BOX 3.2 How do disasters affect productivity?

Epidemics that occurred since 2000 are estimated to have lowered labor productivity by a cumulative 6 percent after five years, mainly through their adverse impact on investment and the labor force. In contrast, severe climate events tend to be of shorter duration and reduce labor productivity mainly through weakened total factor productivity. Severe disasters have disproportionately deeper negative effects on productivity partly because they have been more likely to trigger financial stress. Given its global nature, COVID-19 may lead to sizable adverse cross-border spillovers and weaken global value chains, which will further damage productivity. The immediate policy focus is to address the health crisis but policymakers also need to introduce reforms to rekindle productivity growth once the health crisis abates.

Introduction

Prior to the emergence of COVID-19, there were already concerns about the prospects for long-term productivity growth in emerging market and developing economies (EMDEs) and the achievement of development goals, especially the reduction of poverty. COVID-19 has put these goals in even greater jeopardy (World Bank 2020e). In less than half a year since its start, COVID-19 already ranks as a major disaster (Figure 3.2.1). Since pandemics are rare events, this box sheds light on the effects of COVID-19 on labor productivity by examining severe disasters (including epidemics, climate disasters, and wars) since 1960.

Natural disasters (such as biological, climate, and geophysical events), and wars have caused significant economic damage.[1] Past severe disasters (more than 100 deaths per million people) are relevant for gauging the likely effects of COVID-19 on labor productivity and understanding the channels through which disasters may affect the economy. The box examines three questions:

- What are the main channels through which severe disasters affect productivity?
- What are the frequency and extent of severe disasters?
- What are the likely implications of severe disasters for productivity?

Channels through which severe disasters affect productivity

Severe disasters, such as pandemics, epidemics, severe climate disasters, and wars, can affect productivity and long-term growth through supply- and demand-side channels.

Disasters can impact supply through:

- *Depleted labor force and human capital.* Major disasters can disrupt the functioning of labor markets by making it difficult for workers to get to their places of employment or (in the case of infectious diseases) work in close physical proximity with each other, or by causing widespread sickness, injuries and fatalities that directly reduce the labor supply (Field 2019; Ksoll, Macchiavello, and Morjaria 2010; and Mueller 2013). These disruptions undermine the productivity of those remaining in the workforce owing to the loss of complementary skills. Unexpected adverse events that affect large geographic areas have been shown to have lasting consequences on human capital formation (health, education and nutrition outcomes) regardless of the income group.[2]
- *Destruction and misallocation of physical capital.* Severe climate and geophysical disasters tend to reduce and degrade the capital stock, and can lead to a misallocation of capital which can weigh on productivity (Hallegatte and Vogt-Schilb 2019). Disasters more generally can hold back growth-enhancing investment—including by damaging the outlook for activity and profitability, increasing uncertainty, triggering capital flight, and tightening credit conditions (Collier 1999; Hutchinson and Margo 2006). By magnifying economic uncertainty, disasters can also cause a misallocation of investment (Claessens et al. 1997; Claessens and Kose 2017, 2018).
- *Disruption of supply chains and innovation.* Major disasters can damage global value chains.[3] They also

Note: This box was prepared by Alistair Dieppe, Sinem Kilic Celik, and Cedric Okou, with research assistance from Yi Li, Kaltrina Temaj, and Xinyue Wang.

[1] Natural disasters include climate (floods, cyclones), biological (epidemics, insect infestation), and geophysical disasters (earthquakes, volcanoes), and follow EM-DAT definitions.

