Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change?

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Abstract

The COVID-19 crisis is likely to have dramatic consequences for progress on climate change. Imminent fiscal recovery packages could entrench or partly displace the current fossil-fuel-intensive economic system. Here, we survey 231 central bank officials, finance ministry officials, and other economic experts from G20 countries on the relative performance of 25 major fiscal recovery archetypes across four dimensions: speed of implementation, economic multiplier, climate impact potential, and overall desirability. We identify five policies with high potential on both economic multiplier and climate impact metrics: clean physical infrastructure, building efficiency retrofits, investment in education and training, natural capital investment, and clean R&D. In lower- and middle-income countries (LMICs) rural support spending is of particular value while clean R&D is less important. These recommendations are contextualized through analysis of the short-run impacts of COVID-19 on greenhouse gas curtailment and plausible medium-run shifts in the habits and behaviours of humans and institutions.

I. Introduction

The COVID-19 crisis could mark a turning point in progress on climate change. This year, global greenhouse gas (GHG) emissions will fall by more than in any other year on record. The percentage declines likely in 2020, however, would need to be repeated, year after year, to reach net-zero emissions by 2050. Instead, emissions will rebound once mobility restrictions are lifted and economies recover, unless governments intervene. There are reasons to fear that we will leap from the COVID frying pan into the climate fire.

However, the crisis has also demonstrated that governments can intervene decisively once the scale of an emergency is clear and public support is present. COVID-19 has precipitated a major increase in the role of the state (Helm, 2020; Klenert *et al.*, 2020). Decisive intervention has begun to stabilize infection rates, prevent health systems being overwhelmed, and save lives.

The climate emergency is like the COVID-19 emergency, just in slow motion and much graver. Both involve market failures, externalities, international cooperation, complex science, questions of system resilience, political leadership, and action that hinges on public support. Decisive state interventions are also required to stabilize the climate, by tipping energy and industrial systems towards newer, cleaner, and ultimately cheaper modes of production that become impossible to outcompete (Acemoglu *et al.*, 2012; Grubb, 2014; Aghion *et al.*, 2014; Farmer *et al.*, 2019; Mealy and Teytelboym, 2020).

Will such action be forthcoming? Public support for action on climate change increased to a peak prior to the pandemic; government and corporate action was also gathering momentum. COVID-19 has clearly slowed this momentum, not least in delaying the international conference on climate (COP26) from 2020 to 2021. However, the momentum could find new strength if, humbled by the ability of 'natural' forces to shock the global economy, humans recalibrate our sense of omnipotence. Furthermore, opinion polls in many countries show that people are noticing the clean air, uncongested roads, the return of birdsong and wildlife, and are asking whether 'normal' was good enough; could we not 'build back better' (Ipsos, 2020)? The shape of COVID-19 fiscal recovery packages put in place in the coming months, once lockdowns are eased, will have a significant impact on whether globally agreed climate goals are met.

This paper identifies stimulus policies that are perceived to deliver large economic multipliers, reasonably quickly, and shift our emissions trajectory towards net zero. The recovery packages can either kill these two birds with one stone—setting the global economy on a pathway towards net-zero emissions—or lock us into a fossil system from which it will be nearly impossible to escape.[1]

In section II, we examine the recent effects of COVID-19 on emissions. In section III, we catalogue over 700 stimulus policies proposed or enacted during and since the Global Financial Crisis (GFC) and develop a set of 25 policy archetypes. We conduct a global survey of over 230 experts, including from financial ministries and central banks, to subjectively assess the economic and climate impact potential of these archetypes. We establish that respondents consider it feasible for policy action to stimulate economic activity and make progress towards net-zero emissions. In section IV, we briefly consider the broader impacts of COVID-19 on trends in individual and corporate behaviour, including towards less travel and more working from home, increased localization and self-sufficiency, and institutional trends towards scepticism of multilateralism and coordinated global action. We conclude that progress on climate change will depend significantly on policy choices in the coming 6 months; the right choices could drive a long-term downward trend in GHG emissions.

II. Early days: the economic slowdown and fiscal relief measures

(i) Decline in economic activity

All G20 nations have implemented restrictions on mobility (IMF, *2020a*) such as 'self-isolation' and 'social-distancing' (Wilder-Smith and Freedman, 2020). These restrictions have reduced the spread of the virus (Hou *et al.*, 2020; Koo *et al.*, 2020), but with severe economic consequences. On the supply side, an estimated 81 per cent of the global workforce has been hit by full or partial lockdown measures (del Rio-Chanona *et al.*, 2020; ILO, 2020), with unprecedented job losses and furloughs (ILO, 2020). On the demand side, consumer spending has fallen as it is no longer possible to travel, including to shop for discretionary items, go to restaurants, or to engage in experience-based activities (Chen *et al.*, 2020; Muellbauer 2020; Andersen *et al.*, 2020). Aviation volumes have collapsed, with international airlines projecting a reduction of 503–607m passengers and losses of US$112–135 billion in the first half of 2020 (UNICAO, 2020). Consumer confidence is falling (OECD, 2020) and job losses and furloughs simply exacerbate spending contractions as workers lose their incomes.

(ii) Decline in fossil fuel use and GHG emissions

These dramatic declines in economic activity have reduced energy demand and the use of fossil fuels, which supply 85 per cent of our energy demands (BP, 2019). The collapse in oil demand has exacerbated market imbalances (Oxford Analytica, 2020*a*; Oxford Analytica, 2020*b*), and contributed to Brent crude prices dipping to their lowest level in over two decades.[2]

The fall in fossil fuel use has reduced pollution of various kinds, including GHGs such as carbon dioxide (CO_2) and nitrous oxide (N_2O), as well as aerosols, short-lived gases (Jacobson, 2010; Myhre *et al.*, 2013), and harmful particulate matter. While it is currently impossible to accurately detect CO_2 emissions in the short term at a regional scale (Artuso *et al.*, 2009; Yang *et al.*, 2019), estimates can be pieced together using data on fuel use, and measurements of nitrogen dioxide (NO_2) concentrations (Konovalov *et al.*, 2016), which is emitted alongside CO_2 in industrial and automotive combustion.[3] For instance, it has been estimated that China's shutdown in February resulted in a 25 per cent decline in CO_2 emissions (200 $MtCO_2$) due to lower coal and oil consumption (Myllyvirta, 2020).

