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Subnational Investments in Mitigation and Adaptation to Climate Change: Some Financing and Governance Issues

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Abstract

This paper explores the role of subnational investments in climate change mitigation and adaptation, emphasizing the importance of subnational entities in driving climate action at the local level. We discuss financing options, including public funds and private sector engagement, as well as governance structures necessary for effective subnational climate action. We also highlight the need for multi-level governance, collaboration, and clear policy frameworks to support subnational entities in implementing climate change initiatives.

Keywords: climate change, climate mitigation, subnational governance

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I. Introduction

As the human and economic costs of climate change (CC) become more and more evident, both mitigation (measures to reduce greenhouse gas (GHG) emissions) and adaptation (measures to reduce the impacts of climate change on economies and societies) are taking increasing priority and urgency in governments' policy agendas worldwide. The fight against CC is a global challenge that requires action spanning a variety of policy domains as well as coordination both among and within governments, with distinct but interrelated roles for cooperation at the international, national, and subnational levels. This paper focuses on the role of subnational investments in mitigation and adaptation, their financing, and their governance.

Section II begins with a brief overview of estimates of global investment needs for CC in mitigation, especially in the energy, transportation, and buildings sectors. The section makes the case for place-based policies in these areas and discusses the role of subnational governments (SNGs) in each of them.

Section III focusses on adaptation. Estimates of investment needs for adaptation vary widely across countries, as do the relative roles of government and the private sector in meeting these needs. The case for place-based policies, and consequently for the role of subnational investments, can be argued to be even stronger in adaptation than in mitigation, given that the vulnerability to CC-induced shocks tends to vary widely within national territories, reflecting geographic conditions and the state of existing infrastructures.

The availability of financing frequently represents a major constraint on subnational investments, including CC-related ones. Section IV discusses various funding and financing options, including subnational own revenues, intergovernmental transfers, borrowing—in particular, green loans and bonds—and the use of public-private partnerships.

Section V focuses on two main governance-related issues: ensuring adequate coordination between national and subnational CC-related goals and investments and strengthening the management of subnational green investments.[2]

Section VI offers some brief conclusions.

II. The Role of SNGs in Climate Change Mitigation[3]

1. Global needs of GHG emission reductions to meet the net-zero objective

Most countries around the world have committed to GHG emission reduction targets to meet the 2015 Paris Agreement goal of limiting global warming relative to pre-industrial times to well below 2ºC, and preferably below 1.5ºC. 130 of these countries (accounting for 90 percent of GHG emissions) have also committed to achieving carbon neutrality by mid-century. However, there is broad consensus in the literature that policy action has so far been insufficient to put emissions on track to reach medium-term (2030) and mid-century targets, although estimates of the gap vary significantly both globally and by country.[4]

The net-zero emissions (NZE) scenario prepared by the International Energy Agency provides useful insights into the magnitude of the needed reduction of carbon emissions, as well as the policy options available to achieve agreed targets by mid-century (IEA, 2021). The scenario

[2] In this paper we refer interchangeably to investments in mitigation and/or adaption as green, climate-relevant, or climate-sensitive investments.

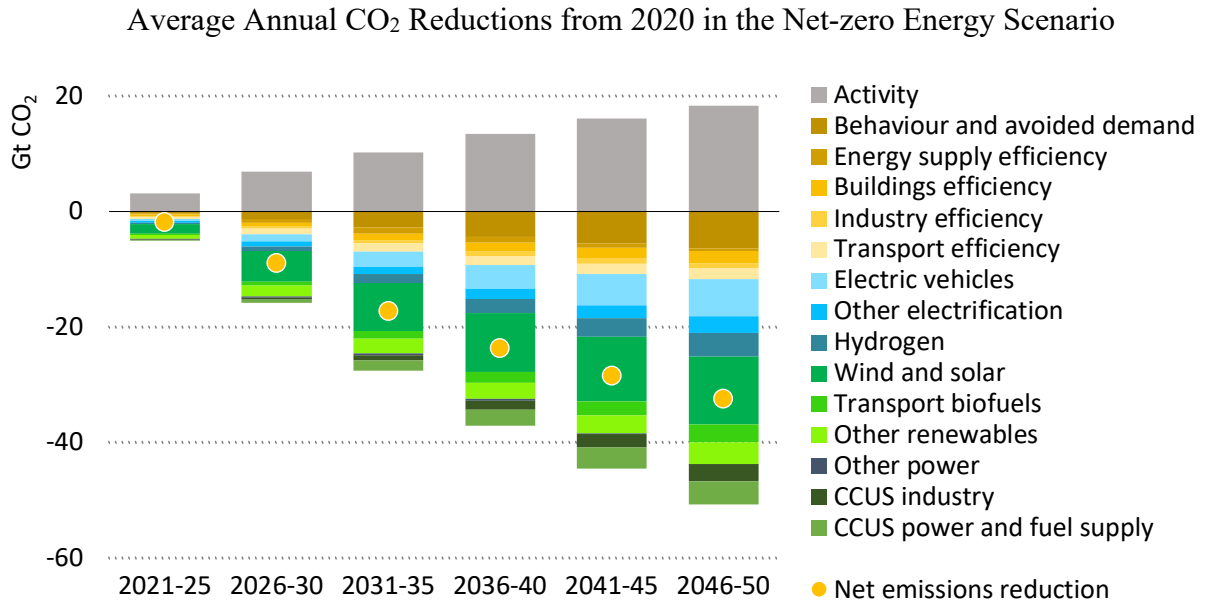
[3] This section draws significantly on a previous paper by the authors on the same subject (de Mello and Ter-Minassian, 2023).