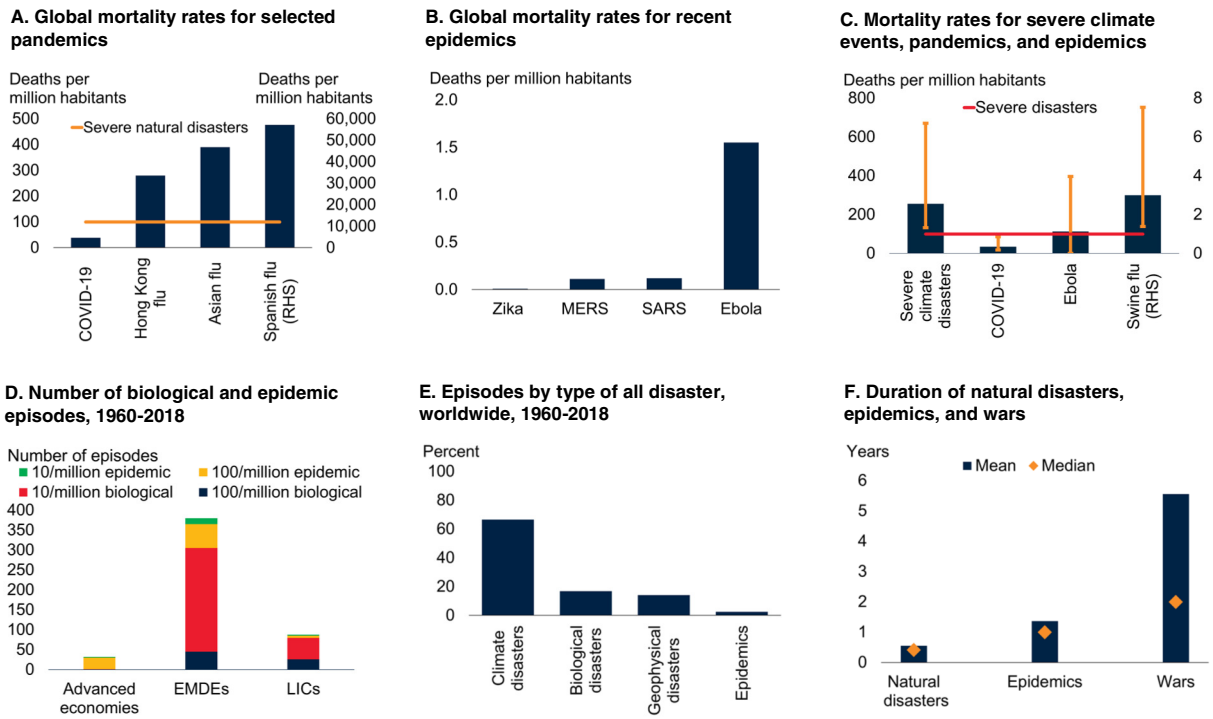
[2] See Acevedo et al. (2018), IMF (2017), and Thomas and López (2015). Biological epidemics can also disproportionally affect low-skilled workers and raise inequality (Furceri et al. 2020).

[3] See Collier (1999), Reynaerts and Vanschoonbeek (2018), and Rodrik (1999).

BOX 3.2 How do disasters affect productivity? *(continued)*

FIGURE 3.2.1 Severity, frequency, and duration of pandemics, epidemics, and climate disasters

In less than half a year, COVID-19 already ranks as a major disaster. In the most severely affected countries, its impact may be as large as those from a severe climate disaster, which typically results in mortality rates of over 100 per million of the population. Climate disasters were the most frequent type of natural disaster in 1960-2018, accounting for nearly 70 percent of all disasters. Epidemics and wars are much rarer although their duration is longer. About 20 percent of biological disasters that have affected EMDEs and LICs have been severe and resulted in death ratios of over 100 per million (0.01 percent) of the population.



Source: Centers for Disease Control and Prevention; Correlates of War; EM-DAT; Johns Hopkins University; OurWorldInData.org; Peace Research Institute Oslo; United Nations; World Bank; World Health Organization.

A.-C. Cumulative deaths per million habitants worldwide. Last observation of death toll for COVID-19 is May 14, 2020. Severe climate disasters are defined as events that led to at least 100 deaths per million population.

C. Blue bars indicate the medians of mortality rates across affected countries. The bottom (top) of the yellow line represents the 1st (3rd) quintile. Red marker indicates 100 deaths per million habitants.

D.-F. Natural disasters include climate (floods, cyclones), biological (epidemics, insect infestation), and geophysical (earthquakes, volcanoes) disasters, and follow EM-DAT definitions. Wars are identified using the World Bank's Correlates of War database. The sample includes 170 economies: 35 advanced economies and 135 EMDEs, of which 27 are low-income countries.