Globally, GHG emissions might fall by 8 per cent or 2.6 $GtCO_2$ in 2020 (IEA, 2020*a*), which is more in absolute terms than in any other year on record (Boden *et al.*, 2017; Le Quéré *et al.*, 2018). By comparison, annual CO_2 emissions fell by an average of 4 per cent during the Second World War (1939–45), 3 per cent during the 1991–92 recession, 1 per cent during the 1980–81 energy crisis, and 1 per cent during the 2009 Global Financial Crisis (Boden *et al.*, 2017). The declines in 2020 are significant relative to major historical wars and epidemics (Pongratz *et al.*, 2011; Boden *et al.*, 2017).

This decline in GHG emissions has been advanced as a 'silver lining' of the COVID-19 crisis (Bandyopadhyay, 2020; Isaifan, 2020; Teale, 2020), but the UN Environment Programme estimates that global GHG emissions must fall by 7.6 per cent *every year* from 2020 to 2030 to keep temperature increases to less than 1.5°C (UNEP, 2019). Further, every year that GHG emissions are above zero, atmospheric GHG concentrations continue to build, increasing the risk that even incremental increases could trigger feedback loops that result in outsized and permanent damage to the climate (Farmer *et al.*, 2019).

Without decisive government intervention, discussed in the next section, emissions will rebound once the lockdowns end.[4] However, the magnitude of the rebound will depend on the speed of the economic recovery, the nature of rescue spending (keeping businesses and people alive) and recovery spending (reinvigorating the economy once mobility restrictions can be relaxed), the extent of a rebound in consumer demand, and the prescience of certain human and institutional trends discussed in section IV. Conceivably, in the event of a rapid rebound, pent-up demand could even bring a short-term increase in GHG emissions above the long-term average. A rebound in emissions can already be seen in China, where mobility restrictions are being relaxed and factories are reopening.

More important than the short-run impact on emissions are the impacts on investment in clean technologies such as renewable energy. Falling energy demand means sharp reductions in the growth of installed wind, solar, and battery capacity in 2020, with effects lingering into 2021; solar photovoltaic installations in particular are projected to fall by 48 per cent in Q2 2020, followed by a gradual recovery (Eckhouse and Martin, 2020). These challenges are further compounded by disruptions to global supply chains for key parts, as well as the collapse in oil prices (IEA, 2020*b*), which increases the allure of fossil-fuel-based consumption in the economic recovery phase, particularly in emerging economies (Fox-Penner, 2020).

(iii) The climate impact of existing rescue packages

Many G20 national governments have already proposed and/or implemented sizeable fiscal rescue measures. These emergency measures are hoped to protect balance sheets, reduce bankruptcies and address immediate human welfare concerns during lockdown periods, including through curtailing the spread of the virus and addressing incremental healthcare costs. In April 2020, all G20 nations (including most EU member states), had signed such fiscal measures into law, earmarking a total of over US$7.3 trillion in spending. We identified over 300 implemented policies of significant magnitude, detailed in full in the Supplementary Materials. Distinguishing between rescue and recovery measures (see section III) we find that the vast majority of these policies are of the rescue typology, including significant worker and business compensation schemes which defend livelihoods. Our subjective assessment is that 4 per cent of policies are 'green', with potential to reduce long-run GHG emissions, 4 per cent are 'brown' and likely to increase net GHG emissions beyond the base case, and 92 per cent are 'colourless', meaning that they maintain the *status quo*.

The priority of the rescue packages has naturally been to increase cash flows to individuals in financial distress and to support those who need to spend on food, shelter, health, electricity, and other basic goods. Multiple nations have already implemented policies hoped to have this effect. For instance, the 2020 United States *CARES Act*, signed into law on 27 March 2020, includes relief provisions to directly support citizens through cash-in-hand programmes

(Courtney, 2020). Other countries have implemented schemes to similar effect. The UK's *Coronavirus Job Retention Scheme* (UK Coronavirus Act, 2020) allows firms to apply for government assistance to cover up to 80 per cent of furloughed workers' wages, capped at £2,500 monthly.

However, some rescue policies also cover emissions-intensive firms, such as airlines, that face bankruptcy or significantly reduced revenue as a result of COVID-19. Examples include Russian tax breaks for airlines (through the *Anti-crisis Fund*) (Ostapets *et al.*, 2020), AU$715m of unconditional Australian airline relief (through the *Coronavirus Economic Response Package* (Commonwealth of Australia, 2020), and US$32 billion of bailouts (including grants and loans) for US airlines (through the *CARES Act*) (Courtney, 2020). Fossil fuel industries, facing extraordinarily low oil prices (Ngai *et al.*, 2020), are likely to request future tax breaks or bailouts. While there may be good reasons for such support, such bailouts should be conditional on these industries developing a measurable plan of action to transition towards a net-zero emissions future.

Overall, although COVID-19 has reduced GHG emissions in 2020, the overall impact will be driven by investment choices. The emergency rescue packages that are currently being implemented represent life and death decisions made by government officials about people alive today. The imminent recovery packages, soon to be designed and implemented, will reshape the economy for the longer-term, representing life and death decisions about future generations, including through their impact on the climate.

III. The climate impact of fiscal recovery packages

While most G20 governments have implemented rescue packages, as of April 2020 no government has fully exited lockdown and introduced significant recovery packages. These recovery packages could be 'brown', reinforcing the links between economic growth and fossil fuels and risking future stranded assets (Pfeiffer *et al.*, 2018), or 'green', decoupling emissions from economic activity.