[4] A recent paper, based on the IMF-World Bank Climate Policy Assessment Tool (CPAT), estimates that current nationally determined contributions (NDCs) would only reduce emissions by about 12 percent by 2030, compared with 2019. This is less than half of the emissions cuts needed for 2^0C and less than a quarter of those needed for 1.5ºC warming. Moreover, actual implementation to date falls well short of the NDCs targets (Black et al., 2023).

emphasizes the importance of increasing reliance on renewables and electrification (Figure 1) and draws attention to the substantial investments needed to reach emission neutrality by mid-century (Figure 2). In particular, achieving NZE in 2050 will require global annual investment in the energy sector to rise from USD 2.3 trillion in recent years to USD 5 trillion by 2030.

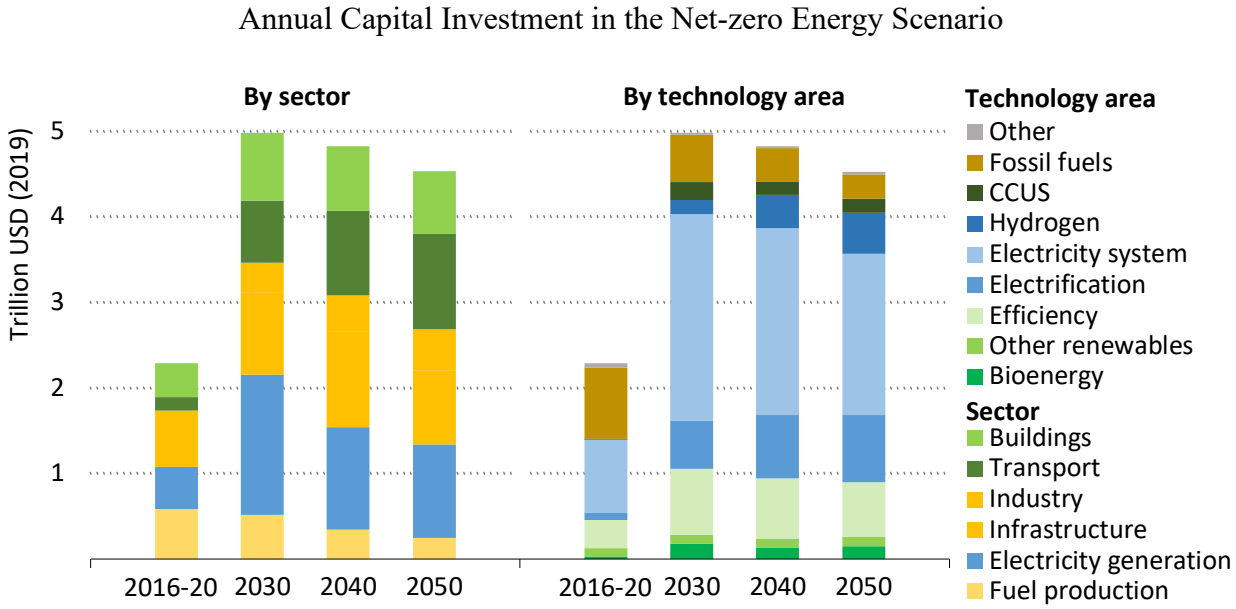
Infrastructure, buildings, and transport account for sizable shares of the required investment to achieve NZE by mid-century. For transport-related clean energy alone, investment would need to rise from USD 75 billion per year to over USD 570 billion by 2030. Efforts are also needed to improve efficiency in the use of energy in the economy, and to influence households' and firms' behavior to achieve significant reductions in energy demand.

Figure 1. Sectoral Distribution of Reductions in Global Carbon Emissions Needed for Net-zero Scenario



Source: International Energy Agency (2021)

Figure 2. Sectoral Composition of Global Investments Needed for Net-zero Scenario



Source: International Energy Agency (2021)

2. The case for place-based mitigation efforts

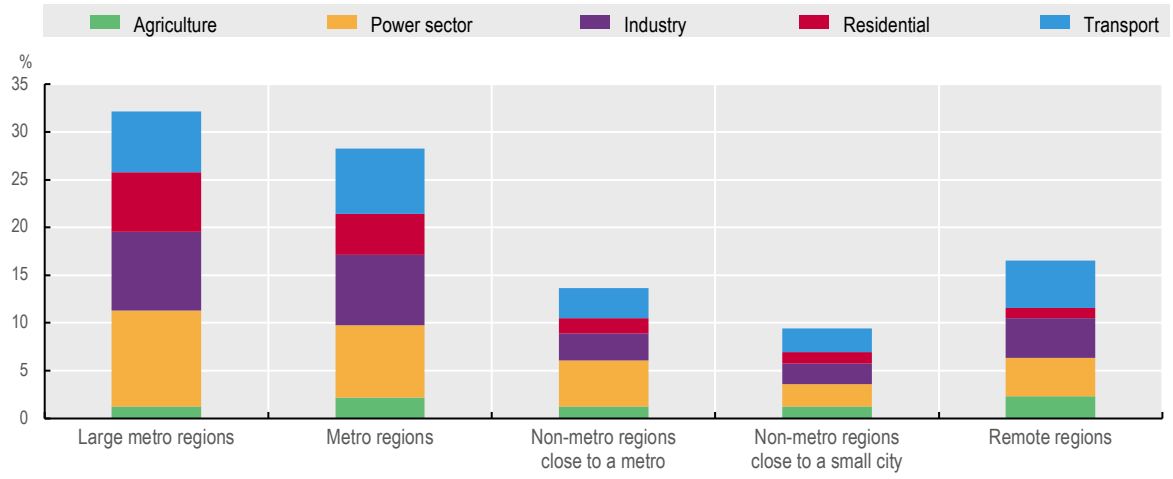
The current level and projected increase in GHG emissions vary widely not only among, but also within, countries. In several regions of OECD countries, emissions have increased despite ambitious goals set at the national level. OECD estimates, based on the Emissions Database for Global Atmospheric Research (EDGAR) of the European Commission's Joint Research Centre (JRC, 2020), indicate that in 2018 metropolitan areas accounted for about 60% of GHG emissions, with the bulk stemming from the power, transport, and residential sectors (Figure 3). In per capita terms, however, the level and growth of GHG emissions in rural and remote regions far exceeded those in urban areas (OECD, 2021, 2022a). The intensity of emissions in each region reflects its productive structure, resulting in a wider variation within than across countries. For instance, regions that are rich in fossil fuels or rely heavily on industries dependent on such

