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What Policies Address Both the Coronavirus Crisis and the Climate Crisis?

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Abstract
The coronavirus pandemic has led many countries to initiate unprecedented economic recovery packages. Policymakers tackling the coronavirus crisis have also been encouraged to prioritize policies which help mitigate a second, looming crisis: climate change. We identify and analyze policies that combat both the coronavirus crisis and the climate crisis. We analyze both the long-run climate impacts from coronavirus-related economic recovery policies, and the impacts of long-run climate policies on economic recovery and public health post-recession. We base our analysis on data on emissions, employment and corona-related layoffs across sectors, and on previous research. We show that, among climate policies, labor-intensive green infrastructure projects, planting trees, and in particular pricing carbon coupled with reduced labor taxation boost economic recovery. Among coronavirus policies, aiding services sectors (leisure services such as restaurants and culture, or professional services such as technology), education and the healthcare sector appear most promising, being labor intensive yet low-emission—if such sectoral aid is conditioned on being directed towards employment and on low-carbon supply chains. Large-scale green infrastructure projects and green R&D investment, while good for the climate, are unlikely to generate enough employment to effectively alleviate the coronavirus crisis.

1 Introduction

As decision makers around the world scramble to respond to the coronavirus crisis and the deep and possibly prolonged recession that follows it, commentators have called for them to use the opportunity to also further our progress in mitigating climate change, which a majority of people believe to be as serious a crisis as the coronavirus (Ipsos 2020). By pursuing policies that can both alleviate the economic recession caused by the coronavirus and help reduce greenhouse gas emissions, the current crisis presents an opportunity to put the world on a new trajectory with a lower risk of future climate

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calamities. Crisis management often requires exceptional policies, and may temporarily alter constraints on decision making. Strategic vision at such a time can help decision makers take into account longer-term objectives, which might be difficult to meet under normal circumstances. As Rahm Emanuel famously said, "You never want a serious crisis to go to waste".

Yet, for climate policies to have a chance of implementation at this moment, they cannot be at odds with addressing the current crisis. In this paper, we seek to systematically identify where the intersection between 'coronavirus policies' and 'climate policies' lies. We are interested in which types of policies can help mitigate the impacts of the coronavirus crisis, and also make headway in setting societies on low-carbon pathways. We intentionally focus on long-term climate impacts. Many coronavirus policies have temporary effects on carbon emissions (e.g., reduced traffic due to a lockdown), but we see such temporary effects as unimportant, given the long timescales involved in anthropogenic climate change (Le Quéré et al. 2020).

Specifically, our contribution is the following. We first identify policies which alleviate the coronavirus crisis, as well as a set of channels through which relatively short-term policies can have impacts on climate change in the longer run. Second, we present data on sector-specific economic activity and emissions. We then use these tools, together with previous research, to evaluate and score policies in terms of their usefulness in tackling the climate and coronavirus crises. Policies ranked as 'good for climate' should be expected to yield substantial long-run emission reductions. Policies ranked as 'good for coronavirus recession' should help alleviate the job losses due to the current recession and (in some cases) have public health benefits regarding current or future pandemics. We present a set of policies that can help reduce the economic fallout of the coronavirus crisis, and simultaneously aid societies in meeting climate change mitigation targets in the longer run. We hope this exercise can help policymakers think through their policy options if they want to chart a 'green recovery' while dealing with the coronavirus crisis.

'Green stimulus' is of course not a new term. In the wake of the financial crisis of 2008–2009, Strand and Toman (2010) evaluated potential stimulus policies in terms of their potential to improve long-term environmental outcomes. Some of their recommendations are still valid. However, for the current crisis one has to evaluate policies that are specific to it, i.e., that are adapted to the health aspects of the coronavirus, and the unprecedented economic shock of a simultaneous sharp fall in both demand and supply. Hence, our set of policies differ from Strand and Toman (2010). We also consider some channels for long-run impacts that they did not touch upon. Other, more recent, analyses (e.g., CAT 2020) outline the climate effects of various policies, but ignore whether any of the policies (such as green R&D) are actually good at alleviating the coronavirus crisis. The paper by Hepburn et al. (2020) has a similar objective to ours, but their analysis starts from previously used stimulus policies (since the financial crisis of 2008–2009) and is based on surveys of expert opinions. We start from policies that seem especially appropriate in the current crisis, and evaluate them based on an analysis of the individual policies, combined with basic empirical observations about the carbon, labor and layoff intensity of different sectors and jobs. Finally, Helm (2020) discusses the broad effects macroeconomic policies intended to tackle the coronavirus may have on carbon emissions. We take a complementary perspective, looking at a large set of individual policies in more detail.

We want to defuse two potential criticisms against the notion that crisis policies should be evaluated based also on their effect on environmental outcomes. The first relates to the Tinbergen Rule: that, to obtain an efficient outcome, one needs as many instruments as there are externalities. In particular, policymakers should use one set of instruments to

deal with the health crisis, another to achieve macroeconomic stabilization, and a third to achieve long-term environmental objectives.

In a first-best world this would of course be true. In practice there are constraints—practical and political—that make perfect fine-tuning difficult. Given such constraints, we have to ensure that measures to address one goal do not undermine another. We illustrate with two examples from our analysis. First, implementing a carbon tax would, if done in isolation, likely worsen the current recession. But if the proceeds were used to lower labor taxes, the policy could instead alleviate the coronavirus crisis. Second, economic stabilization will involve government investment, or subsidies to private investment, into capital assets. The question is then: which types of capital assets? The answer necessarily has to account for the effect the assets will have on the climate.

The second criticism is that beneficial long-term effects on climate are unlikely to be achieved in the absence of long-term policies to price externalities (Strand and Toman 2010). Without pricing the externality directly, rebound effects can undo the beneficial effects of e.g. green stimulus policies. Further, the general equilibrium effects of stimulus policies on emissions may be hard to assess. Sectoral policies should consider the complementarity of targeted sectors with emissions-intensive sectors. A prominent example relates to sectors linked to air travel: e.g., hotels and restaurants have limited direct emissions, but high indirect emissions through tourism and business travel. Stimulus payments aimed at such carbon-complementary sectors may backfire unless also accompanied by other measures, such as carbon pricing (Dwyer et al. 2010). Uniform carbon pricing on all fuels would eliminate such concerns.

