The analysis uses a local projection framework that mimics the one used for the analysis of mobility. Panels 1 and 2 of Figure 2.4 show that a lockdown tightening and an increase in COVID-19 cases both lead to a statistically significant negative effect on job postings, corroborating the findings based on mobility. Both lockdowns and voluntary social distancing in response to higher infections appear to have played an important role in driving the reduction in job

**Figure 2.3. Further Insights on the Impact of Lockdowns on Mobility (Percent)**

The impact of lockdowns on mobility is weaker when COVID-19 cases are higher. Furthermore, a lockdown easing tends to have a smaller impact on mobility relative to a lockdown tightening.



Source: IMF staff calculations.

Note: See Online Annex 2.1 for data sources and country coverage. The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

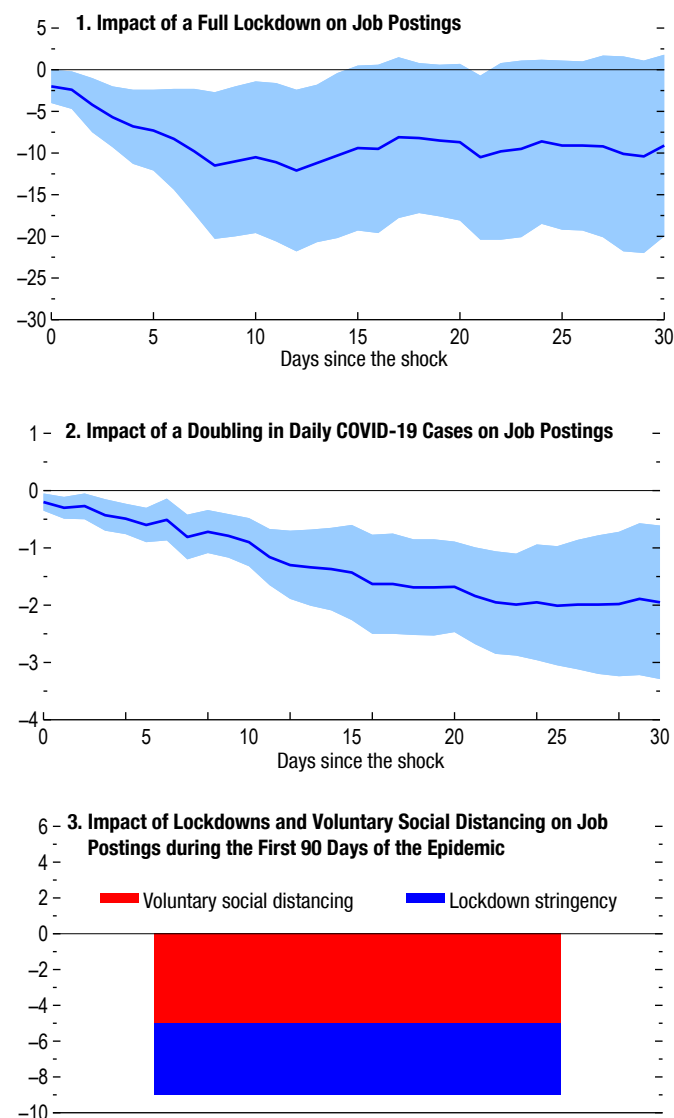
<sup>9</sup>Given the severity of the downturn, the crisis may have also reduced the level of potential output, thus leading to permanent losses even after the pandemic is over. This is an important issue for future research.

postings during the first three months of each country's epidemic (panel 3). Consistent with the analysis of mobility, the contribution of voluntary social distancing is relatively higher because the country sample includes mostly advanced economies.

Data from Indeed can also be disaggregated by job categories, providing additional insights consistent with the results presented so far. First, panel 1 of Figure 2.5 suggests that both lockdowns and voluntary social distancing contributed to the reduction in job postings. More-contact-intensive jobs—such as those in the hospitality, personal care, and food sectors—declined before stay-at-home orders, likely because of voluntary social distancing as customers grew wary of infection risks. Manufacturing job postings instead started to decline closer to the adoption of stay-at-home orders, reflecting the impact of lockdown measures. The figure also shows that job postings in contact-intensive sectors declined more than in the manufacturing sector, likely reflecting a larger drop in aggregate demand because of voluntary social distancing. Second, panel 2 provides evidence consistent with the notion that easing lockdowns is unlikely to generate a sharp rebound in economic activity. The removal of stay-at-home orders has coincided with only a marginal increase in job postings, even in the less-contact-intensive manufacturing sector.

**Figure 2.4. The Impact of Lockdowns and Voluntary Social Distancing on Job Postings (Percent)**

Lockdowns and voluntary social distancing have a substantial negative impact on job postings.



Sources: Indeed; and IMF staff calculations.

Note: See Online Annex 2.1 for data sources and country coverage. The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

## The Unequal Effects of Lockdowns across Gender and Age Groups

The pandemic is having disproportional effects on the most economically vulnerable segments of the population. As reviewed in Box 2.1, the literature documents strong negative effects on lower-income households, workers with lower educational attainment, minorities,

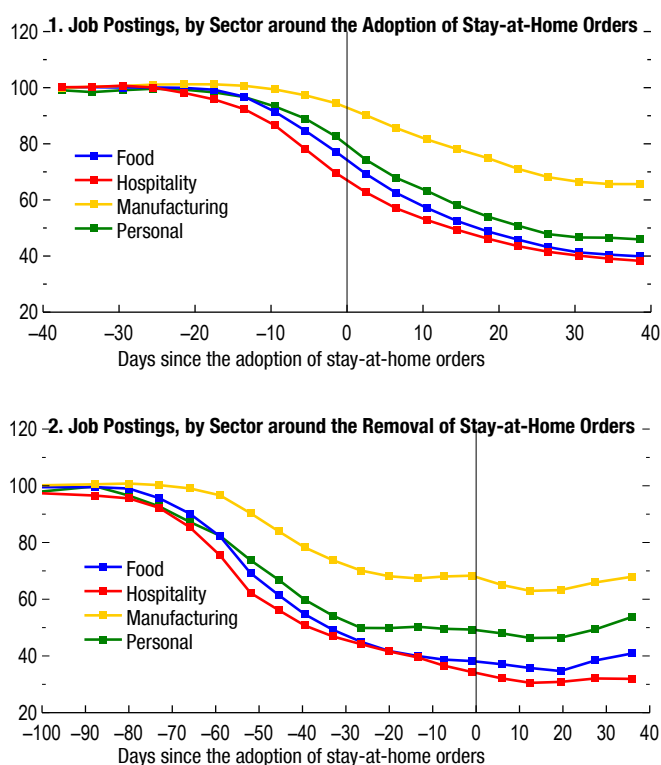
immigrants, and women. For example, unlike previous recessions, women's employment has generally declined more than men's has. This section provides additional insights on the uneven impact on women using novel mobility data provided by Vodafone for Italy, Portugal, and Spain. By tracking phone connections across cell towers, Vodafone can create mobility indexes by gender based on the information that customers provide when subscribing to a phone plan. Data are aggregated at the provincial level to protect customers' privacy. Vodafone data also differentiate mobility indexes by age groups.

Panel 1 of Figure 2.6 shows mobility levels for men and women 30 days before and after the adoption of stay-at-home orders for people aged 25 to 44. These orders coincided with a large drop in mobility for both men and women, leading to a drop of about 20 percent in the number of people who leave their homes within a given day. However, the effect on women was stronger by about 2 percent, a modest but statistically significant difference. Because stay-at-home orders in Italy, Portugal, and Spain coincided with school closures for almost all regions, the higher reduction in women's mobility may reflect that women are more likely to care for children when schools are closed. Consistent with this hypothesis, data show a smaller difference between men and women for people aged 45–64, who are less likely to have young children that require supervision at home.

Panel 2 provides additional evidence on women's role in caring for children. Focusing on a few regions in northern Italy that closed schools two weeks before the national lockdown, mobility data show that the gender gap already widened at the time of school closures. The national stay-at-home order increased the gap further, possibly reflecting higher female employment in contact-intensive sectors (such as retail, tourism, and hospitality) that were closed during the national lockdown. The evidence provided in panels 1 and 2 thus points to a

**Figure 2.5. Jobs Postings, by Sector around Stay-at-Home Orders**  
(Normalized to 100, 40 days before stay-at-home orders)

Analysis of sectoral job postings confirms the importance of both lockdowns and voluntarily social distancing. Jobs in contact-intensive sectors declined before lockdowns, while manufacturing jobs declined around the adoption of stay-at-home orders. Job postings have remained subdued, even after national stay-at-home orders were lifted.



Sources: Indeed; and IMF staff calculations.

Note: This figure reports binned scatter plots showing the evolution over time of the seven-day moving average of job postings in different categories. The x-axis variable is divided into 20 equally sized bins. The sample includes countries that introduced national stay-at-home orders according to the Oxford Coronavirus Government Response Tracker. The countries included are: ARE, AUT, BEL, ESP, FRA, GBR, IND, IRL, ITA, MEX, NLD, NZL, POL, SGP. Country list uses International Organization for Standardization (ISO) country codes.

disproportionate effect of lockdown measures on women, calling for targeted policy intervention to support women (by offering parental leave, for example) and to avoid long-lasting effects on their employment opportunities.<sup>10</sup>

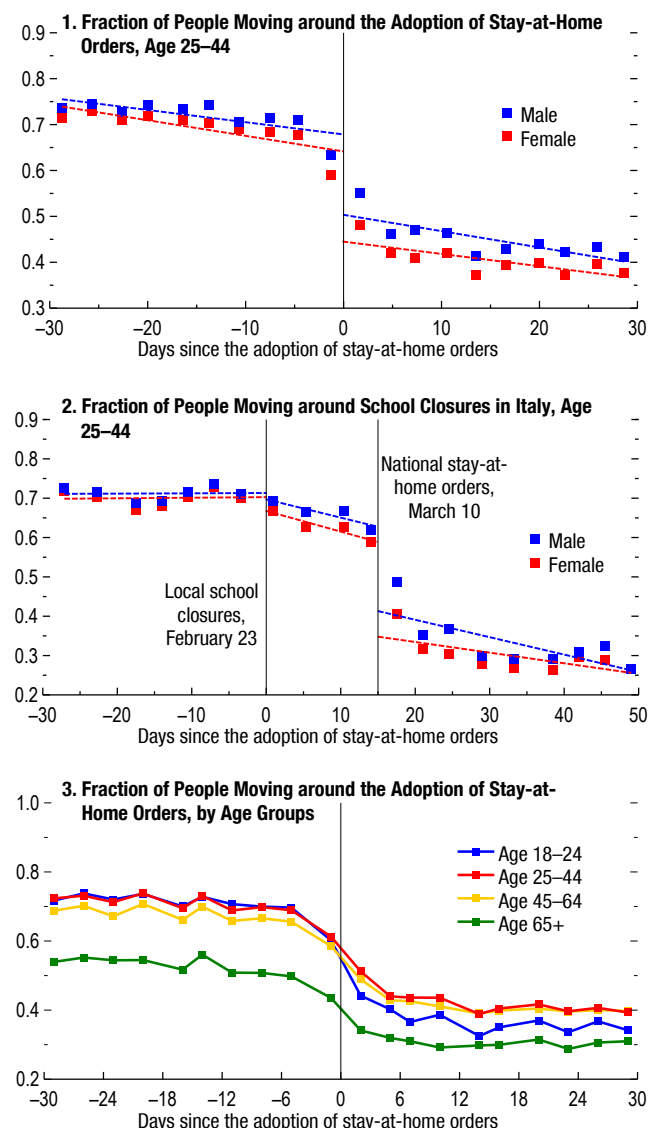
Vodafone data also reveal uneven effects of lockdowns across age groups. Panel 3 shows that the adoption of stay-at-home orders led to a considerable reduction in mobility across all age categories. Nonetheless, the effects were considerably stronger for younger cohorts. Starting from a higher level of mobility consistent with the need to go to work, working-age people experienced a sharp contraction in mobility around the adoption of stay-at-home orders. The drop was particularly large for people aged 18 to 24 (some of whom, however, are students) and for people aged 25 to 44. The impact was substantially weaker for people aged 65 and above, who generally no longer work and whose level of mobility was already lower before the stay-at-home orders. These findings highlight that lockdowns tend to have a disproportionate impact on relatively younger workers and could thus widen intergenerational inequality. While older people can rely on retirement income, especially in advanced economies, younger workers depend on labor income and often have temporary job contracts that are more likely to be terminated during a crisis.

