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COVID-19 AND OTHER PANDEMICS: A LITERATURE REVIEW FOR ECONOMISTS

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ABSTRACT

We provide a comprehensive review of the literature on the economic impact of pandemics and identify the transmission channels at play. The primary channel comes from the supply side, as pandemics reduce both the quantity and the quality of labour. They can also lead to a destruction of capital, as businesses close and investment is curtailed. On the demand side, consumption is particularly vulnerable to the impact of both reduced income and declining consumer confidence. A third channel works through the financial system. While the natural rate of interest might be expected to fall, leading to a period of low interest rates, financial institutions are likely to come under stress. Rising uncertainty, along with an increase in the number of borrowers with debt servicing difficulties, may dampen investment and generate a liquidity squeeze, exacerbating the demand effects of the pandemic. All three channels work to reduce current and potential output. Spillovers and asymmetries can explain the varying impact of the pandemic across countries, but it seems that open economies, embedded in global value chains, are especially vulnerable. Nonetheless, the literature provides ample evidence on how to limit the impact of pandemics using monetary and fiscal policy combined with measures to ease liquidity constraints on the financial sector. In the context of the EU, the coordination and mutualisation of the policy response to the pandemic can prove to be very beneficial.

Keywords: COVID-19; pandemic; lockdown; social distancing; propagation; spillovers

JEL classification: E2; E3; E5; G1

COVID-19 ΚΑΙ ΑΛΛΕΣ ΠΑΝΔΗΜΙΕΣ: ΕΠΙΣΚΟΠΗΣΗ ΤΗΣ ΒΙΒΛΙΟΓΡΑΦΙΑΣ ΓΙΑ ΟΙΚΟΝΟΜΟΛΟΓΟΥΣ

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ΠΕΡΙΛΗΨΗ

Η μελέτη αποτελεί μια επισκόπηση της βιβλιογραφίας όσον αφορά τις οικονομικές επιπτώσεις μιας πανδημίας και των διαύλων μετάδοσής τους. Ο κύριος δίαυλος προέρχεται από την πλευρά της προσφοράς, καθώς οι πανδημίες μειώνουν τόσο την ποσότητα όσο και την ποιότητα της προσφερόμενης εργασίας. Ενδέχεται επίσης να οδηγήσουν σε καταστροφή κεφαλαίου, καθώς κάποιες επιχειρήσεις αναγκάζονται να μειώσουν τις επενδύσεις τους ή και να παύσουν τη λειτουργία τους. Από τη σκοπιά της ζήτησης, είναι ιδιαιτέρως πιθανόν να πληγεί η κατανάλωση, λόγω της μείωσης του διαθέσιμου εισοδήματος και της καταναλωτικής εμπιστοσύνης. Ένας τρίτος δίαυλος είναι χρηματοπιστωτικός. Παρότι το φυσικό επιτόκιο είναι πιθανόν να μειωθεί, προμηνύοντας μια περίοδο χαμηλών επιτοκίων, είναι αναμενόμενο ότι τα χρηματοπιστωτικά ιδρύματα θα υποστούν πιέσεις. Η αύξηση της αβεβαιότητας και η άνοδος του ποσοστού των δανειοληπτών σε δυσχέρεια οδηγούν σε περιορισμό της ρευστότητας και επιτείνουν τις αρνητικές επιπτώσεις της πανδημίας στη ζήτηση. Διαμέσου των τριών αυτών διαύλων, τόσο το παραγόμενο όσο και το δυνητικό προϊόν υφίστανται μείωση. Οι οικονομικές επιπτώσεις μιας πανδημίας ενδέχεται να διαφέρουν από χώρα σε χώρα, λόγω ασυμμετριών και φαινομένων διάχυσης. Ωστόσο, φαίνεται ότι οι ανοικτές οικονομίες, που είναι ενταγμένες στις διεθνείς αλυσίδες αξίας, είναι ιδιαιτέρως ευάλωτες σε αυτές τις επιδράσεις. Στο πλαίσιο της Ευρωπαϊκής Ένωσης, ο συντονισμός και η αμοιβαιοποίηση των οικονομικών μέτρων για την αντιμετώπιση των επιπτώσεων της πανδημίας μπορεί να αποβεί εξαιρετικά επωφελής.

COVID-19 AND OTHER PANDEMICS: A LITERATURE REVIEW FOR ECONOMISTS*

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1 INTRODUCTION

The COVID-19 pandemic is arguably the largest peace-time potential threat to life on a global scale for a century. In probably the most well-known simulation study, Ferguson et al. (2020) argue that COVID-19 could be the deadliest pandemic since the Spanish Flu, with half a million deaths in the UK and over 2 million in the US. COVID-19 and the unprecedented non-pharmaceutical interventions (NPIs) and preventative policies to contain it place urgency on trying to gauge the likely economic impacts.[1]

While fatality rates are difficult to gauge, due to large uncertainty about the number of cases, it seems that COVID-19 is unlikely to be as deadly as the Spanish Flu, which claimed at least 50 million lives (see Table 1). A notable difference is that the Spanish Flu primarily affected prime-age workers, which suggests more severe economic impacts of the 1918 influenza pandemic, particularly for potential output.[2] But 21st-century epidemics can spread more widely and more quickly, having a ruinous impact on the economy of the affected country and a contagion effect on the global economy. The more complex nature of modern global supply chains, the intense mobility of human populations, the greater role of services, and the improvements in information and communication technologies are important factors for understanding the macroeconomic effects of COVID-19. While 102 years after the Spanish Flu, there is a more sound knowledge of infectious diseases as well as a wider range of potential interventions effective in preventing their spread, most of the countries worldwide still face the same challenge of mitigating the disruptive impacts of the pandemic.

A large set of papers has emerged on macroeconomic issues surrounding the COVID-19 pandemic. The world has entered into uncharted territory, with little history to guide policy makers on what the expected economic fallout will be, which societal interventions are warranted to contain its spread, and how a sys-

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1 The 20th century has witnessed two influenza pandemics since the Spanish Flu of 1918: the Asian flu of 1957 and the Hong Kong flu of 1968. The 21st century has seen a number of pandemics, most notably the Severe Acute Respiratory Syndrome (SARS) in 2002, H1N1 ("bird flu") in 2009, the Middle East Respiratory Syndrome (MERS) in 2012, and Ebola, which peaked in 2014-16.

2 99% of the victims of the Spanish Flu were below 65 years of age, and around half of them were aged between 20 and 40.

Table 1 Nineteen deadly pandemics since early modern times

Event	Start	End	Death toll
Black Death	1347	1352	75,000,000
Plague in Spain	1596	1631	600,000-700,000
Italian Plague	1629	1631	280,000
Great Plague of Sevilla	1647	1652	2,000,000
Naples Plague	1656	1656	1,250,000
Great Plague of London	1665	1666	100,000
Great Northern War Plague	1700	1721	176,000-208,000
Great Plague of Marseille	1720	1722	100,000
First Asia Europe Cholera Pandemic	1816	1826	100,000
Second Asia Europe Cholera Pandemic	1829	1851	100,000
Russia Cholera Pandemic	1852	1860	1,000,000
Fourth Cholera Pandemic	1863	1875	600,000
Global Flu Pandemic	1889	1890	1,000,000
Sixth Cholera Pandemic	1899	1923	80,000
Encephalitis Lethargica Pandemic	1915	1926	1,500,000
Spanish Flu	1918	1920	100,000,000
Asian Flu	1957	1958	2,000,000
Hong Kong Flu	1968	1969	1,000,000
H1N1 Pandemic	2009	2009	203,000

Source: Cirillo and Taleb (2020).
Note: The list is not exhaustive, but focuses on pandemics on which data are available.

temic response should be organised. What is the economic impact of a pandemic? Are the economic effects temporary or persistent? What is the impact of public health responses on the economy? Does the early and extensive use of NPIs, such as social distancing and lockdowns, which slow the spread of the pandemic, reduce its medium-term economic severity despite the inevitably heavy short-run toll?[3]

There are several policy proposals, with a large number of them collected in Baldwin and di Mauro (2020a). For example, Gourinchas (2020) argues that "flattening the infection curve inevitably steepens the macroeconomic recession curve". Although the measures that help address the health crisis can make the economic crisis worse —at least in the short run— the consensus amongst economists seems to be that containment is the appropriate policy. Economic policy can act decisively to limit the economic damage and thus "flatten the curve".

The remainder of this paper is structured as follows: in Section 2 we seek to shed some light on the above questions by, first, focusing on the literature that looks at the economic impact of past pandemics, including the Black Death and the Spanish Flu. We then move on to Section 3 to explore how economists are modelling the impact of the current pandemic within their empirical models. An examination of both strands of the literature allows us to identify the channels through which pandemics

3 NPIs intend to reduce infectious contacts between persons and form an integral part of plans to mitigate the impact of an influenza pandemic. The potential benefits of NPIs are supported by both mathematical models and historical evidence on the impact of such interventions in past pandemics (see for example Bootsma and Ferguson 2007; Markel et al. 2008; Hatchett et al. 2007).

impact economies. In particular, it is possible to quantify the impact on various macroeconomic aggregates, including GDP, inflation, wages, poverty, trade, non-performing loans (NPLs) and social capital. The literature also points to potential policy measures that can mitigate the impact of the pandemic. Section 4 draws on the assessment recently made by international institutions to discuss the role of asymmetries and the spillover effects of COVID-19. Section 5 draws on all previous sections to summarise the key transmission channels and provide economic policy implications. Section 6 concludes.

2 REVIEW OF RESEARCH ON THE ECONOMIC IMPACT OF PAST PANDEMICS

2.1 EMPIRICAL RESEARCH ON PAST PANDEMICS

The economic history literature on the relationship between pandemics and economic outcomes is hardly new (see Tables 2 and 3 for a summary). Most historical studies have typically focused on one event in one country or region and have traced local outcomes for up to a decade at most. Due to the absence of recent pandemics, work has primarily relied on aggregated data at the regional or national level.[4]

By far the most severe pandemic in terms of fatality rates was the **Black Death (Plague)**, which decimated anywhere between 30% and 60% of Europe's population in the 14th century.[5] Most work has shown that, by sharply reducing the size of the working population, the Plague led to a substantial increase in nominal wages for workers that persisted into the 15th century. Real wages took considerably longer to reach pre-Plague levels, especially for skilled workers (Munro 2005), as the supply shock-driven food inflation was higher than wage inflation. One reason for this was institutional: governments in several regions instituted formal wage restraints, particularly for rural workers (Munro 2005). The impact on per capita income is less clear, since rents also fell in the aftermath of the Black Death (Hirshleifer 1987; see also Robbins 1928).[6] Jedwab et al. (2019), using a granular dataset for a large sample of European cities, argue that population changes fit well a Malthusian growth paradigm, where production relies on fixed factors (land and natural resources) with little to no technological improvements, making the lessons learnt from the Black Death of little value for modern pandemics.

Due to its unprecedented devastation, the Black Death is likely to have for ever altered the economic and social landscape of Europe. Jedwab et al. (2019) provide evidence that rural villages were abandoned, as inhabitants moved to more affected cities to exploit the abundance of fixed factors of production. Voigtländer and Voth (2012) provide the most shocking example of persistent social effects. Scapegoating of Jews during the Black Death was quite prevalent in Central Europe, and mass killings took place in several cities in Germany. The authors show that cities with anti-Jewish pogroms during the Black Death had markedly higher patterns of violent antisemitism in the 1920s. While this is not causal evidence of Black Death affecting antisemitism, it is strong evidence of the endurance of cultural traits, which are likely to have been in some way shaped by the Black Death.

The most widely cited major pandemic was the **Spanish Flu**, due to its relatively recent occur-

4 The economics pandemic literature has typically not considered HIV/AIDS together with other major pandemics, despite its large-scale death toll (over 30 million). The economic effects of HIV/AIDS are likely very different because it is much more difficult to transmit than pandemics caused by flu, cholera or plague, and can hence be more manageable; flu episodes can occur very suddenly, giving rise to outbreaks. HIV/AIDS is also slow-acting (death occurs within years versus days for the rest). The WHO has classified HIV/AIDS as a global epidemic, instead of a pandemic.

5 The Black Death —a combination of bubonic and pneumonic plagues— killed roughly one-quarter of the Western European population between 1348 and 1351, and recurring epidemics continued to inflict high death tolls on the continent over the next quarter-century. It is unclear whether the Black Death caused more absolute fatalities than the Spanish Flu, but the relative magnitude in terms of total population was far higher.