E. Biological disasters include epidemics.

F. The five pandemics and epidemics considered are SARS (2002-03), MERS (2012), Ebola (2014-15), and Zika (2015-16) .

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undermine the incentives to invest in R&D and new technologies, including by triggering wide-scale institutional dysfunction, weakening property rights, and increasing costs of doing business. Capital outflows tend to be associated with drops in inward foreign direct investment, which can be an important source of technology transfer. Containment efforts during biological events—such as workplace closures and quarantines—can further limit the diffusion of technologies.

Disasters can also impact demand through:

- *Lower business investment.* Short-term projections of demand and economic activity tend to be scaled back and business uncertainty to increase sharply following

BOX 3.2 How do disasters affect productivity? *(continued)*

major disasters, while financial conditions tighten, including in response to increased risk aversion. These typically cause a sharp drop in investment demand. A more prolonged disaster, even at the same magnitude, results in higher uncertainty. This causes firms to delay or deter investments and thereby compounding the negative economic effects of disasters (Bloom 2014; Baker, Bloom, and Terry 2019; and Bloom et al. 2018). The more severe the disaster, the larger the uncertainty (Ludvigson, Ma, and Ng 2020). Model-based estimates by Baker et al. (2020) suggest that increased uncertainty accounts for half of the output loss in the United States in early 2020.

- *Weaker consumer demand.* Job losses, reduced income, increased cost of debt service, higher uncertainty, the forced closure of marketing outlets, and, in the case of diseases, fear of infection, all tend to cause consumers to reduce their spending on goods and services and to increase saving rates. Furthermore, effects on consumer behavior could be long-lasting—for example, a pandemic could cause households to reduce their demand, over an extended period, for travel, tourism, eating out, entertainment, and other activities involving human interaction, and to increase their saving in the absence of close substitutes.

Frequency and short-term effects of disasters

This section briefly reviews the experience of severe disasters over the past 60 years for insights into the main channels through which they impact productivity. Pandemics, epidemics and wars are rare events although they last longer than other types of disasters. Biological disasters and geophysical disasters are more common. Climate disasters (such as storms, floods, droughts, and periods of extreme temperature) occur more often but typically last for less than six months. All these events are associated with weaker productivity over long time spans.

Pandemics. The Spanish flu (1918-19) has an unusually high death toll and mortality rate, killing between 20-100 million people globally. Other, more recent, pandemics had far lower mortality rates. They included the Hong Kong flu (1968-69) and the Asian flu (1957-58), with nearly 300 and 400 deaths per million, respectively. This was followed by swine flu (2009-10), with 11 deaths per million globally (Figure 3.2.1). COVID-19 is the most severe pandemic since the Hong Kong flu, despite the unprecedented mitigation efforts that have been implemented.

Epidemics since the 2000s. During 2000-18, the world experienced SARS (2002-03), MERS (2012), Ebola (2014-15), and Zika (2015-16). The increased frequency of epidemics increases the likelihood that pandemics will break out. Since 1960, there have been more than 250 episodes of biological disasters with losses of life of over 10 per million population in the countries affected. LICs have been disproportionally affected by these types of disasters, whereas advanced economies were not affected. The frequency of biological episodes has been increasing over time, but they have mostly been contained in size and severity.

Frequent climate disasters. Climate disasters accounted for around 70 percent of natural disasters during 1960-2018, occurring twice as often as other types of natural disasters combined (Figure 3.2.1). However, the frequency of severe climate disasters—defined as causing losses of life exceeding 100 people per million—has stabilized since 2000, perhaps reflecting better mitigation policies in some countries as they have confronted climate change (Figure 3.2.2). Furthermore, climate disasters tend to be short-lived compared to epidemics which on average last twice as long.