Several factors are relevant to the design of economic recovery packages: the long-run economic multiplier, contributions to the productive asset base and national wealth, speed of implementation, affordability, simplicity, impact on inequality, and various political considerations. A key objective of any recovery package is to stabilize expectations, restore confidence, and to channel surplus desired saving into productive investment. However, 'business as usual' implies temperature increases over 3°C, implying great future uncertainty, instability, and climate damages. An alternative way to restore confidence is to steer investment towards a productive and balanced portfolio of sustainable physical capital, human capital, social capital, intangible capital, and natural capital assets (Zenghelis *et al*, 2020), consistent with global goals on climate change. Finally, any recovery package, including climate-friendly recovery, is unlikely to be implemented unless it also addresses existing societal and political concerns—such as poverty alleviation, inequality, and social inclusion—which vary from country to country.

(i) Assessing economic and climate impact potential

Studies of fiscal responses during the GFC suggest that the economic success of fiscal stimulus is strongly affected by two attributes: the speed at which the stimulus delivers real-world impact; and the short- and long-run economic multiplier, or return for every dollar of expenditure (Freedman *et al.*, 2009; Coenen *et al.*, 2012; Ramey, 2019). Compared to the GFC, the COVID-19 crisis has had a severe and broad impact; it is not focused on a particular sector (as distinct from 1973–5, 1981–2, 2001, and 2008–9). The rescue packages have had to be rapidly acting. Given the sudden need, limitations on administrative capacities have affected the design of programmes and have been a binding constraint. Speed is important but less critical for the recovery packages, where there is greater scope for carefully directing resources towards investments in high productivity assets, with higher economic multipliers, to deliver a capital stock and a labour force suited to the challenges of the future (Hepburn *et al.*, 2020).

What determines the long-run multiplier? High-productivity economies of the future will be those that make the most of artificial intelligence and the technologies of the fourth industrial revolution (Schwab and Davis, 2018) while also protecting and enhancing natural capital, such as ecosystems, biodiverse habitats, clean air and water, productive soils, and a stable climate. Here, we focus on the climate impact. Co-benefits of climate policies (Karlsson *et al.*, 2020) often include reduced waste and inefficiency, pollution (Dong *et al.*, 2015; Bollen, 2015), congestion (Portugal-Pereira *et al.*, 2013), and food waste (Munesue *et al.*, 2015), and improved health outcomes (Chivian and Bernstein, 2008; Andersen, 2017; Quam *et al.*, 2017), biodiversity (Bryan *et al.*, 2016; Wüstemann *et al.*, 2017), and ecosystem sustainability (Palm *et al.*, 2014); these are vitally important but not the focus of this paper.

(ii) Lessons from previous crises

The COVID-19 crisis is different from the 2009 GFC, but there is nevertheless much to learn. Economic multipliers are near zero when the economy operates near capacity. In contrast, during crises such as the GFC, economic multipliers can be high. Uncertainty, reluctance to invest for the future, and concern about the affordability of spending prompts economic actors to take economically undesirable measures. Businesses may cut investment and shed workers, banks may rein in credit, and consumers may contain spending. Lack of confidence can thereby prove self-fulfilling in delivering a weaker economy through Keynesian 'multiplier' and 'accelerator' effects.

Expansionary policy in a slump can arrest the negative reinforcing feedback resulting from a shortfall in private activity and prevent negative hysteresis effects on future supply, whereby capital is scrapped and labour skills are lost due to underutilization (DeLong and Summers, 2012). Fiscal injections during such slowdowns have been found to generate multipliers as high as 1.5–2 (Auerbach and Gorodnichenko, 2012) or even as high as 2.5 (Blanchard and Leigh, 2013). Three models for the UK, applying estimates only to fiscal injections based on additional borrowing, find that the long-run multiplier lies in a narrow range of 2.5 to 3.0 (IMF, 2014; Abiad *et al.*, 2015; Mourougane *et al.*, 2016). In this case, depending on the nation and the sector, increased tax revenues can go a long way to financing any increases in expenditure.

Within the set of expansionary policies, government spending on investment appears preferable to tax reductions, delivering higher multipliers (Mahfouz *et al.*, 2002). Direct cash transfers to households have also performed well (Gechert and Rannenberg, 2018). So far, financial systems have remained functional and low real interest rates provide the opportunity for targeted investment in productive assets to deliver higher short- and long-run economic multipliers (Freedman *et al.*, 2009).

Of course, no crisis is the same. There are at least four reasons that COVID-19 spending might have smaller multipliers. First, if the uncertainty in the current crisis is deeper than in previous crises, individuals and firms could engage in more precautionary behaviour, hoarding cash. Second, if fear of COVID-19 means that people choose not to engage in travel and social activities, efforts to stimulate economic activity will be less effective. Third, it may be difficult to target government injections to where there is a high marginal propensity to spend.

Fourth, the impact on expectations may be shaped more by emerging health risks than by financial responses (Stiglitz, 2020).

Nevertheless, it is likely that there are lessons to heed from the past, including with respect to the impact of such measures on the climate. We therefore undertook a light-touch assessment of 196 stimulatory fiscal recovery policies implemented in response to the GFC, finding that 63 were green, 117 were colourless, and 16 brown. A lesson from the GFC is that green stimulus policies often have advantages over traditional fiscal stimulus. For instance, renewable energy investment is attractive in both the short and the long run. Renewable energy generates more jobs in the short run (higher jobs multiplier), when jobs are scarce in the middle of a recession, which boosts spending and increases short-run GDP multipliers (which are derived from expanding demand). In the long run, renewable energy conveniently requires less labour for operation and maintenance (Blyth *et al.*, 2014). This frees up labour as the economy returns to capacity. The more efficient use of labour and the savings on fuel means that renewables are also able to offer higher long-run multipliers (which are derived from expanding supply).