6 Bloom and Mahal (1997) re-examine the effect of the Plague on the wages of unskilled agricultural workers in England during epidemics that occurred between 1310 and 1449. They find a positive but statistically insignificant relationship between real wages and population growth, with similar results for France. However, their study is hampered by its very small sample size.

Table 2 Summary of main empirical papers on past pandemics

	Summary of findings	Short-term impact	Long-term impact	Channel of transmission
Black Death				
Munro (2005)	Real wages initially fell but eventually grew substantially and persistently.	Negative effect on real wages despite higher nominal wages.	Large gains in real wages lasting for a century.	Labour shortages led to poor harvests in the short run, raising food inflation faster than wages. Wage controls imposed by landowners. In the long run, these effects waned and the shortage of labour relative to capital led to persistent wage gains.
Voigtländer and Voth (2012)	Antisemitism in the 1920s higher in cities with anti-Jewish pogroms in Black Death. Cities with high levels of trade or immigration show less persistence.		Local continuity of violence against Jews over 600 years (votes for the Nazi Party, deportations after 1933, attacks on synagogues).	Persistence of cultural traits.
Jedwab et al. (2019)	Affected cities recovered their population over the very long run.	Negative effects on city size.	Recovery according to Malthusian model.	Migration to areas with labour shortages and abundant fixed production factors (trade potential).
Spanish Flu				
Brainerd and Siegler (2003)	Substantial macroeconomic effects in the US, even after controlling for differences across states. Likely a contributing factor to post-WWI recessions.	Substantial business failures which caused the economy to be below trend, on average, between 1919 and 1921.	One more death resulted in an average annual increase of at least 0.2% in growth over the next 10 years.	Effect of prime-age influenza mortality rates (rather than overall mortality rates) on growth. Higher capital deepening (business failures' effect smaller than labour supply effect), lower labour force growth, increased investment in human capital.
Almond (2006)	Children of infected mothers fared worse in later life.		Depressed human capital.	Sickness during pregnancy.
Garrett (2009)	Wages in the US grew in relative terms in more exposed areas.	Approximately 4% of total wage growth (1914-19) is attributed to influenza mortalities.		Reduction in labour supply raised marginal product of labour. However, it is not always clear to what extent the results are attributable to WWI.
Karlsson et al. (2014)	Sweden; persistent decline in rental income and increase in poverty; no effect on earnings. More affected regions grew slower after the pandemic.	Rental income decline.	Rental income decline and higher poverty rates.	Labour quality fell in affected areas, mitigating wage growth due to labour scarcity. Also explains higher poverty and lower marginal product of capital.
Correia et al. (2020)	Areas that were more severely affected see a sharp and persistent decline in real economic activity, controlling for other factors. Early and extensive NPIs have no adverse effect on local outcomes; instead, a relative increase in real economic activity after the pandemic.	18% decline in state manufacturing output; rise in bank charge-offs. Reacting 10 days earlier increases employment by 5% in post-period; 50 additional days raise employment by 6.5%; one s.d. higher number of days induces a 7.5% larger local banking sector after 1918.	More affected areas remain depressed relative to less exposed areas from 1919 through 1923. The reduction in bank assets is persistent.	Reductions in both supply and demand. NPIs can have economic merits, beyond lowering mortality. Important channel of transmission of both demand and supply shocks could have been the banking sector.
Barro (2020)	NPIs have no significant impact on cumulative mortality in the US.	Short duration; but peak mortality does fall.		
Velde (2020)	Little short-term economic effects of the pandemic in the US. Recessions short and modest.			Considers a number of high-frequency indicators to show little impact during the pandemic, but large recession after the pandemic. Puzzling results given other papers showing large long-term effects.
Barro et al. (2020)	Declines in GDP and consumption. Effects are fully permanent or fully temporary or somewhere in between. Decreased realised real returns on stocks and, especially, on short-term government bills. Higher inflation at least temporarily.	Increased inflation rates (at least temporarily). Effect on stock negative but not significant; negative and significant effect on bonds.	Reduction of real per capita GDP by 6%. Larger effects for consumption. For the US only 1.5 % decrease in GDP and 2.1% in consumption. Effects on asset return not reversing	Effects of the Great Influenza Pandemic and WWI on economic growth (treated as (mostly) exogenous variables), gauged by growth rates of real per capita GDP and real per capita consumption (personal consumer expenditure). WWI and Great Influenza Pandemic are viewed as unanticipated and contemporaneously perceived as having some persistence but ultimately being temporary.
Le Moglie et al. (2020)	Spanish Flu mortality associated with lower social trust.		Long-run impact on descendants of immigrants.	Social distancing measures impeded social interactions. Persistence of cultural traits.
All pandemics				
Jordà et al. (2020)	Large and persistent reduction in natural interest rate; opposite for real wages.	Limited effects in the short run (until ten years).	Substantial effects lasting for at least four decades, longer in some countries.	Excess supply of capital relative to labour; wars (which destroy capital) opposite effect. With sufficiently low depreciation, higher growth potential can be accommodated with low investment, leading to lower natural rates. Wage effects as in Munro (2005).

rence and truly global nature.[7] Brainerd and Siegler (2003) were the first to examine its effects[8] on subsequent growth. Using data from a sample of US states, they find a positive correlation, even after controlling for a number of differences across states.[9] They suggest that one more death per thousand resulted in an average annual increase of at least 0.2 percentage point in the rate of economic growth over the next ten years. However, they find that flu deaths in 1918 and 1919 among prime-age adults are a significant predictor of business failures in 1919 and 1920, implying that the economy may have been below trend, on average, between 1919 and 1921. In other words, some of the growth from 1919-21 to 1930 is only a return to trend after this large temporary shock. The concurrent presence of higher business failures immediately after the pandemic and higher subsequent growth in affected areas may reflect a combination of factors: higher capital deepening (if the destruction of capital as a result of business failures were small enough, relative to the reduction in labour supply); lower labour force growth (as the young were especially affected); increased investment in human capital; or simple convergence. At the same time, long-term effects are hard to infer due to the boom of the 1920s and the subsequent crash of financial markets in 1929.

Garrett (2009) examines the immediate effect of influenza mortalities on manufacturing wages in US cities and states, jointly with the effect of World War I (WWI). The hypothesis is that influenza mortalities, by reducing the supply of manufacturing workers, raised the marginal product of labour and thus real wages. Since, in the short term, labour immobility across cities and states is likely to have prevented wage equalisation across states, a substitution to capital is unlikely to have occurred. The study finds that states and cities with greater mortalities experienced greater wage growth – roughly 2 to 3 percentage points for a 10% change in per capita mortalities. Approximately 4% of total wage growth from 1914 to 1919 is attributed to influenza mortalities. However, it is not always clear to what extent the results attributable to the effect of influenza are distinct from the impact of WWI.

More recently, Karlsson et al. (2014), using a difference-in-differences analysis of high-quality administrative data from Sweden, estimate the effects of the 1918 influenza pandemic on earnings, capital returns and poverty. They find that the pandemic led to a significant increase in poverty rates, and a reduction in capital returns; but, contrary to others, they do not find significant effects on earnings. At the same time, they show that more affected regions grew slower in the aftermath of the pandemic. Thus, the combination of falling capital income and growth in more affected areas but with no difference in earnings may explain the labour supply reaction, i.e. the reduction in average worker quality. In this way, the study shows that labour heterogeneity needs to be taken into account when analysing the effects of a pandemic.

A few recent papers have revisited the effect of the Spanish Flu on the US economy, with mixed results. Correia et al. (2020) study a variety of economic outcomes using city-level variation in mortality. They find that more exposed areas experienced a sharper and more persistent decline in economic activity relative to other areas, controlling for possible contemporaneous shocks, interacted with local characteristics. Consistent with Brainerd and Siegler (2003), they find that severely and moderately affected areas had similar levels of population, employment, and income per capita before 1918. They also address endogeneity concerns by exploiting the fact that regions differed in susceptibility to influenza outbreaks,

7 Why the wave was so deadly —with mortality rates 5 to 20 times higher than normal— and why it primarily affected young adults is still unclear, despite much recent research on the 1918 influenza epidemic by microbiologists.

8 Bloom and Mahal (1997) examine the effect of the 1918 influenza pandemic in India, which experienced an estimated 17 to 18 million deaths, and find no relationship between the magnitude of the population decline and changes in acreage sown per capita.

9 Brainerd and Siegler (2003, p. 7) conclude that "the statistical evidence also supports the notion of influenza mortality as an exogenous shock to the population".

Table 3 Summary of papers which model past pandemics

	Assumptions	Model/Aim	Scope	GDP impact			Comments
Meltzer et al. (1999)	Gross attack rate 15%-35%. Predefined probability distributions for a set of input variables by age and risk group. Four options of vaccination schemes.	Monte Carlo simulation. Economic impact of vaccine-based interventions.	US	USD 71.3-166.5 billion Disease-associated medical costs, indirect costs from losses of time and income by careers, and morbidity/mortality costs measured as expected foregone lifetime earnings. Excluding disruptions in commerce and society.			Loss of life accounted for approximately 83% of all economic losses at any given attack rate. The largest returns come from interventions that prevent the largest number of deaths. Vaccinating priorities should be set depending on the policy objective. Other multiplier effects resulting from disruptions in commerce and society need also to be valued. Large uncertainty about the gross attack rate of an actual pandemic.
Lee and McKibbin (2004)	Temporary shock (6 months): increase in country risk premium, drop in demand for services and increase in costs in the services sector. Country-specific index of "global exposure to SARS". Persistent shocks of equal size fade out equiproportionately over a 10-year period. Rational expectations and forward-looking intertemporal behaviour.	G-Cubed (Asia-Pacific) model. Economic costs of SARS.	Global	**Temporary shock** Global GDP loss close to USD 40 billion in 2003; Hong Kong (2.63% of GDP) with the services sector the largest contributing factor; China (1.05%) with effect evenly spread across factors.	**Persistent shock** Global GDP loss close to USD 54 billion in 2003. China, Hong Kong, Malaysia, the Philippines, Singapore and Taiwan larger loss vs OECD and others lower GDP loss. Greater capital outflow from affected countries into the least affected countries. Net capital outflows from China and Hong Kong are estimated to 0.8% and 1.4%, respectively. Persistence in rise of risk premium causes large capital outflow; sharp contraction in investment leads to persistent decline in production capacity.		Medical expenditures and demographic consequences of SARS are insignificant. The results overall point towards the argument that in a complex interrelated world, a disease outbreak might have a huge economic impact for the global economy and not only for the affected economies. The recession is found to last for a number of years afterward.
Bloom et al. (2005)	Mild pandemic (attack rate 20%; case fatality rate 0.5%; one year). Scenario 1: psychological impact affects demand for two quarters. Scenario 2: four quarters. Exogenous consumption shock of 3% and contraction in the export of services; demand shock only in Asian countries; 2-week period of labour supply shock (not working due to the disease).	Oxford Economic Forecasting (OEF) global model. Short-run economic impact of a human-to-human influenza.	Asia	**Scenario 1** Asia: 2.3% GDP demand shock; 0.3% GDP supply shock.	**Scenario 2** More severe. Global GDP shrinkage 0.6%: world recession. Global trade of goods and services contraction by 14%.	**Long-term impact** Even after 5 years in Scenario 2 Asia's GDP growth will be lower by 3.6 percentage points.	Demand and supply effect. Direct: Asian consumers reduce activity. Indirect: rest of world reduces consumption, impacting trade and investment. Open economies more vulnerable, exporters of services hard-hit. Timely policy responses can help prevent and mitigate the economic impact of a pandemic. Cooperation and coordination among countries.