Wars. Apart from their direct toll on human life and welfare, wars also have major adverse effects on output and productivity (Abadie and Gardeazabal 2003; Cerra and Saxena 2008). The frequency of wars has dropped over 2000-18, although a typical LIC was twice as likely to experience a conflict as a typical EMDE.[4] The destruction, disruption, and diversion effects of wars can cause sharp reductions in the labor force and physical capital, and also dampen productive investment and innovation.[5]

Damaging severe disasters. Compared to unaffected countries, severe biological disasters are associated with 9 percent lower median labor productivity and 8 percent lower total factor productivity (TFP) three years after the shock (Figure 3.2.2). Severe natural disasters (including climate and biological disasters) also correlate with weaker labor productivity and TFP compared to countries not suffering such disasters. In EMDEs, three years into a

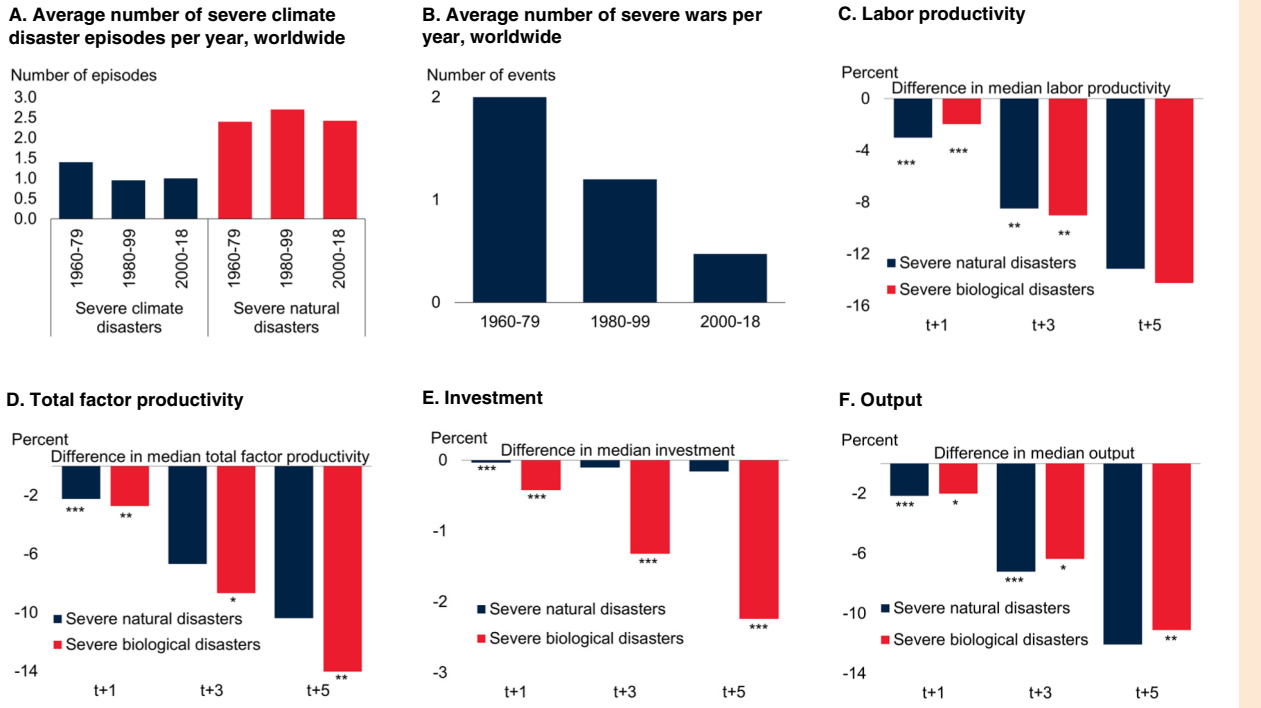
[4] The definition and data for wars are from the Correlates of War database (Singer and Small 1994). The dataset was updated after 2007 using the Peace Research Institute Oslo (PRIO) data (Pettersson, Högbladh, and Öberg 2019). In the database, wars are defined as conflicts with at least 1,000 battle-related deaths.

[5] See Becker and Mauro (2006); Collier (1999); Easterly et al. (1993); Field (2008); Raddatz (2007); and Rodrik(1999).

