Fiscal Incentives for Green Private Investment

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1. Introduction

The Covid-19 pandemic has caused a major global economic downturn. This has affected some sectors more than others. However, the overall impact of the pandemic has been to slow aggregate demand more than aggregate supply. Many have argued that this is an opportune time to increase green investment, both to help the recovery and to set it on a more sustainable path.[2] Yet action in this direction so far has been limited. For example, to date, only a small fraction of the massive fiscal support packages to cushion the impact of the pandemic (IMF, 2021) is aligned with the objectives of the Paris Agreement on climate change. Many governments are using post-Covid-19 recovery measures to roll back existing environmental regulations and taxes and to increase fossil-fuel intensive infrastructure and electricity (OECD, 2020).

In the light of these circumstances, this Note rehearses the argument that the environmental challenge is important and large-scale. It discusses the reasons why specifically *green* private investment is needed and why environmental policy cannot rely on *public* investment alone, despite the arguments in favour of public investment where there are difficult-to-correct market failures. The Note then sketches the economic rationale for using taxes and subsidies to influence the investment choices of the private sector. The advantages and disadvantages of various types of subsidies and tax expenditures is considered. The importance of fiscal authorities helping to set an appropriate macroeconomic and regulatory framework as well as taxes, subsidies and investment incentives is stressed. Finally, the Note summarises its implications for policy.

2. Overview

Why is green private investment needed and how can it be encouraged?

Green private investment can be broadly defined as private investment that promotes the environmental sustainability of an economy – the ability of an economy to meet "the needs of the present without compromising the ability of future generations to meet their own needs" (the Brundtland Report (WCED, 1987)).[3]

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[1] This paper is part of a World Bank project, led by Miria Pigato (Lead economist) on 'Securing a Sustainable Recovery: A Guide to Green Taxes and Spending'', under the supervision of Chiara Bronchi (practice manager) and Marcello Estevao (Global Director) in the Macroeconomics, Trade and Investment Global Practice of the World Bank. The project includes seven technical Notes in response to a growing demand from client countries for insights on green spending polices and tax instruments to help support a sustainable recovery from the Covid-19 induced recession. Financial support from the Just-in Time COVID 19 Support Window for DPFs is gratefully acknowledged.

[2] The merits of engineering a specifically green recovery at this macroeconomic conjuncture are discussed further in Bowen, A. (2021) "Green Public Investment: A Technical Guidance Note."

[3] The concept of sustainability and the related notion of 'green growth' are discussed further in Bowen (2021).

Sustainability requires as a minimum that the sum of an economy's capital stocks – physical, human, intellectual, 'social' and natural – are not eroded over time. As different types of capital are not perfectly substitutable for each other, sustainability requires that particular attention is paid to the outlook for types of capital that are declining. The empirical evidence, not least about the Earth's climate, suggests that natural capital is the type being eroded. According to the estimates of Managi and Kumar (2018), between 1992 and 2014, produced capital per person doubled and human capital per person increased by about 13% globally; but the stock of natural capital per person declined by nearly 40%.[4] Natural capital accounted for 42% of wealth among low-income countries but only 14% of the wealth of an average high-income country. Nearly 90% of countries suffered a decline in natural wealth per capita, while around one third of 140 countries suffered a decline in 'inclusive wealth' per capita – that is, a fall in the sum of produced capital, human capital and natural capital (narrowly defined). In India, for example, the share of natural capital in inclusive wealth more than halved between 1990 and 2014. The World Bank publication "The Changing Wealth of Nations 2018" painted a similar picture (World Bank, 2018). Stopping human-induced climate change is probably the biggest challenge, combating the "greatest market failure the world has ever seen" (Stern et al., 2006). Debate continues about how costly climate change will be, but recent economic studies have tended to project higher costs than did earlier work (Auffhammer, 2018) and the scientific evidence is also more foreboding (Royal Society, 2017). There are other environmental problems that are big enough to have serious adverse macroeconomic effects in due course as well, such as air pollution, unsustainable fertiliser and pesticide use and excessive exploitation of exhaustible natural resources (see, for example, Hamilton et al. (2005), Rockström et al. (2009), TEEB (2010), Chang et al. (2016) and World Bank (2018)).

Some types of natural capital can be augmented directly by human activity – for example, tree planting to restore forests. But the restoration of many types of natural capital depends on changing economies' production and consumption processes so that they use fewer natural inputs, produce fewer waste products, and disrupt ecosystems less. This requires investment in the physical capital associated with greener production and consumption (a broader interpretation of 'green investment' than the one suggested by standard industrial classifications, in particular, investment solely in the environmental goods and services sector). For example, IPCC (2014) reported that, to keep global temperature change below 2°C: a net increase in annual investment of around US$340 billion would be required in sectors with a baseline annual investment rate of around US$1200 billion – a rise of nearly 30%. Bowen et al. (2014) showed that carbon pricing could generate sufficient fiscal revenues within each major world region to finance its total (not just incremental) investment in energy supply and incremental investment requirements were well within the range of past fluctuations in national investment and saving rates. But additional investment in energy efficiency downstream from the energy sector might need to be over twice as much.[5]

Private versus public investment

The rationale for fiscal incentives for private green investment (in addition to direct spending on increased public green investment) is broadly two-fold.

[4] Their estimates are based on a narrow definition of natural capital, focusing on (1) renewable resources: forest resources (stocks of timber and a selected group of non-timber resources), fisheries (stocks were estimated from past records of catch) and agricultural land (cropland and pastureland); and (2) non-renewable resources: fossil fuels and a selected set of minerals. Estimates of the social cost of carbon were used to value future losses from global climate change caused by greenhouse gas emissions.

[5] It should be noted that, if the costs of climate change mitigation were to be borne by world regions in proportion to their GDP, large flows of funds to the global South would be warranted (Bowen et al., 2017). Across six different climate-economy integrated assessment models, four models implied that a North-to-South annual financial transfer of around US$400 billion would be required by 2050, while the other two models implied larger sums, up to US$2 trillion (well in excess of the US$100 billion p.a. goal set in the UNFCCC's 2009 Copenhagen Accord). Given the importance of tropical ecosystems for biodiversity, another global good, substantial increases in international funding for green investment in developing countries appear warranted, on the grounds of enlightened self-interest.

First, private sector investment is the larger part of global investment (some 70% according to An et al. (2019) – and over 60% in low-income developing countries) and affects the environment for good or ill. Public capital is not perfectly substitutable for private capital (An et al., 2019). Fiscal policies can help make that private investment greener. Macroeconomic demand management usually places emphasis on stimulating private investment, which tends to be more volatile and responsive to changes in the economic outlook than is consumption. Fiscal incentives can help ensure that nations' private sectors 'build back better' after recessions.