Table 3 Summary of papers which model past pandemics *(continued)*

	Assumptions	Model/Aim	Scope	GDP impact			Comments
McKibbin and Sidorenko (2006)	Mild: similar to 1968-1969 Hong Kong flu. Moderate: similar to 1957 Asian flu. Severe: similar to 1918-1919 Spanish flu. Ultra: Spanish Flu but with higher mortality rates for older people. Epidemic shocks: indices of possibility of each severity to occur, sickness index for morbidity rate. Attack rate 30%. Reduction in consumption, increase in cost of doing business, increase in country risk premia. Global exposure of the country to the disease.	Asia Pacific G-Cubed model (extended for the UK). Estimate macro consequences of influenza pandemic.	Global	**Mild scenario** 1.4 million deaths worldwide and global GDP would fall by approximately 0.8%, with mortality and morbidity shocks being the main drivers assuming that monetary policy can effectively contaminate demand changes.	**Moderate scenario** As severity of the pandemic increases, the importance of cost increases rises, resulting in a larger shrinkage of global GDP, but with the negative effect being larger for Asia and developing countries. More substantial GDP losses (9.3% for Hong Kong and 7.3% for the Philippines).	**Severe scenario** Contraction in most affected economies reflects much larger shocks and large reallocation of global capital. World is substantially affected (up to 26% contraction in Asia).	**Ultra scenario** Over 142.2 million deaths, and income losses of over 12% of GDP (USD 4.4 trillion) worldwide. Over 50% in some developing countries such as Hong Kong in 2006. Large-scale collapse of Asia causes global trade flows to dry up and capital to flow to safe havens. Prices rise in the short run, the result depends on whether demand or supply effect is larger. Monetary tightness (as a response to declining output, inflation changes or exchange rate changes) results in higher economic impact and may have a great importance for bond markets together with fiscal response. Policy makers should invest a lot in averting an outbreak because of the significant potential consequences for the global economy.
Burns et al. (2006)	Replication of the results of McKibbin and Sidorenko (2006). Human-to-human pandemic with similar mortality rate to the Spanish Flu (1.08% of people die across the world) For a year, 20% decline in air travel and in services sector. Global economic linkages of trade flow adjustment and capital flow reallocation.	Simulations. Breakdown of the economic impacts (mortality, morbidity and demand changes).	Global	1918-like pandemic scenario: developing countries would be hit the hardest (5.3% fall in GDP). High-income countries 4.7% fall in GDP. Great global recession (4.8% fall in GDP). Human-to-human pandemic: total impact 3.1% with the highest impact coming from shifts in demand (1.9% of GDP).			Initial impact purely from additional deaths. Public and private efforts to mitigate the spread of the disease by imposing travel restrictions and social distancing have a large impact on real activity. As the disease spreads to the rest of the world, global economic activity declines significantly in an effort to monitor the outbreak.
Fan et al. (2016)	Estimates of the probabilities of pandemics on an annual basis. Two severity scenarios: moderate scenario has age-specific mortality distributions like 1957 and 1968 and severe scenario has age-specific mortality distributions like 1918. Expected severity is defined in terms of standardised mortality units.	Inclusive cost of a pandemic.		**Moderate scenario** Annual excess mortality rate in the lower-middle income countries is expected to be about 0.06% (18,000 deaths) For the world, the excess expected number of deaths is 37,000. Expected annual income losses are USD 16 billion.	**Severe scenario** Annual excess mortality rate in the lower-middle income countries is expected to be about 1.2% (370,000 deaths). For the world, the excess expected number of deaths is 680,000. Expected annual income losses are USD 64 billion.	**Total impact** Annual income loss: 1.6% fall in lower-middle income countries and 0.62% fall for the world economy. Expected annual inclusive cost of 0.7% of global income.	As the severity of the pandemic increases, the intrinsic cost of premature death and illness rises, and this is far more obvious for the lower-middle income countries.

and instrument Spanish Flu mortality with the previous year's influenza mortality for the region. They find strong effects on manufacturing employment and output, bank assets, and car registrations, pointing to both supply and demand channels, as well as financial frictions.[10] The estimates imply that the pandemic reduced manufacturing output by 18% for regions with average exposure,[11] while national banks saw an increase in losses charged off relative to assets in 1920-21, indicating an increase in NPLs in 1919-20.

Velde (2020), on the other hand, uses a variety of high-frequency data to argue that the short-term economic effects of the pandemic were quite modest. Industrial output fell sharply but rebounded after a few months, the financial system was robust, and business failures were minimal. Business failures did rise substantially, and several measures of economic activity (including retail trade and payments) contracted severely in the second half of 1920, with industrial production reaching a trough in May 1921. However, the 1920 wave was much smaller than the 1918-19 wave, and occurred in February. As Velde (2020) notes, the discrepancy between his results and those of Correia et al. (2020) and Brainerd and Siegler (2003), who show negative effects on long-term outcomes, presents a challenge for economics research, highlighting the need to find a state variable that propagates the shock of 1918 to 1923 and later.

Correia et al. (2020) also consider the economic effects of NPIs. They build on the epidemiology literature establishing that NPIs decrease influenza mortality, and use variation in the timing and intensity of NPIs across cities to study their economic effects. They find that cities that intervened earlier on and more aggressively experienced a relative increase in manufacturing employment, manufacturing output, and bank assets in 1919, after the end of the pandemic. The effects are economically sizeable. Reacting 10 days earlier to the outbreak of the pandemic in a given city increased manufacturing employment by around 5% in the post-pandemic period. Likewise, implementing NPIs for an additional 50 days increased manufacturing employment by 6.5% after the pandemic. In 1919 and 1920, an increase in banking assets was observed in cities with early and longer interventions after 1918, which helped to mitigate the exacerbation of the crisis that resulted from bank deleveraging due to higher defaults. Altogether, their findings suggest that pandemics can have substantial economic costs, and NPIs can have economic merits, beyond lowering mortality.

They conjecture that the results may be driven by the fact that the pandemic itself can have important economic effects, as people cut back on consumption and labour supply, and that NPIs can reduce the length of disruption by solving coordination problems. On the other hand, a particularly strong channel for this pandemic was probably the fact that it targeted prime-age adults, and so NPIs had strong effects in preserving the local labour force. An important channel of transmission of both demand and supply shocks could have been the banking sector. The temporary nature of the pandemic should in principle lead to increased demand for liquidity (Holmström and Tirole 1998), and healthy banks could then smooth the shock and mitigate the decline in demand and production. Widespread defaults, however, may stress the banking system, impairing its assets, and potentially amplifying the pandemic to a financial crisis. This has important implications for COVID-19; bridge loans to levered actors to prevent unnecessary defaults and destruction of productive capacity are key, and it is no surprise that they are an essential element of rescue packages. Nevertheless, it should be noted

10 Local manufacturing should be somewhat insensitive to changes in local demand, so lower relative manufacturing employment would be indicative of a supply shock. The opposite holds for car registrations, while for bank assets both types of effects are possible; supply shocks may lead to defaults, while lower demand may shrink lending. Credit rationing could be an important amplifier of the shock.

11 A concern is that data on manufacturing outcomes are only available for 1914 and 1919, which makes it hard to control for the effect of WWI. However, data on car registrations and bank assets are annual, thereby sharpening identification substantially.

that Velde (2020) finds little short-term effects of mortality on bank outcomes at the city level, making the connection to long-run outcomes puzzling.

On the other hand, Barro (2020) finds no evidence of a relationship between NPIs and mortality. Though the curve was flattened, in that the ratio of peak to average deaths did fall, the total effect was unrelated to NPIs. He argues that this is because the measures were not implemented long enough to have substantial effects, as they had an average duration of around one month. Yet it is possible that some types of NPIs may be more effective than others, as he finds significant negative effects for restrictions on public gatherings.

Furthermore, Lilley et al. (2020) collect a larger sample of data and argue that the results of Correia et al. (2020) regarding the effects of NPIs are driven by pre-existing trends in population, and hence manufacturing employment and output. In fact, they find that NPIs are strongly related at the city level with population growth ten years before the pandemic, causing a spurious relationship between NPIs and employment growth. Once this is taken into account, results are uninformative about the true effects of NPIs.[12]

Barro et al. (2020) study the macroeconomic impact of the 1918 influenza pandemic at the country level for 42 countries, separating the effect of WWI by controlling for the deaths of soldiers in combat. The analysis yields flu-generated declines for GDP and consumption in the typical range of 6%-8%, respectively.[13] The results cannot rule out effects of the flu pandemic on the level of real per capita GDP that are fully permanent, or fully temporary, or somewhere in between. The authors also provide some evidence that higher flu death rates decreased realised real returns on stocks and, especially, on short-term government bills. There is no prediction that the short-term negative effect will be reversed. Finally, the results on inflation confirm that the 1918 influenza pandemic and, especially WWI, increased inflation rates at least temporarily.

With regard to lessons for the COVID-19 episode, it should be stressed that the industrial structure is substantially different now than a century ago. Notably, services now account for a much larger share of the economy compared with the late 1910s, whereas the opposite holds for manufacturing or agriculture. A large portion of services are demanded at a specific point in time, with a smaller role for pent-up demand than is the case with durable or even non-durable goods. For instance, restaurant meals foregone due to closures will not be recovered once lockdowns are lifted (even abstracting from lower demand due to continued fear of infection or income uncertainty), unlike purchases of dishwashers or furniture. As such, even if the downturn resulting from the Spanish Flu was short-lived, this does not necessarily imply that the COVID-19 effects will follow a similar path.

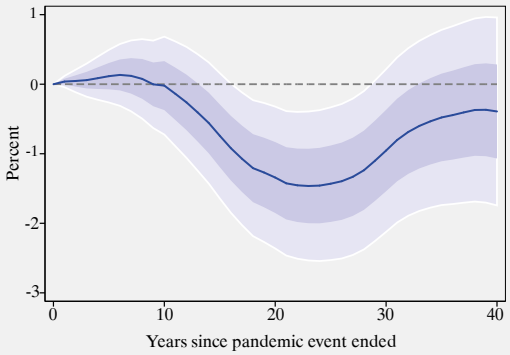
Other interesting papers that study the effect of the Spanish Flu include Almond (2006) and Le Moglie et al. (2020). Almond (2006) explored a longer-term effect of the Spanish Flu: whether in utero exposure to the influenza had negative economic consequences for individuals later in their lives. The hypothesis is that individuals' health endowments are positively related to human capital and productivity and thus also to wages and income (the fetal origins hypothesis). Using 1960-80 decennial

12 In a later response to the findings of Lilley et al. (2020), Correia et al. argue that the population values used by the authors are problematic, as they are not census-based and reflect extrapolations from values between 1900 and 1910, leading to measurement error. Furthermore, they argue that the spurious relationship between NPIs and employment growth documented in Lilley et al. (2020) is not present with employment growth five years before the pandemic. Accounting for population growth gives results close to the original ones. See http://scorreia.com/research/pandemics-llr-response.pdf.

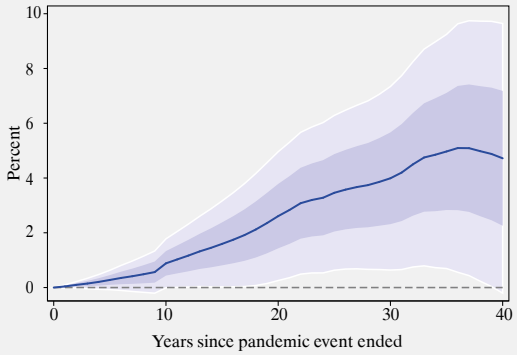
13 The flu death rate for 1918-20 has an overall correlation of -0.25 with a country's real per capita GDP in 1910. This may largely reflect the impact of better health services and better organisation on the probability of death from the disease (reflecting partly risk of infection and partly the mortality rate given infection). An offsetting force, however, is that more advanced economies are likely to have greater mobility and interactions, which foster the spread of contagious diseases.

Impulse responses to major pandemics

A. Response of the European real natural rate of interest following pandemics



B. Response of real wages in Europe following pandemics



Source: Jordà et al. (2020).
Note: Response of the real natural rate of interest and of real wages to a pandemic in Europe, one to 40 years into the future. Shaded areas are 1 and 2 s.e. bands around response estimates.

census data, Almond (2006) found that cohorts in utero during the 1918 pandemic had reduced educational attainment, higher rates of physical disability, and lower incomes. "Children of infected mothers were up to 15% less likely to graduate from high school. Wages of men were 5-9% lower because of infection" (Almond 2006, p. 673).

In a very recent paper, Le Moglie et al. (2020) study the social effects of the Spanish Flu. The extremely high rates of infection and fatality (over 2%, relative to less than 0.1% for the typical flu), together with public health guidelines to limit physical contact, similar to the measures taken against COVID-19, had a substantial effect on social interactions. Using a representative survey of the descendants of immigrants to the US, they show that descendants of immigrants coming from countries with higher influenza mortality had significantly lower levels of social trust, with an additional death per thousand population being associated with a 1.4 percentage point decrease in trust, relative to descendants of immigrants who had migrated from the same countries before the Spanish Flu. A possible mechanism is the comparison between countries that were neutral and belligerent in WWI; in the former, lack of censorship meant that societies internalised the threat of the disease and the need for social distancing.