fuels tend to have levels of per capita emissions that are several times higher than their respective national averages.

Differences in emission levels and in their sources in turn entail differences in the intensity and nature of required emission reduction efforts. To illustrate, OECD regions would have to cut their emissions by a factor of 6 by 2030 to meet the United Nations (UN) target of 2.1 tons of CO2-equivalent per capita (OECD, 2022a). These efforts can have significantly different economic, fiscal, and social costs across the national territory. Such differences need to be taken into account in the design of national mitigation agendas, evidencing the importance of place-based policies in such agendas. These considerations underscore the importance of a meaningful involvement of SNGs, as well as other relevant stakeholders, in the formulation and implementation of the agendas, given their knowledge of local economic and social conditions.

Figure 3: Regional GHG Emissions

Contribution by Type of Region, 2018



Note: OECD countries, Romania and Bulgaria. GHG emissions exclude those from land use and land use change.

Source: OECD calculations based on EDGAR, JRC (2020)

CC mitigation policies can also have important benefits, in addition to addressing the effects of climate change itself. They include: a) improvement in air quality, with related positive effects on public health and productivity; b) reduction in traffic congestion and related gains in work and leisure time; c) improvement in the quality of life of households currently living in poorly insulated dwellings; and [d) increases in energy efficiency of building and related reduction of energy poverty, to name just a few (OECD, 2021). By virtue of their knowledge of local conditions, SNGs are best placed to ensure that such potential co-benefits are taken into account in the design of mitigation policies.

3. Subnational spending policies for CC mitigation

3.1. Delivery of public services and direct energy use

SNGs are important players in most of the sectors where significant reductions in emissions will be required in the net-zero scenario mentioned above. They also have a substantial stake in the success of CC mitigation, as they are responsible for large shares of spending on adaptation to climate change and tend to be first responders to climate-related natural disasters.[5]

As highlighted by the IEA scenario, the electricity sector is key to meeting net-zero emission targets, given its large share in emissions worldwide. Whereas global demand for electricity is expected to grow at a rapid pace in the years ahead on account of economic growth, especially in emerging-market and developing economies (EMDEs), the mitigation policies discussed below in industry, transport and buildings will have the opposite effect to the extent that electricity generation is shifted away from fossil fuels towards cleaner sources, such as hydropower, solar

[5] For a discussion of complementarities and possible trade-offs between mitigation and adaptation policies, see OECD (2021b).

and wind, and efficiency in its use is enhanced. In many countries, regional and local governments are involved in the generation and distribution of electricity,[6] most often through enterprises in which they have ownership or controlling interest. Thus, they can influence production, pricing, and investment decisions of their SOEs operating in the energy sector. Moreover, they are generally responsible for street lighting and in some cases for district heating, as well as for efficiency in the use of energy for the provision of these services.

In the transport sector, despite a projected continued strong rise in passenger and freight travel, major cuts in emissions are targeted to be achieved over the next decades through a combination of: a) electrification of transport systems and light vehicles, and increased use of biofuels and hydrogen in heavy vehicles and aviation; b) shifts in transport modes (e.g., increased use of public transport and rail for long-haul transport); and c) behavioral changes that could lead to sustained reductions in demand (e.g., reduced commuting, greater recourse to carpooling, and increased use of low- or non-emitting vehicles, such as bicycles).

SNGs can play an important role in many of these changes through pricing mechanisms, such as carbon taxes and emissions trading schemes (ETS); through policies regarding taxation and non-tax measures; through regulation and behavioral nudges; and through investments in relevant low-emission infrastructure, including mass urban transport systems and charging stations for electric vehicles.

The decarbonization of residential and commercial buildings is expected to make a growing contribution to the targeted reduction in emissions over the next decades, essentially as a result of electrification (because it reduces the indirect use of energy in buildings) and policy-driven

[6] In contrast, electricity transmission is generally a national responsibility.

improvements in energy efficiency (because it reduces the direct use of energy in the operation of buildings) (Figure 1 above).[7] SNGs have an important role to play in this area, because they account for the lion's share of public spending in housing in OECD countries. They are often active in the subsidized market segment, by investing in the construction of new properties to be leased on favorable terms to vulnerable social groups; by financing the upkeep of the existing social housing stock; and/or by subsidizing rents in the private housing market. They also often participate in the not-for-profit segment in joint ventures with private-sector developers and managers. Thus, they can directly influence carbon emissions from such buildings by adhering to high standards for the sourcing and use of energy in new buildings, and by retrofitting old ones. Moreover, they can promote the decarbonization of private real estate through their taxation, subsidization, and regulatory policies.