BOX 3.2 How do disasters affect productivity? *(continued)*

FIGURE 3.2.2 Disasters and productivity

The frequency of the most severe climate disasters stabilized after 2000. In EMDEs, severe natural disasters, especially severe biological disasters, are associated with lower labor productivity. Severe biological disasters are also correlated with lower investment, possibly reflecting a sizable increase in uncertainty that holds off new spending.



Source: EM-DAT; World Bank.

A. B. Natural disasters include climate (floods, cyclones), biological (epidemics, insect infestation), and geophysical (earthquakes, volcanoes) disasters, and follow EM-DAT definitions. Wars include intra-state and external (extra-state and inter-state) wars. Severe climate or natural disasters and severe wars are defined as events that led to at least 100 deaths per million population. The sample includes 170 economies: 35 advanced economies and 135 EMDEs, of which 27 are low-income countries.

C-F. Bars show the difference between the median growth of macroeconomic indicators in EMDEs with and without severe biological disasters (red) and severe natural disasters (blue; including climate, biological, geophysical disasters). A Fisher's test is used to test if medians in two subsamples (with and without disasters) are equal. Severe natural disasters are defined as those that lead to at least 100 deaths per million population. The four biological disasters considered are SARS (2002-03), MERS (2012), Ebola (2014-15), and Zika (2015-16). Swine flu (2009), which coincided with the 2008-09 global financial crisis, is excluded to limit possible confounding effects. ***, ** and * indicates 1, 5, and 10 percent significance levels.

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severe natural disaster episode median labor productivity was around 8 percent lower in the countries affected, and TFP was 7 percent lower than in countries unaffected whereas investment remained virtually unchanged, which could reflect large-scale reconstruction investment offsetting other negative effects.

Long-term effects of severe disasters

To help draw inferences on the possible effects of COVID-19, this section examines the extent different types of disasters such as epidemics, climate disasters, and wars have lasting negative effects on labor productivity. Epidemics are particularly damaging to productivity, lowering it by between 6 percent and 15 percent (if accompanied with recessions) after five years. Climate disasters weaken productivity by between 4 to 8 percent. Wars also affect productivity for a sustained period.

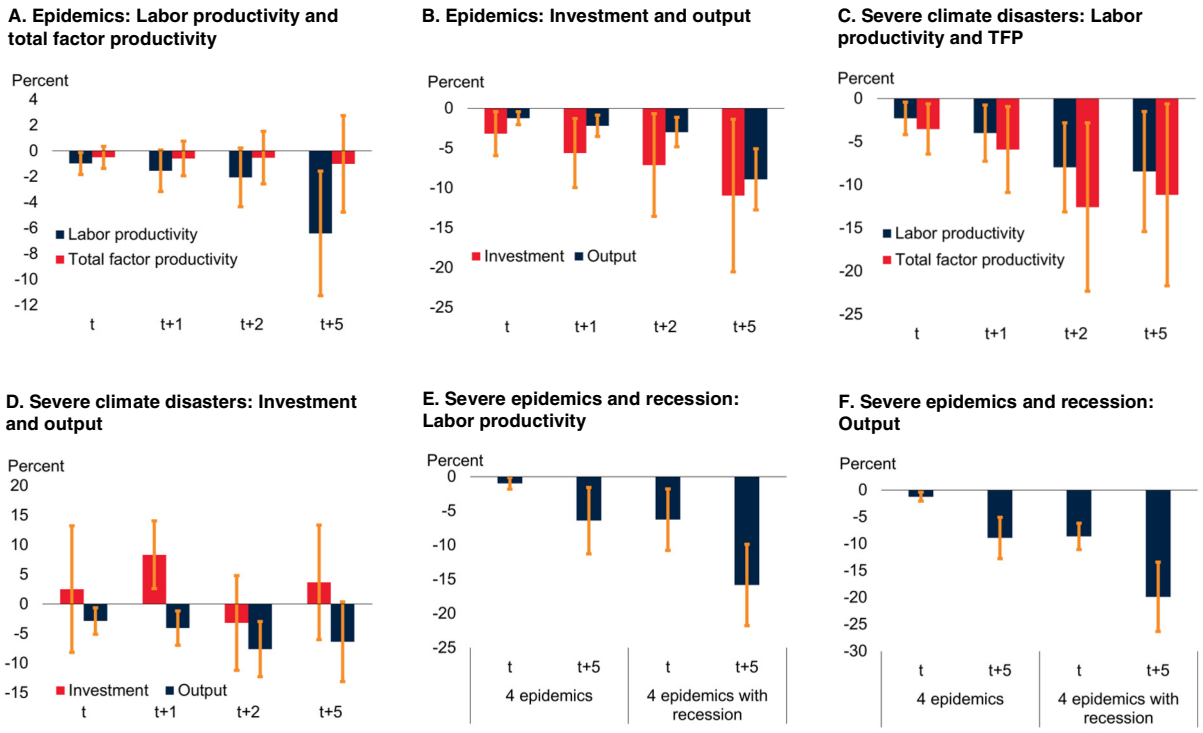
Methodology. The local projection method (LPM) is used to provide a reduced-form estimate of the response of labor productivity to adverse events over various horizons, and to identify key transmission channels through output, investment, and TFP (Jordà, 2005; Jordà, Schularick, and Taylor, 2013).