Some studies have also looked at more localised pandemics, such as the **Severe Acute Respiratory Syndrome (SARS)** outbreak in Asia, which caused economic disruption even though a global health crisis was averted. Studies of the macroeconomic effects of the SARS epidemic in 2003 found significant effects on economies through large reductions in consumption, an increase in business operating costs, and a re-evaluation of country risks reflected in increased risk premia (for a review, see McKibbin and Fernando 2020). Shocks to other economies were transmitted according to the degree of the countries' exposure to the disease and to the affected economies. The Asian Development Bank estimated that the economic impact of SARS amounted to around USD 18 billion, or 0.6% of GDP, in East Asia (Fan 2003), mainly through its effects on consumption.[14]

14 Other studies of SARS include Chou et al. (2003) for Taiwan, and Siu and Wong (2004) for Hong Kong. These studies focus mostly on assessing the damages induced by SARS in affected industries such as tourism and the retail services sector. Siu and Wong (2004) reported that retail sales figures dropped by 15.2% between late 2002 and April 2003. They also reported substantial declines of 10.4% in passenger travel to Hong Kong over a similar time period.

Finally, Jordà et al. (2020) study the effect of pandemics across all major events since the Black Death, looking at outcomes up to 40 years out. They study rates of return on assets[15] using a dataset that covers France, Germany, Italy, the Netherlands, Spain, and the UK, focusing on 15 major pandemic episodes, where more than 100,000 people died. The results show that following a pandemic, the natural rate of interest declines for decades thereafter, reaching its nadir about 20 years later, with the natural rate about 150 basis points lower than what would have been the case if the pandemic had not taken place, and returns to trend around four decades later (see panel A of the chart). The heterogeneity of the responses is quite striking. For France, Italy, and Spain the effects of pandemics are much larger (3%-4%) relative to Germany, the Netherlands and the UK. This reflects, among other explanations, the timing of the pandemics across countries, the relative exposure, the relative size of the working population, and the relative degrees of industrialisation. The authors also look at some more limited evidence on real wages and find that the response of real wages is almost the mirror image of the response of the natural rate of interest, with its effects being felt over decades, a result consistent with the baseline neoclassical model (see panel B of the chart). Real wages gradually increase until about three decades after the pandemic, where the cumulative deviation in the real wage peaks at about 5%. All results are robust to controlling for wars, possible major trend breaks and after omitting the Black Death and the Spanish Flu. The results indicate that pandemics are followed by decades of depressed investment opportunities, possibly due to excess capital per unit of labour. The authors also speculate that there may also be a higher propensity to save (due to higher risk aversion or a rebuilding of depleted wealth), but they do not really provide any evidence for this. Instead, they show that wars are associated with an increase in natural rates, suggesting that sharp changes in capital per unit of labour may trump demand effects.

2.2 MODELLING THE ECONOMIC IMPACT OF PAST PANDEMICS

Meltzer et al. (1999) examine the likely economic effects of an influenza pandemic in the US and evaluate several vaccine-based interventions. They use a Monte Carlo mathematical simulation model with predefined probability distributions for a set of input variables by age and risk group. At a gross attack rate (i.e. the number of people that become clinically ill out of the total population) of 15%-35%, the estimated total economic impact (i.e. disease-associated medical costs, indirect costs from losses of time and income by careers, and morbidity/mortality costs measured as expected foregone lifetime earnings) for the US economy ranged from USD 71.3 billion to USD 166.5 billion (excluding disruptions to commerce and society), and the estimated deaths ranged from approximately 89,000 to approximately 207,000 people. The costs associated with mortality accounted for approximately 83% of all costs. Thus, the results indicate that in the event of a pandemic any intervention should aim at lowering the death rates. The authors also argue that vaccinating priorities should be set depending on the policy objectives (preventing deaths, maximising economic returns, or other), leading to different vaccine-based intervention plans. However, the results for the economic returns of vaccination schemes presented in the paper are sensitive to the assumed gross attack rate and cost of vaccination. Furthermore, the authors use an economic value of life of USD 1 million, while conventional current estimates put it at around USD 10 million for the US, implying that these estimates may be an order of magnitude higher in current US dollars. Finally, the authors acknowledge that (a) other multiplier effects resulting from disruptions in commerce and society need also to be valued and incorporated in the model, and (b) the range of the

15 Aggregate real interest rates are constructed by weighting real interest rates on long-term debt by GDP shares (Maddison 2010). The underlying assets are debt contracts, "which are not contracted short-term, which are not paid in-kind, which are not clearly of an involuntary nature, which are not intra-governmental, and which are made to executive political bodies".

gross attack rate of an actual pandemic is quite wide, thereby leading to considerable uncertainty about a pandemic's potential economic impact.

Bloom et al. (2005) use the Oxford economic forecasting global model to estimate the potential short-run economic impact for Asia of a pandemic resulting from a mutation in the avian flu that spreads from human to human. They look at two scenarios, both assuming a mild pandemic spread around a year with a 20% attack rate and a 0.5% case-fatality rate. Under the first scenario, there is a consumption shock of 3% and a reduction in the trade of services, which last for two quarters and only affect Asian countries. Supply shock is assumed as a two-week absenteeism from work. The economic impact for Asia is estimated at around USD 99.2 billion from the demand side and USD 14.2 billion from the supply side. Under the second scenario, where the shocks last for four quarters, the impact is greater since there is also a reduction in consumption in the rest of the world, leading to a global GDP shrinkage of 0.6% and a contraction of 14% in global trade of goods and services. This implies that open economies and exporters of services are more vulnerable to international shocks. For Asia, GDP growth is predicted to remain low even five years after the pandemic. Taking all these together, the results show that timely policy responses can help prevent and mitigate the economic impact of a pandemic, also necessitating cooperation and coordination among countries.

Lee and McKibbin (2004) use a global model (called "G-Cubed Asian Pacific" model), consisting of 20 countries and 6 sectors, to estimate the impact of SARS arguing that (a) direct medical costs and demographic effects because of the epidemic might be low (or at least ambiguous for the supply-side effect), and (b) there are important linkages between and within economies through both international trade and capital flows. Hence, a global model that takes into account integrated economies, rational expectations and forward-looking intertemporal behaviour (although this is acknowledged to be an unrealistic assumption for the real world when a new disease appears) is more adequate to get a full picture of the channels of transmission and of the economic costs from a global disease. Under the assumption of a temporary shock (captured as an increase in country risk premium, a drop in demand in the services sector and an increase in costs in the services sector) of six months to the affected economies, and by calculating a country-specific index of "global exposure to SARS" (depending, among other things, on geographical distance to China and governance response) to scale the shock to other countries, the authors find that despite a relatively small number of cases and deaths, the global costs of SARS were significant and not only limited to the countries directly affected. They estimate GDP losses of between 2.63% and 0.5% for China, Hong Kong, Singapore and Taiwan. Analysis of the data revealed that the retail sector and travel industries suffered the largest declines. The model also predicts how the expectations about future developments related to the disease might affect the potential economic costs of SARS. The more persistent SARS is assumed to be (lasting up to ten years), the larger the negative economic impact in affected economies, but the smaller the impact in the rest of the world, which reflects the direction of capital flows to the least affected countries. The calculations suggest that the cost of SARS in 2003 for the world economy was close to USD 40 billion in the event of a temporary SARS effect and around USD 54 billion in the event of a persistent SARS shock (not including actual costs in later years if in fact SARS does persist). The recession is found to last for a number of years afterward. Under a persistent shock, for the affected economies, the primary impact comes from the rise of the country risk premium, leading to a sharp decrease in investment. Net capital outflows from China and Hong Kong are estimated to 0.8% and 1.4%, respectively, with a positive effect on their trade balances due the exchange rate depreciation. The results overall point towards the

argument that in a complex interrelated world, even if toll rates are low and demographic effects are insignificant compared with other major epidemics, a disease outbreak might have a huge economic impact for the global economy and not only for the affected economies.

McKibbin and Sidorenko (2006) adapt the Lee and McKibbin (2003) G-Cubed Asian Pacific model (also extended here to include the UK) to examine the global economic consequences of a range of pandemic influenza severities: a mild pandemic similar to the 1968-69 Hong Kong flu, a moderate pandemic similar to the 1957 Asian flu, a severe pandemic similar to the 1918-19 Spanish Flu and an "ultra" pandemic scenario (toward the upper end of the range of estimates for severity in 1918), which is not based on any known previous pandemic but has the characteristics of the Spanish Flu in addition to higher mortality rates for older people. In the model, the various epidemic shocks (estimated using some indices capturing the possibility for each country that each severity might occur and a sickness index that captures morbidity rate), given an attack rate of 30%, affect Asian economies through a large reduction in consumption (modelled as endogenous shifts), an increase in the cost of doing business (scaled for the services sector exposure of the economy across countries and for the mortality shocks across scenarios) and an increase in country risk premia (calculated as a composite indicator of the responsiveness of the health services sector to the pandemic, the quality of governance and the exposure of the country to foreign capital). At the same time, shocks are transmitted to other economies depending on the global exposure of the country to the disease. Shocks are shown to be temporary, lasting only for 2006 for most countries and fading out until 2008 when real activity recovers. The authors estimate that the ultra scenario would lead to over 142.2 million deaths, and to income losses of over 12% of GDP (USD 4.4 trillion) worldwide and over 50% in some developing countries such as Hong Kong in 2006. Even under a mild scenario it is estimated that a pandemic would cost 1.4 million lives worldwide and global GDP would fall by approximately 0.8%, with mortality and morbidity shocks being the main drivers, assuming that monetary policy can effectively contaminate demand changes. As the severity of the pandemic increases, the importance of cost rises as well, resulting in a larger shrinkage of global GDP, but with the negative effect being stronger for Asian and developing countries, where contraction of demand is larger, mortality rates are higher and capital outflows are more substantial. Under the severe scenario, contraction in some countries of Asia reaches 26% relative to the baseline scenario of no pandemic, partly reflecting large reallocation of capital to more "safe" economies. The composition of the results shows a great difference among countries, with developing countries being the most adversely affected. Although prices rise in the short run, the result depends on whether the demand-side or the supply-side effect is stronger. Monetary tightness (as a response to declining output, inflation changes or exchange rate changes) results in a more severe economic impact and may have a great relevance for bond markets, together with fiscal response. The paper concludes that although there is high uncertainty about how an influenza pandemic evolves with little historical guidance on how people tend to react under a severe situation and how such a crisis should be managed, policy makers should invest a lot in averting an outbreak because of its significant potential consequences for the global economy (see Table 4).

Previous studies by the World Bank (see Jonas 2013) looked at pandemic risk and estimated that a 1918-like pandemic could cost USD 3 trillion globally. Burns et al. (2006) replicate the results of McKibbin and Sidorenko (2006) and find that, under a 1918-like pandemic scenario (severe scenario), developing countries would be hit the hardest (5.3% fall in GDP) relative to the high-income countries (4.7% fall in GDP) and there would be a great global recession (4.8% fall in GDP). The authors also

Table 4 Summary of estimated effects from two recent pandemics

SPANISH FLU, 1918-1919				
GDP growth (%)	**1908-13**	**1914**	**1914-18**	**1919**
	Average	*Annual*	*Average*	*Annual*
Australia	5.16	-7.70	0.89	-1.84
Canada	8.69	-6.70	3.54	-11.14
United Kingdom	2.88	1.00	3.02	-13.89
Japan	2.52	-3.00	5.56	7.94
United States	5.48	-7.70	6.09	-5.22

ASIAN FLU, 1957-1958		
GDP growth (%)	**1953-57**	**1958**
	Average	*Annual*
Australia	4.38	4.80
Canada	5.28	1.79
United Kingdom	3.06	-0.21
Japan	8.43	5.83
United States	2.62	-0.49

Source: McKibbin and Sidorenko (2006).

present results under a different scenario of a human-to-human pandemic with a similar mortality rate to the Spanish Flu (1.08% of people die across the world) and provide a breakdown of the economic impacts from mortality, morbidity and demand changes (where it is assumed a 20% decline in air travel and in services). The total economic impact is a 3.1% fall in world GDP, with the strongest impact coming from shifts in demand (1.9% of GDP), i.e. public and private efforts to mitigate the spread of the disease by imposing travel restrictions and social distancing have a large impact on real activity. The main policy implication of the simulation study is that there is a big immediate impact on the affected countries, but as the disease spreads to the rest of the world, global economic activity declines significantly in an effort to contain the outbreak (see Table 5).