Our immediate answer is that we agree that long-term externality pricing is critical, and we include tax and subsidy reforms such as revenue-neutral carbon pricing in our set of policies. A further riposte, indeed to both of the above criticisms, is that long-term pricing policies are endogenous: policies today affect what is politically feasible tomorrow (Acemoglu and Robinson 2013). Subsidies are not a substitute for carbon pricing (Helm 2020) but may help pave the political route to their implementation.

2 Approach for Analysis

Our goal is to evaluate policies in terms of their potential to mitigate the economic fallout of the coronavirus pandemic, and their long-term effect on climate change. To this end, we start by discussing what types of policies can help deal with the consequences of the pandemic. We then present channels via which relatively short-term policy interventions can have longer-run impacts on climate change and climate policy. These two classification exercises allow us to identify policies that have effects on both crises. We then present some data that will be useful in evaluating policies.

2.1 Policies for Mitigating the Coronavirus Pandemic

When people are forced to stay at home they do not go to work and they consume less. The inability to work is a supply shock, while the reduction in consumption is a demand shock. The combination of the two implies bankruptcies and layoffs, aggravating income losses and lowering demand even further. The supply shock will disappear as an improving understanding of the coronavirus allows for more targeted public health measures, and eventual control of the pandemic. However, the economic effects on aggregate demand

are likely to persist, so that the demand shock will outlive the supply shock. We mainly focus on policies implemented in the medium term, and thus centered around the economic recovery, rather than around pandemic control per se.

Economic stimulus policies—in particular, ensuring high demand by supporting incomes and employment—will be central for mitigating the economic fallout. It is well established empirically that wealthy capital owners tend to save a larger share of their income than people who are poorer and who rely on labor income (see e.g. Bernheim and Scholtz 1993; Beverly 1997; Browning and Lusardi 1996; Dynan et al. 2004; Diamond and Hausman 1984; Gentry and Hubbard 2004; Quadrini 2000; Alan et al. 2015; Dupas and Robinson 2013; Gandelmann 2017). Hence to assess the potential of a policy to restart the economy, we will evaluate policies based on their potential to secure employment (which also benefits mental health) and labor income.

Some of the firms that now go bankrupt may not be able to quickly resume their old activities once the health crisis is over. It may take time for firms and labor to match, for investors and firms to match, and so on. Helping businesses survive will reduce such frictions. For this reason, policies that reduce bankruptcies can also help the recovery. Unfortunately, data on bankruptcies are not yet readily available. We conjecture (based, e.g., on Andersen et al. 2020, Carvalho et al. 2020, and our own analysis using preliminary data, see Appendix A.1) that bankruptcies are highly correlated with layoffs.

2.2 Channels for Long-Run Climate Impacts

Policies may have long-run implications on climate change through a variety of channels. We have identified four channels we see as particularly relevant for our purpose.

1. **Investment – Direct effect of long-lived investments.** To mitigate the unprecedented economic crisis, governments are planning to stimulate economies through massive investment programs, either implemented directly by governments, or by subsidizing private-sector investments. Such investments have direct long-run impacts once sunk: some will be long-lived, and either substitute or complement fossil fuels (e.g., power generation or transportation infrastructure). Once made, they will be used, and thus have long-run impacts on baseline emission pathways and on the cost of implementing future climate policies (Shalizi and Lecocq 2009; Seto et al. 2016).
2. **Political – Dynamic political economy effects.** Policy can be persistent: economic decisions taken by firms, in response to policies intended to be temporary, can affect political incentives, preventing a future reversal of a policy (Coate and Morris 1999). This can happen as an indirect effect of sunk investments which changes the structure of vested interests (with respect to climate policies): a devaluation of fossil-related assets, or the introduction of new assets complementary to climate policies, will affect the power and incentives of interest groups to influence future policies (Acemoglu and Robinson 2013). Similar effects could result from the destruction of interest groups, e.g. due to bankruptcies in a sector that receives little stimulus money. The formation of special interest groups may also prove to be a self-fulfilling prophecy (Grey 2018), and short-term disruptions to interest group formation can have long-run effects.
3. **Technological – Path dependence due to technological development.** A further indirect effect may arise through changes in the direction of R&D (e.g. low carbon versus carbon intensive). When technological change is directional, temporary policies may determine in which direction an economy develops. Such differences can persist: tem-

porary growth in one type of technology may sustain itself, due to innovation incentives being geared towards a dominant technology, and due to complementarities in R&D (Acemoglu et al. 2012; Hart 2013; van der Meijden and Smulders 2017).

4. **Learning – Forced experimentation and learning effects.** Consumers and producers may not perfectly optimize their choices, e.g. due to costs of finding out about the characteristics of various options, because of biases in decision making, institutional constraints, or because of habit formation favoring status quo behavior. Temporary disruptions to choice sets may force them to look for new options, which may be preferred after the disruption has ended (Seto et al. 2016; Larcom et al. 2017; Helm 2020). Policies that promote or subsidize experimentation can help a wider set of agents explore novel options, and thus promote permanent changes in behavior.

2.3 Data

We focus on two metrics for alleviating the coronavirus crisis: the number of layoffs in an industry and the labor intensity of the industry, expressed in employees per unit of value added. For judging the climate effects, we focus on the emissions intensity of an industry: climate goals suggest the long-run prospects of relatively clean industries should be prioritized. We use two empirical metrics: emissions per unit of value added, and per employee.

We collect data on emissions, number of employees and value added by sector from Eurostat. Layoffs data are from national sources: Swedish Public Employment Service for Sweden; the Helsinki GSE Situation Room for Finland.[1] We show results for labor and emissions intensity for the European Union, Germany, France, the United Kingdom, Sweden and Finland. Our results for layoffs are limited to the countries for which we could find reliable data on recent layoffs during the coronavirus recessions (Sweden and Finland).[2] These roughly correlate with productivity and demand declines (see Appendix Figure A2).