Adverse effects of epidemics. Results suggest that four epidemics since 2000 (SARS, MERS, Ebola, and Zika)

BOX 3.2 How do disasters affect productivity? *(continued)*

FIGURE 3.2.3 Impact of disasters

Disasters have resulted in considerable losses in output and labor productivity in EMDEs. Severe disasters have larger effects. SARS, MERS, Ebola, and Zika left lasting scars on labor productivity with declines of around 6 percent and larger effects on investment, whereas estimates suggest that total factor productivity hardly declined. The impact of swine flu too was probably large, but impossible to assess because the epidemic overlapped with the 2008-09 global financial crisis. Climate disaster has also led to significant productivity losses, although public and private investment have tended to increase in the short term, reflecting the shorter duration of the shock and reconstruction.



Source: EM-DAT; World Bank.

Note: Orange lines display the range of the estimates with 90 percentile significance.

A.B. Bars show the estimated impacts of the four most severe biological epidemics on output, labor productivity, total factor productivity, and investment levels relative to non-affected economies. The four epidemics considered are SARS (2002-03), MERS (2012), Ebola (2014-15), Zika (2015-16). Swine flu (2009), which coincided with the 2008-09 global financial crisis, is excluded to limit possible confounding effects. The sample includes 116 economies: 30 advanced economies, and 86 EMDEs.

C.D. Bars represents impulse responses of various economic variables to a severe adverse climate event. Severe climate disasters are defined as those that resulted in at least 100 in 1 million population death tolls. The sample includes 116 economies: 30 advanced economies and 86 EMDEs.

E.F. Bars show the estimated impacts of the four most severe biological disasters on labor productivity and output. Orange lines display the range of the estimates with 90 percentile significance. The four epidemics considered are SARS (2002-03), MERS (2012), Ebola (2014-15), and Zika (2015-16). Swine flu (2009-10), which coincided with the 2008-09 global financial crisis, is excluded to limit possible confounding effects.

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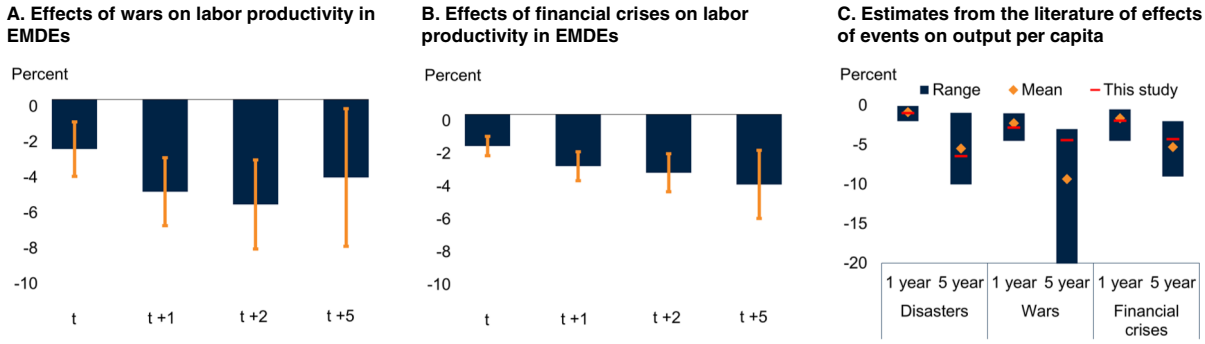
had significant and persistent negative effects on productivity (swine flu is excluded since it coincided with the global financial crisis).[6] These estimates indicate that epidemics led, on average, to a contemporaneous loss of productivity equal to about 1 percent (Figure 3.2.3). After five years, such disasters lowered labor productivity by a