SNGs can also contribute to GHG emission reductions through their activities relating to the use of public land under their control by limiting or banning the mining of coal and the exploration of fossil fuels in their respective jurisdictions; by safeguarding existing forests, which are important carbon sinks; by expanding urban green spaces; and by limiting urban sprawl through regulation. Finally, they can also promote decarbonization through actions affecting their own use of energy, not least by retrofitting their own buildings, especially schools and equipment, to make them more energy-efficient; by incentivizing the use of public transport by their employees, and by reducing their commuting frequency by allowing work from home, when

[7] Efforts will also be required to reduce emissions embodied in the materials used in construction, maintenance and throughout the lifecycle of buildings and structures. Progress has been much slower in this area (de Mello, 2023).

appropriate; and by facilitating remote access of the population to many public services through digitalization.

The regulatory functions of the SNGs cannot be underestimated in the CC mitigation arena. Land use and zoning requirements, which are often under the purview of the local administrations, as mentioned above, can have significant effects on energy use and other environmental outcomes. Building codes are also generally established by the local governments and can do much to set standards for construction, which affects energy use throughout the lifecycle of buildings. Beyond these aspects, SNGs can regulate the use of fuels in transport and housing, influencing technology choices by households and firms. For example, many local governments are banning gas-powered technologies, such as boilers, and are planning to ban the use of diesel for light vehicles in their jurisdiction. Other local governments are developing, or ramping up the use of, energy performance certification and labelling mechanisms, to encourage investment in energy efficiency.

3.2. Investments in green infrastructure

As shown in Figure 2 above, to meet the NZE target, annual global investments in infrastructure would have to more than double in the current decade from their 2016-20 average and remain at that higher level in the following two decades. SNGs will likely have to bear the brunt of such investment effort, since they accounted on average for nearly two-thirds of climate-related public investments in OECD countries over the period 2000-16 (OECD, 2019).[8] However, such investments were equivalent to only 0.7% of GDP for the general government and 0.4% of GDP

[8] The analysis used a novel preliminary methodology to track climate-related components of government spending and investments in OECD countries (excluding Israel, Korea, and the United States).

at the subnational level. As discussed in the previous subsection, the increased investment effort will need to be concentrated in electricity, transport, and buildings, which together account for the bulk of emissions.

In addition to investments in mitigation-oriented infrastructure, some SNGs are also involved in supporting the development of new technologies to produce clean energy. According to the IEA, while most of the targeted global emission reductions in the current decade will utilize existing technologies, successful innovations will need to play a major role in the subsequent decades. Increased public funding of the R&D needed to develop new technologies would help accelerate their design, testing of prototypes and eventual deployment to scale. While national governments can be expected to carry out most of this effort, given resource availability, economies of scale, and the externalities associated with such activities, some SNGs, especially at the regional level, are also devoting resources to R&D on mitigation either through direct programs or by supporting universities, corporations and start-ups active in this area (OECD, 2021).

This is an area where SNGs can work in tandem with national governments to boost support for green innovation. Global government spending on R&D in energy is estimated to have fallen from 0.1% of GDP in 1980 to only 0.03% of GDP in 2019. According to the OECD Environmental Policy Stringency indicator, government support for green technologies more broadly (including R&D subsidies and support for the use of solar and wind power), and overall green innovation output, at least as far as gauged by green patent filings, have stalled since early-to-mid 2010s (Kruse et al., 2022). These trends will need to be reversed if the levels of investment in new technologies required to achieve net-zero emissions by mid-century are to be met.

III. The Role of SNGs in Adaptation to CC

1. Estimates of investment needs for adaptation

There is broad consensus that CC is already responsible for the increased frequency and severity of a range of damaging natural events, including hurricanes and typhoons, floods, extreme heat waves, droughts, and the melting of ice caps and related sea level rise. The human and economic damages wrought by CC are expected to continue to rise in the decades ahead, even if mitigation efforts are ramped up well beyond their current levels (Global Commission on Adaptation, 2019).

This backdrop highlights the essential role of climate change adaptation as a complement to mitigation. Reflecting the wide range of such damages, adaptation spans a broad range of actions by public and private economic agents, including changes in agricultural practices; prevention and control of wildfires; improved water management; and strengthening infrastructures' resilience to extreme wind conditions, floods, and sea level rise, to name just a few.

These actions have both short- and longer-term economic benefits, in many cases of national macroeconomic relevance, but also entail short-term private and fiscal costs. Therefore, adaptation cannot aim to eliminate all risks and damages from CC, and choices must be made by private and public agents on the extent of risk reduction that they can afford. Such decisions involve a host of time- and place-varying considerations of an economic, socio-political, and scientific nature. Complex assessments of the level and distribution of benefits of specific adaptation measures, based on currently available scientific evidence, need to be made by comparing estimates of the relevant "states of the world" with and without the measures. The

assessments must extend to the costs of such measures, and the availability of resources to meet such costs.[9]

Therefore, it is not surprising that estimates of global needs for investment in adaptation range widely. A recent meta-analysis by IMF staff (Aligishiev and others, 2022) of studies by the UN, the World Bank, and the OECD, indicates that such estimates range between 0.05 percent and 0.25 percent of projected global GDP in 2030, rising to as much as 0.3 percent of GDP by 2050. In 2019, the Global Commission on Adaptation estimated that global investments in five key areas of adaptation (improvements in early warning systems, infrastructure resilience, dryland cultivation, water resource management, and mangrove protection) equivalent to USD 1.8 trillion cumulatively over the current decade would yield economic benefits nearly four times as large.