In a different strand, Fan et al. (2016) assess the inclusive cost of a pandemic that adds to the income loss the intrinsic value of premature mortality and morbidity. They use estimated probabilities of pandemics on an annual basis under two severity scenarios to provide estimates of mortality rates and of the associated cost. Expected severity is defined in terms of standardised mortality units[16] and it is assumed that the moderate scenario has age-specific mortality distributions like 1957 and 1968 and the severe scenario has age-specific mortality distributions like 1918. The results show that the annual excess mortality rate due to a pandemic in the lower-middle income countries is expected to be about 0.06% (18,000 deaths) under the moderate scenario and about 1.2% (370,000 deaths) under the severe scenario. For the world, the excess expected number of deaths is 37,000 and 680,000 people, respectively. Translating these figures into an annual income loss gives a 1.6% fall in lower-middle income countries and a 0.62% fall for the world economy

16 The standardised mortality unit (SMU) represents a 10-4 mortality risk and is used to represent small numbers as integers.

Table 5 Possible economic impacts of a flu pandemic

(% change in GDP, first year)

	Mild	Moderate	Severe
World	-0.7	-2.0	-4.8
High-income countries	-0.7	-2.0	-4.7
Developing countries	-0.6	-2.1	-5.3
East Asia	-0.8	-3.5	-8.7
Europe and Central Asia	-2.1	-4.8	-9.9
Middle East & North Africa	-0.7	-2.8	-7.0
South Asia	-0.6	-2.1	-4.9
Deaths (millions)	**1.4**	**14.2**	**71.1**

Source: Burns et al. (2006).
Note: The mild scenario is modelled on the Hong Kong flu of 1968-69; the moderate flu has the characteristics of the 1957 Asian flu; and the severe scenario is benchmarked on the 1918-19 Spanish Flu.

(annual mortality cost). For the world, the expected annual income losses amount to USD 16 billion under the moderate pandemic and USD 64 billion under the severe pandemic scenario. This means that as the severity of the pandemic increases, the intrinsic cost of premature death and illness rises as well, and this is far more obvious for the lower-middle income countries. Adding these two costs together gives an expected annual inclusive cost of 0.7% of global income.

3 UNDERSTANDING THE ECONOMIC IMPACT OF COVID-19

3.1 MODELLING COVID-19: CONVENTIONAL ECONOMIC MODELS

Motivated by the recent outbreak of COVID-19, a number of papers use full-scale macro models to gauge its potential economic impact and explore the relative merits of alternative economic policy responses. According to the literature, the economic impact of the current pandemic can be thought of as entailing both a supply shock, stemming from the self-imposed social distancing and the state-imposed lockdown, and a demand shock, i.e. a negative shock to consumption resulting from reduced opportunities to consume. Moreover, the pandemic increases risk and uncertainty both in the real economy and in the financial sector. However, modelling a pandemic to examine its impact on the economy is challenging, due to the large degree of uncertainty with respect to the nature, the persistence and the size of the shocks arising from the pandemic. Indeed, different papers adopt very different approaches.

Fornaro and Wolf (2020) choose to model the impact of the pandemic as a drop in labour productivity growth. They opt for an unexpected, very highly persistent shock, as they want to explore the pessimistic scenario that the COVID-19 outbreak leads to a long-lasting supply disruption. However, they point out that the persistence of the shock (supply disruption) is crucial to their analysis, as it induces agents to revise their expectations of future income downwards.[17] They find that such a shock leads to a decline in demand and, given the downward revision of agents' future income expectations, to a decline in output and employment. If we assume that the decline in demand also leads to a decline in investment,

17 In earlier theoretical work, Torój (2013) had proposed that, within a standard DSGE model, an epidemic can be modelled as a reduction in labour utilisation under unchanged labour cost. Such a shock has a smaller impact than a negative labour supply shock, as the latter directly affects the nominal wage. It is argued that such a representation is adequate when computing the costs of short-lived diseases like epidemics of influenza, if one assumes away any possible long-run consequences stemming from higher morbidity or mortality.

the initial shock may generate a "supply-demand doom loop", as a decline in investment endogenously generates a further drop in productivity. Within this model, monetary stimulus can mitigate the impact of COVID-19 on employment and output, and will have a multiplicative positive effect by containing the doom loop. If, however, monetary policy is limited by the zero lower bound, then agents' expectations of lower income become self-fulfilling and may lead to a stagnation trap. In this case, fiscal policy should be used to support public and private investment, thus helping labour productivity (and expectations) to rebound. In this context, it is unclear whether inflation will be pushed upwards or downwards, but the central bank does face a trade-off between stabilising inflation and employment.

Bayer et al. (2020) assume that a random fraction of workers (10% or 30%, depending on the scenario) is in quarantine, i.e. they have zero productivity, a state from which they recover quickly (there is a 50% exit probability at the end of each period). The shock leads to a reduction in output, while its randomness introduces income risk into the model, as it is ex ante unknown exactly which households will be quarantined and which will not. The setup is a HANK-DSGE model with numerous frictions and incomplete financial markets, due to which idiosyncratic risk is uninsurable at the household level. The authors find that the quarantine shock, which reduces the effective labour force, leads to a sharp decline in consumption and investment upon impact, and thus to a reduction in output. The increase in income risk leads to a decline in aggregate demand and an increase in households' precautionary cash holdings, as they try to self-insure. The decline in demand prompts a decline in investment and thus a further decline in output. In other words, the ensuing recession is due to both depressed supply and depressed demand. Output falls by a maximum of 3.5% in the trough period Q3, in the scenario where 10% of the labour force is in quarantine for one quarter, and by a corresponding 11% if 30% of the labour force is in quarantine. Recovery is slow – it takes up to three years to fully recover from the shock, as some of the job losses are persistent. The authors explore the potential impact of the recently announced US fiscal package and find that the transfer component has a high multiplier (between 0.4 and 1.2), depending also on the responsiveness of monetary policy to inflation. Key for this high multiplier are the transfers which are directly paid to the unemployed and/or the quarantined households, as these have a high marginal propensity to consume, and the transfers ex ante reduce their income risk.

Guerrieri et al. (2020) assume that a fraction of agents are "unable" to work in the first period, because the epidemic has rendered their occupation unsafe. They explore the circumstances under which a negative supply shock, such as one induced by a pandemic, can generate a demand shortage and thus an output decline larger than the initial shock – a type of shock which they term "Keynesian" supply shock. The authors show that, in the model specification with two sectors and incomplete markets, when the initial supply shock only hits one sector, such "Keynesian" supply shocks can materialise. They also model a "business exit multiplier", which occurs when firms are put out of business due to the epidemic, prompting a cascade of "business exits", as their employees cut back on their consumption – a second type of "Keynesian" supply shock. Low substitutability across sectors and incomplete markets with liquidity constrained consumers, all contribute towards the possibility of such shocks. Fiscal policy is overall less effective in such a model. However, optimal policy, which comprises a containment of the epidemic, a loosening of monetary policy and a social insurance policy which compensates workers in the affected sectors, alleviates the possibility of a "Keynesian" supply shock and makes it easier for public health objectives to be pursued.

Faria-e-Castro (2020) models the COVID-19 pandemic as a demand-side shock, i.e. a large

negative shock to the marginal utility of consumption that induces households to reduce current consumption. The shock is imposed on the sectors that produce contact-intensive services – according to the author, these comprise hospitality and leisure, certain types of retail (bricks and mortar) and air travel. Additionally, it is assumed that the output of these sectors is unlikely to be consumed by the government so that, in the model, a rise in government spending does not boost demand for contact-intensive services. The author calibrates the size of the shock so that the rate of unemployment rises to 20%, to capture the worst-case scenario put forward by the Treasury Secretary to Members of the US Congress on 17 March 2020. He assumes that the pandemic lasts exactly three quarters, i.e. that there is a shock of equal size in each quarter and that the economy returns immediately to the initial state once the pandemic is over. Constrained agents (modelled as borrowers), who have a high marginal propensity to consume, will be affected and thus non-service consumption will also decline. Constrained agents will default on their loans more often, leading banks to charge higher interest rates on loans, thus further depressing overall consumption, demand for labour and inflation. Expansionary monetary policy helps, but if constrained by the zero lower bound, a deep recession can ensue. By design, the economy rebounds immediately after the shock. The author considers one-quarter fiscal interventions of five alternative types (increase in government consumption, cut in labour income tax, increase in unemployment insurance, unconditional transfers to all agents and a per-wage subsidy to services sector firms) designed to have a comparable impact on the fiscal balance. The latter intervention is the only one which protects employment in the services sector. The measure that yields the highest GDP multiplier is government consumption. However, the author acknowledges that there may be strong complementarities between policies, which are not further examined.

McKibbin and Fernando (2020) use a global model (a hybrid between a DSGE model and a computable general equilibrium model) which explicitly models 20 countries and 4 sub-regions for the rest of the world and 6 sectors, with cross-country trade linkages. In line with similar work of theirs for SARS, they consider seven epidemiological scenarios: three scenarios where the epidemic only hits China (with varying mortality and morbidity rates) and affects the rest of the world only via changes in trade, capital flows and risk premia; three scenarios of a pandemic affecting all countries; and one scenario of a mild annually recurrent pandemic. These epidemiological scenarios are then mapped into the following economic shocks:

- A labour supply shock which comprises a mortality rate and a morbidity rate. The mortality rate is set on the basis of data on the SARS epidemic (0.02%-0.9% depending on the scenario). The morbidity rate reflects (i) the share of the population that will contract the virus and will have to stay at home for 14 days (1%-30%) and (ii) the notion that for every sick person a carer will also take sick leave, while 70% of the female labour force participation will have to stay at home for 14 days due to school closures. This is then adjusted from country to country based on indices reflecting the extent of linkages to China, urban population density and health security *inter alia* (adjustments benchmarked against China). In the pandemic scenarios, China suffers a shock to its labour supply ranging between -1.05% and -3.44% (annualised), which implies a shock to labour supply of about half the size for European countries.

- A shock to the equity risk premium which, for the milder scenario, is calibrated on the basis of the US equity markets' observed initial response to COVID-19. This is then used as a benchmark and adjusted for different scenarios and for different countries based on country-specific indices of country

risk, financial risk, governance risk, health policy, etc.

- A shock to the cost of production (beyond labour inputs) in each sector and country, meant to reflect the fact that trade as well as land, air and sea transport have been affected (though this is purely a cost effect, rather than a quantity effect). The authors calculate the cost input of these sectors to the six aggregate sectors in the model. They benchmark the shock for the mild scenario to the percentage increase in the cost of production observed in the Chinese manufacturing sectors during SARS. This is then scaled across sectors and countries depending on how exposed they are to China and to land, air and sea transport.

- A shock to consumption (over and above the decline in consumption which stems from depressed income), due to changes in preferences, benchmarked against the reduction in consumption expenditure observed in China over the SARS epidemic.

The authors calculate that the impact on GDP for the euro area ranges from -2% to -8.5% approximately. The pandemic causes a sharp drop in consumption and investment which, combined with the risk shocks, leads to a dampening of economic expectations, a sharp drop in equity prices and a move towards safe-haven bonds and cash, despite an endogenous easing of monetary policies. Capital flows out of severely affected economies like China and other emerging market economies and developing countries and into safer advanced economies which experience a currency appreciation. This generates a corresponding adjustment of current accounts: countries which experience a capital flight see higher exports and lower imports, while the trade balance of advanced economies deteriorates. The recovery is V-shaped in all countries and scenarios, except for the recurrent outbreak scenario.

A similar but much simpler exercise is undertaken by Luo and Tsang (2020), who first calculate the impact of the loss of labour input in Hubei province on its own production and that of any other province in the country; then, using input-output tables and the industry composition of each province, they back out the loss in aggregate output due to this loss of labour input. Subsequently, they attempt to estimate the loss in global output based on global trade linkages.[18] Luo and Tsang (2020) calculate that China will suffer an output loss of about 4% per month of lockdown, while global output will correspondingly drop by 1% due to the economic contraction in China. About 40% of the impact is indirect (rather than a direct result of lower labour supply in the affected region) coming from spillovers through the supply chain inside and outside China.