Figure 1 plots both layoffs and layoffs per thousand employees against CO_2 emissions per employee (note the logarithmic scale on the horizontal axis) for the sectors given in Table 1. The most affected sectors in Sweden, in terms of total layoffs, are I (hotels and restaurants), G (wholesale and retail trade), H (transport and storage), N (rental and real estate), and R (culture). Some of these show large layoffs simply because of their size. When layoffs are normalized per 1,000 employees, the same sectors stand out except that sector E (water and sanitation) is badly affected while sector G (wholesale and retail trade) appears less affected. The picture for Finland is broadly similar, except that there are more layoffs in sector C (manufacturing).

We emphasize that this is a high-level categorization which masks detail—yet it serves as a useful benchmark for stimulus and other policy decisions. We specifically highlight three caveats. First, CO_2 intensity is measured in a narrow sense: direct emissions from the sector under consideration. Since sectors are connected, a subsidy to one sector will affect other sectors as well, e.g. indirectly subsidizing sectors that produce complementary outputs. The full effect of a sector-specific subsidy should include any

[1] Sweden: https://arbetsformedlingen.se/om-oss/statistik-och-analyser/statistik. Finland: https://www.helsinkigse.fi/korona-data/.

[2] For the EU there are no aggregate data on layoffs. The United States does not report CO_2 emissions data at the required level of sectoral detail. We therefore exclude it from the analysis. We do present layoff data by sector for the United States in Appendix A.1, which are highly correlated with layoffs in Sweden and Finland.

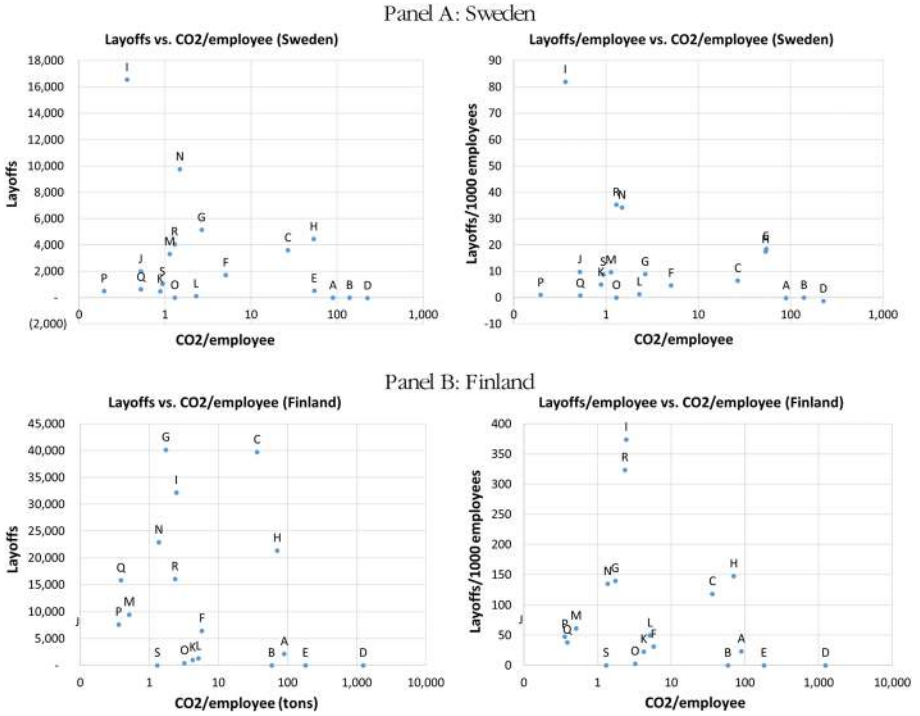

Fig. 1 Layoffs (graphs on the left) and layoff intensities (graphs on the right) vs. CO_2 emissions (in tons) per employee, by sector, for Sweden (Panel A) and Finland (Panel B). **Notes:** Figure shows excess layoffs for the period March 1st-April 17th, 2020 for Sweden (compared to January and February); for the period March 15th-May 19th, 2020 for Finland (compared to the same period in 2019). Data on CO_2 emissions and employees by sector are from Eurostat

Table 1 Sector definitions used in the empirical analysis

A	Agriculture, forestry, fisheries	K	Finance and insurance
B	Mining	L	Real estate
C	Manufacturing	M	Legal, economics, R&D and technology
D	Electricity and heating	N	Rental, real estate services, travel services and other support
E	Water and sanitation	O	Public administration
F	Construction	P	Education
G	Wholesale and retail trade	Q	Healthcare and elder care
H	Transport and storage	R	Culture, entertainment and hobby
I	Hotels and restaurants	S	Other services
J	Information and communication		

indirect emissions coming from the effects of the subsidy on related sectors, i.e., the total general-equilibrium effect. Second, layoffs are a recent snapshot and may be temporary. Figure 1 is likely to change over the course of the coronavirus recession, and

might look very different several years from now. Finally, there is within-industry heterogeneity which should be considered when applying detailed policy suggestions.

In the absence of uniform carbon pricing across all sectors, accounting for indirect emissions may be important. For example, hotels have a low emissions intensity as the emissions from associated travel are allocated to the transport sector, but clearly hotels facilitate (carbon-intensive) travel via tourism and business trips (Dwyer et al. 2010). Greenhouse gas emissions from tourism are substantial, with estimates suggesting the sector accounts for more than 8% of global greenhouse gas emissions (Lenzen et al. 2018; see Appendix A.2 for a further discussion of this). A second example relates to the relationship between the emissions-intensive transport sector, and the seemingly low-emissions services sectors. An important fraction of transport demand results from activity in services sectors (Alcántara and Padilla 2009). In the construction sector, also, indirect emissions can make up a large share of total emissions (Acquaye and Duffy 2010). The indirect effects of policies on emissions, output and employment may be important to consider and could be tackled using input–output analysis (Mäenpää and Siikavirta 2007; Markaki et al. 2013). This is a promising avenue for further research, both academically and for applied policymaking, but beyond the scope of the present paper.