[6] Jordà, Singh, and Taylor (2020) consider major pandemics and find long lasting effects on output. Barro and Ursúa (2008) report that the macroeconomic impact of the Great Influenza Pandemic of 1918 is substantial. Sustained low levels of demand, and excess capacity during disasters, including pandemics, can have persistent effects on productivity (Dieppe, Francis, and Kindberg-Hanlon, forthcoming). Ma, Rogers, and Zhou (2020) focused on the same set of epidemics in 210 countries and found that real GDP in EMDEs is around 2 percent lower, on average, in the first year, and 4 percent lower, on average, after five years. This suggests some uncertainty around the long-run effects.

BOX 3.2 How do disasters affect productivity? *(continued)*

FIGURE 3.2.4 Impact of wars and financial crises on productivity

Wars tend to leave large and persistent productivity losses. Many disasters have been associated with financial crises, which often result in large and persistent losses in labor productivity.



Source: Correlates of War (COW); EM-DAT; Laeven and Valencia (2018); Peace Research Institute Oslo (PRIO); World Bank
Note: Wars include intra-state and external (extra-state and inter-state) wars (COW and PRIO). Financial crisis episodes include banking crisis, currency crisis, and sovereign debt crisis (Laeven and Valencia 2018). Natural disasters include climate, biological, and geophysical disasters (EM-DAT). EMDEs=emerging market and developing economies (including low-income countries), The sample includes 170 economies: 35 advanced economies and 135 EMDEs, of which 27 are low-income countries.
A.B. Blue bars indicate the average impact of the event for each group and orange lines represent the 90 percent significance range.
C. The range of estimates is from the literature.
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cumulative amount of about 6 percent. Over the same horizon, investment declined by nearly 11 percent reflecting heightened uncertainty and risk aversion.

Losses associated with severe climate disasters. In EMDEs, severe disasters (greater than 100 deaths per million) have resulted in considerable losses in output, labor productivity, and total factor productivity. The LPM estimates for climate disasters indicate that labor productivity was lower by 8 percent after five years (Figure 3.2.3, Fomby, Ikeda, and Loayza; 2013). The estimates show that lower labor productivity is mainly accounted for by weaker total factor productivity rather than reduced investment. Possibly because after a severe disaster, firms delay or cancel investment in R&D, which impedes the creation, transfer, and adoption of new technologies and hinders global value chains. On the other hand, reconstruction spending offsets to some extent the negative impact on other capital spending.

The literature finds severe disasters have disproportionately larger economic impacts due to non-linear effects on labor force participation and human capital, particularly amongst younger workers (Cavallo et al. 2013; Hallegatte and Przyluski 2010; Loayza et al. 2012). Furthermore, the cumulative loss of productivity tends to be larger if the disaster lasts for a more extended period—as is the case with biological disasters—or if reconstruction efforts are delayed (Cerra and Saxena 2008; Sawada 2007).[7] Twelve out of around 360 recessions (excluding the 2009 global financial crisis) were associated with severe disasters; 38 were associated with epidemics. In the case of the four major epidemics, the effects associated with recessions are significantly larger on productivity (Figure 3.2.3).[8]

Scarring effects of wars. This is due to the destruction of human and physical capital and reduced total factor productivity. In EMDEs, wars (including internal and external wars) have been especially damaging as they lowered labor productivity by about 4.5 percent after five years (Figure 3.2.4).

[7] The pace of reconstruction may be slowed by financial, physical, and transaction constraints (Hallegatte and Rentschler 2018).