Second, governments may prefer economic activity to take place in the private sector, ceteris paribus, in the belief that the private sector is likely to have stronger entrepreneurial and management skills than the public sector and is subject to more pressure for cost control and efficiency (if private markets are competitive and stakeholders monitor managers effectively).

Internalising externalities

Public authorities have to consider carefully the design of public policies, including fiscal measures, in order to try to correct the many market failures that exacerbate environmental problems in the first place. Taxes and subsidies can be used to help ensure that private companies and individuals internalise social costs and benefits associated with their activities that are not already reflected in market prices. The idea of internalising externalities by putting a price on marginal non-market costs and benefits stretches back to the early 20th century (for example, in Pigou, 1912, 1932). The public authority does not need to have detailed knowledge of the private costs of the business or individual incurred in adjusting their activities, so this obviates the need for public authorities to decide, for example, how much a given company can pollute or how much R&D it should undertake. At the same time, the price or subsidy changes the pattern of incentives for future investment, consumption and innovation, directing all three away from harmful activities and towards beneficial ones.

It is easy to point to examples of economic behaviour harmful to the environment that warrant taxing because of market failures. It is perhaps less easy to identify positive externalities that warrant subsidies, which is not surprising when the evidence suggests that adverse environmental externalities have been winning out over recent decades. But various market failures inhibit green innovation (Stern, 2007, Part IV; Jaffe et al., 2005).

First, there can be spillovers from the creation of new knowledge because its use by its creator does not prevent its use by others (the use of knowledge is 'non-rival'). As a result, the benefits to society from R&D investment are often much greater than the benefits captured by the firms undertaking the investment; in other words, the social returns exceed the private returns (Jaffe, 1986; Griliches, 1992). Popp (2006) estimated that the social returns are of the order of four times the private returns and are comparable in environmental and energy R&D to those in other fields. That would warrant a subsidy of three times the private costs of R&D. Subsequent research suggests that green patents (along with those in some other sectors such as pharmaceuticals) have greater spill-overs benefiting subsequent research than does 'dirty' innovation Dechezlepretre et al., 2014). However, some approaches to correcting this problem via intellectual property law rather than subsidies can create monopoly power, which can give rise to a market failure itself.

Second, there are externalities from the adoption and use of new technologies, due to network effects, learning-by-using and learning-by-doing (Jaffe et al., 2003; Edenhofer et al., 2005). These can lead to path dependence of the choice of technologies and the 'lock-in' of high-carbon plant and equipment (Unruh,2000; Acemoglu et al., 2009). Temporary subsidies to output of green sectors are thus theoretically justified to push economies from a dirty equilibrium growth path on to a greener one. But the detailed design of subsidy schemes matters (see, for example, the critique by Johansson

and Kristöm (2019) of the Swedish 'green certificates' energy scheme and the dangers of wasteful duplication of R&D activities pointed out by Hall and Laincz (2019)).

Third, the generation of knowledge is affected by uncertainties and asymmetric information (Böhringer et al., 2009); these can hold back the private sector from green innovation.

Fourth, market failures in the rest of the economy can have implications for climate change mitigation and renewable energy support. For example, Sjögren (2009) and Guivarch et al. (2009) explore the interaction of environmental and labour market imperfections.

Hence there is a strong argument not only for carbon prices to influence private firms' behaviour but also for fiscal subsidies to investment in green R&D (and to the output of green sectors to the extent that technical progress is a function of cumulative output and/or (green) capital investment) (see, for example, Fischer and Newell (2007) and Kalkuhl et al (2013)). However, it is worth noting that Kalkuhl et al found that "without some form of carbon pricing, pragmatic renewable energy policies may turn out to be a fatal aberration for mitigating global warming as costs explode."

Complicating factors

Three major problems, however, complicate the design of Pigouvian fiscal incentives for private investment (see Ayres and Warr (2010), Dasgupta and Mäler (2003) and Dasgupta (2021) for broader critiques of property-rights-based and Pigouvian tax-subsidy solutions).

First, in practice, output subsidies may be the consequence of the political economy of environmental taxes and subsidies rather than an application of Pigouvian welfare economics. Whereas the economic rationale for taxes and subsidies is that they alter relative prices to provide an incentive for behaviour to change, taxes and subsidies also alter income flows to and from public authorities and the private sector. This often gives rise to political lobbying.

Second, in the face of uncertainty and varying marginal costs of abating the environmental bad and the marginal benefits of so doing, it may be better to set quantity limits to environmentally damaging activities than to apply a tax. The work of Pizer (2002), Newell and Pizer (2003) and Weitzman (1974, 2012) implies that, in the realm of climate change, a carbon tax is preferable in the short run but a cumulative greenhouse-gas emissions target in the longer run (so that the planned trajectory for a carbon tax should be revised regularly in response to new data on cumulative emissions). For some environmental problems, there is some risk of marginal damages becoming very high very suddenly (see Dasgupta (2021) on lake eutrophication and species extinction), as an irreversible change is triggered from an environmentally healthy equilibrium to an unhealthy one.

Third, it is not always easy to calculate the optimal tax or subsidy rate, or indeed on whom it should be levied. For example, the size of the wedge between the private and social returns on a given amount of R&D spending depends on factors such as the industry sector involved, its market structure, complementarities between R&D spending and existing produced capital and the economy-wide supply of inputs to R&D activities. Goolsbee (1998) noted that government R&D subsidies increase the price as well as the quantity of inventive activity, in particular by bidding up the pay of scientists and engineers, and concluded that the literature overstated the contribution of public subsidies to R&D in the USA by 30-50%. In countries where R&D workers are in inelastic supply, this is a bigger problem. While economists largely agree on the virtues of global carbon pricing, on the basis that a ton of CO_2 does the same damage to the world's atmosphere wherever it is emitted and by whatever means it is produced, it is less easy to get agreement on the level at which a global carbon price should be set, given differences in views about discount rates, abatement options and climate-change risks (see IPCC (2014) on the range of model-based estimates for the appropriate carbon price).

3. Fiscal measures in practice

General scale and direction of taxes and subsidies

In the light of the emerging evidence about the erosion of natural capital, it is striking that, in the OECD, the share of environmentally related taxes in total tax revenue and compared to GDP has been falling (OECD, 2017).[6] The major contributions came from energy and transport (70% and 26% of the tax base respectively). Waste and water management, forestry, mining, and hazardous chemicals generated only 4%.