3.2 MODELLING COVID-19: ECONOMIC MODELS WITH AN EPIDEMIOLOGICAL BLOCK

An entirely new and innovative strand of economic literature has emerged, as academics strive to understand the impact of the COVID-19 pandemic on economic variables. In a seminal paper, Eichenbaum et al. (2020) were the first to explicitly model the interaction between economic decisions and the rate of infection by embedding a standard epidemiological model within a DSGE framework, i.e. by explicitly modelling the probabilities that economic agents transition between the states: susceptible, infected, and either recovered or "removed" (the SIR-macro model). The agents' optimising behaviour in each of these states is also explicitly modelled. Both consumption and labour supply increase the agents' individual probability of infection (as well as the overall infection rate) and thus economic agents optimally reduce their labour supply and consumption – that is, without the introduction of a shock as in previous models. The economic and epi-

18 In the same spirit, Fernandez (2020) also attempts to calculate the economic impact of COVID-19. For example, under the assumption of a 3-month lockdown, Greece is projected to suffer a contraction of 6.5% in GDP. However, no details of the model or the calculations are given.

demiological implications of alternative scenarios are then examined.[19]

The agents' micro-founded behaviour reduces the economy-wide rate of infection and death and generates a sharp recession, which peaks 32 weeks from the outbreak at a maximum deviation from the steady state of 8% (the baseline scenario). If there is concern that the healthcare system may become overwhelmed (modelled by making the mortality rate an increasing function of the number of people infected), people cut back on work and consumption even more aggressively, as they self-impose stricter social distancing. In this case, the timing of the trough is earlier, but it is much deeper (reaching -22% on the trough week) and somewhat more protracted than in the baseline scenario. From an epidemiological policy perspective, it is optimal to gradually impose compulsory social distancing measures and to tighten them whenever infection rates increase and reduce them whenever infection rates decline, until a critical share of the population achieves immunity (optimal containment scenario). Such a policy results in a recession which peaks a few weeks later than in the baseline scenario but is extremely protracted, reaching a maximum deviation of approximately -20% from the steady state on the trough week. When the model instead incorporates a positive probability of a vaccine being discovered, it is optimal from an epidemiological perspective to immediately introduce severe social distancing measures and to keep them in place until the vaccine arrives, resulting in an immediate (i.e. not bell-shaped) recession, the trough of which is more protracted but less deep (maximum deviation from the steady state at 14%). It should be noted that, in terms of the long-run post-epidemic equilibrium, the impact of social distancing is positive: while both consumption and labour supply are lower in the new post-epidemic equilibrium, their decline is smaller because a smaller cumulative number of deaths has been achieved.

A number of papers build on the seminal work of Eichenbaum et al. (2020). Jones et al. (2020) extend the model by adding (i) multiple consumer goods with different contagion risk and (ii) the possibility of working from home which requires learning-by-doing. They find two additional effects. First, the fatalism effect, whereby if agents think they will inevitably contract the virus, they may feel it is best to contract it early on. Second, the front-runner effect, which also yields the same result: economic agents who worry that the healthcare system may become overwhelmed at a later date may opt to get infected today to ensure better healthcare. Both effects imply that optimal government interventions should be more front-loaded.

Krueger et al. (2020) introduce different infection probabilities across sectors but assume that it is easy to substitute contact-intensive services (e.g. having a pizza at a pizzeria) with equivalent non-contact intensive ones (e.g. takeaway pizza). Similarly, they assume that workers are able to quickly relocate to sectors now in demand, e.g. waiters will do deliveries. Under this specification, the "Swedish approach" to the epidemic, which prescribes no government intervention, suffices to mitigate up to 80% of the human and economic cost. In other words, in their model, endogenous shifts in private consumption across sectors act as a mitigation mechanism during the epidemic. However, the authors acknowledge that their findings crucially hinge on both substitutability and labour market flexibility.

Glover et al. (2020) model a number of distinctions between agents: (i) young workers

19 A number of recent papers explore variations and extensions of the standard SIR epidemiological model which underlies the economic model of Eichenbaum et al. (2020); see for example Atkeson (2020), Berger et al. (2020), Casares and Khan (2020), Ferguson et al. (2020) and Stock (2020). However, they do not embed these epidemiological models within a macroeconomic model and thus do not explore the economic implications of the pandemic. Rather, their focus is on healthcare cost dynamics, forecasting the duration of the pandemic, exploring the optimal length of the lockdown and considering possible alternative approaches to testing – e.g. broader testing of asymptomatic patients coupled with a more limited lockdown and thus a smaller economic fallout. An exception of sorts is Greenstone and Nigam (2020) who employ the Ferguson et al. (2020) simulation model for the US to estimate the number of lives saved as a result of social distancing and then attempt to "monetize" them. This provides a quantification of the social distancing measures' economic benefits.

versus old pensioners; (ii) healthy versus sick workers; and (iii) basic sector (which cannot be quarantined) versus luxury sector (which can). They highlight the fact that the pandemic affects these cohorts differently; to some the epidemic poses a major health risk, while not to others. Similarly, mitigating measures such as the quarantine have a heterogeneous impact on agents: some will lose their income due to the quarantine, while others won't. In sum, both the pandemic itself and its mitigation have distributional effects, as gains and losses are unequally distributed. Mitigation measures generate a need for redistributive policies, i.e. a need to tax agents who still work in order to compensate those who cannot work for the income lost. The authors show that optimal redistribution and mitigation policies interact, e.g. governments which find redistribution measures too costly may decide that a lower mitigation effort is optimal. Ultimately, the optimal policy will reflect a compromise between the policy paths preferred by different subgroups of the population.

Finally, Velasco and Chang (2020) focus on the dilemma of the healthy: to forego today's income by adhering to the quarantine in order to be healthy tomorrow and enjoy tomorrow's income, or to work today and risk foregoing tomorrow's income in case they get infected. They find that the initial income level matters for this choice: poorer workers are unlikely to willingly forego today's salary. Thus, quarantines are more difficult to enforce in poorer economies than in advanced ones. However, economic policy can affect this choice. If the policy maker compensates agents for their income loss, they will be willing to comply with social distancing measures. Alternatively, the policy maker may commit to implementing expansionary policy in the next period, so that agents find it optimal to adhere to social distancing measures today in order to enjoy the next period's higher income. In all cases, policy credibility is crucial. The authors conclude that economic policy can change the contagion dynamics via its impact on incentives.

It should be noted that most of the aforementioned papers were written with the aim of understanding the immediate implications of COVID-19 for the economy, i.e. with a short- to medium-term perspective in mind. Indeed, they barely touch upon the potential long-run economic implications of the COVID-19 pandemic. Furthermore, in most of the papers mentioned above that use DSGE models, the pandemic shocks are temporary. Thus, the economy eventually returns to its pre-shock long-run equilibrium. A notable exception are papers in the spirit of Eichenbaum et al. (2020) where, in the long run, there is a permanent decline in the labour force, equal to the cumulative number of deaths, leading to a permanent reduction in GDP. All in all, this literature suggests that the duration of the downturn depends crucially on the duration of the lockdown, the degree of persistence of the resulting economic shock and, where applicable, the mortality rate. However, the authors acknowledge that they abstract from a number of potentially important determinants of an epidemic's economic impact, such as hysteresis effects from unemployment, protracted bankruptcy costs and the destruction of supply chains inter alia, all of which could affect the long-run performance of the economy and have positive and normative implications. These and other economic aspects of COVID-19 are discussed in a non-technical manner in two recent VoxEU/CEPR e-books (Baldwin and di Mauro 2020a and 2020b).[20]

3.3 THE IMPACT OF THE COVID-19 PANDEMIC ON ECONOMIC EXPECTATIONS

The COVID-19 pandemic may also be affecting the economy through its impact on economic expectations, an avenue not directly explored in the aforementioned literature. Fet-

20 The COVID-19 outbreak has also prompted new work on the measurement and timing of economic activity. Leiva-Leon et al. (2020) propose an empirical framework for measuring the degree of economic weakness of the global economy in real time and use it to gauge the impact of the COVID-19 pandemic. Laeven and Valencia (2020) have updated their systemic banking crises database to facilitate comparisons between the current crisis and past ones, improve understanding of how economically damaging this crisis may be and inform policy making.

zer et al. (2020) use experimental data, survey data and internet search data to measure COVID-19 perceptions and explore how they affect economic expectations.[21] They document a rapid surge in economic anxiety since the COVID-19 outbreak. They find that the experiment participants' beliefs regarding mortality rates and contagiousness causally affect their anxiety regarding both the aggregate economy and their personal economic situation. However, the participants' aforementioned beliefs exhibit substantial heterogeneity and often grossly overestimate both contagiousness and mortality rates, thus potentially affecting their economic decisions disproportionately. Bartik et al. (2020) undertake a similar survey exploration of small businesses and find that firms too have widely varying beliefs about the likely duration of COVID-19-related disruptions, while they also tend to anticipate problems with accessing state aid, such as bureaucratic hassles and difficulties establishing eligibility. These papers highlight the economic importance of clearly and effectively conveying to the public the scientific facts on COVID-19, as well as the need for timely policy measures which will both decrease economic hardship and reduce perceived economic uncertainty, so as to limit the economic impact of the pandemic.

3.4 THE IMPACT OF THE COVID-19 PANDEMIC ON FINANCIAL MARKETS

Finally, a few recent papers explore how the COVID-19 pandemic is affecting financial market participants' behaviour and perceptions. Baker et al. (2020a) empirically document that no previous infectious disease outbreak, including the Spanish Flu, impacted the stock market as strongly as the COVID-19 pandemic. They attribute this to: (i) the ease and speed with which information on the pandemic is disseminated, which generates high stock market volatility; (ii) the high interconnectedness of the world economy, which implies that economic disruption in one location has large spillover effects; but mostly to (iii) the COVID-19 containment policies, which are much more extensive and widespread than similar efforts in the past and lead to a sharp decline in labour supply.

Hassan et al. (2020) construct time-varying measures of the exposure of individual firms to COVID-19, as well as measures of firm-specific sentiment and riskiness with regard to the COVID-19 pandemic. They do so for a global sample of firms, by applying a text-classification technique on their quarterly earnings conference calls with market participants. These measures reflect both firms' and markets' concerns as, during the conference calls, firm managers have to respond directly to questions from market participants about their firm's prospects and thus address issues they might not have raised voluntarily. The authors thus identify which firms are expected to gain or lose from the pandemic and which are most affected by the associated uncertainty. They find that, in the first quarter of 2020, firms' primary concerns related to the collapse of demand, increased uncertainty, and disruptions in supply chains. Other important concerns relate to capacity reductions, closures, and employee welfare. By contrast, financing concerns are mentioned relatively rarely. A limited number of firms foresee opportunities in new or disrupted markets due to the spread of the disease. Finally, there is some evidence that firms which have experience with SARS or H1N1 have more positive expectations about their ability to deal with the COVID-19 outbreak.

Ramelli and Wagner (2020) focus on the industry-level cross-section of returns and find that, within the same industry and controlling for standard firm characteristics, more leveraged firms and those with limited cash holdings suffered more severely, even those with little or no international activities or linkages to China. In contrast to Hassan et al. (2020), they

21 In a similar vein, Briscese et al. (2020) show that ensuring the public's expectations of the lockdown duration are unbiased matters for the success of the policy. Other papers draw on principles of behavioural economics to explore how COVID-19-related messages can be conveyed more effectively to the broader public; see for example Haushofer and Metcalf (2020).

conclude that investors were mainly concerned about firms with corporate debt and limited liquidity, thus amplifying the COVID-19 economic crisis through financial channels.

Zechner et al. (2020) study how dividends have behaved during the recent period of turbulence. They find that, although firms normally attach great importance to smoothing their dividend payouts, so as to provide shareholders with projectable income streams, the opposite is true in disaster states. Despite robust 2019 earnings, many companies have slashed previously announced dividends to protect their liquidity, or are expected by the market to do so, while in some European countries regulators have forced companies to stop paying dividends or have tied government subsidies intended to help them cope with the crisis to dividend cuts. Thus, it seems that the liquidity which dividends represent for shareholders disappears in precisely those states in which predictable cash payments would be valued most highly. This explains the recent sharp increase in the risk premium on dividend claims.

3.5 THE IMPACT OF THE COVID-19 PANDEMIC ON LABOUR MARKETS AND DIFFERENT SEGMENTS OF SOCIETY

Several papers explore the ways in which the COVID-19 pandemic has affected labour markets and different social groups. Dingel and Neiman (2020) classify all occupations in terms of work-from-home feasibility. By merging this classification with occupational employment data for the US, they find that 37% of US jobs can plausibly be performed at home. Hensvick et al. (2020) compute the share of teleworking undertaken in the US over the period 2011-18, by occupation and industry, as an indication of the extent to which teleworking could be employed during the pandemic, and find that it varies greatly.