To overcome some of these concerns, Fig. 2 plots a measure of labor intensity (employees per million euros of value added) against a measure of emissions intensity (CO_2 emissions per million units of value added) for each of the sectors in the European Union, Germany, France, the United Kingdom, Sweden and Finland. Per amount of stimulus spent, industries with high labor intensity may also be relevant to target from a recession perspective, since each unit of spending can be expected to have a larger employment effect in those sectors.[3] From the climate perspective, one would like to focus on sectors with low emission intensities.

The results vary somewhat across countries, but paint a remarkably consistent picture. First, there is a slight negative relationship between labor intensity and emissions intensity, perhaps reflecting that sectors with low labor shares rely on more energy-intensive capital. Industries that stand out as potential targets that score well on the coronavirus-climate interface are not necessarily the ones that have seen the most layoffs, although they overlap partially.

For the European Union as a whole, the set of high-labor, low-emissions sectors include I (hotels and restaurants), G (wholesale and retail trade), N (rental and real estate), Q (health care and elder care), P (education), R (culture) and S (services). Sectors I, G, N and R have also experienced a peak in recent layoffs. For each of the individual countries, almost the same set appear on the high-labor, low-emissions list. In Appendix A.2, we comment on these sectors individually, and end by commenting on some other industries.

[3] There are several caveats to this type of policy focus, including preventing stimulus packages from being taken up by the owners without maintaining employment. We expand on this in Sect. 3.2.1 below.

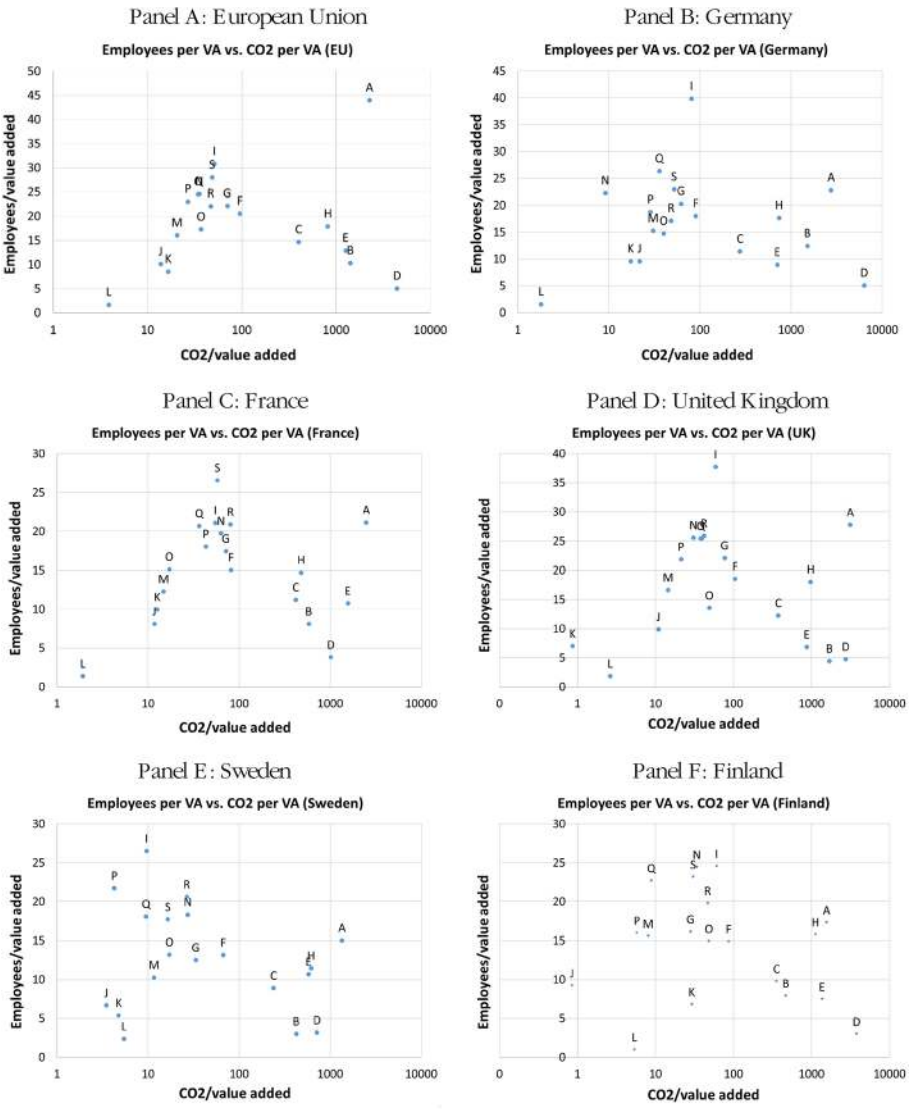

Fig. 2 Employees per million euros of value added vs. tons of CO_2 per million euros of value added, by sector, for the European Union (Panel A), Germany (Panel B), France (Panel C), the United Kingdom (Panel D), Sweden (Panel E) and Finland (Panel F). **Notes:** Figure shows data for calendar year 2017. Value added is in millions of euros. Source: Eurostat

3 Analysis

3.1 Categorizing Policies

To structure our analysis we categorize policies along the following dimensions (Table 1). First, we split them into policies that are primarily motivated by their effects