## Lockdowns and COVID-19 Infections

Lockdowns engender sizable short-term economic costs, but they are also an investment in public health to protect

**Figure 2.6. Differentiating the Mobility Impact of Lockdowns by Gender and Age Group (Percent)**

Women and younger workers are disproportionately affected by lockdowns.



Sources: Vodafone; and IMF staff calculations.

Note: All panels present binned scatter plots around the time of stay-at-home orders introduction. In panels 1 and 2, the series are residualized with respect to province and day-of-the-week fixed effects. In panel 2, the sample is restricted to five northern Italian regions where school closures were introduced before stay-at-home orders. The x-axis is divided into 20 equally sized bins.

<sup>10</sup>The analysis faces several limitations. For example, the sample is restricted to a few European countries, data do not provide information on the employment status prior and after lockdowns, and various other factors can amplify or attenuate gender inequality during the pandemic. These are important areas for future research.

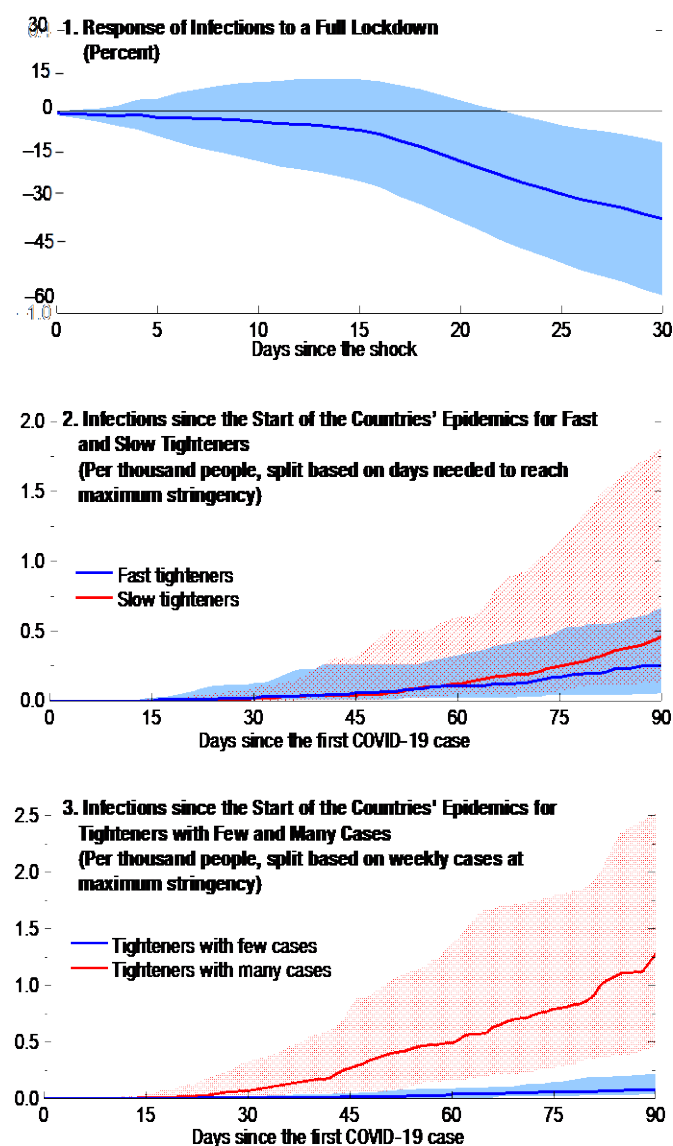
susceptible populations from the highly transmissible virus. The analysis now examines the effectiveness of lockdowns in curbing infections. Growth rates of confirmed COVID-19 cases are regressed using local projections over the stringency of lockdowns while controlling for country and time fixed effects as well as other variables that can affect infections, such as outside temperature and humidity, public information campaigns, testing, and contact tracing. Online Annex 2.5 provides additional details.

Panel 1 of Figure 2.7 shows that lockdowns tend to have a negative impact on infections. A stringent lockdown leads to a reduction in cumulated infections of about 40 percent after 30 days. Note that the effects of lockdowns on confirmed COVID-19 cases tend to materialize after at least two weeks, consistent with the COVID-19 incubation period and the time required for testing. Acknowledging this aspect is important to properly guide people's expectations about the effectiveness of lockdowns. Furthermore, the lagged impact on infections points to the need to adopt lockdowns before infection rates increase too rapidly.

Panels 2 and 3 of Figure 2.7 provide additional evidence on the benefits of adopting lockdowns early in a country's epidemic. Panel 2 shows the evolution of infections since the first COVID-19 case, differentiating countries by the number of days passed from the first case to when lockdown measures reached their maximum stringency. Countries that imposed lockdowns faster experienced better epidemiological outcomes. The differences are even more striking if countries are divided with respect to the number of COVID-19 cases at the time of lockdowns (panel 3). Countries that adopted

**Figure 2.7. The Impact of Lockdowns on COVID-19 Infections**

Lockdowns are an effective tool to reduce infections, especially when they are implemented early in the epidemic.



Source: IMF staff calculations.

Note: See Online Annex 2.1 for data sources and country coverage. Panel 1 shows the response of infections to a full lockdown; panels 2 and 3 show the number of infections since the first COVID-19 case. The shaded area in panel 1 corresponds to 90 percent confidence intervals computed with Driscoll-Kraay standard errors; the shaded areas in panels 2 and 3 correspond to the interquartile range.



lockdowns when COVID-19 cases were still low witnessed considerably fewer infections during the first three months of the epidemic compared with countries that introduced lockdowns when cases were already high.

The observation that lockdowns can reduce infections but involve short-term economic costs is often used to argue that lockdowns involve a trade-off between saving lives and protecting livelihoods. This narrative should be reconsidered in light of the earlier findings showing that rising infections can also have severe detrimental effects on economic activity. By bringing infections under control, lockdowns may thus 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 even leading to positive net effects on the economy. This remains a crucial area for future research as more data become available.

## Individual Lockdown Measures and Nonlinear Effects

So far, the analysis has used a lockdown stringency index that combines a broad range of underlying measures. These include, for example, travel restrictions, school and workplace closures, and stay-at-home orders. 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 panel 1 of Figure 2.8. Therefore, the empirical analysis tends to capture the marginal impact of a given measure conditional on those that are already in place. As discussed in Online Annex 2.6, this underestimates the importance of measures that are adopted at a later stage. For example, stay-at-home orders are found to have a modest impact on mobility because various other measures are already in place.

An analytically sounder approach is to examine whether further tightening of lockdown measures continue 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 shed light on this issue, the analysis uses quadratic terms of the lockdown index in the regression framework. Panel 2 of Figure 2.8 shows that the introduction of additional lockdown measures has a weaker marginal impact on mobility once other measures are already in place—that is, when the lockdown stringency index is already relatively high. This suggests that lockdowns have marginally weaker negative economic effects as they become more and more stringent. For example, stay-at-home orders may have only a modest negative impact on economic activity if governments have already mandated workplace closures.

Conversely, panel 3 shows that lockdowns become progressively more effective in reducing COVID-19 cases when they become sufficiently stringent. Mild lockdowns appear instead ineffective in curbing infections. A possible interpretation is that preventing only a few instances of personal contacts, such as by closing schools alone, is not enough to reduce community spread significantly. Additional measures, such as workplace closures or stay-at-home orders, are needed to effectively bring the virus under control.



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 prolonged mild lockdowns. Based on past experience, tighter lockdowns appear indeed to entail only modest additional economic costs while leading to a considerably stronger decline in infections. It will be important to reexamine these results as the pandemic progresses because the relative benefits between mild and tight lockdowns may change. For example, if an expansion of contact tracing and broader use of face masks succeed in limiting infections, mild lockdowns could be sufficient to contain new localized flareups of the virus.

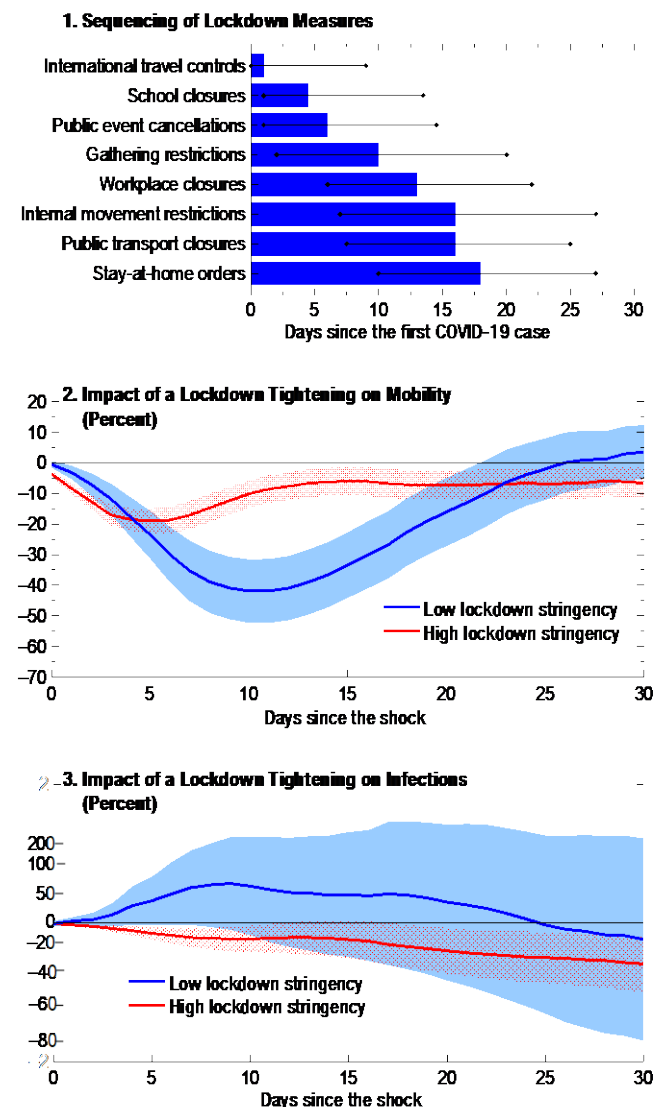
## Conclusions

The chapter documented that lockdowns and voluntary social distancing in response to rising infections have both played a crucial role in reducing economic activity during the pandemic. Consistent evidence on the impact of lockdowns is provided by examining cross-country economic indicators for a large set of countries and high-frequency proxies for economic activity, such as mobility and job posting data from Google and Indeed. Furthermore, the negative impact of lockdowns on mobility is robust to using subnational data to strengthen identification.

Despite lockdowns having negative short-term 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 has severe detrimental effects on the economy. The contribution of voluntary social distancing in reducing mobility is particularly high in advanced economies, where people can more easily stay at home

**Figure 2.8. Individual Lockdown Measures and Nonlinear Effects**

Countries tend to introduce different lockdown measures following a similar sequence. More stringent lockdowns have a marginally weaker impact on mobility but stronger effects on infections.



Source: IMF staff calculations.

Note: See Online Annex 2.1 for data sources and country coverage. The blue bars in panel 1 represent the median number of days and the horizontal lines the interquartile range. Low and high stringency in panels 2 and 3 refer to the 25th and 75th percentile of lockdown stringency. The shaded areas in panels 2 and 3 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level. A lockdown tightening corresponds to an increase in the index by 100 units.

thanks to teleworking arrangements, higher personal savings, and more generous social security benefits.