Green construction projects, such as insulation retrofits or clean energy infrastructure, can similarly deliver higher multipliers. These large construction projects are less susceptible to offshoring to imports (Jacobs, 2012). Clean energy infrastructure is also helpfully very labour intensive in the early stages—one model suggests that every $1m in spending generates 7.49 full-time jobs in renewables infrastructure, 7.72 in energy efficiency, but only 2.65 in fossil fuels (Garrett-Peltier, 2017). In the long run, these public investments offer high returns by driving down costs of the clean energy transition (Henbest, 2020). Harnessing more of these opportunities could result in 'kick starting the green innovation machine' (Acemoglu *et al.*, 2012) and driving an efficient, innovative, and productive economy, with higher spillovers that benefit the wider economy (Aghion *et al.*, 2014) and higher 'green complexity' (Mealy and Teytelboym, 2020).

Speed of implementation is critical for the rescue packages but also valuable for the longer-term recovery packages. Fast-acting climate-friendly policies include residential and commercial energy efficiency retrofits, as well as natural capital spending (afforestation, expanding parkland, enhancing rural ecosystems) (Bowen *et al.*, 2009; Houser *et al.*, 2009). When implemented through existing programmes (Houser *et al.*, 2009), energy efficiency retrofits can be the 'most obvious option for a shovel-ready, local green investment' (Kamal-

Chaoui and Robert, 2009). Natural capital spending is fast-acting because worker training requirements are low, many projects have minimal planning and procurement requirements, and most facets of the work meet social distancing norms. Through their nationally determined contributions (NDCs), many countries have already prepared 'shovel-ready' projects, and in most lower- and middle-income countries (LMICs) these NDCs are heavily oriented towards infrastructure.

Investment could also be used for development and early-stage demonstration of key technologies that appear necessary to reach net-zero emissions. Greenhouse gas removal (GGR) technologies, including land-based biological processes and industrial carbon capture and storage (CCS), are one example. GGR technologies are necessary to meet the Paris goals, but barriers exist, and costs remain uncertain; more research, development, and deployment could be extremely beneficial (Hepburn *et al.*, 2019).

(iii) Global survey of fiscal recovery policies

In April 2020, we surveyed 231 finance ministry officials, central bank officials, and other economists, representing 53 countries including all G20 nations, to ascertain their perspectives on COVID-19 fiscal recovery packages. These perspectives are relevant to policy design. A set of 25 policy archetypes—6 rescue-type policies (A, C, D, I, K, O) and 19 recovery-type policies (Figure 1, details in Appendix 2)—were defined, following a wide cataloguing effort of over 700 significant G20 fiscal stimulus policies proposed or implemented over the period 2008–20. Respondents were systematically identified using a filtering procedure with associated methodology described in Appendix 3. Our 'target group' comprised senior central bank officials (226 contactable officials identified, 43 respondents), senior development bank officials (301 contactable officials identified, 41 respondents), senior members of finance/treasury ministries (147 officials identified, 23 respondents), expert academics (217 experts identified, 71 respondents), and think-tank commentators (128 experts identified, 21 respondents).

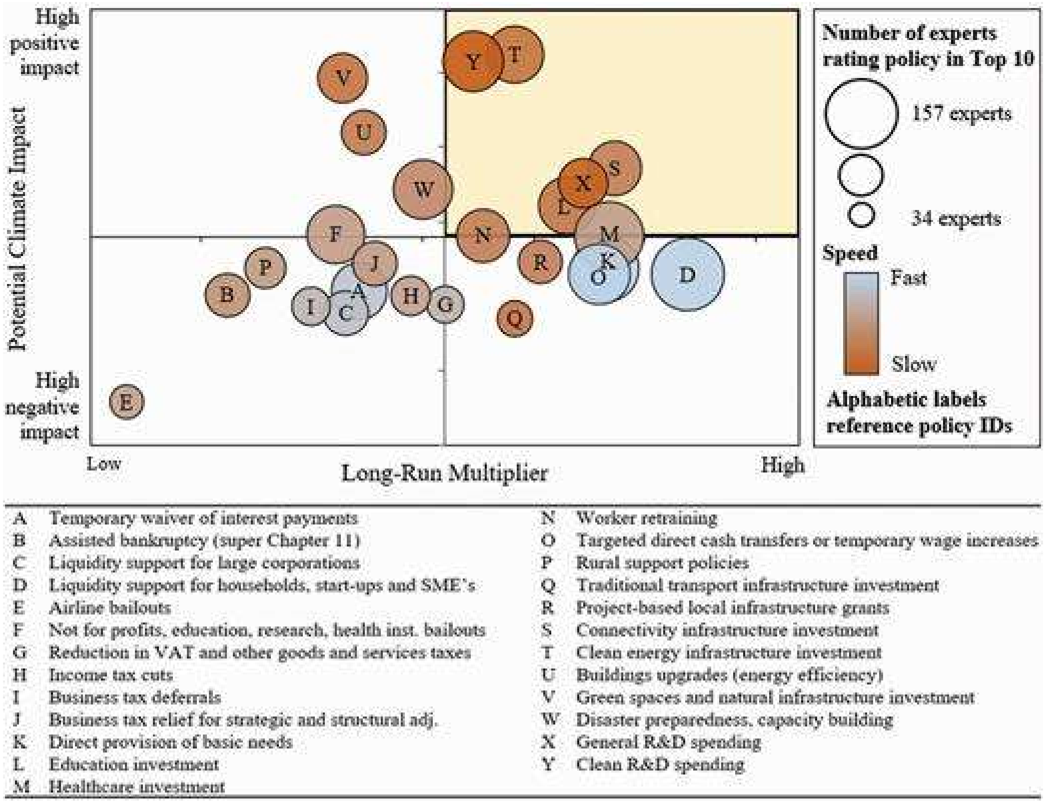

Figure 1: Target group mean survey results aggregated using relativity-adjusted scores.