Alon et al. (2020) explore whether the economic downturn caused by the current COVID-19 outbreak may have implications for gender equality during both the downturn and the subsequent recovery. During typical recessions, male employment is affected more severely than female employment. This reflects both differences in the sectoral composition of their employment (women tend to be employed in more "secure" sectors, e.g. the government) and the fact that women often opt to increase their labour force participation as a response to their male partners' employment uncertainty. Conversely, the decline in employment which stems from social distancing measures may have a relatively larger impact on sectors with high female employment shares. In addition, school closures increase child care needs, which likely has a particularly large impact on working mothers. The effects of the crisis on working mothers are likely to be persistent, due to high returns to experience in the labour market. In the long run however, the adoption of flexible work arrangements may ultimately promote gender equality in the labour market. Moreover, the fact that fathers may also often be obliged to take primary responsibility for child care during the epidemic could help erode discriminating social norms and have a permanent positive effect on male participation in child care, as is known to be the case for compulsory paternity leave.

Allcott et al. (2020b) use location data from a large sample of smartphones to show that, controlling for other factors, areas with more Republicans engage in less social distancing. They then present new survey evidence of significant gaps between Republicans and Democrats in beliefs about their personal risk and the future path of the pandemic.

Baker et al. (2020b) study transaction-level household data and find that households drastically altered their spending behaviour, as the number of COVID-19 infections began to grow. Initially, spending increased sharply, particularly in retail, credit card spending and food items. This was followed by a sharp decrease in overall spending. They detect substantial heterogeneity across partisan affiliation, demographics and income. Specifically,

Republicans were more likely to stockpile, possibly because they are on average older, but also perhaps because they are more concerned about the financial implications of the epidemic. Other cohorts that undertook relatively more stockpiling were pensioners, households with children, and women.

4 ASYMMETRIES AND SPILLOVER EFFECTS OF COVID-19: KEY TAKEAWAYS FROM THE ASSESSMENT OF INTERNATIONAL INSTITUTIONS

International organisations, such as the European Commission, the OECD, the IMF and the World Bank, have attempted to quantify the effects of COVID-19 and to integrate its impact into their fully fledged forecasts for the world economy. The quantification of the impact, which is largely based on simulation analysis, is surrounded by a high degree of uncertainty, due to the unpredictability of factors, such as the success of containment measures and the possible occurrence of successive outbreaks. This section focuses on some of their findings with respect to the asymmetric impact and the spillover effects of the COVID-19 pandemic within and across countries and regions.

The economic impact of COVID-19 can be greater in certain regions compared with others, mainly due to differences in financial conditions and available policy space. Emerging market economies (EMEs) are particularly vulnerable to the financial channel of transmission of the crisis, compared with most advanced economies (AEs). This has been evident in the tightening of financial conditions in these countries and the unprecedented capital outflows due to increased risk aversion and a flight by investors to safety and liquidity (see, for example, UNIDO 2020). Whereas a group of 25 EMEs including China, India, South Africa and Brazil had a net inflow of investments of USD 79 billion in 2019, a total of USD 97 billion in portfolio equity and debt investments has already exited these countries during 2020Q1, according to the Institute of International Finance (2020). These capital flows are larger than during any recent crisis episode, including the global financial crisis in 2008. The capital flight has renewed fears of insolvency and sovereign default. This could be further accelerated by currency depreciations in EMEs and notably in countries such as Argentina, Turkey or South Africa.

In addition, in many EMEs, fiscal automatic stabilisers are weaker relative to AEs, due to the magnitude of the informal sector and less developed social safety nets. Under these conditions, macroeconomic policies to support employment and incomes, such as unemployment benefits and subsidised leaves, have limited effect. As a result, lockdown measures can be more costly and lead to widespread unemployment and bankruptcies, with significant income losses in lower-income economies, particularly affecting the poorest members of society. ILO (2020) estimates for the impact of COVID-19 on global employment suggest that lower-income countries are more vulnerable, largely due to higher informal employment.[22]

Moreover, although public and corporate sectors are highly leveraged across the world, they are a particular source of vulnerability for EMEs. Coupled with the high share of external debt, debt denominated in foreign currencies and heavy reliance on short-term debt, EMEs could be subject to serious balance sheet mismatches. Several EMEs are also net energy exporters and, hence, would be heavily exposed to the negative supply shock of low commodity prices, which is mainly driven by plunging global energy demand.

The IMF (2020), in its *World Economic Outlook* of 13 April 2020, highlights these potential asymmetric effects of COVID-19 between AEs and EMEs, notably due to tighter credit conditions and differences in policy space. The

22 Lower middle-income countries are set to register the highest rate of working hours lost (12.5%) in 2020Q2, compared with the pre-crisis baseline (2019Q4). By contrast, working hours in high-income countries are set to decline by 11.6%.

asymmetries are manifested in both the short-term and the longer-term ("scarring") effects of the pandemic and in the containment measures. More specifically, based on a global model and a detailed sector-based analysis, the IMF presents a simulation exercise with three adverse scenarios for global GDP compared with its forecast baseline, according to which global GDP growth is projected at -3.0% for 2020, i.e. a 6.3 percentage point downward revision compared with the January 2020 *WEO Update*. The three scenarios assume: (i) a lockdown that lasts 50% longer than in the baseline; (ii) a second outbreak in 2021; and (iii) both a longer lockdown and a second outbreak, respectively. The model assumes that the impact is driven by containment measures and a tightening of financial conditions, and is mitigated by fiscal and monetary policy measures. Despite policy support, the pandemic leaves scarring effects on capital, productivity and trend employment.

Moreover, the model incorporates asymmetric effects of COVID-19 brought about by the lack of available policy space in EMEs, which limits their ability to improve financial market conditions and to mitigate the scarring on the economy, compared with AEs. As a result, the impact of COVID-19 on this group of countries is amplified. The decline in GDP for 2020 and 2021 is estimated to be of similar magnitude to that in AEs, despite the fact that the services sectors, which are most affected by COVID-19, have a relatively smaller economic significance in EMEs compared with AEs. Notably, output decline in the medium term is greater in EMEs relative to AEs due to the ineffectiveness of policy in mitigating the scarring of the economy. In the most adverse scenario, the output loss in 2024 is around 3.5% for AEs, against almost 4.5% for EMEs.

The World Bank (2020a), in a publication on 8 April 2020, presents a simulation exercise using a BVAR model to predict growth for developing countries in the "Europe and Central Asia" (ECA) region, compared with the January 2020 projections. Trade, transport and tourism, as well as financial conditions and commodity prices are assumed to be the main transmission channels of the COVID-19 impact for this particular group of countries. Global financial stress and flight-to-safety put pressure on currencies and are expected to lead to tightened financial conditions, with possible negative repercussions for corporate balance sheets. Also, given that countries in the region are significant energy exporters, the fall in oil and metal prices, mainly due to reduced imports from China, is expected to affect exports and strain fiscal positions in the region. The results of the analysis predict 5.4 percentage points lower GDP growth for the region in 2020 in the baseline scenario, and 7.0 percentage points lower growth in the downside scenario, which assumes that the containment measures, financial market pressures and low commodity prices last beyond 2020H1. This translates into a GDP growth rate of -2.8% for 2020 in the baseline scenario and of -4.4% in the downside scenario.

Kohlscheen et al. (2020), in a BIS paper of 6 April 2020, simulate the propagation of COVID-19 putting emphasis on the amplification effects from spillovers across countries.[23] In particular, they employ a quarterly global BVAR over the period 1997-2019 with five major economic blocs: the US, China, the euro area, "other advanced economies" and "other EMEs". The economic impact of the virus depends on: (i) the direct effects of confinement measures and their duration; (ii) the extent to which the direct effects persist and magnify; and (iii) the size of spillovers and spillbacks across regions. The model sheds light on the multiplier effects of the initial slowdown in activity, the persistence of the slowdown within each region, and the extent of spillovers.

Global economic spillovers are set to be large. The authors estimate that, on average, the full-year GDP loss in the regions included in the model would be between 1.5 and 2 times the ini-

23 The group of "other advanced economies" comprise Australia, Canada, Switzerland, the UK, Japan and Sweden, while the group of "other EMEs" comprise Brazil, India, South Korea and Mexico.

tial impulse from containment measures. In their V-shaped scenarios, the recovery in 2020H2 is modest, and even at end-2021, the level of GDP in all regions would still be below the pre-virus forecast. In their W-shaped scenarios (i.e. a second wave of confinement follows two quarters after the first wave), the weakness in economic activity persists for even longer; in most regions examined, GDP growth is negative throughout 2020 and a sustained recovery would not begin until 2021, or around six months later than in the V-shaped scenarios.

The persistence of weak activity partly reflects two types of spillovers. One is due to the risk that uncoordinated lockdowns lead to repeated virus outbreaks and confinements across the globe. The other is the more traditional trade and financial interlinkages. For AEs, spillovers from EMEs account for between 25%-30% of the GDP shortfall in 2020Q4. The spillovers are larger for the euro area, due to a larger share of exports in GDP, than for the US. Moreover, domestic mitigation alone is ineffective. Even if a country successfully limits its domestic slowdown, it will not be immune from insufficient or ineffective policies in other parts of the world. The authors run a scenario where the effect of domestic containment measures on euro area GDP is -2.5%, but the shock still hits other regions by -5%. The decline in euro area GDP after four quarters would still be 6.5% in the V-shaped and 9.9% in the W-shaped scenario, relative to the baseline. This outcome reinforces the importance of international cooperation in designing policies to limit the spread and the re-emergence of the virus and combat its economic consequences.

In the same vein, the OECD's (2020a) estimates in early March 2020, based on NiGEM simulations for the G20, highlight the positive spillover effects induced from policy coordination.[24] These suggest that collective country action yields higher output gains than individual country responses via positive confidence and trade spillovers; in particular, coordinated fiscal, monetary and structural policies should raise the level of GDP by 0.75% in the first year, 1.25% in the second year and 1.0% in the long run. By contrast, individual country responses would increase GDP by only 0.4%, 0.75% and 0.7%, respectively.

Moreover, several international institutions highlight the fact that the asymmetric impact of COVID-19 is driven by a varying sectoral demand composition, reflecting the share of the affected sectors in consumption spending and total output.

More specifically, in a two-step approach, the OECD (2020b) in late March 2020 (updated in mid-April) provides an illustrative exercise on the initial, short-term impact of the lockdown from COVID-19 on the level of real GDP in OECD economies. First, from a sectoral output approach, it is assumed that value added declines by 50%-100% in the sectors affected by the lockdown. Second, from a spending approach, cutbacks in categories of consumer spending are assumed to range between 50% and 100%. Common effects are assumed within sectors in all countries. A caveat is that cross-sectoral spillovers, potential indirect effects or other offsetting factors, such as policy measures, are not taken on board. Estimates suggest that real output loss on impact ranges between 20% and 25% in the G7, and between 15% and 35% in major AEs and EMEs, the highest being in Greece. Differences across countries reflect a varying sectoral composition of output. The spending-based assessment underpins an even sharper short-term impact on consumer spending in all countries.

The European Commission (2020) —in addition to its DSGE simulations for the impact of COVID-19 on the EU economy presented in its Spring 2020 Economic Forecast on 6 May 2020— puts forward an input-output sectoral model to assess the sectoral and country spillovers from lockdown measures during the

24 Coordinated policy responses include a debt-financed fiscal easing of 0.5% of GDP in all countries for three years, a reduction in interest rates and competition-enhancing reforms which raise TFP by 1% after five years.

COVID-19 pandemic. Based on the Trade-SCAN input-output multi-country model, simultaneous shocks to sectoral final demand are applied to the EU and the rest of the world. Final demand is assumed to decline by about 5%, which is consistent with the respective QUEST "baseline" simulations. Model estimates imply a high degree of propagation of demand shocks across countries and sectors, with the final effect being higher than the initial direct hit to demand; euro area GDP contracts by 5.7% in 2020 on average, while output losses range between -5.0% in Finland and -8.0% in Greece and Malta. Differences across Member States reflect their relative exposure to tourism and the importance of input-output spillovers in the tourism sector.