The important contribution of voluntary social distancing to the recession should caution against expecting a quick economic rebound once lockdowns are lifted. This is especially relevant for countries that lift lockdowns prematurely, when infections are still relatively high. In this case, lockdowns tend to have a weaker impact on mobility, likely because people's decisions are driven largely by fear of contracting the virus. Further tempering the expectations of a sharp economic rebound, the analysis shows that lifting lockdowns tends to have a more modest impact on mobility compared with the impact of a lockdown tightening.

These findings suggest that, as long as significant health risks persist, economic activity is likely to remain subdued. Therefore, policymakers should refrain from withdrawing policy support too quickly and preserve spending on social safety nets. Furthermore, it is important to support economic activity consistent with persistent social distancing, for example by encouraging work from home, facilitating a reallocation of resources toward less-contact-intensive sectors, and promoting the adoption of new technologies to limit the contact intensity within given sectors.

The chapter also provided novel evidence about the unequal effects of lockdowns that severely affect economically vulnerable segments of the population. Mobility data provided by Vodafone for some European countries show that lockdown measures—especially school closures—tend to generate a larger drop in women's mobility. This likely reflects women's disproportionate role in childcare, which could jeopardize their employment opportunities during the crisis. Lockdowns tend to also generate a sharper reduction in the mobility of younger cohorts, a concerning outcome because younger workers rely on labor income and often have temporary job contracts that are at greater risk of being terminated. Targeted policy intervention, such as strengthening unemployment benefits for vulnerable categories and supporting paid leave for parents, is needed to ensure that the crisis does not contribute to widening gender and intergenerational inequality.

The analysis also found that lockdowns are powerful instruments to reduce infections, especially when they are introduced early in a country's epidemic and when they are sufficiently stringent. Considering also that lockdowns appear to impose decreasing marginal costs on economic activity as they become more stringent, policymakers may want to lean toward rapidly adopting tight lockdowns when infections increase rather than rely on delayed mild measures. Nonetheless, these recommendations will need to be reassessed as the understanding of the virus and means to counteract it improve. A crucial area of research is to examine the effectiveness of more-targeted instruments compared to blunt lockdowns, for example restrictions to dense, indoor gatherings or measures to isolate people that are more vulnerable to the virus.

The effectiveness of lockdowns in reducing infections, coupled with the finding that infections can considerably harm economic activity because of voluntary social distancing, provides an important new perspective on the costs of lockdowns. The prevailing narrative often portrays lockdowns as involving a trade-off between saving lives and supporting the

economy. This characterization neglects the point that, despite imposing short-term economic costs, lockdowns may lead to a faster economic recovery by containing the virus and reducing voluntary social distancing. These medium-term gains may offset the short-term costs of lockdowns, possibly even leading to positive overall effects on the economy. More research is warranted on this important aspect as the crisis evolves and more data become available. Meanwhile, policymakers should also look for alternative ways to contain infections that may have even lower economic costs. In line with the advice of public health experts, these may include expanding testing and contact tracing, promoting the use of face masks, and encouraging working from home.

The analytical results and policy implications presented in this chapter are subject to several caveats. First, the analysis tried to alleviate concerns about the endogeneity of lockdowns by showing that the results hold using cross-sectional and time-series identification and by relying on national and subnational data when available. However, identification concerns cannot be fully dismissed, including regarding the measurement of voluntary social distancing. Second, the analysis relied on short-term indicators, such as mobility and job postings, which provide an imperfect measure of economic activity. The chapter's findings will need to be reexamined as more conventional economic indicators become available. Third, the analysis has focused on the economic consequences of lockdowns, neglecting important side effects, for example, on educational attainment and mental health issues. These are crucial areas for future research.

## Box 2.1. An Overview of the Literature on the Economic Impact of Lockdowns

The literature on the economic crisis triggered by the coronavirus pandemic has been expanding at a very rapid pace. This box offers a nonexhaustive overview of some of this literature that focuses on the economic impact of lockdown measures.<sup>1</sup>

### *Economic Impact of Lockdowns and Inequality Aspects*

Several authors point to a substantial role of lockdowns in the United States leading to employment losses, substantial decline in spending, and deterioration of local economic conditions (Baek and others 2020; Baker and others 2020; Béland, Brodeur, and Wright 2020; Chernozhukov, Kasahara, and Schrimpf 2020; Coibion, Gorodnichenko, and Weber 2020; Gupta and others 2020). Similar effects have been documented across different countries (Carvalho and others 2020; Chronopoulos, Lukas, and Wilson 2020; Deb and others 2020b).

Other papers argue that voluntary social distancing has had a more important role than lockdowns (Allcott and others 2020; Bartik and others 2020; Kahn, Lange, and Wiczer 2020; Maloney and Taskin 2020). This literature notes that people's mobility and economic activity in the United States contracted before lockdowns (Chetty and others 2020), and that lifting lockdowns led to a limited rebound in mobility (Dave and others 2020b) and economic activity (however, Cajner and others 2020, and Glaeser and others 2020 are exceptions). Goolsbee and Syverson (2020) finds small differences in people's visits to nearby retail establishments that faced different regulatory restrictions because they were located in different jurisdictions. Chen and others (2020b) documents similar results that expands the analysis to Europe and finds no robust evidence of the impact of lockdowns. Sweden's case also highlights the importance of voluntary social distancing—despite avoiding strict lockdown measures, the country has experienced similar declines in mobility and economic activities compared with comparable countries (Andersen 2020; Born, Dietrich, and Müller 2020; Bricco and others 2020; Chen and others 2020b). Aum, Lee, and Shin (2020) draws relatively similar conclusions analyzing the South Korean experience.

The literature also documents that the early phases of the pandemic have had a harsher effect on more economically vulnerable individuals, both in the United States and other countries (Alstadsæter and others 2020; Béland, Brodeur, and Wright 2020). These individuals include those with lower income and educational attainment (Cajner and others 2020, Chetty and others 2020, Shibata 2020), minorities (Fairlie, Couch, and Xu 2020), immigrants (Borjas and Cassidy 2020), and women (Alon and others 2020a, Del Boca and others 2020, Papanikolaou and Schmidt 2020). One reason is that lower-paid workers are often unable to perform their jobs from home (Barrero, Bloom, and Davis 2020, Dingel and Neiman 2020, Gottlieb and others 2020). This warns of a potential widening of inequality (Mongey, Pilossoph, and Weinberg 2020; Palomino, Rodríguez, and Sebastian 2020).

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The author of this box is Nicola Pierri.

<sup>1</sup>At the time of writing, most of the cited papers had not yet undergone a peer-review process; thus, their conclusions must be interpreted with caution.

Some papers use rich structural models of production to predict the damage of lockdowns, mostly finding very large effects on economic activities (Barrot, Grassi, and Sauvagnat 2020; Baqaee and Farhi 2020b; Bonadio and others 2020; Cakmakli and others 2020; Fadinger and Schymik 2020; Inoue and Todo 2020) and on firms' liquidity and solvency (Carletti and others 2020, Schivardi and Romano 2020). Chen and others (2020a) looks at stock market reactions instead and presents evidence consistent with market beliefs that mitigation policies are good for businesses in the long term. Furthermore, some papers study how supply shocks may cause demand shortage (Guerrieri and others 2020) and interact with nominal rigidities (Baqaee and Farhi 2020a).

### *Impact of Lockdowns and Social Distancing on Infections*

Some empirical analyses also document a significant role of social distancing and lockdowns in slowing the spread of the coronavirus (Chernozhukov, Kasahara, and Schrimpf 2020; Ciminelli and Garcia-Mandico 2020; Dave and others 2020a; Deb and others 2020a, Fang, Wang, and Yang 2020; Friedson and others 2020; Glaeser, Gorbach, and Redding 2020; Imai and others 2020; Jinjekar and others 2020; Yilmazkuday 2020). However, several factors have affected effectiveness and compliance, such as social capital (Barrios and others 2020, Ding and others 2020), availability of high-speed internet connection (Chiou and Tucker 2020), electoral concerns (Pulejo and Querubín 2020), labor precariousness (Levy Yeyati and Sartorio 2020), or sick leave policies (Andersen 2020). Some of these papers also argue that less restrictive mitigation policies, such as wearing face masks and mass testing, can play an important role in slowing the spread of infection (Chernozhukov, Kasahara, and Schrimpf 2020; Gapen and others).

### *Optimal Mitigation Policy and Historical Perspectives*

Some studies use theoretical (mostly quantitative) models to characterize optimal mitigation policies while considering the detrimental impact on the economy. For instance, see Acemoglu and others (2020); Akbarpour and others (2020); Alvarez, Argente, and Lippi (2020); Bodenstein, Corsetti, and Guerrieri (2020); Cakmakli and others (2020); Checo and others (2020); Eichenbaum, Rebelo, and Trabandt (2020); Farboodi, Jarosch, and Shimer (2020); Favero, Ichino, and Rustichini (2020); and Jones, Philippon, and Venkateswaran (2020). The higher risk faced by the elderly, the role of voluntary social distancing, and hospital capacity constraints are among several issues these models study. Many of these papers document an important role for targeted lockdown policies and early interventions. Others focus on how optimal policies may differ in developing economies (Alon and others 2020b, von Carnap and others 2020).

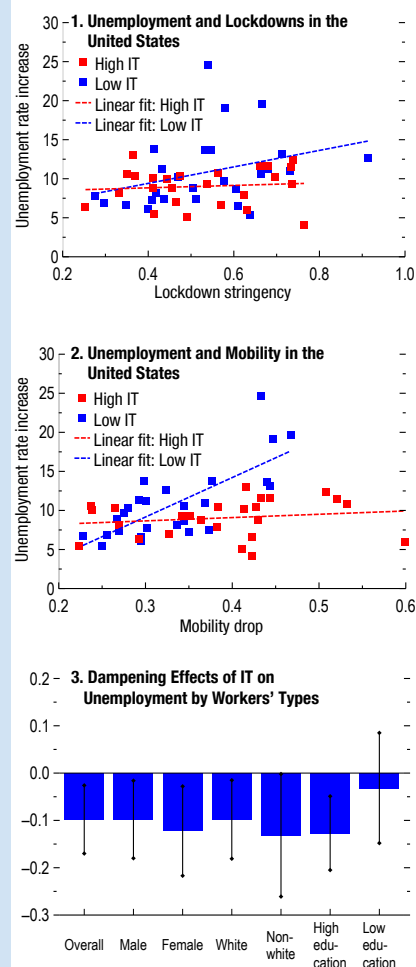
A few papers offer an historical perspective on the economic impact of lockdowns. Correia, Luck, and Verner (2020) finds that lockdowns imposed in US cities to contain the Spanish flu had a positive impact on their subsequent growth, although Lilley, Lilley, and Rinaldi (2020) revisits this evidence and argues that it is inconclusive. Bodenhorn (2020) studies the Spanish flu's impact in the US South and finds no evidence that mandated business closures led to more business failures.

## Box 2.2. The Role of Information Technology Adoption during the Pandemic: Evidence from the United States

This box analyzes how firms' adoption of information technology alters the impact of lockdowns and voluntary social distancing on the labor market in the United States. Firms' information technology adoption can dampen the economic effect of the pandemic in several ways: by facilitating teleworking, promoting online sales, or organizing contactless delivery. The analysis finds that employment has been more resilient in US states where firms have high levels of information technology adoption. Panel 1 of Figure 2.2.1 shows the increase in the unemployment rate between February and April for each US state over the stringency of lockdowns during the same period. Similarly, panel 2 illustrates the association between the increase in unemployment and the drop in mobility. In states with low levels of information technology adoption, there is a strong correlation between the intensity of the lockdown, the drop in mobility, and the rise in the unemployment rate. Conversely, lockdowns and mobility are not associated with rising unemployment rates in states with higher levels of information technology adoption. This suggests that information technology may significantly shield local economies during the pandemic.