Respondents were asked to assess, in a relative and subjective manner using sliding responses, each policy archetype on three core metrics; 'speed of implementation' from the time of legislation (scaled from less than a month to more than 3 years), 'long-run economic multiplier' (low to high), and 'climate impact potential' (highly negative to highly positive). A fourth summative metric, 'overall desirability' (strongly opposed to strongly support) was also tested to account for relevant social, political, and personal factors not addressed by the climate and economic metrics. Respondents provided demographic data (6 questions) including country of focus, experience level, and educational training. Respondents were also encouraged to provide any additional comments in a free response question and had the option to leave their name for publication (see Appendix 1). In this way, each respondent answered 106–108 questions, giving a total of 24,703 data points for the survey. Each 'target group' expert received a controlled individual link for personal response as well as an unrestricted link for sharing with colleagues. Unrestricted respondents formed the 'supplementary group'. Details on sampling groups and survey design are included in Appendix 4.

Policies perceived to be in the desirable upper-right quadrant of Figure 1 (large long-run multiplier and strongly positive impact on climate) included connectivity infrastructure (S), general R&D spending (X), education investment (L), clean energy infrastructure (T), and clean energy R&D spending (Y). Each of these was also often identified as being in the top 10 desired recovery policies of respondents. Other notable policy options included healthcare investment (M) and worker retraining (N). Two archetypes scored highly on potential climate impact but were not recognized for high multiplier or speed of implementation: green spaces and natural infrastructure (V), and energy efficient buildings upgrades including retrofits (U).[5]

Many traditional ‘relief type’ measures, clumped to the centre right of the figure, including liquidity support for households, start-ups, and SMEs (D), direct provision of basic needs (K), and targeted direct cash transfers (O), predictably out-performed others in terms of speed of implementation and ranked among the highest for long-run multiplier. Non-conditional airline bailouts (E) recorded a markedly poor performance on all metrics and featured in fewer experts’ top 10s than any other policy.

The clean R&D archetype, when directly compared to general R&D, was perceived to be significantly more desirable overall, and to have greater positive climate impact potential. However, it received a lower ranking for both speed (25th vs 20th) and multiplier (12th vs 6th), suggesting target group respondents placed a relatively strong weighting on the importance of climate impact.

In the target group, the most desirable recovery-type policies (ordered by mean, starting with the best policy) were healthcare investment (M), disaster preparedness (W), clean R&D spending (Y), not for profit bailouts (F), and clean energy infrastructure investment (T). The worst-performing policies (ordered by mean, starting with the worst policy) were airline bailouts (E), traditional transport infrastructure (Q), income tax cuts (H), reduction in VAT and other goods and services taxes (G), and rural support policies (P).

Figure 2 illustrates notable response variation between sampling groups. After think tanks, finance and treasury ministry officials had the highest overall variation in responses from the target group mean (see Appendix 7). Finance officials reported comparatively low overall desirability for reduction in VAT (G), direct cash transfers (O) and direct provision of basic human needs (K). On climate, officials perceived that the negative climate impacts of unconditional airline bailouts (E) were not as severe as what others reported. Officials also indicated that the multiplier of business tax relief for strategic and structural adjustments (J) was much higher than the indications of other groups, while the speed of implementation of assisted bankruptcy (B) and VAT reductions (G) were much lower. On an overall basis, opinion on the climate impact potential of policies across all groups was the least controversial (lowest variation) while speed of implementation was the most controversial (highest variation).