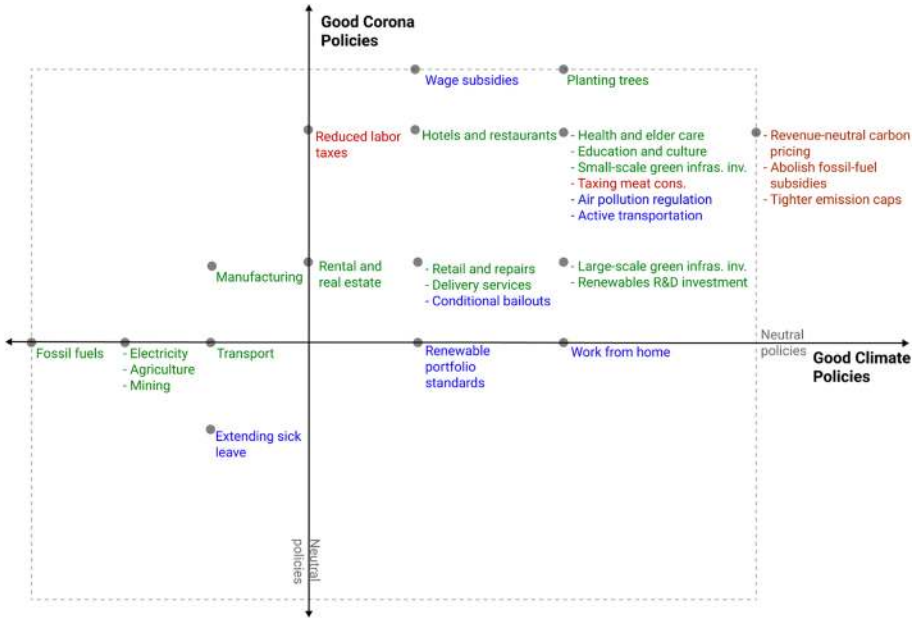

Fig. 3 Summary of policy evaluation. Green: stimulus spending policies, red: tax reform policies, blue: cross-cutting policies

on the recession caused by the coronavirus pandemic vs. policies that are primarily motivated by climate change. Second, we classify policies into three categories: stimulus spending, tax reform and cross-cutting policies.

Stimulus spending refers to policies that require substantial amounts of government funds, with the aim to preserve employment, avoid bankruptcies, create new jobs, and help the hardest-hit consumers. The second category includes tax reform policies that are complementary or even somewhat orthogonal to stimulus, but that raise extra revenues that can be used as additional stimulus, and that have overall economic efficiency benefits. Third, some policies do not require large financial injections from the government; e.g., mandates, standards, or bans. They may also span several categories. We group them under 'cross-cutting' policies.

Any categorization of policies is necessarily imperfect: there is no optimal choice of dimensions and policies will spill across categories or overlap with each other. Policies vary in their breadth and budgetary requirements. The most important matter is that our list of policies is reasonably complete. We believe it is, with some caveats. We purposely omit some policies. We do not tackle coronavirus policies that have no long-run climate impacts, or that are not relevant beyond the immediate crisis. These include test-trace-isolate, travel restrictions, and vaccine development. Similarly, some central policies to manage the pandemic have significant but short-lived effects on emissions—yet long-run climate impacts appear highly limited. These include distancing policies such as lockdowns, restricting access to public spaces, and the closing of restaurants and schools.

Table 2 A categorization of climate and corona policies, our main conclusions and references to appendix sections

Corona policies	Climate policies
Stimulus spending	Stimulus spending
Helicopter money, monetary stimulus and other redistribution (bad-to-good, unknown, A.3)	Small scale green infrastructure investment (good, good, A.4)
Aiding industries (see Table 3 and Fig. 3 for a sector specific evaluation)	Large scale green infrastructure investment (neutral-to-good, good, A.4) Renewables R&D investment (neutral-to-good, good, A.5)
	Planting trees and maintaining national parks (very good, good, A.6)
Tax reform	Tax reform
Reduced labor taxes (good, neutral, A.7)	Revenue-neutral carbon pricing (good, very good, A.8)
	Tighter emissions caps (good, very good, A.11)
	Abolishing fossil fuel subsidies (good, very good, A.9)
	Taxing meat consumption (good, good, A.10)
Cross cutting	Cross cutting
Paying wages of private employees (very good, neutral-to-good, A.12)	Introducing or tightening renewable portfolio standards (neutral, good, A.14)
Extending sick leave provisions (neutral-to-bad, neutral-to-bad, A.13)	Tightening air pollution regulations (good, good, A.15)
Encouraging work from home (neutral, good, A.16)	Promoting active modes of transportation (good, good, A.17)
	Conditions on bailouts (neutral-to-good, neutral-to-good, A.18)

Conclusions summarized as (evaluation for coronavirus, evaluation for climate)

3.2 Evaluating Policies

We have evaluated the set of policies in Tables 1 and 3 (the latter breaks down financial assistance to firms by industry). Figure 3 summarizes the conclusions from this analysis. We plot policies according to how good they are for the coronavirus crisis (vertical axis) and for the climate crisis (horizontal axis). Policies marked green denote stimulus policies, policies marked red denote tax reform policies, and policies marked blue denote other cross cutting policies. Below we proceed to comment on policies we have identified as particularly promising (located in the upper right corner). A detailed analysis of these—and other policies—can be found in the appendix (A.3-A.18). There, after describing each policy and briefly analyzing it, we draw a conclusion as to how it scores in terms of alleviating the recession and its long-run climate impact. These scores take seven levels: very bad; bad; bad-to-neutral; neutral; neutral-to-good; good; very good (these results are also presented in Tables 2 and 3). The precise scoring can be refined, but we present a conceptual framework for analyzing the joint set of policies meant to address the coronavirus recession and climate crises.

Table 3 Evaluation of industry aid per sector. Please note that this is not an analysis of all sectors presented in the data section

Sector	Industries and evaluation
A	Agriculture, forestry, fisheries (neutral, bad)
B	Mining (neutral, bad), Fossil fuels (neutral, very bad)
C	Manufacturing (neutral-to-good, bad-to-neutral)
D	Electricity and heating (neutral, bad)
G	Wholesale and retail trade (neutral-to-good, neutral-to-good)
H	Transport and storage (neutral, bad), delivery (good-to-neutral, good-to-neutral)
I	Hotels and restaurants (good, neutral-to-good)
N	Rental, real estate services, travel services and other support (neutral-to-good, neutral)
P	Education (good, good)
Q	Healthcare and elder care (good, good)
R	Culture, entertainment and hobby (good, good)

We present here sectors for which we have conclusions to share. See details in Appendix A.2

3.2.1 Industry-Based Stimulus to Protect Employment and Prevent Bankruptcies

We plot these policies in green, labelled by industry. There have been various policy proposals on how to support businesses and workers, in general, during the crisis. These include giving out loans or grants to small businesses, or providing firms with tax relief (Becker et al. 2020; Scarpetta et al. 2020). These policies aim to support business owners, to support workers and allow them to maintain their relationship with the firm, or to prevent the overall collapse of businesses.