This pattern is confirmed using individual-level data from the joint US Census Bureau–US Bureau of Labor Statistics Current Population Survey. The probability of being unemployed in April is higher for respondents living in metropolitan statistical areas that experienced larger mobility declines, but information technology adoption of companies mitigates this impact.<sup>1</sup> The increase in the probability of being unemployed associated with a large drop in mobility (one standard deviation, equal to 10 percentage points) is 25 percent larger in metropolitan statistical areas with low levels

**Figure 2.2.1. The Dampening Effects of Information Technology Adoption on US Unemployment (Percent)**



Sources: Google Community Mobility Report; Keystone; and IMF staff calculations.

Note: The y-axis in panels 1 and 2 is the increase in the state-level unemployment rate between February and April 2020 in percent. The x-axis in panel 1 is the average lockdown stringency between February and April 2020; and the x-axis in panel 2 is the average drop in mobility. Panel 3 illustrates the results of a regression using data from the Current Population Survey in which the dependent variable is a dummy indicating if the respondent is unemployed in April 2020, and the independent variables are the IT adoption and the drop in mobility in the metropolitan statistical area where the respondent lives, together with their interaction. The y-axis of panel 3 reports the magnitude of the coefficient of the interaction term for each subsample. Low education refers to respondents who did not graduate from high school. See Pierri and Timmer (forthcoming) for more details. IT = information technology.

The authors of this box are Nicola Pierri and Yannick Timmer. The analysis largely draws from Pierri and Timmer (2020), which includes technical details.

<sup>1</sup>A metropolitan statistical area is defined by the United States Census Bureau as a geographical region with a relatively high population density at its core and close economic ties throughout the area.

of information technology adoption than in those with high levels (5 percentage points versus 4 percentage points).

The analysis also explores the impact of information technology adoption across different categories of workers (panel 3 of Figure 2.2.1). Information technology adoption cushions the unemployment impact of mobility for both male and female and for both white and non-white workers. However, information technology adoption does not mitigate the impact for individuals who do not have a bachelor's degree. Therefore, even though information technology adoption may, in the aggregate, significantly shield labor markers against the effects of the coronavirus pandemic, it may also contribute to widening inequality by increasing the unemployment gap between high- and low-educated individuals.



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## Annex 2.1. Data Sources and Country Coverage

Annex Table 2.1.1 lists the data sources used in the analysis. The country coverage for the different sections of the analysis is reported in Annex Table 2.2.2, with the selection of countries being driven by data availability. For the cross-country analysis, the sample varies between 22 and 52 countries based on data availability. In the case of 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 subnational data on mobility is employed, the sample consists of 422 units for 15 G20 countries. Vodafone data is limited to Italy, Spain, and Portugal. Finally, the analysis of infections is based on a sample of 89 countries for which information on temperature, humidity, public information campaigns, testing, and contact tracing is available. At the subnational level, the sample consists of 373 units for G20 15 countries.

**Annex Table 2.1.1. Data Sources**

Indicator	Source
Altruism	Global Preference Survey
Contact tracing	Oxford COVID-19 Government Response Tracker
COVID-19 cases	Oxford COVID-19 Government Response Tracker
GDP per capita in PPP terms	World Economic Outlook database, April 2020
Humidity	Air Quality Open Data Platform
Industrial production	Haver analytics
Lockdown measures	Oxford COVID-19 Government Response Tracker
Lockdown stringency index	Oxford COVID-19 Government Response Tracker
Mobility indicators	Google Community Mobility Reports, Baidu for China
Monetary policy rate	Haver analytics
Percent of people moving by age and gender	Vodafone
PMI manufacturing	Haver analytics
PMI services	Haver analytics
Population	World Economic Outlook database, April 2020
Population density	World Economic Outlook database, April 2020
Public information campaigns	Oxford COVID-19 Government Response Tracker
Real consumption	Haver analytics
Real consumption forecasts	World Economic Outlook database, January 2020
Real GDP	Haver analytics
Real GDP forecasts	World Economic Outlook database, January 2020
Real investment	Haver analytics
Real investment forecasts	World Economic Outlook database, January 2020
Retail sales	Haver analytics
Rule of law	World Governance Indicators
Stock of job postings	Indeed
Temperature	Air Quality Open Data Platform
Testing	Oxford COVID-19 Government Response Tracker
Trust	Global Preference Survey
Unemployment rate	Haver analytics

Source: IMF staff compilation.

# WORLD ECONOMIC OUTLOOK

**Annex Table 2.1.2. Country Coverage**

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

Source: IMF staff compilation.

Note: *CE* = cross-country regressions of economic indicators; *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; *GA* = gender-age mobility regressions.

## Annex 2.2. Cross-Country Evidence of the Impact of Lockdowns on Economic Activity

This annex provides technical details about the cross-country analysis presented in the chapter. Panel 1 of Figure 2.1 of the chapter displays the correlation between the average lockdown stringency and the GDP growth forecast error in the first half of 2020.<sup>1</sup> The forecast error is defined as the deviation of real GDP growth from the January 2020 World Economic Outlook projections, which are the latest ones before the COVID-19 outbreak.<sup>2</sup> The figure indicates that there is a clear negative correlation between the stringency of the lockdown measures and the real GDP growth forecast error, suggesting that countries with a tighter lockdown stringency experienced larger output losses.

The analysis then looks at the correlation between lockdowns and economic activity more systematically. To do that, the following specification is estimated:

$$y_i = \alpha_i + \beta \text{lock}_i + \gamma \text{cases}_i + \varepsilon_i \quad (2.1)$$

where  $y_i$  is, alternatively, one of the following economic activity indicators for country  $i$ : the forecast error of real GDP, real consumption, and real investment in the first half of 2020; the average growth of industrial production and retail sales; and the average change in the level of manufacturing purchasing manager index (PMI) and services PMI in the first three months after a country's epidemic started;  $\text{lock}_i$  is the average lockdown stringency during the same period used for the  $y_i$  variable; and  $\text{cases}_i$  is the log of per capita COVID-19 cases at the end of the period used for the  $y_i$  variable.

Annex Table 2.2.1 and panel 2 of Figure 2.1 of the chapter report the results of the estimations. To compare the lockdown estimates across economic activity indicators, the figure shows the coefficient  $\beta$  multiplied by the ratio of the standard deviation of lockdowns to the standard deviation of the relevant economic activity indicator. The results suggest that lockdown are associated with lower economic activity, and that the impact is significant whether or not the spread of the virus is controlled for.

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<sup>1</sup> Data on lockdown stringency come from the Coronavirus Government Response Tracker of the University of Oxford. The lockdown stringency index is constructed as a simple average of nine sub-indexes built from ordinal indicators where policies are ranked on a numerical scale. These indicators measure school closures, workplace closures, cancellations of public events, gathering restrictions, public transportation closures, stay-at-home requirements, restrictions on internal movement, controls on international traveling, and public information campaigns. Since public information campaigns have a direct impact on voluntary distancing, the analysis constructs the stringency index excluding those.

<sup>2</sup> The real GDP growth forecast error for the first half of 2020 is calculated by first taking the sum of real GDP in the first two quarters of 2020 and then calculating the growth of this sum relative to its counterpart a year ago.

Annex Table 2.2.1. The Impact of Lockdown on Economic Activities

	GDP forecast error in Q1	Consumption forecast error in Q1	Investment forecast error in Q1	Industrial production	Retail sales	PMI, manufacturing	PMI, services	Unemployment rate
A. Without controlling for COVID-19 cases								
Lockdown stringency	-0.205*** (0.0588)	-0.235*** (0.0479)	-0.566** (0.273)	-0.421*** (0.0970)	-0.210** (0.0908)	-0.134*** (0.0435)	-0.277*** (0.0632)	0.0602* (0.0347)
Constant	0.245 (2.199)	-0.583 (2.032)	13.52 (10.19)	10.55* (5.658)	2.918 (5.391)	-2.253 (2.709)	-3.943 (3.731)	-2.082 (1.775)
Observations	52	33	33	45	40	40	22	43
R-squared	0.220	0.287	0.203	0.230	0.068	0.128	0.248	0.077
B. Controlling for COVID-19 cases								
Lockdown stringency	-0.197*** (0.0549)	-0.237*** (0.0559)	-0.569** (0.270)	-0.458*** (0.114)	-0.239** (0.107)	-0.134*** (0.0487)	-0.225** (0.0877)	0.0789* (0.0429)
COVID-19 cases	-0.362 (0.288)	-0.341 (0.513)	-0.483 (1.762)	1.747 (1.067)	0.577 (1.368)	0.00636 (0.381)	-1.113 (0.893)	-0.489 (0.417)
Constant	-0.0468 (2.060)	-0.354 (2.241)	13.85 (10.03)	13.24* (7.040)	4.611 (6.089)	-2.241 (3.054)	-7.132 (5.390)	-3.250 (2.386)
Observations	52	33	33	45	40	40	22	43
R-squared	0.246	0.299	0.207	0.282	0.074	0.128	0.286	0.131

Source: IMF staff calculations.

Note: Heteroskedasticity and autocorrelation robust standard errors in parentheses. \* p < .10; \*\* p < .05; \*\*\* p < .01.

## Annex 2.3. Impact of Lockdowns on Economic Activity using High-Frequency Indicators

This annex describes the methodology to assess the impact of lockdowns on economic activity using high-frequency data. The first indicator to proxy economic activity is an average of the mobility indexes provided by Google.<sup>1</sup> The advantage of this indicator is that it is available for over 130 countries (including many emerging market and developing economies) and at daily frequency since early February. The second indicator employed in the analysis is the number of job postings from the online platform Indeed, which is available for 22 countries, among which 18 advanced economies and 4 emerging market and developing economies.

### Mobility

#### *The Impact of Lockdowns on Mobility*

To assess the dynamic response of mobility to the implementation of a lockdown, the analysis relies on local projections (Jordà, 2005). Specifically, the following panel regressions are estimated with data on 128 countries since early February until mid-July, 2020:

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta cases_{i,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + \sum_{p=1}^P \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (2.3)$$

where  $mob_{i,t+h}$  denotes mobility for country  $i$  at time  $t + h$ , with  $h$  being the horizon;  $\ln \Delta cases_{i,t-p}$  is the log of daily COVID-19 cases, which is used to track the stage of the pandemic, with  $p$  being the lag length;<sup>2</sup> and  $lock_{i,t-p}$  is the index measuring lockdown stringency. 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. Standard errors are clustered at the country level.<sup>3</sup>

Lockdowns are generally imposed when the country's epidemic is entering an acute phase. At that time, people are also more likely to voluntarily reduce social interactions because they fear being infected or infecting others. This complicates the assessment of the extent to which the decline in mobility after lockdowns is driven by government restrictions or by people's behavioral changes. By controlling for the stage of the pandemic, the coefficient  $\delta_0^h$  isolates the impact of lockdown measures. At the same time, for a given level of lockdown stringency, the coefficient  $\beta_0^h$  should reveal the extent of voluntary social distancing.

The results of the estimations are reported in Figure 2.2 of the chapter. As shown in panel 1, in response to a full lockdown, mobility declines after a week by almost 25 percent relative to the level prior to the lockdown. The effect dies off over a month, as restrictions are gradually eased

<sup>1</sup> The mobility index used in the analysis is constructed as the average of the mobility indexes 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.

<sup>2</sup> Replacing the log of daily COVID-19 cases with the log of daily COVID-19 deaths does not change the results.

<sup>3</sup> Similar results are obtained if the standard errors are corrected for cross-sectional dependence following Driscoll-Kraay (1998).

as shown in Figure 2.3.1. Panel 2 of Figure 2.2 of the chapter shows the impact of daily COVID-19 cases on mobility. A doubling of COVID-19 cases leads to a decline in mobility of about 2 percent after 30 days. The results are similar when COVID-19 cases are replaced with COVID-19 deaths. In this case, mobility declines by 28 percent a week after the introduction of a lockdown; and a doubling of COVID-19 deaths leads to a reduction in mobility by 1.2 percent after 30 days.