Country-specific studies show both larger averages[10] and greater variance of estimates of adaptation investment needs, reflecting substantial differences in countries' vulnerability to CC, due to their geographic and climate conditions, level of development, state of infrastructures, etc. Not surprisingly, estimates tend to be larger (relative to GDP) in developing than in advanced economies and to be especially large in small island countries in the Caribbean and the Pacific, given their exposure to hurricanes and sea level rise.[11]

[9] Annex 1 in Aligishiev et al. (2022) contains a useful discussion of simulation models and other econometric tools to assess CC costs and adaptation benefits.

[10] For example, the 46 countries that included adaptation cost estimates in their Nationally Determined Contribution estimated a total collective cost for these measures of USD 783 billion by 2030 (or about 1.5 percent of their GDP annually from 2015 on average) (Buchner et al., 2019).

[11] For some of these countries, estimates of cumulative adaptation investment needs over the next decades are equivalent to multiples of GDP.

The respective roles of the private and the public sectors in meeting adaptation needs can also be expected to vary significantly across countries. Market failures of various types (e.g., failure of households or firms to properly assess the benefits of investments in adaptation, or their concerns that such benefits would spillover onto other agents; and financing or liquidity constraints) are likely to affect adversely the private sector's contribution, placing more of the burden of adaptation on public investments. Governments can use their taxation, spending, and regulatory powers to address such failures, but the design, calibration and implementation of these policies involve significant socio-political, as well as capacity, challenges. The next subsection discusses some of these policies at the subnational government level.

2. SNGs' role in adaptation to CC

CC-induced damages vary not only among but also, and often substantially so, within nations, reflecting the diversity of geographic and economic conditions, especially in large countries. Coastal regions are more vulnerable to hurricanes and typhoons and to sea level rise; relatively arid regions to droughts; forested regions to fires; localities bordering rivers and lakes to floods; urban areas to heat waves and air pollution. The state of existing infrastructures plays a major role as well in determining the extent of damages from extreme weather events. Within each community, the poorer segments of the population are more likely to be disproportionally impacted by adverse weather events. Recognition of the wide geographical variance of adaptation needs underlies, for instance, the EU's Mission Adaptation to Climate Change, whose main goal is to support at least 150 European regions and communities in strengthening resilience to CC by 2030.

These considerations suggest that place-based policies, well-tailored to the nature, causes and distributional effects of CC-induced damages, are even more necessary for adaptation than for

mitigation. Local governments, by virtue of their being closest to their respective communities, can bring the benefit of their knowledge of local conditions to the design and implementation of such policies. For their part, regional governments, which in many countries have oversight power and responsibility over the local governments, can help avoid negative spillovers and strengthen positive ones from local adaptation policies across their regions.

Adaptation efforts also require appropriate risk identification and management by SNGs, given their specific conditions, such as geography and climate. Many jurisdictions are nevertheless ill-prepared for this task, especially in developing countries and emerging-market economies. They often lack risk registries or inventories of assets at risk, given the broad modalities of natural hazards or climate-related risks they are most likely to face, and lack the technical expertise to formulate the risk management strategies that need to underpin adaptation plans. As argued by de Mello and Ter-Minassian (2023), and OECD (2023 a), intergovernmental cooperation is crucial in this area, since the hazards and risks that require most urgent adaptation, such as those related to wildfire, coastline erosion and exposure to extreme weather events, tend to span interjurisdictional borders, requiring collective action to overcome common problems.

In most countries, SNGs have taxation, spending and regulatory powers in many areas that are of key importance for adaptation. Specifically, they can:

- Affect land use in several ways. For example, they can shape households' and firms' location decisions (including relocation from more disaster-prone areas) through appropriately enforced regulation, subsidies, and levies and fees related to climate risks.
- Provide financial and technical support to farmers in their areas to shift to drought-resistant crops, and invest in improving irrigation networks.

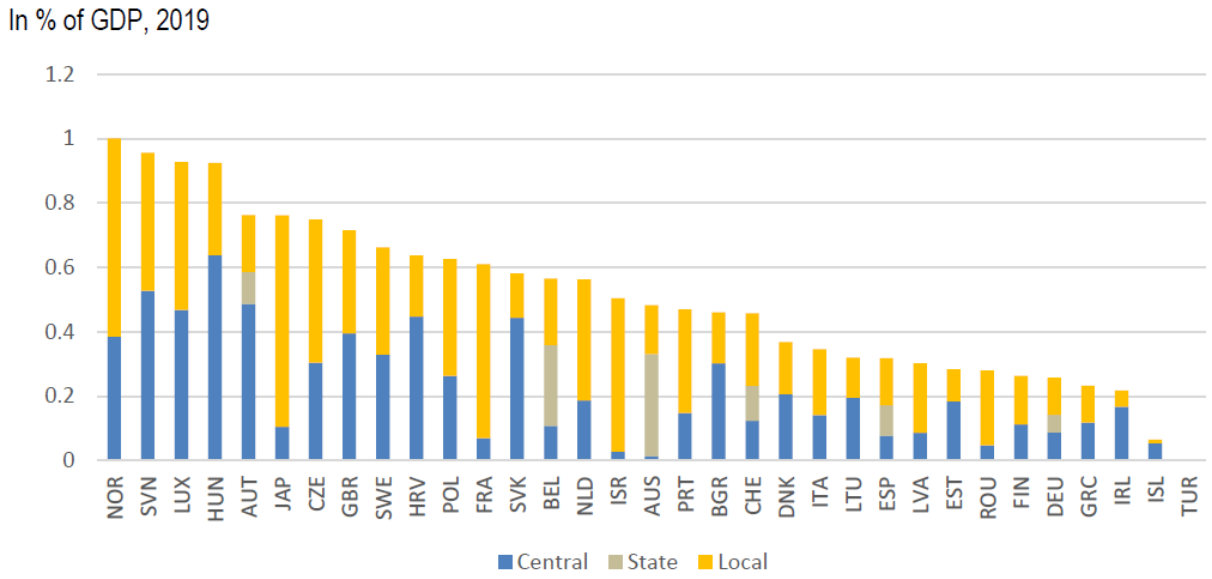
- Control deforestation to help minimize the risk of landslides and exercise or mandate forest management techniques that reduce the risk of wildfires. They can also invest in expanding green spaces in urban areas, to mitigate the impact of heat waves.
- Strengthen and appropriately enforce building codes, with a view to reducing the vulnerability of houses and other private and public buildings to fires, floods, and high winds.
- Increase the resilience of the electric grid in their communities to extreme weather events through direct investments, investments by controlled SOEs, or by regulation of private electricity companies, as relevant in each case; and
- Improve the resilience of other infrastructures in their jurisdictions, such as ports, levees, bridges, and roads, to weather-induced damages through improved maintenance, as well as through new investments, as appropriate.