The scope for higher tax rates and tax receipts is evident in the area of carbon taxation. OECD (2017) noted that, "In OECD countries, the average effective [carbon tax] rate outside the transport sector is €7.90 per tonne of CO_2. Only 6% of priced emissions are above 30 €/tCO_2 (a conservative estimate of their cost to society) and 65% of emissions are not priced at all. BRIICS economies (Brazil, Russian Federation, India, Indonesia, People's Republic of China, South Africa), have an average effective rate of 1.30 €/tCO_2. Only 2% are priced above 30 €/tCO_2 and 81% of emissions are unpriced." OECD (2021a)[7] examined effective carbon taxation in the energy sector in 15 developing countries and found that effective carbon tax rates were significantly lower than in the OECD in 2018 on average for all types of fossil fuel, with fuel oil, LPG and natural gas receiving net subsidies. For coal and other solid fossil fuels, for example, the average effective net carbon tax rate was 0.3 €/tCO_2 compared with the OECD average of 13.4 €/tCO_2. The OECD pointed out that the potential increase in tax revenues if effective carbon prices were raised to reach the benchmark of €30/tCO_2 for all fossil fuels would be nearly 1% of GDP on average for the fifteen countries (compared with less than 0,5% of GDP for the OECD countries on average).[8] This suggests that much greater use of environmental taxation – particularly by developing-country governments that currently have smaller tax bases – is desirable both to encourage investment in less polluting and disruptive technologies and to improve governments' fiscal positions.

As far as subsidies are concerned, it is difficult to obtain comprehensive data on a comparable basis. Estimates also depend on the methods chosen to deal with non-transparent subsidies due to the use of different tax regimes across industry sectors and similar factors. Coady et al. (2019) projected that, globally, subsidies to fossil fuels were US$ 5.2 trillion (6.5% of GDP) in 2017 (a rise from 2015).[9] For clean energy, which is probably the most important area of subsidy helping the environment, Taylor (2020) has estimated the supply-side subsidies for renewable energy to have been around US$ 167 billion in 2017, with total subsidies to renewable power generation of around US$ 128 billion in 2015 and transport sector subsidies of US$ 38 billion (the IEA estimates a 14% higher figure for renewable power generation). The EU accounted for around 54% of total estimated renewable subsidies in 2017, followed by the United States with 14%, Japan with 11%, China with 9%, India with 2% and the rest of the world with 9%. Yet fossil fuel subsidies are still much higher in absolute terms. Taylor (2020) estimated total direct fossil-fuel subsidies in 2017 to be around US$ 447 billion, with subsidies to petroleum products the largest component, at US$ 220 billion, followed by electricity-based support to fossil fuels at US$ 128 billion (these figures exclude any allowance for the climate-change and health costs of fossil-fuel subsidies). In terms of subsidy per unit of energy, these figures

[6] The revenue raised from these taxes in 2014 represented about 5.2% of all tax revenue, equivalent to 1.6% of GDP in the OECD area.

[7] This publication used a narrower definition of subsidies and effective tax rates than is used in the reference publication OECD (2018). The reference publication is expected to be updated to 2018 data in May 2021.

[8] Across the 15 countries, effective carbon prices varied considerably, both by fuel and overall, so that potential tax revenue gains varied from less than 0.1% of GDP for Uganda and Costa Rica to over 1.5% for Egypt, Ecuador, and Morocco.

[9] This IMF projection used a broad definition of subsidy: fuel consumption times the gap between existing and efficient prices (i.e., prices warranted by supply costs, environmental costs, and revenue considerations). The IMF found that efficient fossil fuel pricing in 2015 would have lowered global carbon emissions by 28% and fossil fuel air pollution deaths by 46%, and increased government revenue by 3.8% of GDP.

suggest that renewable energy attracts a higher rate of subsidy than do fossil fuels (if the implicit subsidy entailed by failing to tax carbon efficiently is ignored) but not enough to correct for the environmental harms for which fossil fuels are responsible. Overall, energy use in general is subsidised, distorting private investment, and encouraging owners of exhaustible fossil fuel stocks to run down these stocks too fast. The problem is particularly acute for countries with large fossil fuel stocks.

This problem of inappropriate subsidies encouraging excessive output, and hence private investment, is evident elsewhere as well, such as in fishing. Sumaila et al (2019) examined various types of subsidies provided by governments to fisheries around the world and suggested that total subsidies were about US$ 35.4 billion in 2018, of which environmentally damaging capacity-enhancing subsidies[10] were US$ 22.2 billion, a higher proportion of the total than in 2009. The top five subsidising political entities (China, European Union, USA, Republic of Korea and Japan) contribute 58% of the total estimated subsidy. For all regions, the amount of capacity-enhancing subsidies was higher than other categories, except for North America, which had higher beneficial subsidies. Fuel subsidies constituted the greatest part of the total subsidy.

The Eliasch Review (Eliasch, 2008) considered the global state of forests and noted that, "The policy and legal framework in many forest nations is skewed towards deforesting practices, for example through subsidies and tax breaks." The Review cited problems in Indonesia and South America. Dasgupta (2021) noted, "Estimates are hard to compile, but global subsidies for energy, agriculture, water, and fisheries are conservatively in excess of US$4-6 trillion annually (Andres et al., 2019; Coady et al., 2019; OECD, 2019; Sumaila et al. 2019). Rents on the use of those resources are therefore negative, meaning that we are encouraged to exploit them even more profligately than open access resources." Case studies also suggest grounds for caution. For example, Kombat and Wätzold (2018) noted how some African countries are now turning their attention to the use of economic instruments, including taxes, to pursue environmental objectives. Their study of the emergence and implementation of three environmental taxes in Ghana – taxes on plastics, over-aged vehicles, and petroleum – found that they fell well short of the optimal economic design, although they did contribute somewhat to mitigating environmental problems, partly because a share of the tax revenue was used for this purpose. In the developed world the same difficulties arise. Zatti (2020), for instance, analysed environmental taxes and subsidies applied in Italy and argued that "the implementation and design of taxes and subsidies have been, and still are, mainly driven by non-environmental objectives, leading to mixed and not completely satisfactory effects." Although there are some striking exceptions (see Chapter 5 of OECD (2013)) on Costa Rica's policy framework for green investment), it is difficult to escape the conclusion that government taxes and subsidies have been as much part of the problem as part of the solution to the erosion of natural capital.