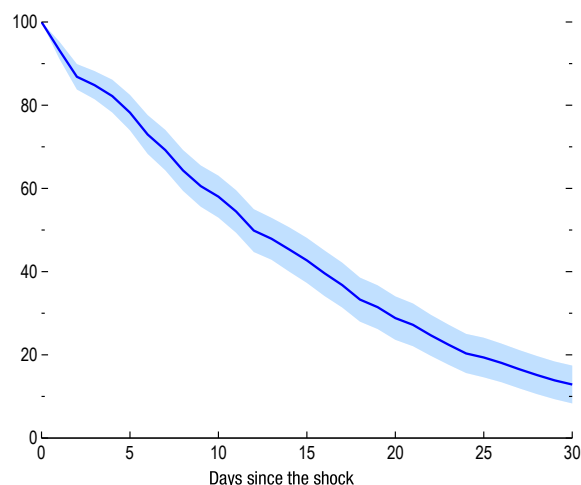
The analysis also proposes an alternative identification strategy that takes advantage of the sub-national disaggregation of the mobility data from Google. Some countries imposed national lockdowns in reaction to localized outbreaks in highly affected regions. Therefore, these national lockdowns were largely exogenous to the conditions in regions with less COVID-19 infections. Moreover, voluntary social distancing was likely weaker in regions with less COVID-19 cases. Thus, by focusing on countries that adopted national lockdowns (instead of different measures for each region) and examining the impact on mobility in regions that were less affected by COVID-19, the analysis should uncover the causal effect of lockdowns in curbing mobility.

Thus, to ensure the reliability of the results based on national data, the following specification is estimated on data for 422 subnational units of 15 G20 countries:<sup>4</sup>

$$mob_{j,t+h} = \alpha_j^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta cases_{j,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + \sum_{p=1}^P \rho_p^h mob_{j,t-p} + \varepsilon_{j,t+h} \quad (2.4)$$

where  $j$  is the subnational unit, excluding the unit in each country with the largest number of

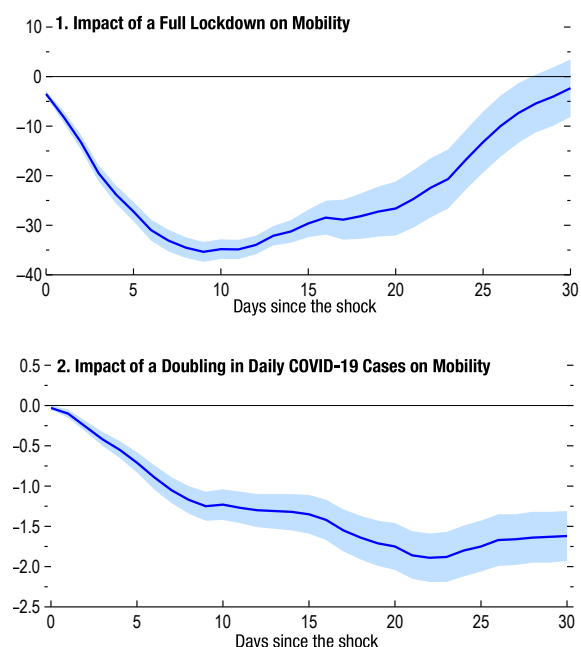
**Annex Figure 2.3.1. Persistence of a Full Lockdown (Index)**



Source: IMF staff calculations.

Note: The shaded area corresponds to 90 percent confidence interval computed with standard errors clustered at the country level.

**Annex Figure 2.3.2. The Impact of Lockdowns and Voluntary Social Distancing on Mobility, Subnational Data (Percent)**



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the subnational level.

<sup>4</sup> For this exercise the sample is restricted to G20 countries for which subnational level data on mobility and COVID-19 cases are available. The level of geographical disaggregation is determined by Google mobility data and it varies across countries. For the US, state-level mobility data are available, but since policies are determined at the state level, all US observations are excluded from the sample.

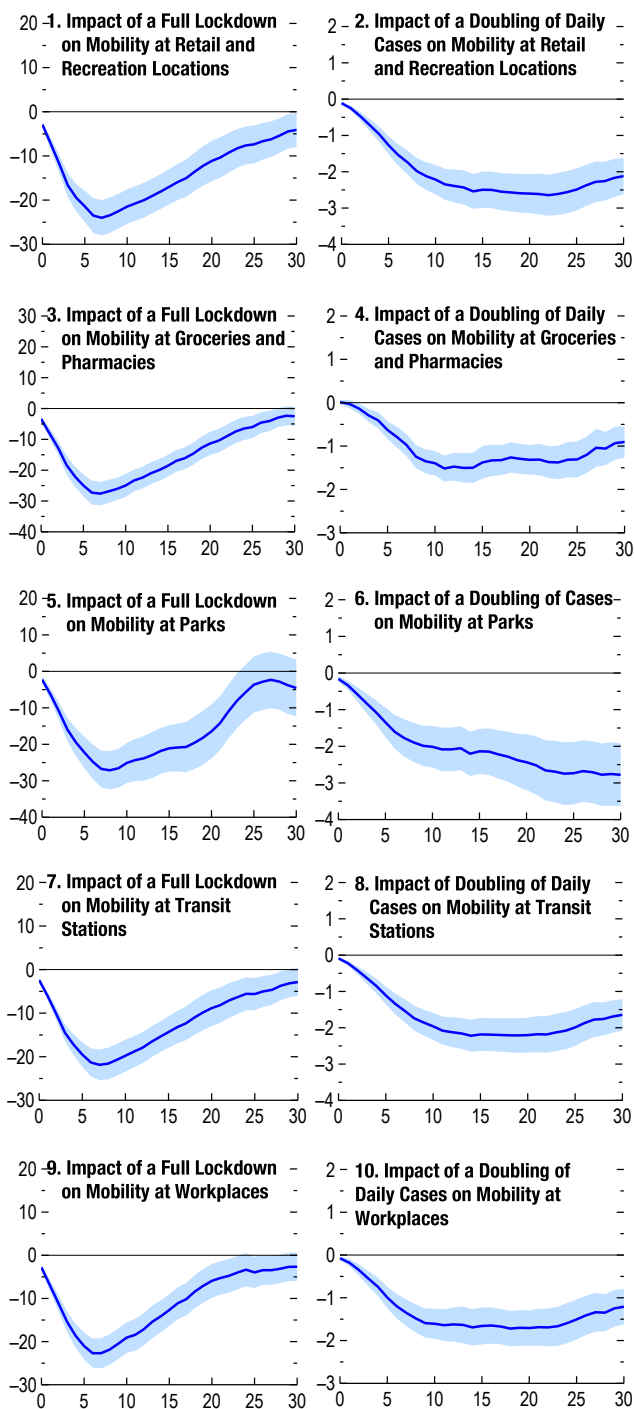
cases. The analysis also excludes units that had more than 20 percent of the country's total COVID-19 cases.

The estimates reported in panel 1 of Figure 2.3.2 corroborate the negative effect of lockdowns on mobility. While the shape of the mobility response is similar to the one obtained with national data, the magnitude is about 10 percentage point larger. Yet, differences may be related to the sample coverage. Symmetrically, Panel 2 of Figure 2.3.2 shows the impact of COVID-19 on mobility. 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.

### Robustness

This section presents several robustness exercises. First, to ensure that the results are not driven by the dynamics in mobility at specific locations, the analysis replaces the average mobility indicator in equation (2.3) with the mobility at retail and recreation, groceries and pharmacies, parks, transit stations, and workplaces.<sup>5</sup> The results in Figure 2.3.3 suggest that the decline in mobility in response to a full lockdown and in response to a doubling of COVID-19 cases are in line with the ones presented in panels 1 and 2 of Figure 2.2 of the chapter. That is, across all locations a full lockdown leads to a reduction in mobility between 23 and 28 percent about a week after the introduction of the lockdown; and a doubling in COVID-19 cases leads to a decline in mobility between 1 and 2.8 percent after 30 days.

**Annex Figure 2.3.3. The Impact of Lockdowns and Voluntary Social Distancing on Mobility at Different Places**  
(Percent; days since the shock on x-axis)



Source: IMF staff calculations.

Note: The shaded areas in panels 1–10 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

<sup>5</sup> When the average mobility indicator is substituted with mobility observed at specific locations China drops from the sample.



Second, public information campaigns, contact tracing, and massive testing may lead people to re-assess the risk of getting infected (and infecting others) and therefore could contribute to a decline in mobility. The analysis estimates the specification in equation (2.3) including these controls (and their lags). The results presented in Figure 2.3.4 are consistent with the ones in panels 1 and 2 of Figure 2.2 of the chapter: a full lockdown reduces mobility by 24 percent after a week, and a doubling of COVID-19 cases leads to a reduction in mobility by 1.9 percent after 30 days.

Third, there are several country characteristics that could potentially affect the magnitude of the impact of lockdowns on mobility. These include population density and governance variables such as rule of law, among others. The test if these factors determine the impact of lockdowns on mobility, the analysis estimates the following specification:

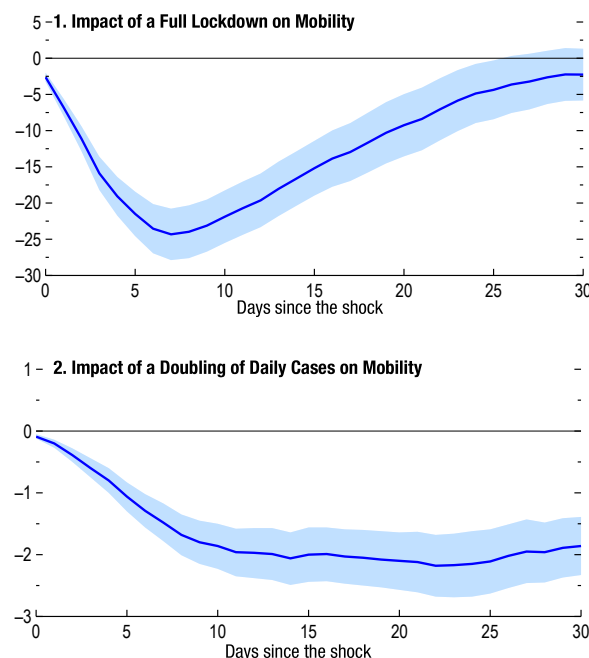
$$\begin{aligned} \text{mob}_{i,t+h} = & \alpha_i^h + \tau_t^h + \\ & \sum_{p=0}^P \beta_p^h \ln \Delta \text{cases}_{i,t-p} + \sum_{p=0}^P \delta_p^h \text{lock}_{i,t-p} + \sum_{p=0}^P \gamma_p^h \text{lock}_{i,t-p} \times x_{i,t-p} + \\ & \sum_{p=1}^P \rho_p^h \text{mob}_{i,t-p} + \varepsilon_{i,t+h} \quad (2.5) \end{aligned}$$

where  $x_{i,t-p}$  is, alternatively, population density as of 2019 or rule of law as of 2018. Similarly, social capital could change the impact of voluntary social distancing on mobility. The analysis then tests if trust and altruism affect the results by estimating the following specification:

$$\begin{aligned} \text{mob}_{i,t+h} = & \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta \text{cases}_{i,t-p} + \sum_{p=0}^P \delta_p^h \text{lock}_{i,t-p} + \\ & \sum_{p=0}^P \gamma_p^h \ln \Delta \text{cases}_{i,t-p} \times x_{i,t-p} + \sum_{p=1}^P \rho_p^h \text{mob}_{i,t-p} + \varepsilon_{i,t+h} \quad (2.6) \end{aligned}$$

where  $x_{i,t-p}$  now is, alternatively, an indicator of trust or altruism as of 2012. The results in Figure 2.3.5 and Figure 2.3.6 indicate that the impact of lockdowns and voluntary social distancing are not statistically different in countries with different population densities, strength of rule of law, and levels of trust and altruism. Thus, the results presented in the chapter extend to countries that are different in these characteristics.