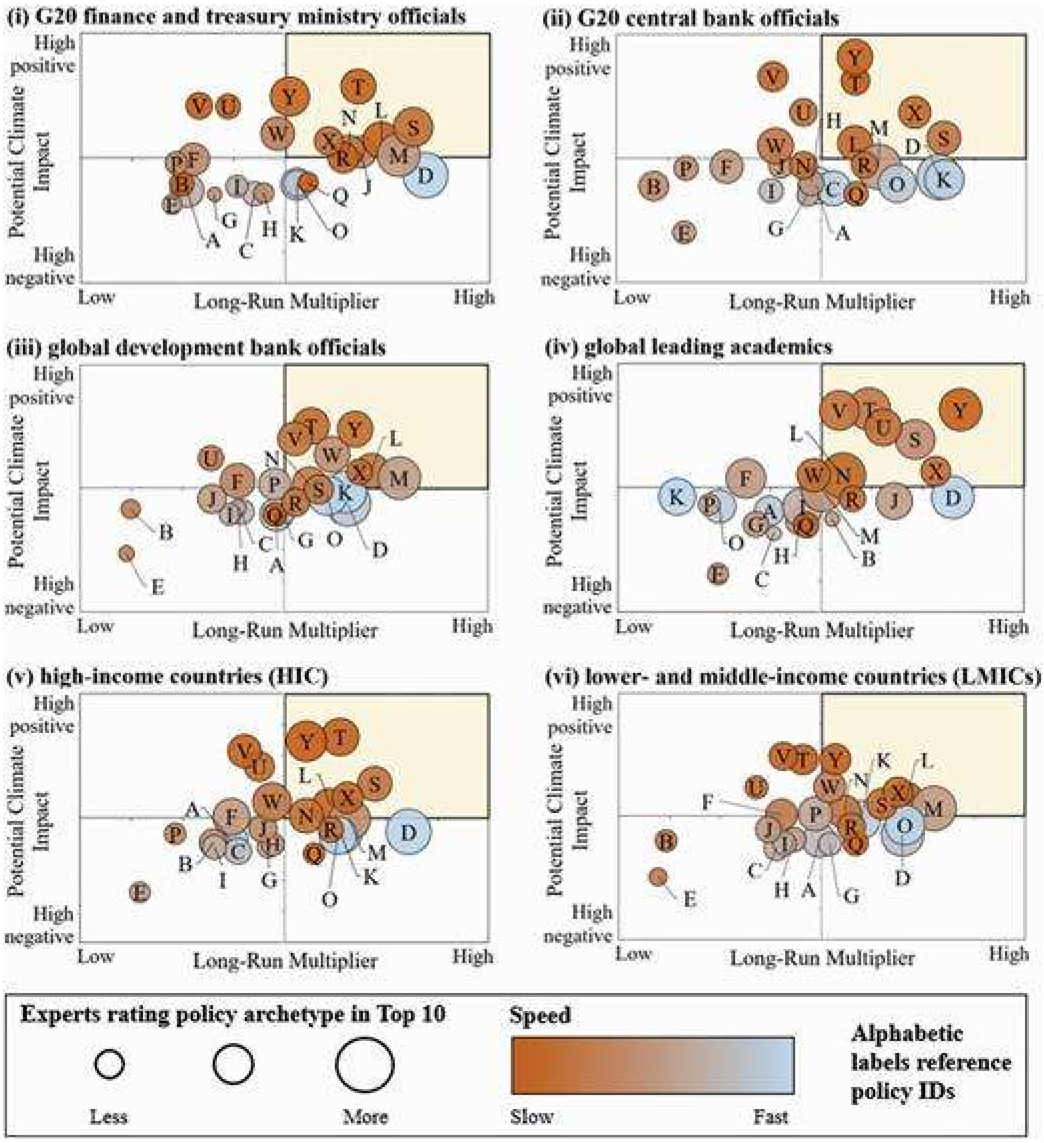

Figure 2: Mean policy response characteristics by sampling group (i to iv) and wealth of focus economy (v to vi).

Under the hypothesis that national wealth influences optimal fiscal response strategy, all survey responses were categorically sorted into higher-income countries (HICs) (N = 168) and lower- and middle- income countries (LMICs) (N = 63) under the most recent OECD (2017) definition. As shown in Figure 2, variation in mean responses was sizeable, suggesting that local economic context is a significant driver of policy appropriateness. The greatest variations between HIC and LMIC expert opinion, those of 8 points or higher on the relativity-adjusted 100-point scale (see Appendix 7), were in rankings of overall desirability of targeted rural support policies (P: 13 point difference, LMICs higher than HICs) and clean R&D spending (Y: 8 point difference, HICs higher than LMICs). These policies manifest differently in LMICs to HICs. While rural support policy in a HIC may involve agricultural subsidies to support existing enterprise, in a LMIC it may involve direct creation of jobs through state-owned enterprises. While HIC clean R&D spending can represent investment to becoming a global leader in high-margin future industries, due to a deficit in local highly skilled labour, analogous LMIC spending is unlikely to bring the same multiplier.

Our results suggest that, in many cases, experts think that climate-positive policies also offer superior economic characteristics. However, there is the potential that these results are driven by participation and/or response bias related to any number of background factors. For instance, climate change beliefs of respondents could have influenced their responses to economic metrics in either direction. The survey was not framed as focused on climate change and the survey question on climate impact potential came after the questions on economic impact. However, the invitation for the survey was sent by the authors, who have a public track record of research on climate economics. We acknowledge the potential role of bias in our results and suggest that readers interpret them as uncorrected, subjective and relative perspectives.

(iv) Guidelines for policy-makers

Based on our review of the literature, the survey results, and our own judgement, we suggest the following three key insights for policy-makers designing COVID-19 recovery packages.

1. **Recovery policies can deliver both economic and climate goals.** Following the ‘colourless’ emergency rescue packages, there are a set of fiscal recovery policy types which offer high economic multipliers and positive climate impact. Combining survey responses with evidence from the literature, five policy types stand apart from the rest:
    - clean physical infrastructure investment in the form of renewable energy assets, storage (including hydrogen), grid modernization, and CCS technology,

- building efficiency spending for renovations and retrofits including improved insulation, heating, and domestic energy storage systems,
- investment in education and training to address immediate unemployment from COVID-19 and structural shifts from decarbonization,
- natural capital investment for ecosystem resilience and regeneration including restoration of carbon-rich habitats and climate-friendly agriculture, and
- clean R&D spending.

In many LMICs, clean R&D spending might be replaced with:

- rural support scheme spending, particularly that associated with sustainable agriculture, ecosystem regeneration, or accelerating clean energy installations.

While political and other circumstances related to the national interest may render some climate-negative policies unavoidable, even these policies can be designed to have long-term positive climate outcomes by attaching appropriate conditions. For instance, conditional green bailouts for airlines could require achievement of net-zero emissions by 2050 with intermediate targets set at 5- or 10-year intervals (O'Callaghan and Hepburn, 2020). If airlines are unable to meet these targets, bailout funding could be converted to equity at today's very low stock market spot prices.

Finally, different countries have different starting points and national priorities. Mealy and Teytelboym (2020) show that it is possible to identify 'nearby' opportunity for expanding the green industrial base; policy-makers could use this framework to target stimulus towards industries adjacent to the newer clean industries of the future.

2. **Co-benefits can be captured.** As indicated by the survey results, there are non-economic, non-climate attributes of climate-positive policies which increase their overall desirability. For instance, electric vehicle incentives reduce local air pollution, which is especially valuable in dense urban areas. Support for energy efficiency retrofits could be directed towards lower-income households to decrease social and

health inequality by shrinking real electricity costs and keeping homes warm in winter. In LMICs, new renewable energy can be used to increase rural electrification and provide support to citizens working to escape the poverty trap (Aklin *et al.*, 2018).

Policy-makers must proactively act to identify potential co-benefits during the policy design stage and shape implementation criteria to maximize impact. As national priorities and urgent social needs can differ manifestly between countries, the prioritization of relevant co-benefits is also likely to differ. Governments can shape policy to best meet the needs of their constituency.

3. **Policy design is important.** Poorly designed recovery policy is likely to be ineffective in delivering economic, climate, and social outcomes, regardless of theoretical potential. During the GFC, many governments needlessly wasted the opportunity for significant long-run economic benefits and climate impact.

   Policy timeliness and flexibility will be important characteristics, since it is unclear how long the pandemic will last and whether there will be second or third waves. It also remains unclear whether the current recession will progress to a deeper depression with possible default cascades (Stiglitz, 2020).

   Extreme urgency was appropriate in introducing rescue packages during the lockdown phase. There is probably more time to ensure that the recovery packages prioritize the types of investments that deliver productive assets for the future. This will be significantly more likely if policy design processes are fast but also consultative and evidence-based. Success will depend upon the specific social, political, environmental, and financial contexts of actors.