Design of fiscal incentives for investment in practice

Incentives can take many forms. Incentives may be direct, that is, linked explicitly to investment by firms, or indirect, via incentives to output, inputs or actions with respect to the environment. For example, many subsidies are granted not as cash transfers but as tax expenditures – reductions in taxes levied in return for more of something, such as abatement of greenhouse gases, relative to some baseline. According to OECD (2021b), OECD countries deliver most (or all) support to fossil fuels through tax expenditures while, for the OECD partner economies covered,[11] 43% of the total value of support is provided by tax expenditures. The implications for the tax burden on companies are different from straightforward cash subsidies. For example, carbon abatement tax relief can be allowed instead of a carbon tax being levied, in such a way that the marginal price of carbon

[10] Subsidies to enhance the capacity of fishing fleets to draw down the existing stock of fish.

[11] These economies are the non-OECD G20 and the European Union Eastern Partnership economies.

emissions facing firms is the same, achieving the same change in the firms' behaviour at the margin (for firms paying sufficient taxes to be able to benefit from the full tax relief). However, a firm that does not change its behaviour suffers no impact on its income, whereas if it were subject to a carbon tax it would have to pay a tax proportional to its baseline emissions. Thus, tax expenditures on abatement move the baseline compared to that used for a carbon tax (and also discriminate between profitable and unprofitable companies unless tax reliefs can be carried over to future profitable years or applied to profits generated in previous years).

So-called 'bonus-malus' schemes that penalise bad behaviour (e.g., use of a very fuel-inefficient vehicle) and use the revenues raised to reward good behaviour (e.g., use of vehicles with class-leading fuel efficiency) also try to introduce a marginal incentive while not increasing the overall tax burden on the relevant industry sector.[12] Similarly, existing tax expenditures favouring fossil fuels sometimes in practice subsidise fossil fuel use only above a non-zero baseline. That illustrates the importance of assessing the impact of proposed environmental reforms to tax and subsidy systems on corporate income as well as on the effective marginal price imposed on environmental 'bads.' In particular, impacts on corporate income can affect firm entry and exit and the size of the relevant industry sector (so 'bonus-malus' schemes to retire polluting vehicles, for example, are likely to support vehicle production compared with a Pigouvian pollution tax that would also incentivise switching investment and new entry towards cleaner industry sectors).[13] Turning to the range of investment incentives used in practice, Table 1 below offers a summary.

TABLE 1: Common forms of fiscal incentives for investment

Measure	Description
Accelerated depreciation	Accelerated (or free) depreciation (allowing businesses to write off depreciation of assets more rapidly).
Corporate income tax rate (CIT) reduction	Corporate income tax reduction over a defined period.
Customs/sales tax exemption	Exemption from import duties, export taxes, VAT, or sales tax.
Grants	Financial support towards specific investment costs.
Investment tax credit or investment allowance	Reductions in taxes that are based on the amount of investment and are in addition to normal depreciation. Tax credits are deducted from income before gross income is determined. Typically, the business must own or have built the relevant equipment/structure and it must meet specific quality and performance standards.
Land/property tax exemption	Exemption from land/property registration fees, stamp duties.
Tax deduction	Deductions of certain expenses from taxable income, such as employment taxes paid for specialist labour hired or sales taxes/VAT on certain inputs. Tax deductions are taken when calculating tax due, reducing net taxable income.
Tax holiday	Total income tax exemption over defined period, possibly linked to the location of the relevant activity in a special zone (e.g., 'special enterprise zone,' 'free port,' 'export-processing zone').

(Based on Table 7.1 in OECD (2021c) and Table A.1 in OECD (2013), augmented by the author)

These measures can be made conditional on the firm undertaking environmentally desirable activities, producing low-carbon products and/or acquiring physical capital embodying clean(er) technology. Countries frequently use a combination of these incentives to encourage green investment, as illustrated by the OECD's investment reviews. For example, OECD (2013) lists a wide range of incentives offered by the government of Costa Rica for green investment, including:

[12] Sweden, Switzerland, and France are amongst the countries with examples of such schemes for cars. The complexities of evaluating such schemes are illustrated by Alberini et al. (2018) and Habibi et al. (2018) among others.

[13] The basic theoretical analysis of taxes, tax expenditures and environmental regulation in Rajah and Smith (1993) is still pertinent today.

- co-financing (50 % of the total investment costs) or discounts on electricity bills (20% of the amount equivalent to the annual energy savings) to promote investment in technologies that help reduce energy use
- tax exemptions (sales tax, excise tax, ad valorem tax, tax on imported goods) on specific machinery, equipment, and materials for renewable energy production to promote and gradually implement a programme 'to promote rational energy use and achieve energy efficiency'
- a water use fee reduction for small hydroelectric plants
- a tax exemption on the acquisition of wastewater treatment system components, materials, and equipment to mitigate pollution of water sources and improve water quality
- a tax exemption on the import of motor vehicles and equipment and acquisition of machinery and supplies, an income tax exemption for ten years and a sales tax exemption for the production and/or sale of organic agricultural produce
- a tax exemption on supplies and equipment (granted only once) to promote investment, research and technology transfer aimed at conservation and sustainable use of biodiversity

Renewable energy supply is a particularly popular recipient of green fiscal incentives, which is not surprising given its capital intensity, concerns about energy self-sufficiency and the need to displace fossil-fuel-based energy supply using mature technologies. OECD (2021), discussing Middle Eastern and North African investment perspectives, noted that Egypt uses tax deductions, customs/sales tax exemptions and grants to encourage investment in renewable energy. However, Egypt also uses tax deductions and customs/sales tax exemptions to support the hydrocarbon sector, thereby reducing the effectiveness of green fiscal incentives to decarbonise energy. This points to the desirability of formulating a comprehensive policy framework for fiscal incentives so that they do not tend to counteract each other. The OECD also noted that, "Investment incentives in the MENA focus economies are often open to interpretation and discretion of implementing authorities (in many cases investment promotion agencies or councils of investment composed of representatives from different ministries), increasing the risk of corruption and aggressive tax planning by firms." This problem is widespread.

Deadweight losses reflecting incentives granted to firms that would have invested anyway are common; surveys suggest that most firms would invest even without incentives (IMF-OECD-UN-World Bank, 2015). Profit-based incentives are more likely to incur deadweight fiscal losses than cost-based incentives; the latter reduce the costs of investment (rather than benefiting firms already profitable) and hence may make marginal investment profitable, increasing the chances of creating additional investment. Reviews of investment incentives in general have tended to be sceptical about their efficacy (see, for example, Zee et al. (2002) and Klemm (2009)). Klemm (2009) summarised his assessment in the following table:

TABLE 2: A summary of the case for investment tax incentives

Case for fax incentives	Characteristic	Best choice of incentive
I. Strong	a. Internationally particularly mobile activity b. Positive extermalities	If perfectly competitive industry; investment allowances; if firm-specific rents: permanently reduce tax rate. Ideally subsidy/tax credit based on activity (e.g., R&D). Otherwise as Ia.
II. Ammbiguos	a. Regional rents b. Unattractive location c. Tax cut could spark reactions in other jurisdictions	Regional tax coordination. Failing that: Ia. Address weakness directly (improve governance, infrastructure…). Failing that: Ia. May be best to wait. However, if eventual tax cuts inevitable, possible benefit from being first mover.