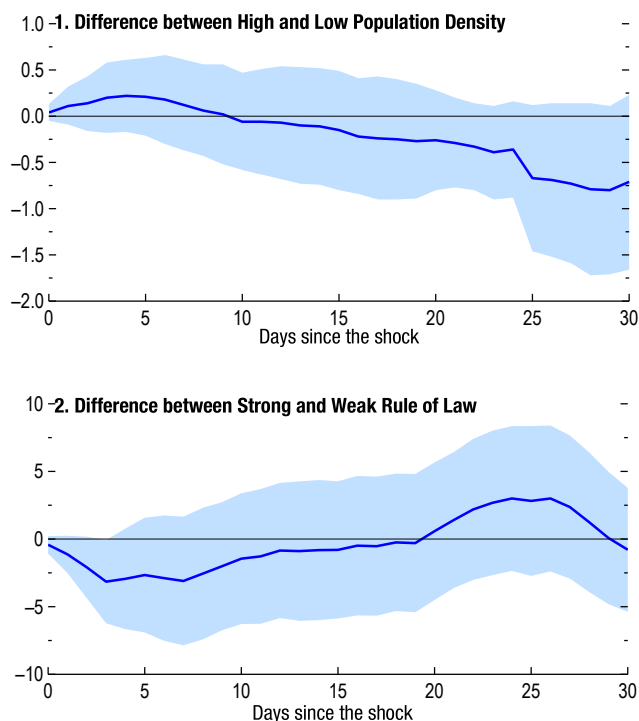
**Annex Figure 2.3.4. The Impact of Lockdowns and Voluntary Social Distancing on Mobility, Controlling for Public Information Campaigns, Testing, and Contact Tracing (Percent)**



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

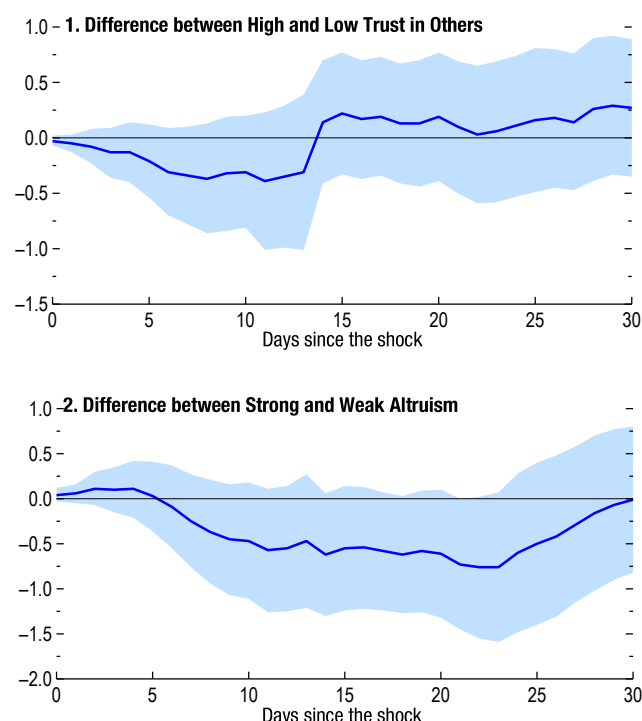
**Annex Figure 2.3.5. Differences in the Impact of Lockdowns on Mobility (Percent)**



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

**Annex Figure 2.3.6. Differences in the Impact of Social Distancing on Mobility (Percent)**



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

## Contributions

The analysis decomposes the decline in mobility due to the tightening of lockdown measures and to voluntary distancing during the first 90 days of the pandemic. Lockdowns and voluntary distancing are likely to have a different impact depending on many factors, including the prevalence of teleworking, the share of people that do not depend on labor income (e.g., retirees), the presence of contactless delivery services, the amount of personal savings, among others. To capture some of these nuances, the specification in equation (2.3) is amended to allow the coefficients of the variables of interest (i.e., the lockdown stringency index and the stage of the pandemic) to depend on the country group:

$$\begin{aligned} mob_{i,t+h} = & \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta cases_{i,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + AE_i \times \\ & (\sum_{p=0}^P \beta_p^{h,AE} \ln \Delta cases_{i,t-p} + \sum_{p=0}^P \delta_p^{h,AE} lock_{i,t-p}) + EM_i \times (\sum_{p=0}^P \beta_p^{h,EM} \ln \Delta cases_{i,t-p} + \\ & \sum_{p=0}^P \delta_p^{h,EM} lock_{i,t-p}) + \sum_{p=1}^P \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (2.7) \end{aligned}$$

where  $AE_i$  and  $EM_i$  are dummy variables identifying 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  $\delta_0^h$ .

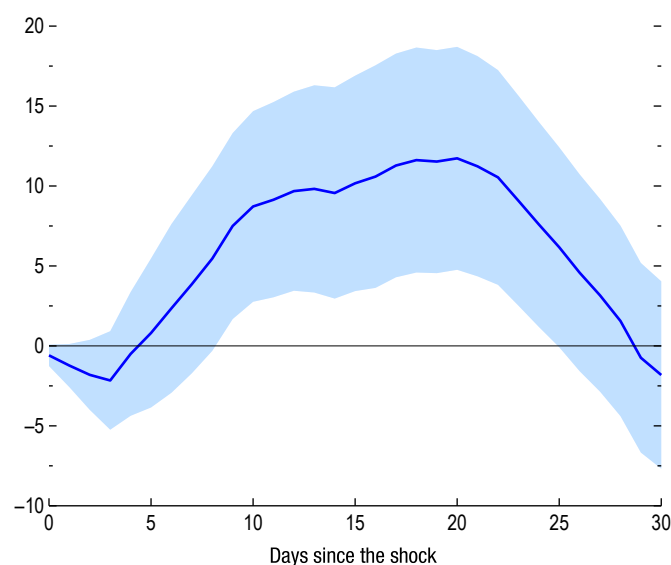
The contributions of lockdowns and voluntary distancing to the decline in mobility are then calculated as follows:

$$C_i^x = \bar{F}^{x,g} \bar{x}_i \quad (2.84)$$

where  $C_i^x$  is the contribution of variable  $x = \{\ln \Delta \text{cases}, \text{lock}\}$  to the decline in mobility observed in country  $i$ ;  $\bar{F}^{x,g}$  is the average coefficient over  $h$  horizons of variable  $x$  for country group  $g = \{AE, EM, LIC\}$ , with  $i \in g$ ; and  $\bar{x}_i$  is the average of the variable during the first 90 days of the epidemic. Contributions are then averaged across countries.

Panel 3 of Figure 2.2 of the chapter shows that lockdowns and voluntary social distancing played a similar role in reducing mobility. For the entire sample of 128 countries, the share of the decline attributed to lockdowns is comparable to the one attributed to voluntary distancing. The contribution of voluntary distancing is larger in advanced economies relative to emerging markets and low-income countries.

**Annex Figure 2.3.7. Difference between High and Low National Cases (Percent)**



Source: IMF staff calculations.

Note: The shaded area corresponds to 90 percent confidence interval computed with standard errors clustered at the country level.

### Informing the Recovery

The analysis also examines if the effect of lockdowns depends on the stage of the country's epidemic by estimating a specification featuring an interaction term between the lockdown stringency index and the number of daily COVID-19 cases:

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta \text{cases}_{i,t-p} + \sum_{p=0}^P \delta_p^h \text{lock}_{i,t-p} + \sum_{p=0}^P \gamma_p^h \ln \Delta \text{cases}_{i,t-p} \times \text{lock}_{i,t-p} + \sum_{p=1}^P \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (2.9)$$

where  $\gamma_0^h$  reveals the differential effect of a lockdown conditional on a given number of daily cases.

The results in panel 1 of Figure 2.3 of the chapter show that the impact of lockdowns on economic activity is smaller when cases are relatively higher. A possible interpretation is that, when cases are high, people's behavior is predominantly influenced by the fear of the virus reducing the impact of lockdowns. Figure 2.3.7 shows that the difference between the effects of lockdowns with high and low cases is statistically significant.

In some cases, people might be scrutinizing the spread of the virus at the global level, rather than at the domestic level. To account for that, the interaction term in equation (2.9) is replaced

with the interaction term of the lockdown stringency index with global cases. Results in panel 1 of Figure 2.3.8 corroborate the findings for which lockdowns have a weaker impact on mobility when cases are relatively higher. Panel 2 of Figure 2.3.8 confirms that the interaction term is statistically significant.

Finally, the analysis examines if the effects on mobility from tightening and loosening lockdown restrictions are symmetric. To address this question, the specification in equation (2.3) is modified to allow for an interaction term between the lockdown stringency index and a dummy variable identifying periods in which restrictions were eased:

$$\begin{aligned} \text{mob}_{i,t+h} = & \alpha_i^h + \tau_t^h + \\ & \sum_{p=0}^P \beta_p^h \ln \Delta \text{cases}_{i,t-p} + \\ & \sum_{p=0}^P \delta_p^h \text{lock}_{i,t-p} + D_{i,t}^+ \times \\ & \sum_{p=0}^P \varphi_p^h \text{lock}_{i,t-p} + \sum_{p=0}^P \theta_p^h D_{i,t}^+ + \\ & \sum_{p=1}^P \rho_p^h \text{mob}_{i,t-p} + \varepsilon_{i,t+h} \quad (2.10) \end{aligned}$$

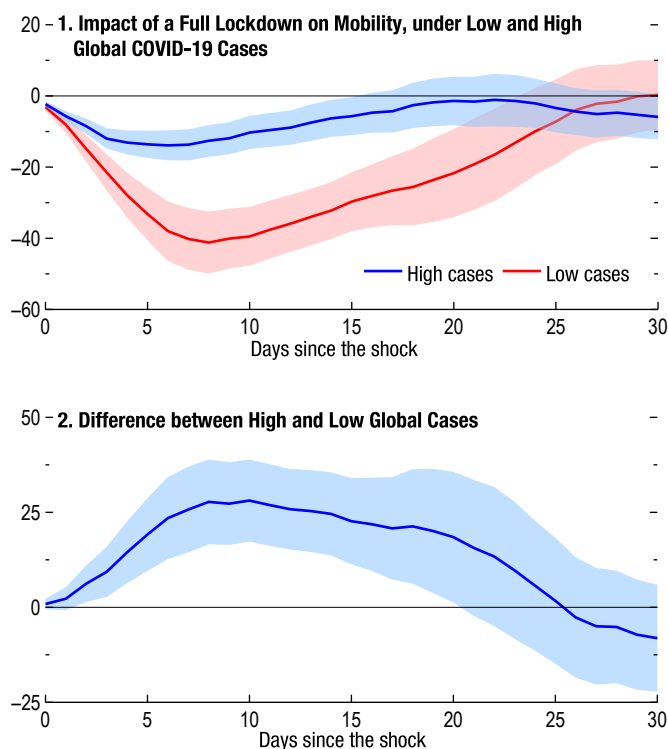
where  $D_{i,t}^+$  is a dummy that takes value one if the seven-day moving average of the change in lockdown stringency is positive and zero otherwise. All periods without a change in stringency following a tightening (loosening) are considered a tightening (loosening) period.<sup>6</sup> The impact of lifting restrictions can be obtained as  $\delta_0^h + \varphi_0^h$ .

The results in panel 2 of Figure 2.3 of the chapter illustrate that tightening and loosening lockdown measures 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. Figure 2.3.9 confirms that the lockdown effects on mobility from tightening and loosening are statistically different from each other.

## Job Postings

To analyze the dynamic response of job postings to the adoption of lockdowns, the analysis relies on the same empirical approach used in Section 2.3. The empirical specification mimics

**Annex Figure 2.3.8. Impact of a Full Lockdown on Mobility (Percent)**



Source: IMF staff calculations.

Note: The shaded areas in panels 1 and 2 correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

<sup>6</sup> The use of a moving average should reduce the chances of interpreting a small increase (decrease) in the lockdown stringency index as a tightening (loosening) during a loosening (tightening) phase.