Finally, SNGs have an important role to play beyond adaptation when climate change-related disasters strike. They are responsible for the provision of immediate relief to their affected population, for ensuring law and order during natural disasters, for supporting national relief and recovery efforts, for managing the reconstruction of damaged local infrastructures, and for identifying good practices that can be shared and used to improve resilience to similar shocks in the future. Indeed, for all these reasons the Sendai Framework for Disaster Risk Reduction emphasizes the role of local governments at all phases of a disaster, from prevention to recovery (de Mello and Jalles, 2023).

Unfortunately, the empirical evidence on the extent and modalities of SNGs' involvement in adaptation, as in mitigation, policies remains limited to date. Efforts to "green-tag" spending, even at the national government level, have not yet produced comprehensive and internationally

comparable databases (Ferreira and others, 2021). In recent years, the OECD has been spearheading efforts to compile a database on climate-significant spending and investments for its member countries. Figure 4 below shows the estimated composition of climate-significant investments (not broken down between mitigation and adaptation) as percent of GDP, by levels of government in 2019. It indicates that the share of SNGs in such investments varied widely across the OECD, from over half a percent of GDP in Japan, Norway, France, and Israel to almost nil in Iceland. Local governments accounted for the bulk of subnational investments, except in Australia and Belgium, where the regional governments undertook the largest share (Dougherty and Nebreda, 2023).

Figure 4. Climate Significant Investment



Source: Dougherty and Nebreda, 2023

IV. Funding and Financing Subnational Green Investments

The previous two sections highlighted the fact that SNGs around the world will face substantial, albeit difficult to quantify, needs for investments in CC mitigation and adaptation in the decades ahead. Such investment needs are likely to pose serious funding and financing as well as governance, challenges for most SNGs. Funding and financing are complementary but interrelated means of covering the cost of the development, operation, and maintenance of CC-related as well as other infrastructures. SNGs need to have sufficient resources to cover the whole-of-life costs of their investments, including their operation and maintenance, and the service of the financing used for their construction. Markets' perceptions of inadequacy of funding sources are often the most serious constraint on SNGs' access to financing for new investments.

1. Funding options

SNGs' main funding instruments are own revenues and transfers from the national government (NG). As highlighted by the extensive literature on the subject, the scope and tools for increasing subnational own revenues vary widely across and within countries, reflecting a host of economic, institutional, and socio-political factors. Therefore, own-revenue mobilization strategies have to be tailored to individual jurisdictions, taking into account the relevance of such factors in each case.[12]

Of particular interest for the funding of subnational climate-related investments are tax and non-tax instruments that can yield a "double dividend" in terms of providing a price incentive to

[12] For overviews of the issues in subnational own revenue mobilization see e. g., Ambrosanio and Bordignon (2006), (Bird, 2010), Fretes and Ter-Minassian (2015) and OECD (2021).

reduce emission-generating activities, while increasing revenues for SNGs. Carbon taxes and emission trading systems (ETS) are the instruments of choice in this respect but, especially because of their administrative complexity, they are more suitable for national than for subnational governments[13]. These price-based mechanisms also often face political economy headwinds that complicate their societal acceptability in many countries.

Easier to administer are subnational taxes on fuel products, or subnational surcharges on national taxes on such products. By being limited to one source of emissions, these taxes are less effective in reducing emissions than all-encompassing carbon taxes. However, since the price elasticity of demand for fuel products tends to be relatively low in the short run, these taxes can raise significant revenues for SNGs in the next several years[14]. Also, if levied at the consumption stage (e.g., at fueling stations), these taxes have less adverse effects on enterprises' competitiveness, although they can still have differential impacts across products (depending on the share of transport costs in their cost structure) and individuals (depending on various factors, such as their access to, and cost of, public transportation; the energy efficiency of the vehicles they use, etc.).

Many SNGs also levy taxes or surcharges on the consumption of electricity. These taxes incentivize households and enterprises to reduce energy consumption and/or increase their efficiency in energy use, but they may also have the unintended consequence of encouraging the

[13] Nevertheless, a number of SNGs around the world have introduced their own carbon taxes or ETS, in some cases ahead of the central governments themselves. According to the World Bank's Carbon Pricing Dashboard, such mechanisms are in place or scheduled for implementation at the subnational level in several Canadian provinces, U.S., and Mexican states, as well as in Japan.