The choice between different industries appears the most consequential decision that governments can make. How the stimulus funds are allocated across industries determines both the short-run employment effects and could have long-run climate implications. The question we therefore ask is: which sectors should be targeted for aid (bailouts, investments, loans, etc.) if the objective is for this to both alleviate the current crisis and be good for the climate?

Whether stimulus for particular industries has meaningful impacts on long-term climate goals depends on several factors. For example, preferentially saving firms in a given sector may not have a large direct impact on the sector in the long run. The reason is that the capital assets, many of them specific to the sector, will still exist; so will a large fraction of the sector-specific human capital. Thus, even if a wave of bankruptcies were to destroy many businesses in some low-emissions sector, that sector may spontaneously recover once the crisis has passed. One potential long-run effect from extensive bankruptcies in a sector is that consumers and buyers may shift their habits away from that sector, implying a long-run decline in sector-specific demand. Furthermore, persistent changes may result through the forced experimentation mechanism or long-lived government investments. Bankruptcies among firms conducting R&D into renewables may lead to a slowing of technological change (which we address separately below).

The political channel can also be at work. Firms will likely vary in their ability to weather the current crisis along many dimensions. If there is systematic variation in survival probability between firms in competing subsectors, long-term effects may result from subsectors that see many firms go bankrupt being unable to represent their

interests in the political process. For example, in the European electricity sector, the largest firms tend to focus on fossil-fuel technologies in their innovation. Large firms also likely have better access to credit. Thus, a wave of bankruptcies may mean policies in the recovery stage may favor large, fossil-oriented firms. Such temporary disruption can have persistent effects, by strengthening the structure of vested interests in the sector, and thus the persistence of policy (Brainard and Verdier 1994; Coate and Morris 1999). This presents another reason for supporting vulnerable 'green' industries.

A word of caution is in place. Aiding industries has at least two problems. First, it may not be politically feasible. Second, it may not be very efficient in general compared to more direct measures at tackling unemployment. Funds to aid firm survival will help firms' owners without necessarily boosting employment. The same holds for tackling climate change. This is since such assistance would work only indirectly to affect the goals (such as employment and lower emissions) and firms may not use the aid as intended. A valuable complement could be conditioning of aid at the firm or industry level, for those who receive it. This policy is orthogonal to other policies but could ensure that industry aid becomes more effective, by aligning the recipient's goals with those of the policy-maker. For instance, assistance could be made conditional on lowering emissions or on the funds being used for hiring or retaining labor. Conditioning loans is common practice at the World Bank and IMF, and for many governments. There are several examples of such conditioning having already been used in the current crisis. For more details on contingent policies, see Sect. 3.2.4.

Based on this analysis, previous research and data of employment and emissions, the sectors **hotels and restaurants, health care** and **education** would be good candidates but for different reasons (for a results of the other sectors see Table 3; for a fuller analysis of all sectors see also Appendix A.2).

Restaurants are very labor intensive, have been hit hard by the lockdown and have low direct emissions. Targeting this sector in the recovery phase could therefore be a good idea. **Hotels** have also been severely affected, but subsidizing hotels likely aids the transport sector which is very emissions intensive. Hence, a finer targeting may be needed here, for instance, only towards restaurants or more broadly to other service industries. We rank aiding this sector as good at alleviating the coronavirus crisis and neutral-to-good for the climate.

The **education** sector has not been hit by the crisis. But having a high labor share and being essential in the structural transformation of the economy forced by the coronavirus crisis, this sector is key in dealing with that crisis. At the same time, it is low on emissions. Stimulus may thus shift production and 'consumption' in a climate-friendly direction. We rank aiding this sector as good at alleviating the coronavirus crisis and good for the climate.

Health care also has high employment intensity. It of course has not seen any layoffs, being essential for dealing with the medical fallout of the current or future pandemics. It is also low on emissions, so the same motivation as for education applies here. We rank aiding this sector as good for alleviating the coronavirus crisis and good for the climate.

Economic stabilization can of course take the form of **monetary stimulus**. Relatedly, it has been suggested the fiscal commitments could be funded as 'helicopter money'—by printing money. We are not aware of research on the climate effects of such policies, so we do not include them in our ranking, summary and conclusions. See Appendix A.3 for further details.

3.2.2 Climate-Oriented Stimulus

These policies are also plotted in green. Fiscal stimulus can be aimed at 'climate-oriented' infrastructure investment such as renewable-energy generation facilities, associated infrastructure, and energy-saving investments. Governments have already announced very large investments in infrastructure as part of stimulus programs. On May 27th 2020, the European Commission presented a revamped long-term EU budget and a €1.85 trillion recovery plan, with the explicit goal to provide the instruments to build a modern, clean and healthy economy, better known as the 'EU Green Deal' (New Europe 2020). Stimulus spending should be directed according to these plans if governments are serious about climate change mitigation. Not doing so will undermine the climate targets: recovery from the coronavirus crisis will exhaust the appetite for public spending for many years. But from a coronavirus perspective, the immediate benefit of such investment stimulus is unclear. The stimulus would primarily operate through the construction sector. However, this sector has not seen severe layoffs due to the health crisis. There is thus a trade-off between optimizing strategic investments that move societies onto more sustainable pathways, and getting societies out of the immediate coronavirus recession as rapidly as possible. If there is potential for sufficiently skilled workers to move in from other sectors, there could be beneficial short-run effects on overall employment.