III. Weak	a. Location-specific rents b. None of the above	Instead of incentive, additional neutral rent tax could be charged. Instead cut overall tax rate or remove other overall disincentive to invest.

Source: Klemm (2009)

Because tax-based incentives favour profitable firms, they are less effective after adverse shocks to aggregate demand, such as those experienced around the world due to Covid-19. They may also help less with firms' immediate cash flow, depending on how quickly tax bills are issued and settled. As well as these incentives becoming less effective with respect to their environmental objective, some of them may also be less useful in stimulating aggregate demand when this is desirable.

Wen (2020) discussed the impact of different forms of explicit investment incentive in the context of temporary stimulus measures designed to help recovery from the Covid-19 induced downturn (although without discussing the unusual sectoral differences in the current crisis). He concluded that, to maximize their effectiveness in bringing forward the timing of investment, these investment incentives should be sharply limited in duration and should target investment spending as directly as possible. Using primarily US data, he found that well-designed, temporary, provisions of accelerated depreciation provide the most cost-effective forms of investment stimulus in recessions. But neutrality of the tax system with respect to taxation requires the non-deductibility of interest as well as 100% depreciation allowances. Also, generous loss-carry-back provisions are needed if loss-making firms are to be strongly affected by the incentive.

It can be argued that if policymakers have 'got prices right' by setting appropriate Pigouvian tax and subsidy rates, this type of temporary policy to encourage investment in general would help private green investment. Neutrality with respect to the tax system in any case bolsters a Pigouvian approach to setting price incentives for appropriate green investment. However, more explicitly targeted incentives and tax holidays may be required given that: (i) building back better entails a change of the direction of economic growth, yet, according to Wen, companies that have not already planned substantial investment when tax incentives are introduced tend not to respond to incentives during periods of economic uncertainty; and (ii) the transformative investment needed in the energy sector entails major long-lived structures, but the planning and implementation costs associated with long-lived investments can make it difficult for businesses to accelerate their plans for such capital investments (for this reason, most investment stimulus proposals have excluded structures). Also, public companies (such as energy utilities) tend to show weaker investment responses than do small and medium-sized firms. Nevertheless, investment incentives of the type Wen discuss should help investment in more labour-intensive so-called 'shovel-ready' green projects and green R&D.

Zhan and Karl (2016) studied a different type of investment incentives, those designed to attract foreign investment, particularly in the context of developing countries. They noted that fiscal incentives are the most frequently used type of incentives to attract foreign investment (as opposed to finance-related and regulatory incentives). The authors argued that such incentives need to be redesigned from a location-based approach (which encourages the erosion of tax receipts in developing countries competing for inward investment) to one that focuses on attracting investment to sectors key to sustainable development and which rewards appropriate investment ex post rather than relying on ex ante commitments by investors. They noted the current tendency to trade off environmental goals against other social goals, allowing natural resource depletion and/or exemption from environmental rules in return for co-investment in social institutions such as hospitals and schools. Fowowe (2013) was also sceptical about the efficacy of current investment incentives, based upon a study of Nigeria, concluding that fiscal incentives had had a *negative* effect on both private investment and foreign direct investment and that, rather than focusing on fiscal incentives, the country should concentrate on factors that discourage investors such as infrastructural bottlenecks, poor-quality institutions and the legal framework.

Finally, investment incentives and other fiscal measures should, in principle, be designed, set and evaluated in broadly the same frameworks used for public investment appraisal, in order to ensure consistency across government objectives and to reflect the range of policy priorities facing governments.

4. Building a supportive framework for private-sector decisions

It was argued above that fiscal authorities can promote green private investment and sustainable development by setting appropriate environmental taxes, subsidies and targeted investment incentives (the latter particularly as an aid to macroeconomic recovery in the short term). But there are also ways in which they can promote sustainable development by helping to set an appropriate fiscal and regulatory environment. Empirical work by Ang et al. (2017) on renewable energy established that, "beyond setting targeted investment incentives, and other climate mitigation policies, policy makers need to consider outstanding regulatory and market barriers to renewables investment, including within investment policy and facilitation, competition, trade policy, public governance and financial market policy (including Basel III regulations). In the solar sector for instance, results show that across OECD and G20 countries, outstanding barriers to solar investment are notably linked to: competition policy and regulatory and market rigidities in the power sector, e.g. to connect solar PV projects to the grid; cumbersome licensing and permitting procedures; property registration procedures and land rights; transparency of infrastructure procurement; and access to financing." Some of the ways in which fiscal authorities can establish a supportive environment for private green investment are discussed below.

First, public green investment can function as a credible guarantee that a public authority is pursuing the related environmental objectives over the long term, thus underpinning development of related environmental technologies by the private sector. Also, if the authority is consistent in its policies, at the same time as it invests, it will be setting appropriate tax and subsidy rates and legal arrangements to encourage private-sector action that also supports those objectives. For example, there has been some scepticism about whether governments using carbon pricing would let the carbon price rise inexorably as theory predicts is likely to be necessary. If governments themselves contract at forward prices consistent with a rising carbon price schedule and make public investments consistent with their stated decarbonisation goals, that is likely to help re-orient the content and level of private-sector investment so that it is also consistent. The converse is true, too. Public investment that is not green and appears to clash with stated environmental goals will discourage green private investment. Research on the impact of the EU Emissions Trading System suggests that, while it has reduced emissions, it has not succeeded in incentivising major technological change and associated capital stocks (see Dechezleprêtre et al. (2018) on the EU ETS and Lilliestam et al. (2020) and Rafaty et al. (2020), on the shortcomings of carbon pricing generally). The EU carbon price may have been too low and volatile (and covered too little of the EU economy) to do so.