[8] Severe disasters can widen inequalities and exacerbate political tensions in affected countries. Besley and Persson (2011) estimated, for a sample of 97 countries in the period 1950-2005, that severe natural disasters increased the probability of wars by about 4 percentage points. Biological epidemics can also disproportionally affect low-skilled workers and raise inequality (Furceri et al. 2020).

BOX 3.2 How do disasters affect productivity? *(continued)*

Conclusions

The COVID-19 pandemic raises questions about its effects on productivity. Pandemics and epidemics are rare events in comparison to climate disasters and wars, but they have had adverse and persistent effects on productivity. Adverse impacts on productivity increase more than proportionately with the severity and duration of these types of disasters. Severe disasters were lowered labor productivity by 6 percent over the subsequent five years.

The COVID-19 pandemic may have a significantly worse impact on productivity than most previous disasters for three reasons:

- *Global reach.* The COVID-19 pandemic appears to have considerably broader reach—in terms of numbers of both countries and people affected—than other disasters since 1960 (Hassan et al. 2020). The increased integration of the global economy, through trade and financial linkages will amplify the adverse impact of COVID-19.

- *Contagion prevention and physical distancing.* As long as strict social distancing is required, some activities will not be viable. In the hospitality sector, where close socialization is part of the product, the capital stock will become obsolete. Even in less directly affected sectors, severe capacity under-utilization lowers TFP while restrictions to stem the spread of the pandemic remain in place. Disruptions to employment, schooling and other education while restrictions remain in place—or, in the event of severe income losses, even once restrictions are lifted—will also lower human capital and labor productivity (World Bank 2020d).

- *Compounding financial stress.* Financial crises tend to result in especially protracted labor productivity losses (Figure 3.2.4, World Bank 2020f).[9] Larger disasters are more likely to cause a cascade of business and household bankruptcies and hence a systemic financial crisis. Whilst only a few disasters have been associated with financial crises, governments and private sectors entered the COVID-19 pandemic with already-stretched debt burdens (Kose et al. 2020). These have since increased further and heighten risk of a financial crisis should financial conditions tighten further (Ludvigson, Ma, and Ng 2020).

Mitigating factors. In some dimensions, disasters can accelerate productivity-enhancing changes. They can encourage investment in new and more technologically advanced capital and to train more highly skilled workers (Bloom 2014). Moreover, destruction of old capital may lead to new opportunities for green growth with environmentally friendly new investment, especially if it is induced by structural reforms (Strand and Toman 2010). The mitigation measures of COVID-19, including social distancing, may encourage investment in more efficient business practices, including robotics and other digital technologies such as artificial intelligence.[10]

Structural reforms. The negative outlook ahead means that, after addressing the immediate health crisis, countries need to make productivity-enhancing reforms a priority. These include facilitating investment in human and physical capital, as well as in research and development; encouraging reallocation of resources toward more productive sectors; fostering technology adoption and innovation; and promoting a growth-friendly macroeconomic and institutional environment (World Bank 2020f). In addition, raising the quality and effectiveness of governance and improving the business climate can encourage a faster rebound from disasters. Governments that improved labor and product market flexibility, strengthened legal systems and property rights, fostered effective competition, and addressed inequality set the foundations for more effective adjustment to adverse events (Anbarci, Escaleras, and Register 2005).

[9] See Benson and Clay (2004); Blanchard, Cerutti, and Summers (2015); Celiku and Kraay (2017); and Cerra and Saxena (2008, 2017). During 1990-2018, the number of financial crises—sovereign debt, banking, and currency—nearly doubled compared to 1960-1989. Over the past three decades, labor productivity growth halved in advanced economies and slowed, albeit less markedly, in EMDEs.

[10] See Hallward-Driemeier and Nayyar (2017); Hsiang (2010); Skidmore and Toya (2002); and Strobl (2011).The accompanying job losses are likely to be lower-skilled and less productive (Lazear, Shaw, and Stanton 2013). To the extent vulnerable groups are particularly exposed to economic losses from disasters, policies to protect these groups are needed (OECD 2020b).