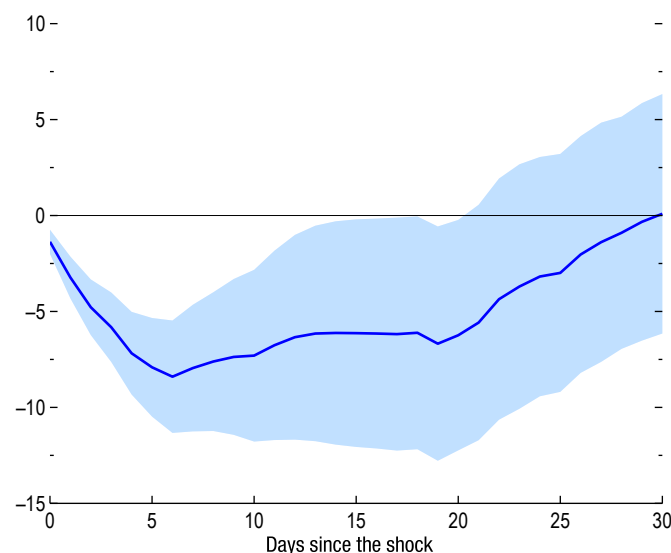
equation (2.3), but in this case the dependent variable is the log of the stock of job postings instead of mobility. The impulse response functions are estimated with data for 22 countries from January 1 to June 28, 2020. In line with the analysis of mobility, the specification includes 7 lags of the dependent and independent variables, and country and time fixed effects to control for time invariant country characteristics and global factors. Standard errors are clustered at the country level.<sup>7</sup> The identification assumption is that the coefficient on the number of COVID-19 cases captures the extent of voluntary social distancing, so that the coefficient on the index of lockdown stringency traces the effect of tighter lockdowns.

Figure 2.4 of the chapter shows that lockdowns have a negative and significant effect on job postings. The estimates in panel 1 suggest that a full lockdown is associated with a decline in job postings of about 12 percent two weeks after the introduction of the lockdown. The negative effect is robust to dropping one country at the time, but the point estimate declines materially if New Zealand is excluded. Voluntary social distancing also plays a role. Doubling COVID-19 cases leads to a 2 percent decline in job postings after 30 days, as shown in panel 2. Following the procedure explained in Section 2.3, these estimates can be used to compute the contributions of each variable to the decline in job postings observed during the first 90 days of the countries' epidemics. Panel 3 shows that both lockdowns and voluntary social distancing contributed to the drop in job postings. Consistent with the results based on mobility, the contribution of voluntary social distancing is particularly large since the sample is mostly based on advanced economies.

### **Analysis of Sectoral Job Postings**

To shed further light on the role played by lockdowns and voluntary social distancing, the analysis compares the dynamics of job postings in contact-intensive sectors—food, hospitality and personal care—to that of less-contact intensive ones—manufacturing. To do that, an event study around the time of the introduction of national-stay-at-home orders is implemented. The sample considers all countries that introduced national stay-at-home orders.

**Annex Figure 2.3.9. Difference between Lockdown Tightenings and Loosenings (Percent)**



Source: IMF staff calculations.

Note: The shaded area corresponds to 90 percent confidence interval computed with standard errors clustered at the country level.

<sup>7</sup> The results are robust to correcting the standard errors for cross-sectional dependence via the Driscoll-Kraay (1998) procedure.

Figure 2.5 of the chapter presents the results of the event study. In panel 1, 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. Job postings in contact-intensive sectors started to decline a few weeks before the introduction of stay-at-home orders, suggesting the importance of fear and hence of voluntary social distancing in these segments of the economy. The decline of job postings in the manufacturing sector coincided instead 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.<sup>8</sup>

A second exercise focuses on the dynamics of job postings around the time of reopening. In panel 2, time zero denotes the time at which stay-at-orders are lifted. The chart shows that lifting lockdown restrictions led also to marginal recovery in job postings. This suggests that simply raising lockdown restrictions is unlikely to provide a sharp boost to the economy until the virus is successfully contained.

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<sup>8</sup> Results are similar if the series are purged of the sector and country specific time-invariant characteristics.

## Annex 2.4. The Unequal Effects of Lockdowns Across Gender and Age Groups

To test whether lockdowns have unequal effects across gender and age groups, a regression discontinuity (RD) approach is adopted in a similar spirit to Davis (2008), Anderson (2014), and Chetty et al. (2020). With respect to a standard cross-sectional RD setting, in this case the running variable is time, with the treatment date as threshold, making this approach akin to an event study exercise. As in more standard RDs, endogeneity is addressed by considering a narrow bandwidth (in this case a time window) around the introduction of the treatment. Within this interval, unobserved confounding factors affecting the outcome variable are likely to be similar.<sup>1</sup>

### Gender

The analysis studies the impact of lockdowns across gender by focusing on the mobility of people aged 25-44, since they are more likely to have young kids and hence be affected by schools' closures. Specifically, the variable of interest is the share of Vodafone customers leaving their homes in a given day disaggregated by gender. The baseline analysis considers a window of 30 days. The series are orthogonalized with respect to day-of-week and province fixed effects.

Panel 1 of Figure 2.6 of the chapter reports a binned scatterplot where each dot represents the mean of the data calculated within 20 equally sized bins and the treatment is the introduction of national stay-at-home orders. The fitted lines are obtained for each group in the pre and post stay-at-home periods. The results suggest that the introduction of national-stay-at-home orders led to a sharp drop in the share of people moving both for men and women. Yet, the share of women moving dropped by a larger extent, with the difference being as large as 2 percent.

To test whether the difference in the mobility drop between men and women is statistically significant, the analysis uses the following local linear regression based on Anderson (2014):

$$PercPeopleMov_{pcgt}^{25-44} = \alpha_p + \tau_{dow} + \beta StayHome_{ct} + \gamma Date_t + \theta StayHome_{ct} * Date_t + \phi Female + \lambda Female * StayHome_{ct} + \nu Date_t * StayHome_{ct} + \psi Female * Date_t + \varepsilon_{pcgt} \quad (2.11)$$

where  $PercPeopleMov_{pcgt}^{25-44}$  is the percent of people moving in the age group 25-44 in province  $p$ , in country  $c$ , for gender  $g$ , at time  $t$ ;  $StayHome_{ct}$  is the treatment variable, equal to one when the national stay-at-home orders are in place;  $Date_t$  is the number of days since the beginning of the stay-at-home-order; and  $\alpha_p$  and  $\tau_{dow}$  are province and days of the week fixed effects. The coefficient  $\beta$  captures the effect for men, while  $\lambda + \beta$  traces the effect for women. Standard errors are clustered at the province level.

Table 2.4.1 reports the results for the baseline model in Column (1). Consistent with the graphical evidence, mobility of women drops by 2 percent more than men, and the difference is statistically significant. The rest of Table 2.4.1 presents some robustness exercises. In Column (2), the estimation is restricted to the age group 45-64, which includes individuals that are less likely to have young kids. The effect is still significant, but smaller—equal to about 1 percent. In

<sup>1</sup> For a comprehensive review of RD in time see Hausman and Rapson (2008).



Column (3), the sample is restricted to Italy and Spain and the difference between men and women is equal to 3 percent. Finally, changing the bandwidth around the treatment to 20 days does not affect the results, as shown in Column (4).

**Annex Table 2.4.1. Effect of Stay-at-Home Orders on Percent of People Moving by Gender – Linear Interacted Model**

	(1)	(2)	(3)	(4)
	Percent of people moving	Percent of people moving	Percent of people moving	Percent of people moving
National stay at home	-0.180*** (0.006)	-0.174*** (0.005)	-0.198*** (0.006)	-0.148*** (0.006)
Date	-0.002*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)	-0.004*** (0.000)
National stay at home x Date	-0.002*** (0.000)	-0.001*** (0.000)	-0.002*** (0.000)	-0.002*** (0.000)
National stay at home x Date x Female	0.001*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Female	-0.035*** (0.004)	-0.036*** (0.003)	-0.035*** (0.005)	-0.036*** (0.004)
National stay at home x Female	-0.023*** (0.004)	-0.014*** (0.003)	-0.024*** (0.004)	-0.026*** (0.004)
Date x Female	-0.001*** (0.000)	-0.000*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
Observations	21,913	21,910	18,863	14,787
R-squared	0.830	0.830	0.808	0.834
NUTS3 FE	Yes	Yes	Yes	Yes
Days of week FE	Yes	Yes	Yes	Yes
Sample	25-44	45-64	25-44, no PRT	25-44, 20 days
Lockdown effect female	-0.203	-0.188	-0.222	-0.174
Lockdown effect male	-0.180	-0.174	-0.198	-0.148

Source: IMF staff calculations.

Note: Standard errors clustered at the province level in parentheses. \* p < .10; \*\* p < .05; \*\*\* p < .01.

The analysis then re-examines the difference in mobility between men and women by restricting the sample to five northern Italian regions where local schools closed before stay-at-home orders. Panel 2 of Figure 2.6 of the chapter presents the results of this exercise, where the first discontinuity is set on February 23<sup>rd</sup>, the date of the local schools' closure, and the second one on March 10<sup>th</sup>, when the national lockdown is implemented. The divergence in mobility between men and women starts to appear around the time of school closures, consistent with the idea that women carry a greater share of childcare responsibilities.

## Age Groups

Finally, the analysis looks at the differential effects of lockdowns across age groups. Panel 3 of Figure 2.6 in the chapter shows that the mobility of all age groups drops at the time of the national stay-at-home orders, however the drop for individuals aged 18-24 is particularly sharp. It also reveals that the mobility of individuals aged 65+ was already significantly lower prior to lockdowns. To test more formally the impact of lockdowns on age groups, the following specification is estimated separately for each age group, with standard errors clustered at the province level:

$$PercPeopleMov_{pct}^{age} = \alpha_p + \tau_{dow} + \beta StayHome_{ct} + \varepsilon_{pct} \quad (2.12)$$

The findings in Table 2.4.2 confirm that people in the age group 18-24 experienced the largest drop in mobility because of lockdowns, close to 30 percent. People in both age groups 25-44

and 45-64 also experienced declines in mobility as large as 20 percent, whereas people aged 65+ saw their mobility decline by 19 percent. The coefficient estimates on the treatment variable are also reported in Figure 2.4.1, which shows that the magnitude of the negative effect becomes smaller for older age groups.

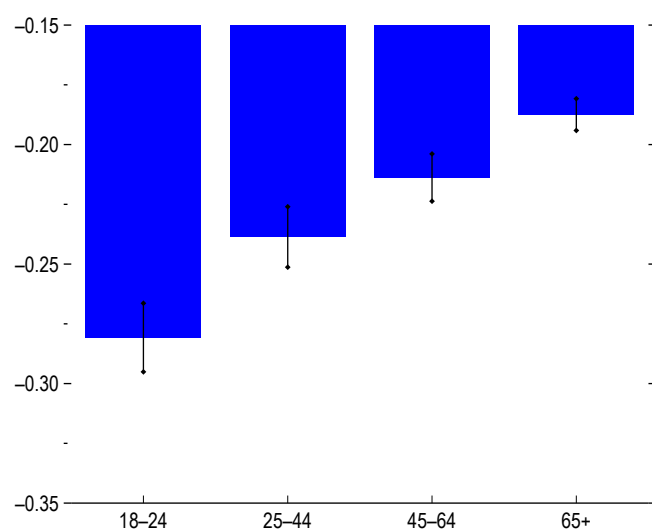
**Annex Table 2.4.2. Impact of Stay-at-home Orders on Different Age Groups**

	(1)	(2)	(3)	(4)
	Percent of people moving	Percent of people moving	Percent of people moving	Percent of people moving
National stay at home	-0.281*** (0.007)	-0.239*** (0.006)	-0.214*** (0.005)	-0.187*** (0.003)
Observations	60,175	60,563	60,543	55,951
R-squared	0.760	0.732	0.723	0.615
NUTS3 FE	Yes	Yes	Yes	Yes
Days of week FE	Yes	Yes	Yes	Yes
Sample	18-24	25-44	45-64	65+

Source: IMF staff calculations.