Second, they can maintain a supportive macroeconomic environment that reduces macro policy uncertainty and maintains private-sector expectations of aggregate demand growth. Historically, green investment has been boosted by economic growth, a sound financial system conducive to low interest rates, and high fuel prices (Eyraud et al., 2013). Measures to promote economic growth after the Covid-19 crisis abates will help to boost private green investment through a general accelerator effect, even though the current fiscal stimuli around the world are not very well aimed at promoting green growth (Vivid Economics, 2021). Unfortunately, the downturn induced by the Covid-19 pandemic has probably taken its toll of green investment by firms. Guérin and Suntheim (2021) investigated previous episodes of financial and economic stress to draw implications for the current crisis, finding that tighter financial constraints and adverse economic conditions are generally detrimental to firms' environmental performance, reducing green investments. The spur of high fossil-fuel prices is absent as well. More positively, real interests remain very low in this downturn

and the financial system has not been impaired in the way it was in 2008-09; finance is unlikely to be a constraint if firms become convinced there is a market for the outputs from green investment.

Third, they can adopt procurement practices for the public sector that establish environmental criteria for private-sector contractors. This can include becoming a contracting party in long-term purchase agreements with energy providers and other companies in key areas for environmental policy, through devices such as contracts for difference and other contractual forms that reduce long-term uncertainty for the private sector. Means such as these can also help underpin official projections of policy variables such as carbon prices and other environmental charges.

Fourth, they can support the development of appropriate property rights in key areas as disparate as intellectual property and land use. That may imply different approaches in developing countries than developed ones, for example, with respect to patent fees and land rights. It may entail, for example, an effort to facilitate user micro payments for using up natural capital (e.g., fishing licences, irrigation charges). Dasgupta (2021) points out that governments need to tread carefully when intervening in traditional societies where non-legal social norms and customs have often already evolved to counter the problems arising from market failures (e.g., community regulation of the size and frequency of fish catches or management of forests and commons). However, traditional solutions are often not robust in the face of broader economic development.

Fifth, fiscal authorities can address the distributional consequences of environmental policies by, for example, increasing housing benefits for residents of energy-inefficient homes or rebating national carbon tax revenues on a per capita basis to families as a 'carbon dividend.' Advani et al. (2013) discussed the distributional implications of carbon pricing and household energy use in the UK and showed how adverse effects on poorer families could be mitigated by appropriate tweaks to the tax-benefit system. The danger in this area is that environmental tax revenues cannot be spent more than once. Bowen (2015) considered the menu of options.

Sixth, fiscal authorities can promote private green investment by promoting financial deepening in general as well as encouraging 'green' finance – for specifically green projects – in particular. Empirical evidence at the macro level (subject to some caveats about econometric specifications) points towards a causal link from finance to economic development, with, for example, the size of the banking sector a robust predictor of GDP per capita (across countries). The voluminous literature on the role of finance systems in development has been reviewed by, amongst others, Beck (2012), Popov (2017) and Beck and Levine (2018). The link seems to be stronger in low- to middle-income countries, perhaps because credit constraints are more pervasive and financial intermediation less so than in the OECD. Bringing private finance into sustainable development has been a major preoccupation of multilateral institutions, as illustrated by the UN Environment Programme's Finance Initiative (https://www.unepfi.org). At one end of a spectrum, that may simply entail public sector subsidies or guarantees for private sector investment conditional on simple ex ante tests of environmental efficacy but, at the other, may involve complex contracts, legal costs and expensive monitoring by the commissioning authority. Public authorities can help to de-risk private green investment by guaranteeing future prices for output (e.g. through contracts for difference), taking on equity-type first-loss risks and indemnifying firms for the crystallisation of tail risks (including those associated with a large change in government policy). This can have benefits for the profile of government spending as well, as in 'build-lease-transfer' projects where the private sector finances and undertakes upfront capital expenditure and leases the new assets back to a public body for a relatively predictable long-term rent.

Finally, the management capabilities of the private sector can be utilised through public-private partnerships while achieving a more efficient allocation of risk between the public and private sector (see Pattberg (2010) for a discussion of public-private partnerships in the context of global climate governance; relevant World Bank resources can be found at

https://www.worldbank.org/en/topic/publicprivatepartnerships). These require a framework of regulation that as far as possible faces private sector agents with incentives making them behave as if they shared the public goals of the commissioning authority while reducing the risks facing private agents. This can generate investment by the private partners for green objectives.

5. Implications for policy

Green private investment is vital if the world is to transition to a more environmentally sustainable growth path. It can also help the global economy to recover, now and soon, from the Covid-19-induced recession. However, policymakers need to consider the setting of fiscal incentives and the economic environment for private firms carefully. This note suggests the following key messages for policymakers:[14]

1. Natural capital is being used up to a dangerous extent. The problem is particularly acute in developing countries. Climate change is a major threat to lives and livelihoods and is at the top of the international environmental agenda, but a wider range of environmental problems are undermining sustainable development. Tackling problems such as particulate pollution, contamination of fresh water and destruction of unique eco-systems can have big short-run economic and social benefits as well as helping to underpin longer-term growth. Governments need to have a coherent and broad policy framework for natural capital and the environment. Part of the framework must support the private sector in investing in more sustainable growth. Governments should take stock of how their environmental policies affect the private sector, inviting independent expert advice.
2. Many benefits of preserving and enhancing natural capital are felt beyond national boundaries. Nations should be prepared to pay for transnational environmental goods, a disproportionate share of which are in developing countries.
3. The most important instruments in the toolbox of fiscal authorities are environmental taxes and subsidies designed to change relative price signals in favour of preserving natural capital. To a certain extent, they can correct market failures without requiring detailed knowledge about technologies and firms' costs on the part of public (some market failures, however, are likely to require direct public intervention and spending). But existing taxes and subsidies rarely reflect the economic rationale for fiscal intervention on behalf of the environment, as illustrated by the continuing large subsidies for fossil-fuel use. Policymakers should analyse and reform existing taxes and subsidies to establish a coherent fiscal framework to support natural capital. Given the current state of the environment, green reforms are likely to be positive for tax revenues and entail reductions in environmentally harmful and expensive subsidies to natural resource depletion. Carbon pricing is the most obvious and pressing need. Green R&D targeted at the needs of low-income developing countries (e.g., in agriculture, ecosystem management and energy) merit greater subsidy (Ang et al. (2017) found that, in emerging economies, public spending on R&D had a particularly strong positive relationship with patents for new renewable energy technologies).
4. The devil is in the detail. Policies can end up inadvertently subsidising harmful consumption (as with domestic natural gas use in the UK) or obstructing relative price changes that would help the transition to sustainable growth (as with many policies supporting renewable energy that end up subsidising energy consumption relative to other goods and services in the economy). Centralising policies on incentives, including green incentives, within government would be helpful, as would consolidating tax incentives in tax laws (rather than in investment laws and executive regulations, legislation governing specific industries or one-off agreements with firms), enhancing transparency and reducing potential overlaps across different parts of government.
5. Policymakers should consider if the costs of green fiscal incentives – in terms of revenue forgone and economic distortions – outweigh their benefits. Cost-benefit analysis prior to introducing

[14] These draw on, inter alia, OECD (2021c) and IMF-OECD-UN-World Bank (2015).

incentives, and monitoring ex post, would help governments assess the extent to which, and at what cost, incentives meet their intended objectives. If such analysis requires data and resources that are not available, simple tax incentive reports, identifying and describing all available incentives, their policy goal and legal reference, are an important first step. Replacing permanent incentives with temporary benefits would also encourage evaluation. Fiscal incentives should be specific, with clear eligibility criteria that reduce room for excessive discretion by implementing authorities. This will allow for fairer competition, lower corruption, and easier evaluation.