[14] The revenues arising from carbon taxes or levies on fossil fuels are temporary, to the extent that carbon pricing leads over time to a substitution away from fossil fuels, and consequently to a reduction in emissions. Nevertheless, in the near term there is significant scope for raising carbon-related taxes at all levels of government, or extending taxation to currently untaxed emissions, with large, albeit temporary, associated revenue gains (D'Arcangelo and others, 2022).

use of more polluting sources of energy, unless these alternatives are also taxed at similar, or preferably higher, rates. Moreover, these taxes can have undesirable distributional effects, since lower-income households tend to consume a higher share of their income on electricity and often face a higher risk of energy poverty because of energy price hikes. These social groups also typically have a lower price elasticity of energy consumption, because they are often ill-equipped to manage energy consumption efficiently, have less energy-efficient household appliances and live in less well insulated dwellings relative to more affluent households.[15] To minimize such effects, electricity taxes generally exempt household consumption below relatively low thresholds.

Another potentially green subnational revenue source are taxes on motor vehicles, levied at the time of sale and/or on an annual basis. These taxes may encourage the use of public transport, but their main purpose is revenue mobilization, rather than climate mitigation. Where these taxes are levied on an *ad-valorem* basis, they may discourage the purchase of newer, more fuel-efficient, and more expensive, vehicles. In other cases, polluting vehicles may be taxed more heavily (OECD, 2022). Differentiating the rates in favor of electric or lower fuel-consuming vehicles would make these taxes "greener", but probably also regressive.

SNGs can also use taxes and fees that capture the value created by installing green infrastructure, by using tax increment financing (TIF) and other land value-capture measures.[16] These instruments are more frequently used in connection with adaptation than mitigation activities.

[15] The analysis reported by de Mello (2023) highlights the importance of targeted support for disadvantaged social groups, whose energy consumption tends to be less price-elastic than that of more affluent households. Budget-constrained social groups are also unlikely to be able to bear the upfront costs of energy retrofitting and the purchase of energy-efficient appliances.

[16] For more detailed discussions of land value capture policies, see Ingram and Hong (2012) and OECD (2021).

Various types of subnational nontax revenues can also yield a double dividend. Some municipalities in large metropolitan areas (e.g., London, Milan, Singapore, and Stockholm) levy congestion charges on vehicles entering the city center during peak traffic hours. Other regional or local governments in various countries use fees or fines on selected carbon-intensive activities (Martinez-Vazquez, 2021). In some cases, betterment fees can also be levied to finance the energy retrofit of urban infrastructure and amenities.

An important consideration regarding the use of price instruments to meet climate objectives concerns the political economy, especially where the overall tax burden is already high. Public opinion support for explicit pricing instruments, such as carbon taxes, tends to be low because of their direct effect on the cost of emissions, and ultimately on consumer prices. Evidence nevertheless shows that popular support tends to rise if the revenue associated with these instruments is seen as financing the provision of services and infrastructure related to CC mitigation and adaptation (OECD, 2022b).

National governments can play an important role in supporting subnational own-revenue mobilization efforts. First, at a minimum they can remove any legal obstacles to the levying by SNGs of green taxes of the types discussed above. For example, they could allow SNGs to levy surcharges on national carbon taxes, where available, or taxes on the consumption of fossil fuels. They could even set floors on the rates of such taxes.[17] Alternatively, they could levy their own carbon or fuel taxes at higher rates and share them with SNGs on a derivation basis. Also, they can incentivize SNGs to adequately exploit their assigned revenue bases by avoiding the emergence of subnational soft budget constraints (Ter-Minassian, 2015).

[17] An example in this respect is the Canadian federal backstop for carbon pricing.

National governments can also help fund subnational investments in mitigation and adaptation through intergovernmental transfers. Given the specific policy objective being pursued with such transfers, earmarked grants are the instrument of choice for this purpose. Some countries include specific conditionalities, output or outcome-based, in this type of grants. The effectiveness of outcome-based conditions depends on the degree of control that SNGs have on the targeted outcome. More generally, the effectiveness of conditionality depends on several factors, including subnational capacities, the existence of timely and monitorable indicators of compliance with the conditions, the independence of the evaluators, etc.

An alternative approach is to use appropriate filters to assess the impact of proposed investments on mitigation or adaptation objectives when deciding on their support through grants. This is for example the approach followed by Canada in its Climate Lens program (OECD, 2021). A blend of matching and non-matching grants may help balance the objective of ensuring additionality of resources devoted by individual SNGs to CC-related investments with the also important objective of enabling poorer jurisdictions that could not meet the matching requirements to benefit from the national support.

2. Financing options

2.1 Main financing constraints

SNGs often face substantial obstacles in mobilizing appropriate sources of financing for their investments. Some of these obstacles are even more pronounced for investments in CC mitigation than in adaptation, since they tend to be affected by greater technical and policy uncertainties and lower appropriability of returns.

Foremost among the obstacles is the fact that many regional and local governments have limited control over their revenues. Own tax revenues frequently account for less than half of their total revenues; nontax revenues tend to be underexploited; shared revenues are generally determined by formulas set in national legislations; and discretionary transfers from national governments (including capital grants) are volatile and often procyclical. These characteristics tend to undermine financial markets' assessment of the creditworthiness of many SNGs.

Subnational access to financing is also limited in many countries by rigid fiscal rules, such as ones that require budgets to be balanced on an annual basis. Such rules do not allow SNGs to borrow to finance their investments even when they have the capacity to service the additional debt.[18] Moreover, these rules often preclude SNGs from borrowing in foreign currency, to avoid unhedged depreciation risks, since their revenues are typically denominated in domestic currency. This limitation constrains subnational borrowing in countries with underdeveloped domestic capital markets.