Finally, the WTO (on 8 April 2020) simulates the GDP effects of the COVID-19 pandemic using a recursive dynamic CGE model, namely the WTO Global Trade Model, which contains detailed sectoral breakdowns and intermediate linkages that enable the study of upstream and downstream effects of the sectoral shocks. The WTO presents three alternative scenarios. In the optimistic scenario, the containment measures will stay in place for three months, followed by a V-shaped recovery. In the less optimistic scenario, measures stay in place for six months, leading to a U-shaped recovery. In the pessimistic scenario, the measures will have to stay in place for the entire 2020, leading to an L-shaped recovery, as heightened economic uncertainty postpones consumption of durable manufactured goods. The short-term global output losses range between 5% and 11% in 2020 relative to the baseline, while regional patterns show the biggest output drops in EMEs. ASEAN (South-East Asia), Mexico and the Newly Industrialised Countries (e.g. Korea, Hong Kong, Taiwan) are projected to see the sharpest decline in GDP. For the US, the reduction in trade is projected to be much larger than the reduction in GDP, as the share of goods traded by air and the share of exports in services are large. Moreover, the relative contribution of different shocks changes over time. In the V-shaped scenario, labour supply, trade costs and sectoral demand shocks contribute 42%, 20%, and 38%, respectively, to the fall in global GDP. In the U-shaped and L-shaped scenarios, the contribution of the sectoral demand shocks rises to above 50%. The largest differences among countries are driven by the sectoral demand component, reflecting the high share of these sectors in total household consumption.

5 A BIRD'S EYE VIEW: CHANNELS, IMPACT AND POLICY IMPLICATIONS

This comprehensive overview of various strands of the literature and of empirical assessments by international institutions allows us to draw some conclusions about the economic impact of pandemics in general and of COVID-19 in particular.

First, we can identify the channels through which pandemics affect the economy. The most obvious channel comes from supply-side effects. Pandemics reduce both the quantity and the quality of labour. Crucially, the quantitative impact will depend on the mortality rate of the epidemic, as well as on the extent to which the working age population is affected. Labour supply may also be affected by the exclusion of different social groups who are deemed likely to spur the spreading of the pandemic, as well as through the impact of the pandemic on migratory flows. In the short term, the labour supply effect is also influenced by the morbidity rate – the extent to which lockdowns lead to workers being unable to work during that period. In losing parts of the working age population, human capital effects are also likely to influence the quality of labour supply in the post-pandemic era. These effects, working through labour supply, negatively impact on both actual and potential output, pointing to longer-term effects from pandemics. Pandemics can also generate destruction of capital effects, as businesses close and investment is curtailed, thus adding to the negative impact on current and potential output.

Aside from supply-side effects, pandemics are likely to induce demand effects. Consumption is particularly vulnerable to the impact of both reduced income and increasing uncertainty which dents consumers' confidence. Uncertainty will also have the effect of, at best, delaying investment and, at worst, dampening it for a period of time. Overall, the savings rate in the private sector should increase as uncertainty over a future health care crisis looms and cash flow constraints pose challenges to debt servicing.

Moreover, the impact of both supply and demand effects is also likely to depend on the reaction of individuals. How quickly and to what extent workers lock down is determined by their beliefs about their exposure to the virus and their views regarding the ability of the health system to cope. Individual reactions will also impact on the ability of the economy to quickly exit lockdown. Even if statutory measures are relaxed, individual behaviour may take more time to adjust.

A final channel works through the financial system. While the natural rate of interest might be expected to fall, leading to a period of low interest rates, financial institutions are likely to come under increasing stress. Rising uncertainty, along with an increase in the number of borrowers with debt servicing difficulties, is likely to generate a liquidity squeeze, which exacerbates the demand effects of pandemics. Moreover, risk premia are expected to rise and the evidence suggests that COVID-19 has had stronger effects on financial markets than past pandemics.

Whether it is the supply channel or the demand channel that dominates is not so important. Even if a shock originates from the demand side, it can then feed back into the supply side through the investment channel. Lower demand reduces labour productivity, as output falls. This then generates lower investment, which further depresses labour productivity and, ultimately, demand. This is what Fornaro and Wolf (2020) call the "supply-demand doom loop". Such doom loops are common in models that include more than one sector – one particularly affected by the lockdown (high-contact sectors) and a second which is less affected. The shock to the most affected sector is easily passed on to less affected sectors, creating vicious circles.

Building upon these channels it is possible to identify the impact of pandemics on some key economic aggregates. All three channels work to reduce current and possibly potential output. Growth is negatively affected in the short run, but usually rebounds in subsequent years. However, output can still remain below trend. The impact on inflation depends on the relative balance of supply versus demand shocks. If the supply shocks are large, as they were during the Black Death, then inflation can rise as shortages develop. On the other hand, if demand effects dominate, deflationary pressures will be present. With respect to inflation, the impact of the demand shock on commodity prices also works to lower inflationary pressures. The impact on trade is usually greater than that on output and this makes open economies and economies that are closely embedded in global value chains especially vulnerable. Travel is usually one of the most affected sectors and thus economies which rely on tourism exports will be more negatively affected than those that are primarily goods exporters. Goods exporters, in today's world, aside from experiencing the impact of weaker demand, also face potential supply shortages, as production chains are disrupted. The destruction of livelihoods, as businesses close and unemployment rises, can have negative implications for poverty, especially in countries that lack a strong welfare state. In general, the distributional impact of the pandemic and its particularly strong impact on specific sectors suggest the need for governments to engage in redistributional policies in order to share the burden more fairly across society. Finally, social capital can also be destroyed during pandemics, as curtailing social interaction leads to a decline in trust. Lower social capital has been shown to reduce growth prospects over the longer term.

The negative effects of the pandemics can be asymmetric across sectors and regions due to various factors. First, uncoordinated confinements can lead to repeated and unsynchronised virus outbreaks across the globe. Second, the absorptive capacity of the exogenous health shock depends on country-specific idiosyncratic factors, such as labour market flexibility, foreign capital dependence, trade openness and policy space. Differences in the initial economic conditions can lead to a varying impact of the pandemic across countries. Third, trade and financial linkages, among others, increase spillovers and amplify the effects of the first-order demand and supply shocks from the pandemic, notably from COVID-19. The total GDP shortfall from COVID-19 could be as much as twice the direct impact of the virus and the confinement measures, highlighting the sizeable effect of multipliers and spillovers in propagating contractions within and across economies. These spillovers are largely evident between AEs and EMEs, but also among AEs.

The negative effects of the pandemics can, of course, be mitigated by policy, and the policy tools that governments have at their disposal are much broader than those that were available to countries during the two largest pandemics – the Black Death and the Spanish Flu. The channels outlined above provide the background for discussing policy responses.

The supply-side effects: One of the strongest effects from past pandemics from the supply side arises from the loss of life and hence the impact on labour supply. COVID-19 is not expected to have such a direct effect on labour supply. The lockdowns have limited the impact of the pandemic on health, and labour supply is disrupted in the short term more or less depending on the length of the lockdown. The supply-side effects in this pandemic are likely to arise from the destruction of economic relations – that is, the laying off of workers and the subsequent rise in unemployment along with business failures, which lead to the destruction of capital. Policy is thus focused on minimising the scarring effects by maintaining economic relations as intact as possible through the lockdowns. Thus, policies to subsidise wages help prevent workers from being laid off. The more widespread use of wage subsidies in Europe compared to the US helps to explain the differing unemployment outcomes. Similarly, policies to provide liquidity support to businesses aim at keeping viable firms alive. In this way, when lockdowns end, economic relations are still fairly intact and it is easier to get production up and running. Of course, some businesses will fail and unemployment will rise. To prevent the latter from having lasting effects on the quality of labour supply, Active Labour Market Policies (ALMPs) have to be a priority area for improvement, especially in Greece where their past performance has been somewhat patchy.

The demand-side effects: Monetary policy loosening either through interest rate reductions or the extension of non-standard measures can help ease liquidity constraints for companies by preventing liquidity shortages either directly or indirectly (through banks or various financial markets which have seized up). The ECB's Pandemic Emergency Purchase Programme (PEPP) is a step in the right direction to ensuring that liquidity provision is maintained.

However, fiscal policy also has to play a significant role. Most countries have been announcing large fiscal stimuli whether it is through transfers to subsidise wages, measures to delay tax and social security payments, or the extension of eligibility for unemployment benefits beyond their usual fixed period. Considerations of redistribution across more and less affected groups are also beneficial in encouraging recovery.

Aside from financing transfers, fiscal policy also has to support investment —both private and public— in the recovery period. The large increase in uncertainty will have led to the postponement of investment plans and makes business less optimistic in developing new plans. As an individual business, it is rational to postpone. An investment will only be prof-

itable if others also invest raising aggregate demand, productivity and hence disposable income and, finally, consumption. The public sector has a role to play in this regard, since such investments usually generate large multiplier effects in the economy and are likely to make smaller private sector investments more profitable. Thus, EU policies for injecting funds into investment projects —either directly through Commission resources or via the European Investment Bank— are welcome. Moreover, investment raises productivity, which can contribute to a demand rebound and help avoid the demand-supply doom loops found in the literature.

However, such stimuli will place an increasing burden on debt levels throughout the euro area. For this reason, some form of mutualisation of the cost is necessary if national programmes are to be feasible and credible. Some have argued that the EU should issue perpetual bonds (Giavazzi and Tabellini 2020; Soros 2020). This proposal is a sound one —the EU has the economic and political power to issue such bonds just as the UK and the US have done in the past (the UK, for example, used perpetual bonds to finance both the Napoleonic Wars and WWI). The EU also has the motive— a powerful symmetric shock facing individual Member States. Indeed, the very act of issuing such bonds would send a strong signal to markets about government commitments to the EU project.

Financial channel: we can also draw some policy lessons for the financial sector. The financial sector has the potential to exacerbate the supply and demand shocks that are the result of a pandemic. First, financial institutions are likely to face liquidity constraints, as interbank markets dry up and, potentially, deposits fall. Second, the impact of the pandemic on income and employment causes debt servicing difficulties among both households and firms. This in turn is likely to lead to rising non-performing loans (NPLs), at a time when a number of EU countries already face higher than usual NPL ratios.

Potential liquidity constraints in euro area banks are being addressed by the Eurosystem. First, Greek government bonds (GGBs) have become eligible both for the PEPP and also as collateral. Moreover, haircuts associated with monetary transactions on all collateral (including GGBs) have been reduced significantly. The ability to tap liquidity from the Eurosystem using credit claims has been expanded. All these measures improve the liquidity situation of Eurosystem banks in general and Greek banks in particular, as they provide the opportunity for banks to resort to the Eurosystem for liquidity in greater amounts rather than relying on interbank markets, which often prove to be more expensive and susceptible to sudden shifts in sentiment.

Turning to the impact of the crisis on the asset quality of banks, evidence suggests that asset quality will deteriorate. At a time when NPLs are already high in certain EU countries, this circumstance poses a particular challenge. National systems to deal with NPLs may not be enough, since they rely on investors from elsewhere to invest in the NPL clean-up. If, however, the demand for such capital injections from outside investors rises, it is not clear that there will be enough outside investors willing to meet that demand. The more systemic the increase in NPLs and thus the need to find a solution across the euro area/EU as a whole, the more likely it is that some form of centralised solution might be required. It is against this background that calls for an EU-wide bad bank are being heard.

6 CONCLUSIONS

In short, pandemics have strong impacts on economies – both in the short run and potentially in the long run. Research relying on historical episodes as well as modern modelling techniques can shed light on the channels through which economies are affected. However, modern states have many more policy weapons at their disposal and the models provide ample evidence on what can be done to limit the impact of such pandemics. Many of

these policies are already being employed. In the context of the EU, their credibility would benefit considerably from a more coordinated and mutualised response to the crisis.

Finally, we can highlight the need for global cooperation. Although policy efforts can mitigate the adverse direct effects of the exogenous shock and preserve economic relationships, incomes and production structures, differences in the available policy space can magnify structural divergences across economies. Advanced economies are expected to be more effective than emerging market economies in coping with the effects of the pandemic as a result of larger policy space. Still, divergences can be observed even among advanced economies. In this regard, domestic mitigation alone is not sufficient to cope with the crisis. Even if countries successfully limit the domestic economic slowdown, they will not be immune from insufficient or ineffective policies in other countries. Hence, positive spillovers stemming from policy coordination can underpin domestic efforts to lessen the economic hardship across the world as a whole.

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