6. It would be sensible for countries to move gradually from broad-based tax holidays and profit-based incentives to more targeted, cost-based incentives in line with government environmental priorities.
7. Explicitly green investment subsidies can be justified in principle if they discriminate by sector and technology, promoting learning-by-doing in green technologies and helping to make dirty technologies redundant. And they can be an effective way of stimulating private investment and thereby helping with macroeconomic recovery. But they work best in this respect by bringing forward investment (in equipment and R&D rather than long-lived structures) that has already been planned. This is not necessarily the case with existing private green investment plans, at least not at the scale desirable, given the past absence of the appropriate price signals. Well-designed, temporary, provisions of accelerated depreciation provide the most cost-effective forms of investment stimulus in recessions.
8. Fiscal authorities need to help establish a supportive framework in which private firms can be confident of the public commitment to more sustainable growth. This requires, inter alia:
    - Credible plans for public green investment, as a token of public-sector commitment to professed environmental goals
    - A supportive macroeconomic environment that reduces macro policy uncertainty and maintains private-sector expectations of aggregate demand growth
    - Green procurement practices in the public sector
    - The development of appropriate property rights in key areas as disparate as intellectual property and land use and the facilitation of user micro payments for using up natural capital
    - Credible fiscal measures to cushion any adverse distributional effects of environmental policies
    - The promotion of green finance to channel savings to private green investment

References

Advani, A., Johnson, P., Leicester, A., and G. Stoye (2013). *Household energy use in Britain: A distributional analysis*. IFS Report R85, Institute for Fiscal Studies, London.

Alberini, A., Bareit, M., Filippini, M., and A. Martinez-Cruz (2018). The impact of emissions-based taxes on the retirement of used and inefficient vehicles: The case of Switzerland. *Journal of Environmental Economics and Management*, 88: 234-258

An, Z., Kangur, A., and C. Papageorgiou (2019). *On the substitution of private and public capital in production*. IMF Working Paper WP/19/232, IMF, Washington DC.

Andres, L., Thibert, M., Cordoba, C., Danilenko, A., Joseph, G., and C. Borja-Vega (2019). *Doing more with less: Smarter subsidies for water supply and sanitation*. World Bank, Washington DC.

Ang, G., Röttgers, D., and P. Burli (2017). *The empirics of enabling investment and innovation in renewable energy*. Environment Working Paper ENV/WKP (2017)10, OECD, Paris, May.

Auffhammer, M. (2018). Quantifying economic damages from climate change. *Journal of Economic Perspectives*, 32(4): 33-52.

Ayres, R., and B. Warr (2010). The economic growth engine: How energy and work drive material prosperity, MIT Press, Cambridge, Massachusetts.

Beck, T. (2012). *The role of finance in economic development: benefits, risks, and politics*. Chapter 6 in Mueller, D.C. (ed.) (2012): *The Oxford handbook of capitalism*. Oxford University Press. Oxford and New York.

Beck, T., and R. Levine (ed. s) (2018). *Handbook of finance and development*. Edward Elgar. Cheltenham.

Bowen, A. (2015). *Carbon pricing: How best to use the revenue?* Grantham Research Institute Policy Brief, LSE, London, November.

Bowen, A. (2016). *Long-term productivity growth and the environment*. OECD Environment Working Paper No. 102, OECD, Paris.

Bowen, A., Campiglio, E., and M. Tavoni (2014). A macroeconomic perspective on climate change mitigation: meeting the financing challenge. *Climate Change Economics*, 5(1): DOI: 10.1142/S2010007814400053.

Bowen, A., Campiglio, E., and S. Herreras Martinez (2017). An 'equal effort' approach to assessing the North-South climate finance gap. *Climate Policy*, 17(2): 231-245.

Coalition of Finance Ministers for Climate Action (2020). *Better recovery, better world: Resetting climate action in the aftermath of the Covid-19 pandemic*. Coalition of Finance Ministers for Climate Action, https://www.financeministersforclimate.org/ .

Chang, T., Graff Zivin, J., Gross, T., and M. Neidell (2016). Particulate pollution and the productivity of pear packers. *American Economic Journal: Economic Policy*, 8(3): 141-69.

Coady, D., I. Parry, N.-P. Le, and B. Shang (2019). *Global fossil fuel subsidies remain large. An update based on country-level estimates*. IMF Working Paper WP/19/89, IMF, Washington DC.

Dasgupta, P. (2021). The economics of biodiversity: The Dasgupta review. HM Treasury, London.

Dasgupta, P., and K-G. Mäler (2003). The economics of non-convex ecosystems: Introduction, *Environmental and Resource Economics*, 26, 499-525.

Dechezleprêtre, A., Martin, R., and M. Mohnen (2014). *Knowledge spillovers from clean and dirty technologies*. CEP Discussion Papers dp1300, Centre for Economic Performance, LSE, London.

Dechezlêpretre, A., Nachtigall, D., and F. Venmans (2018). *The Joint Impact of the EU-ETS on Carbon Emissions and Economic Performance*. OECD Economics Working Paper ECO/WKP (2018)63, OECD, Paris.

Eliasch, J. (2008). Climate change: Financing global forests. HMSO, London.

Fowowe, B. (2013). Do fiscal incentives promote investment? Empirical evidence from Nigeria. *The Journal of Developing Areas*, 47(2): 17-35.

Guérin P., and F. Suntheim (2021). Firms' environmental performance and the COVID-19 crisis. IMF Working Paper WP/21/89, IMF, Washington DC, March.

Habibi, S., Hugosson, M., Sundbergh, P., and S. Algers (2018). Car fleet policy evaluation: The case of bonus-malus schemes in Sweden. *International Journal of Sustainable Transportation*, 13(1):1-14.

Hamilton, K., G. Ruta and L. Tajibaeva (2005). *Capital accumulation and resource depletion: A Hartwick Rule counterfactual*. World Bank Policy Research Working Paper 3480, World Bank, Washington DC.