The most direct long-term climate policy effect of green infrastructure investments is their emissions reduction throughout their long lifetimes. Complementarities (for example due to network infrastructure investments) mean they can also spur further, private investment, and shift societies away from 'carbon lock-in' and towards a 'green lock-in' path. This lock-in can be reinforced by indirect channels. A shift towards green investment generates larger vested interests in favor of e.g. carbon pricing policies, given that renewable investments stand to gain from such policies. For example, in Germany, the feed-in tariffs for renewables generated constituencies and advocacy groups which stabilized the policy regime and led to an expansion of the sector (Jacobsson and Lauber 2006; Strunz et al. 2016). Further, any shift towards greener infrastructure and future pricing policies incentivizes green R&D investments, due to larger potential market size (Acemoglu et al. 2012). The channels involved here are thus long-lived investment, changing political status quo and technological changes.

An important point here is that the labor intensity of infrastructure projects depends on their scale: small-scale projects are more labor-intensive than large-scale projects (Strand and Toman 2010). This could favor small-scale renewables such as residential solar and retrofit projects. Our judgment of the effect on coronavirus crisis is therefore based on the scale of the projects.[4] Based on the above, we particularly want to highlight **small-scale infrastructure projects** such as retrofitting insulation and installing solar panels on houses. We rank this policy as good at alleviating the coronavirus crisis and good for the climate.

For reasons similar to those in the case of large-scale infrastructure investment, we do not think that **extensive green R&D investment**, while good for climate, will be

[4] For instance, Demetriades and Mamuneas (2000) show that regular infrastructure projects give low returns in the short run but high returns in the long run. Hence, for boosting employment under the corona crisis it is not very useful. See also Morrison and Schwartz (1992). Markaki et al. (2013) show similar effects for the Greek economy, although they argue this is partly due to large investment projects requiring more imported intermediate goods.

particularly well-suited to deal with the coronavirus crisis as the effects on employment in the short-to-medium run are essentially limited to those holding the right competence. Investing in green R&D will just shift research labor from one area to another. **Fiscal stimulus to private R&D spending** in the renewable energy sector, by way of grants or loans, can prevent bankruptcies and the breaking up of successful R&D teams. More details can be found in Appendix A.5. We rank both policies as neutral-to-good at alleviating the coronavirus crisis and good for the climate.

Another promising green stimulus option is **planting trees.** Afforestation and reforestation activities are likely cost-effective both in terms of climate and in terms of the coronavirus crisis, as the trees will absorb CO_2 and as planting requires large numbers of manual and unskilled labor (Strand and Toman 2010). We rank this policy as good at alleviating the coronavirus crisis and good for the climate (see more in Appendix A.6).

3.2.3 Green Tax Reform

We plot these policies in red. While tax reforms obviously do not need to be climate-motivated, we have identified **revenue-neutral 'green tax reform'** (involving for example carbon taxes, an abolition of fossil fuel subsidies, tighter emission caps, and meat consumption taxes) as especially promising, because it would enable an even more aggressive stimulus package (see Appendices A.8-A.10).

Revenue-neutral policies not only have important long-run climate effects, but also have the potential to improve economic recovery. Green taxes improve economic efficiency by internalizing the carbon externality. They would thus also help to internalize potential negative externalities from indirect emissions that could result from certain sectoral aid (e.g., aiding hotels and restaurants that are closely linked to travel).

How the revenues are spent determines which industries and consumers are winners vs. losers (and thus whether the policy is on net favorable or unfavorable to preserve employment). There is a possibility of a double dividend if the revenues are used to offset pre-existing distortionary taxes (Goulder 1995; De Mooij 1999). The coronavirus recession may thus be a politically opportune moment for well-designed green tax reform that enables environmental and employment benefits at the same time.[5] We rank **carbon taxes**, an **abolition of fossil fuel subsidies** and **tighter emission caps** as good at alleviating the coronavirus crisis and very good for the climate. We rank a **meat consumption tax** as good at alleviating the coronavirus crisis and good for the climate.

As a benchmark for the neutrality of the green taxes, we assume that the proceeds are spent on reducing labor taxes. One reason for using this benchmark is that fiscal stimulus in the form of reduced labor taxes takes effect more quickly than monetary stimulus (Kaplan and Violante 2014). This could be good for a rapid exit from the coronavirus crisis by stimulating labor demand. Such tax cuts can also be tailored with distributional impacts in mind, and could thus be designed to help households most likely at risk of an immediate liquidity crisis. To use the proceeds for labor tax reductions is of course just one option out of many.

A green tax reform would have an even more favorable impact on the climate if the revenues were spent on direct investments in renewable energy, clean tech R&D, and other

[5] The interaction with pre-existing taxes can still lead to a positive cost of a revenue-neutral carbon tax (Bovenberg and Goulder 1996). The double dividend remains an open question in the general equilibrium literature, with half of simulations achieving negative-cost environmental taxation (Freire-González 2018).

low-carbon technologies. In this case, both the tax itself and the revenues provide immediate incentives to reduce emissions, while also benefiting from path-dependency effects of redirecting capital to build up a greener capital stock. This type of revenue recycling is less attractive from the perspective of mitigating the recession, as many green investments do not require much labor.[6] We would therefore focus on policies that reduce labor taxes economy-wide.

Labor tax cuts are a form of fiscal stimulus which could be considered in isolation for tackling the coronavirus fallout. We are not aware of research that would shed light on the impact of labor tax reductions, in isolation, on climate outcomes. We rank this policy as good for the coronavirus crisis and neutral for climate. See Appendix A.7 for further details.

3.2.4 Other Promising Cross-Cutting Policies

We plot the cross-cutting policies in blue. The pandemic has led many governments to impose different forms of regulations and restrictions on citizens and businesses, related for example to travel, sick leave, and way of doing business. There are also mandates that have been, or could be, imposed with the primary purpose to mitigate emissions and air pollution. These are relevant to analyze as they in turn may impact economic recovery, or adaptation potential for the current or future pandemics. We comment on the most promising of such policies here.