   Finally, domestic climate-positive policy development should involve collaboration with and learning from the international community. A Sustainable Recovery Alliance, proposed in a UK government briefing prepared alongside this research paper (Allan *et al.*, 2020), could provide a forum for nations to avoid a race to the bottom, to learn from one another, and to coordinate their recovery packages for greater impact.

(v) Financial factors constraining and enabling government expenditure

The affordability of these potential interventions varies across countries. Government balance sheets and current financial conditions may limit significant expansionary policy in some LMICs. An internationally coordinated response with support from the IMF might address this (Cleevely *et al*., 2020), or judicious and stronger use of unconventional monetary policy and other non-fiscal policies might be used to steer expectations and help restore confidence.

Concerns about repaying growing local currency public debt and limited 'fiscal space', though understandable, are overplayed in HICs, notwithstanding rapid increases in government borrowing following the pandemic. Real government bond rates in rich countries are near zero or negative, reflecting limited concerns at present about devaluation or default. The US Federal Reserve maintains a policy rate of 0 per cent (Federal Reserve, 2020), while the Bank of England maintains a rate of 0.1 per cent (Bank of England, 2020), and other central banks maintain similarly low rates.

Concerns about total global debt are also frequently raised. According to Tiftik *et al.* (2020), the ratio of global debt to GDP reached an all-time high of 322 per cent towards the end of 2019. More than two-thirds of the debt is in private hands, and dramatic declines in equity valuations and asset values has hit corporate balance sheets, increasing leverage ratios.

However, financial assets are not net wealth, and total global debt is only relevant in that it reflects underlying challenges, such as growing inequality, or in that it creates vulnerabilities from systemic financial interlinkages between entities. For every debtor there is a creditor, and what matters is whether borrowing is used to invest in sustainably productive assets. With rates low and the prospect that borrowing will boost nominal GDP with multipliers greater than one, the cost of servicing debt induced from a large fiscal stimulus is low and, in most cases, sustainable.

Nevertheless, avoiding a downward economic spiral will require careful management (Stiglitz, 2020). The global stock of non-financial corporate debt was at record levels of $74 trillion in Q3 2019 (Tiftik *et al*., 2020). The quality of corporate bonds is also lower (OECD, 2020)—credit ratings are lower and maturities are longer—so the possibility of contagion to the banking system cannot be discounted. The UK Office for Budget Responsibility estimates that if lockdown remains in place for 3 months, UK output would plunge an unprecedented 35 per cent in 2020 Q2 (OBR, 2020). J. P. Morgan forecasts that the US economy will shrink by 9 per cent in the second quarter, relative to the previous quarter, on top of a 1.2 per cent contraction in the first quarter (Domm, 2020). In April, the IMF predicted that advanced economies' GDP will be 6.1 per cent lower than otherwise in 2021, even after a sharp recovery (IMF, 2020*a*). Such a recovery is far from guaranteed without efforts to restore private-sector confidence.

Recovery packages could exacerbate intergenerational inequities if they are focused on consumption, rather than productive investment delivering sustainable returns for future generations. Public borrowing for the recovery will necessarily be matched by corresponding private-sector net financial surpluses, implying greater claims on future taxpayers will be made by the private sector. The real value of the debt might also be eroded by inflation—if recovery plans do generate growth, inflation may well rise. Sensible responses would include progressive environmental and carbon taxes, in addition to conventional tightening monetary policy.

IV. Social and institutional shifts

COVID-19 has already triggered major shifts in individual behaviours, social practices, beliefs, the role of the government in the economy, and relationships between nations and international institutions. These shifts have occurred on remarkably rapid timescales. Which of these changes will have lasting consequences, and what are the climate implications?

(i) Behavioural change in work and transport practices

The COVID-19 crisis has encouraged a rapid shift to digital and remote working practices in many countries (WHO, 2020), and reduced aviation (UNICAO, 2020) and car transportation (IMF, 2020*b*). These 'adaptive behaviours' are common to large-scale disasters (Cohen, 2020). There has been rapid learning of how to manage remote work, improvements in technology, and an appreciation of some of the benefits.

As economies reopen, in some instances one may expect return to pre-crisis normal, but in others behaviour will change permanently. One (inevitably speculative) estimate is that up to one-third of the global workforce will sustain remote working practices part-time on a permanent basis (Global Workplace Analytics, 2020). Even the aviation industry anticipates a permanent shift in the nature of travel, with business travel projected to be permanently suppressed (Sorensen, 2020; Boone *et al.*, 2020) and with flight volumes that return to pre-crisis levels at a slower rate than in other recent pandemics (IATA, 2020).

The extent to which behavioural adaptations become embedded post-crisis is affected by policy choices during the recovery period, as well as the extent and severity of lockdown measures. Behavioural interventions have historically been more effective during times of transition (Geels, 2002; Reeves *et al.*, 2020). Post-crisis recovery spending offers an opportunity to embed climate-positive behaviours, by supporting teleworking, high-speed broadband connectivity, and residential energy efficiency.

(ii) Shifting dynamics of global institutions and leadership

COVID-19 has disrupted the global political and economic order, with potential long-term implications for multilateral institutions. The rapid spread of the virus has also led to calls for an 'unprecedented level' of global cooperation (Kokudo and Sugiyama, 2020), yet the pandemic has exposed weaknesses in international partnerships, particularly the World Health Organization (WHO), but impressive strengths in others. The IMF and United Nations Conference on Trade and Development (UNCTAD) have shown leadership in calling for funding to meet both the economic and health challenges, including a new issuance of Special Drawing Rights (SDRs), and for debt relief. But the multilateral institutions can only be successful if they receive the support of member countries, and with the current US government's weak support of multilateralism, cooperative effects are likely not to come up to what is needed. The WHO, which holds responsibility for coordinating the global health response to any pandemic, has faced criticism for failing to respond to the crisis with adequate speed and force (Mahase, 2020). International financial institutions such as the World Bank and IMF have also faced criticism of their proposed economic relief programmes (IMF, 2020*c*; Malpass, 2020) for conditionalities and limited relief to countries where repayment obligations may undermine health funding (IMF, 2020*c*; Kentikelenis, 2020; Kickbusch *et al.*, 2020). The Joint Ministerial Committee of the Boards of Governors of the Bank and the Fund (the Development Committee) has, however, underscored the vital financial role of the IMF and the World Bank in responding to COVID-19 (World Bank, 2020). And forums such as the G20 have redoubled their commitment to international cooperation (G20, 2020).