IMF-OECD-UN-World Bank (2015). *Options for low income countries' effective and efficient use of tax incentives for investment*. A report prepared for the G-20 Development Working Group by the IMF, OECD, UN and World Bank, https://www.imf.org/external/np/g20/pdf/101515.pdf

IMF (2020). *Greening the recovery*. IMF Fiscal Affairs staff note. Special series on fiscal policies to respond to COVID-19, IMF, Washington DC.

IMF (2021). Fiscal monitor database of country fiscal measures in response to the COVID-19 pandemic. IMF, Washington DC.

IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri, and L.A. Meyer (eds.)]. IPCC, Geneva.

Klemm, A. (2009). *Causes, benefits, and risks of business tax incentives*. IMF Working Paper WP/09/21, IMF, Washingtonm DC.

Kombat, A., and F. Wätzold (2018). The emergence of environmental taxes in Ghana: A public choice analysis. *Wiley Interdisciplinary Reviews Environmental Policy and Governance* 29: 46-54.

Levy, J., Brandon, C., and R. Studart (2020). *Designing the COVID-19 recovery for a safer and more resilient world*. WRI Commentary, World Resources Institute, Washington DC.

Lilliestam, J., Patt, A., and G. Bersalli (2020). The effect of carbon pricing on technological change for full energy decarbonization: A review of empirical ex-post evidence. *Wiley Interdisciplinary Reviews Climate Change* 12(1).

Managi, S., and P. Kumar (2018). Inclusive wealth report 2018: Measuring progress towards sustainability. Routledge, New York.

Newell, R., and W. Pizer (2003). Regulating stock externalities under uncertainty. *Journal of Environmental Economics and Management* 45: 416-432.

OECD (2013). OECD investment policy reviews: Costa Rica 2013. OECD, Paris.

OECD (2017). *Green growth indicators 2017*. OECD Green Growth Studies, OECD, Paris.

OECD (2018). Effective carbon rates 2018: Pricing carbon emissions through taxes and emissions trading. OECD, Paris.

OECD (2019). Towards green growth in emerging market economies: Evidence from environmental performance reviews. OECD, Paris.

OECD (2020). *Making the green recovery work for jobs, income, and growth*. Policy Brief, oecd.org/coronavirus, OECD, Paris, October.

OECD (2021a). Taxing energy use for sustainable development: Opportunities for energy tax and subsidy reform in selected developing and emerging economies. OECD, Paris.

OECD (2021b). OECD companion to the inventory of support measures for fossil fuels 2021. OECD, Paris.

OECD (2021c). Middle East and North Africa investment policy perspectives. OECD, Paris.

Pattberg, P. (2010). Public–private partnerships in global climate governance. *Wiley Interdisciplinary Reviews Climate Change* 1(2).

Pigou, A. (1912). *Wealth and Welfare*. Macmillan, London.

Pigou, A. (1932) (4th edition). *The Economics of Welfare*. Macmillan, London.

Pizer, W. (2002). Combining price and quantity controls to mitigate global climate change, *Journal of Public Economics* 85(3): 409-434.

Popov, A. (2017): *Evidence on finance and economic growth*. ECB Working Paper No. 2115, European Central Bank, Frankfurt, December.

Rafaty, R., Dolphin, G., & F. Pretis (2020). Carbon pricing and the elasticity of CO_2 emissions. *Institute for New Economic Thinking Working Paper Series*, 1-84.

Rajah, N., and S. Smith (1993). Taxes, tax expenditures, and environmental regulation. *Oxford Review of Economic Policy*, 9(4): 41-65.

Rockström, J., Steffen, W., Noone, K., Persson, Å., et.al. (2009). A safe operating space for humanity. *Nature*, 461: 472-475.

Royal Society (2017). Climate updates: What have we learnt since the IPCC 5th Assessment Report? The Royal Society, London.

Schwab, K., and T. Malleret (2020). *COVID 19. The Great Reset.* Geneva: World Economic Forum.

Stern, N., Unsworth, S., Valero, A., Zenghelis, D., Rydge, J., and N. Robins (2020). *Strategy, investment, and policy for a strong and sustainable recovery: An action plan*. Centre for Economic Performance, London School of Economics and Political Science, London, July.

Sumaila, U. R., N. Ebrahim, A. Schuhbauer, D. Skerritt, Y. Li, H. S. Kim, T. G. Mallory, V. W. L. Lam, and D. Pauly (2019). Updated estimates and analysis of global fisheries subsidies. *Marine Policy*, 109.

Taylor, M. (2020). *Energy subsidies: Evolution in the global energy transformation to 2050*. International Renewable Energy Agency, Abu Dhabi.

TEEB (2010). *The economics of ecosystems and biodiversity: Ecological and economic foundations*. The Economics of Ecosystems and Diversity/Earthscan, London and Washington DC.

Vivid Economics (2021). Greenness of Stimulus Index: An assessment of COVID-19 stimulus by G20 countries and other major economies in relation to climate action and biodiversity goals. Vivid Economics and the Finance for Biodiversity Initiative.

WCED (1987). *Our common future*. World Commission on Environment and Development. UN/Oxford University Press, Oxford.

Weitzman, M. (1974). Prices vs. Quantities. *The Review of Economic Studies*, 41(4): 477-491.

Weitzman, M. (2012). GHG targets as insurance against catastrophic climate damages. Journal of Public Economic Theory, 14(2): 221-244.

Wen, J.-F. (2020). Temporary investment incentives. IMF Fiscal Affairs Special Series on Covid-19, IMF, Washington DC, May.

World Bank (2012). Inclusive green growth: The pathway to sustainable development. World Bank, Washington DC.

World Bank (2017). *Who sponsors infrastructure projects? Disentangling public and private contributions*. World Bank/ Public-Private Infrastructure Advisory Facility, Washington DC.

World Bank (2018). *The Changing Wealth of Nations 2018*. World Bank, Washington DC.

Zatti, A. (2020). Environmental taxes and subsidies: Some insights from the Italian experience. *Environmental Economics*, 11(1): 39-53.

Zee, H., Stotsky, J., and E. Ley (2002). Tax incentives for business investment: A primer for policy makers in developing countries. *World Development* 30(9): 1497-1516.

Zhan, J., and J. Karl (2016). *Investment incentives for sustainable development*. Chapter 9 in Tavares-Lehmann, A., Toledano, P., Johnson, L., and L. Sachs (Ed. s). *Rethinking investment incentives: Trends and policy options,* Columbia University Press, New York.