Note: Standard errors clustered at the province level in parentheses. \*  $p < .10$ ; \*\*  $p < .05$ ; \*\*\*  $p < .01$ .

**Annex Figure 2.4.1. Impact of Stay-at-Home Orders on Different Age Groups**  
(Percent)



Source: IMF staff calculations.

Note: The blue bars denote the point estimates and the black lines correspond to the 90 percent confidence intervals computed with standard errors clustered at the province level.

## Annex 2.5. Infections

### The Impact of Lockdowns on COVID-19 Infections

The final section of the chapter examines if countries that adopted lockdown measures experienced less COVID-19 infections. Formally, the following specification is estimated with data for 77 countries since the beginning of January:

$$Incases_{i,t+h} - Incases_{i,t-1} = \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h X_{i,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + \sum_{p=1}^P \rho_p^h \Delta Incases_{i,t-p} + trend_i^h + trend_i^{2,h} + \varepsilon_{i,t+h} \quad (2.13)$$

where  $X_{i,t-p}$  is a vector of controls including the average temperature and humidity in the country, as well as indicators for whether public information campaigns are carried out and if massive testing and contact tracing policies are in place; and  $trend_i^h$  and  $trend_i^{2,h}$  are the country-specific linear and quadratic trends.

The results in panel 1 of Figure 2.7 of the chapter indicate that COVID-19 cases start declining 3 to 4 weeks after the adoption of a lockdown, relative to a no-lockdown scenario. This time lag between the tightening of the lockdown measures and the decline in cases is consistent with the incubation period, the testing, and the time needed to obtain and record the test results. After a month, cases are about 38 percent lower.

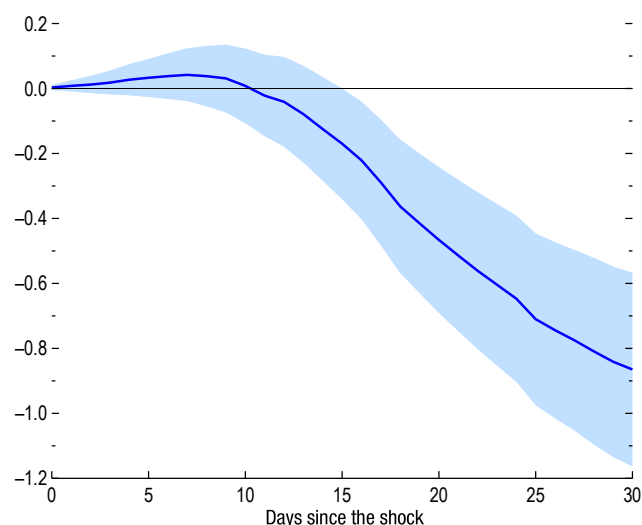
To improve the identification of the impact of lockdowns, the analysis employs subnational data for 339 units in 15 G20 countries, mimicking the approach described for mobility:<sup>1</sup>

$$Incases_{j,t+h} - Incases_{j,t-1} = \alpha_j^h + \tau_t^h + \sum_{p=0}^P \delta_p^h lock_{j,t-p} + \sum_{p=1}^P \rho_p^h \Delta Incases_{j,t-p} + trend_j^h + trend_j^{2,h} + \varepsilon_{j,t+h} \quad (2.14)$$

where controls are dropped as they are not available at the subnational level. It should be noted that, as in the analysis of mobility with subnational data, 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 are excluded from the sample.

The results based on subnational-level data in Figure 2.5.1 corroborate the results

**Annex Figure 2.5.1. Response of COVID-19 Infections to a Full Lockdown, Subnational Data (Percent)**



Source: IMF staff calculations.

Note: The shaded area corresponds to 90 percent confidence interval computed with standard errors clustered at the subnational level.

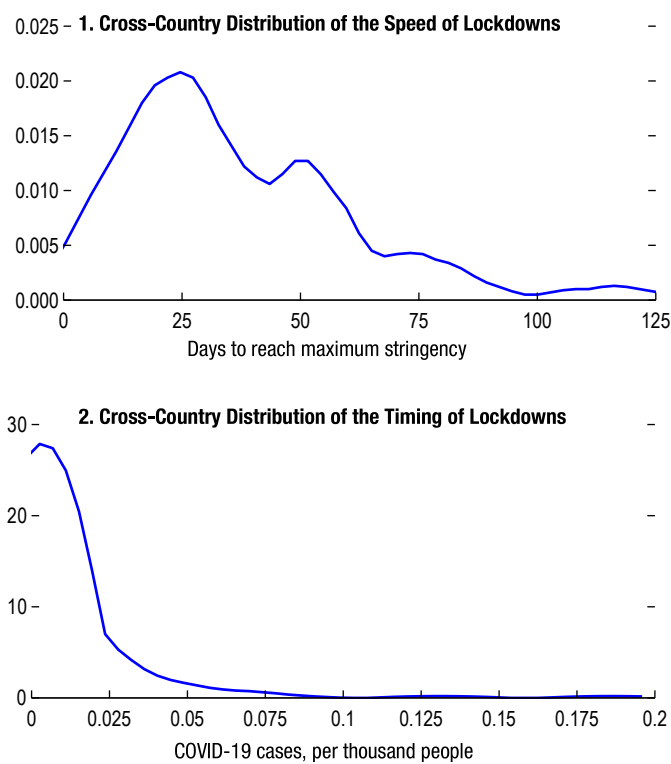
<sup>1</sup> The sample is restricted to G20 countries that adopted national lockdown measures and that provide regionally disaggregated data. The analysis considers only subnational entities that experienced at least one COVID-19 case.”

using national-level data, albeit estimates are larger. After a month since the adoption of a lockdown, COVID-19 cases in subnational units under a national lockdown are 58 percent lower than in subnational units without a lockdown.

### Early and Late Lockdowns

From a policy perspective, it is relevant to understand if countries that adopted lockdown measures early in the pandemic managed to control the spread of the virus better than countries that waited until the number of cases was higher. To differentiate across early and late adopters, the analysis employs two alternative criteria. The first criterion looks at the number of days that went by since the country registered the first COVID-19 case until the moment in which the country reached its maximum lockdown stringency. The second criterion is based on the number of weekly cases at the time in which the maximum lockdown stringency was reached.

**Annex Figure 2.5.2. Speed and Timing of Lockdowns**  
(Density)



Source: IMF staff calculations.

Note: The x-axis in panel 1 denotes the number of days between the first COVID-19 case and the day in which maximum lockdown stringency was reached. The x-axis in panel 2 denotes the COVID-19 cases the day in which maximum stringency was reached.

As shown in panel 1 of Figure 2.5.2, there is a large cross-country heterogeneity in terms of how quickly lockdown measures were tightened. One fourth of the countries tightened lockdown measures within 20 days and half of the countries within a month. It took between a month and a half and four months to tighten lockdown measures for the rest of the countries. However, this also reflects how quickly the virus spread in the population. Panel 2 of Figure 2.5.2 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 sample of countries with respect to the median of the distributions in Figure 2.5.2. The results in panels 2 and 3 of Figure 2.7 in the chapter indicate that countries that tightened lockdown measure early in the pandemic—both with respect of the time needed to reach the maximum stringency and the number of cases at the time in which maximum stringency was reached—had considerably less COVID-19 infections per thousand people than countries that waited until the number of cases was higher to adopt lockdowns.

## Annex 2.6. Individual Lockdown Measures and Nonlinear Effects

The stringency index from the University of Oxford combines a broad range of measures, including school closures, workplace closures, stay-at-home orders, public event cancellations, gathering restrictions, public transportation closures, internal movement restrictions, and international traveling controls. As shown in panel 1 of Figure 2.8 in the chapter, these measures are often introduced in a rapid succession, and this complicates the assessment of the effectiveness of each individual measure due to collinearity.

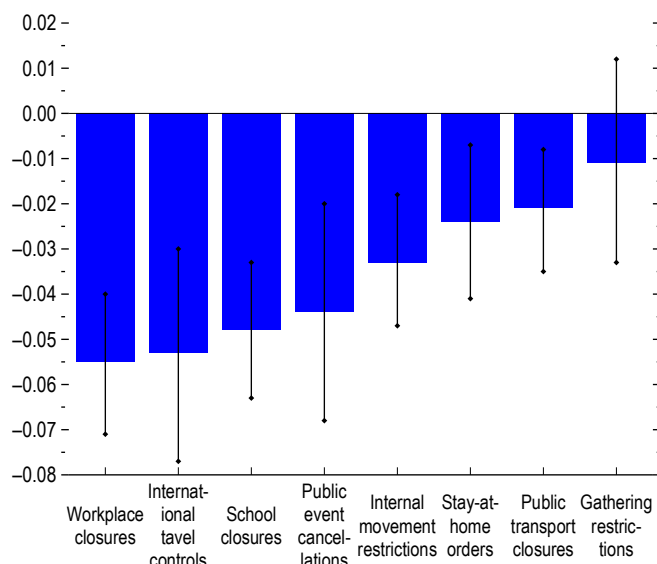
A regression specification that features all the lockdown measures as independent variables would generally capture the marginal effects of a measure conditional on those that have been adopted beforehand. For example, replacing the lockdown stringency index in equation (2.3) with the (rescaled) indices for each individual lockdown measure produces the results in Figure 2.6.1.<sup>1</sup> As expected, 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.<sup>2</sup>

The analysis proceeds to examine nonlinearities in the effects of lockdowns on mobility. This is done by introducing in equation (2.3) quadratic terms of the lockdown stringency:

$$mob_{i,t+h} = \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h \ln \Delta cases_{i,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + \sum_{p=0}^P \omega_p^h lock_{i,t-p}^2 + \sum_{p=1}^P \rho_p^h \Delta \ln cases_{j,t-p} + \sum_{p=1}^P \rho_p^h mob_{i,t-p} + \varepsilon_{i,t+h} \quad (2.15)$$

The results shown in panel 2 of Figure 2.8 in the chapter suggest that introducing new lockdown measures (or tightening existing ones) when other measures are already in place has a weaker effect on mobility compared to introducing them when there are less (or looser)

**Annex Figure 2.6.1. Impact of Lockdown Measures on Mobility (Percent)**



Source: IMF staff calculations.

Note: The bars report the largest negative coefficients over a 30-day projection horizon. The vertical lines correspond to 90 percent confidence intervals computed with standard errors clustered at the country level.

<sup>1</sup> The indices of the lockdown measures provided by the Oxford COVID-19 Government Response Tracker are ordinal indicators where policies are ranked on a numerical scale. Since different indicators have different maximum values in their ordinal scales, each index is rescaled between zero and 100.

<sup>2</sup> This framework could in principle 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.

lockdown measures in place. The quadratic term is positive and statistically significant at various horizons.

The analysis then examines the same question with respect to epidemiological outcomes. Equation (2.13) is modified to include the squared term of lockdown stringency:

$$\ln cases_{i,t+h} - \ln cases_{i,t-1} = \alpha_i^h + \tau_t^h + \sum_{p=0}^P \beta_p^h X_{i,t-p} + \sum_{p=0}^P \delta_p^h lock_{i,t-p} + \sum_{p=0}^P \omega_p^h lock_{i,t-p}^2 + \sum_{p=1}^P \rho_p^h \Delta \ln cases_{i,t-p} + trend_i^h + trend_i^{2,h} + \varepsilon_{i,t+h} \quad (2.16)$$

The results presented in panel 3 of Figure 2.8 in the chapter indicate that lockdown measures have an impact on infections if they are introduced on top of existing ones. The quadratic term is negative and statistically significant at various horizons.

Taken together, these results suggest that tighter lockdowns appear to entail modest additional economic costs while bringing considerable benefits in containing the virus.