These challenges to international institutions have ramifications for the climate crisis, posing risks and opportunities. With attention focused on COVID-19, climate change negotiations have been delayed. However, the lead up to the postponed COP26 to 2021, hopefully after the peak of COVID-19 crisis, offers an opportunity for countries to collaborate and share knowledge on climate-positive economic recovery packages. Global collaboration and strengthening the mandate and financing of global decision-making bodies is essential, not only to ensure an effective response to the virus, but also to facilitate ongoing collaboration in the climate domain (Steele *et al*., 2014; Stavins *et al*., 2014). With widespread international agreement concerning the importance of climate change, a new administration in Washington could also conceivably support an initiative for multilateral assistance for developing countries and emerging markets with climate-friendly policies as a central component.

V. Summary and conclusions

The COVID-19 crisis represents a dramatic shock to the global economy that will affect progress on climate change in multifaceted ways. The biggest driver of the long-term impact on climate is through fiscal recovery packages, along with possible shifts in power within and across national and international institutions. Green fiscal recovery packages can act to decouple economic growth from GHG emissions and reduce existing welfare inequalities that will be exacerbated by the pandemic in the short-term and climate change in the long-term. Short-term reductions in GHG emissions resulting from lockdowns will themselves have minor long-term effects, unless they facilitate deeper and longer-term human, business, and institutional changes. Urgent rescue packages have been necessarily 'colourless' and focused on preserving liquidity, solvency, and livelihoods, but their climate impact is also unlikely to be positive.

In this paper, a survey of officials from finance ministries, central banks, and other leading organizations is combined with a large-scale policy cataloguing effort and review of expansionary fiscal policy literature. We emerge with the recommendation of five policy items (plus one item specific to LMICs) that are well-placed to contribute to achieving economic and climate goals. These are:

- clean physical infrastructure investment,
- building efficiency retrofits,
- investment in education and training to address immediate unemployment from COVID-19 and structural unemployment from decarbonization,
- natural capital investment for ecosystem resilience and regeneration, and

- clean R&D investment.

For LMICs, rural support spending is another high-value policy item, with clean R&D investment less vital. National governments differ significantly in their economic, social, and environmental priorities, and recovery packages will reflect these priorities, with different consequences for the climate.

Several other insights emerged from the survey. Many climate-positive policies were perceived by survey respondents to have high overall desirability; most climate-negative policies had relatively low desirability. This was true even for climate-positive policies that took more time to implement. Long-run multipliers of climate-positive policies were found to be high, reflective of strong return on investment for government spending. Given the uncertainty in the future waves of the pandemic, flexibility and timeliness will also be important considerations. Finally, appropriate policies differ by national context.

As we move from the rescue to the recovery phase of the COVID-19 response, policy-makers have an opportunity to invest in productive assets for the long-term. Such investments can make the most of shifts in human habits and behaviour already under way. In the lead up to COP26, recovery packages are likely to be examined on their climate impact and contributions to the Paris Agreement (UNFCCC, 2015). For many countries, this will be a matter of building on existing NDCs, already framed to facilitate fast-acting investment. Recovery packages that seek synergies between climate and economic goals have better prospects for increasing national wealth, enhancing productive human, social, physical, intangible, and natural capital.

Footnotes

1. Sustainable recovery packages from governments are *necessary* to address climate change. Without a sustainable recovery, emissions will rise, the private sector will not invest enough in clean technology in a depressed economy, and the Paris goals will be nearly impossible to meet. Given the scale of recovery packages, a sustainable recovery could also be nearly *sufficient* to address climate change. Once the macroeconomy has recovered and once the costs of clean technologies are low enough, the private sector would need limited further encouragement, although it is likely that government intervention will also be required to remove

greenhouse gases from the atmosphere (Hepburn *et al.*, 2019). This blending of macroeconomic and microeconomic considerations is atypical of the approach to public economics involving a sequential focus on (i) stabilization of national income; (ii) economic efficiency; and (iii) fair distribution (Musgrave, 1959)—get the macro right before worrying about micro issues such as carbon prices. However, the macro and micro are inescapably interlinked here, due to the scale and timing of the climate challenge and the pandemic. We are grateful to David Vines for these observations.

2. Demand for electricity (which is supplied by higher proportions of renewable energy) has been less affected than demand for transportation, which is predominantly supplied by liquid fossil fuels (IRU, 2020).
3. While NO_2 is not itself a GHG, it also contributes to the formation of the potent GHG, ozone, in the atmosphere (Lerdau *et al.*, 2000; Ghazali *et al.*, 2009). As NO_2 has a short atmospheric lifespan (NOAA, 2020), it is a useful and measurable descriptor for period-specific economic activity (Cui *et al.*, 2019), for example in illustrating changes over the COVID-19 period at a local and regional scale (Worden *et al.*, 2020; EPA, 2020).
4. Reductions in GHG emissions during other economic crises have been transitory. Global CO_2 emissions fell by 1 per cent during the GFC in 2009, but grew by 4.5 per cent in 2010, above the 5-year average increase of 2.4 per cent (Boden *et al.*, 2017). This rebound was attributable to high levels of government investment in fossil fuel dependent economic activities in order to stimulate domestic economies, coupled with low energy prices (Peters *et al.*, 2012).
5. We found this perception surprising: policies U and V have low worker training requirements and are potentially able to be rapidly deployed.

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