Neves and Brand (2019) find that about 41% of short car trips could in theory be replaced by cycling or walking, reducing emissions from car travel by about 5%. City planning policies and infrastructure investments **promote active modes of transportation** by making car travel more expensive (e.g., congestion charging) and less convenient (Winters et al. 2017). We already see initiatives along these lines. Milan plans to reallocate 35 km of street space from cars to cycling and walking in the summer of 2020, in response to the coronavirus crisis. Given path dependencies of infrastructure investment and forced experimentation, initiatives like this can also foster persistent change. A shift towards active modes of transportation could also have long-run health effects in the form of lower rates of obesity, diabetes, and hypertension (Pucher et al. 2010; Rasmussen et al. 2016; Grøntved et al. 2016). This reduces the share of people vulnerable to the coronavirus. We rank this policy as good at alleviating the coronavirus crisis and good for the climate.

Tighter air pollution regulation would reduce carbon emissions: this could involve switching from coal generation to gas generation, especially near population centers, and boosting less emission-intensive transport. Such policies may involve long-lived investments (into renewables and gas-fired plants to replace coal) which will be long-lasting. They will also generate new interest groups (cyclists, drivers of electric vehicles) and perhaps reduce the power of coal generators. There is also some preliminary evidence that local air pollutants, such as nitrogen oxides (NO_x) and atmospheric particulate matter with a diameter of less than 2.5 microm ($PM_{2.5}$) may increase mortality from the coronavirus (Ogen 2020; Wu et al. 2020). If these preliminary findings hold up, they point to long-term

[6] Another common carbon tax proposal distributes revenues as lump-sum transfers to households ('tax-and-dividend'), such as Canada's national carbon tax and several legislative proposals in the United States (Sobczyk 2018; Nuccitelli 2018).

benefits if the virus becomes endemic, circulating in the population indefinitely.[7] We rank this policy as good at alleviating the coronavirus crisis and good for the climate.

There has been a broad debate about **conditioning bailouts** to firms in polluting sectors. If a bailout can be credibly conditioned on future changes in activity, and if, in the absence of bailouts, the industry is likely to resurrect after any bankruptcies, then conditional bailouts of emission-intensive sectors may be beneficial to the climate. Consider airlines: a wave of bankruptcies will wipe out current shareholders, but the aircraft assets will be sold to new companies once the health crisis subsides, and these new firms will operate according to market incentives. A bailout will save the current firms, but it can set conditions on their future behavior, such as reducing the number of short-haul flights for which feasible low-emission alternatives exist. Several airlines have already been given bailout loans with no conditions attached (Laville 2020). On the other hand, the bailout given to Air France comes with the requirement that the company halve its carbon emissions from domestic routes, essentially forcing it to cut back services on routes (Financial Times 2020). We rank this policy as neutral-to-good at alleviating the coronavirus crisis and neutral-to-good for the climate.

Recapitalization is an alternative to conditional bailouts. Rescuing firms by injections of equity using public funds are, effectively, partial nationalizations. As such, they give the state an ownership stake in the firm, and thus a voice in the management of the firm. Many commentators warn against the state taking a role in commercial decisions, even in situations in which it does hold a stake. However, where a firm's commercial decisions involve important externalities, it may be justifiable to have the state exercise its owner's right to influence commercial decisions, so as to take account of the full social costs of these decisions. The recapitalization should be large enough to give a state a voice as a major shareholder. The channels involved here are thus through long-lived investment and political status quo.

Government may **pay wages for private employees** as a way to avoid the labor search costs associated with rehiring once the economy starts to recover (as proposed by Sinn 2020). With regards to the long-term climate effects from this policy the results are less clear. If labor gets increasingly replaced by capital as a result of forced experimentation, where companies adopt new technologies or management practices that replace some of the previous jobs, this shift in the capital-labor share could potentially have a negative climate impact since capital is typically more fossil fuel intensive. The specific impacts may depend on industry; the analysis of Sect. 3.2.1 applies. We conclude that his policy is very good for addressing the coronavirus crisis and neutral-to-good in terms of climate.

In this category we have also looked into **tightening renewable portfolio standards**, and **encouraging working from home**. We have ranked these policies as neutral for alleviating the coronavirus crisis and good for climate (the analysis is found in A.14 and A16 respectively).

A cross-cutting policy that is not promising though is **extending sick leave provisions** (see Appendix A.13). Unless also financed by the government, such provisions may lead to bankruptcies and substitution away from labor. We rank this policy as neutral-to-bad for alleviating the coronavirus crisis and neutral-to-bad for climate.

[7] Parry et al. (2014) estimate the co-benefits associated with a reduction of local air pollutants would already be substantial just for a reduction of coal burning—the co-benefits alone would justify a U.S. carbon price of \$35/tCO_2, of which 30% is due to NO_x and $PM_{2.5}$ emissions. Higher coronavirus mortality rates would increase such co-benefits.

4 Concluding Remarks

The severity and abruptness of the coronavirus crisis do not make the climate crisis any less pressing. Our societies need to solve the former, immediate crisis without taking our eye off the latter, inexorable one. We have above identified a set of policies that would help in tackling both the coronavirus crisis and climate change.

The most effective policies involve revenue-neutral tax reforms towards carbon pricing, which would be excellent climate policies and also help deal with the coronavirus crisis by allowing reductions to labor taxes. Subsidizing temporary employment in less emissions-intensive industries (services sectors including leisure services like restaurants and culture; or professional services like technology, education, and healthcare) can help laid-off workers try out occupations that have potential even under tougher climate policies. Here one needs to be aware of potential indirect emissions effects in sectors with complementary goods, but with proper carbon pricing, such effects could be internalized. Labor-intensive investments into natural capital (tree planting) and into low-carbon physical capital can both support employment and incomes, while storing carbon or helping societies transition towards a low-carbon future. Health and climate goals can also be achieved by promoting transport methods which not only reduce carbon emissions, but local pollutants too, improving cardiovascular health. All sectoral aid should be conditioned on being directed towards employment and on low-carbon supply chains.

The crisis is ongoing, and the full outcomes in terms of health and unemployment are yet to be known. Policies will be tried out, and their effects will be observed. Thus, our results may require revision as more information becomes available. Nevertheless, our approach provides a conceptual framework for how to jointly assess the medium-run effects of policies on the coronavirus crisis and the long-run effects on the climate crisis. Both crises are severe and neither can be ignored. Fortunately, modern societies should be capable enough to walk and chew gum at the same time.

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