Other significant obstacles may include scale considerations (most relevant for smaller SNGs) that discourage some lenders. Market participants' perception of significant shortcomings in SNGs' financial management capacities also discourages access to financing, including budgetary processes and transparency; the planning, selection, and execution of investments; and debt and asset management (discussed in Section V below).

In the light of these considerations, there is a wide variance both across and within countries in the degree of access of regional and local governments to financing for their investments,

[18] The review of subnational fiscal rules carried out by Vammalle and Bambalaite (2021) shows that budget balance objectives in OECD countries often target only current balances (for realized budgets), are set on annual basis and calculated in accrual terms. However, a few countries, such as Austria, Belgium, and the Netherlands, require both the current and capital budgets to be in balance, including off-budget funds.

typically being greatest in the well-developed financial markets of advanced economies and for larger regional and local governments. Meeting the challenge of securing adequate financing for the investment needs of a broader range of SNGs will require significant structural reforms in intergovernmental fiscal relations, especially reforms to increase SNGs' own revenues, to improve the design of overly restrictive fiscal rules, and to improve financial management at the subnational level. Some of these latter reforms are discussed in Section V below. The rest of this subsection focuses on an overview of current subnational financing sources and on some technical innovations that are increasingly being adopted to expand them.

2.2 Main types of subnational financing instruments

SNGs that do have access to financial markets typically resort to loans and the issuance of bonds to finance investment. Loans account for nearly one-half of subnational outstanding debt in G20 countries and may be granted for general budgetary purposes (including the financing of investments) or to finance a specific project. In the latter case, debt service is typically guaranteed by the revenue stream of the project, rather than by the general revenues of the borrower. Therefore, project finance lending is generally limited to large-scale projects with a well-identified stream of future revenues.

Bonds are the second-largest source of financing for subnational investments in G20 countries. Like loans, bonds may be general-obligation ones, backed up by the issuing government's non-earmarked revenues, or project bonds, backed-up by the project's revenue stream. The US municipal bond market is very large (with nearly USD 4 trillion outstanding debt, and more than 50,000 issuers) with a variety of instrument types, which enjoy exemption from the federal

income tax. Subnational bond markets are also well developed in Canada and Japan (the latter under close oversight by the NG, which authorizes new issues).

The last several years have witnessed a rapid rise of bond issues whose proceeds are earmarked for green investments. Green bonds aim to attract especially institutional investors seeking to fulfil environmental goals or mandates. The first such bonds were issued by the World Bank and the European Investment Bank in 2007 and their cumulative issuance has now surpassed USD 2.2 trillion, according to the Climate Bonds Initiative (CBI).[19] Government-issued bonds account for a significant portion of that total. Regional and local governments, especially large cities, have become increasingly active in their issuance, accounting for 6 percent of total in 2020.

Green bonds are self-labelled. Only a small share of them is certified by the Climate Bonds Standards Board to meet the relevant sectoral criteria for "greenness" developed by the Board, meaning that there is still significant scope for "greenwashing" in the characterization of this type of bonds. The proceeds of these bonds are earmarked for use in green projects but the stream of future revenues from the projects may or may not be ringfenced to service the bond. Some green bonds enjoy various forms of tax advantages. Empirical evidence to date on whether green bonds carry a pricing premium (the so-called 'greenium') compared with plain-vanilla ones is mixed (Cortellini and Panetta, 2021) but there are initial indications that certified sustainability-linked bonds do so. If confirmed by further evidence, this could incentivize issuers, including SNGs, to seek such certification. SNGs are also intensifying efforts to finance their green investments by tapping into the interest of small investors by issuing bonds with small denominations (the so-called mini-bonds).

[19] Climate Bonds Initiative | Mobilizing debt capital markets for climate change solutions.

Subnational access to lending for investments can be enhanced in several ways. NGs, national development banks, the World Bank, and other multilateral development banks (MDBs) are major sources of lending to SNGs (in the case of MDBs mostly through the intermediation of the NG). These loans are generally extended at rates and conditions more favorable than loans from banks and other financial intermediaries, but they tend to carry more specific conditionalities than the latter. The same institutions are also often active in the provision of credit enhancement to private loans for SNGs in the form of subordinate tranches or guarantees. Such enhancements increase the availability and lower the cost of subnational borrowing, but they also create contingent liabilities for the grantor, and therefore should be subject to appropriate safeguards, including analyses of their consistency with debt sustainability for both grantor and recipient, and of the quality of the guaranteed investment.

Another significant approach to enhance access, especially by local governments, to investment financing are finance pooling mechanisms. These provide joint access to financial markets for SNGs that have similar missions and credit characteristics but lack the scale, expertise, and credit history to access the markets on their own. Such mechanisms are common in the northern European countries, and examples can also be found in New Zealand (the Local Government Funding Agency created in 2011, majority owned by local councils, and responsible for some 90 percent of local debt), France (Agence France Locale, fully owned by local authorities), Japan (also fully owned by local governments, but working closely with the NG) and the Tamil Nadu Urban Development Fund in India (which leverages international funding, mainly from MDBs, to finance urban infrastructure projects in the Tamil Nadu state).

A recent development in the financing of investments in CC mitigation and adaptation is the increasing use of ‘green loans’. The Loan Market Association published in 2018 Principles for

Green Loans, providing guidance to its worldwide membership on the eligibility of projects to be financed by such loans.[20] The IFC and the IBRD have been trend setters in the use of green loans in recent years.

2.3 Public-private partnerships

In recent decades an increasing number of SNGs, especially but not exclusively in advanced economies, have been seeking to involve private capital in the financing and delivery of infrastructure investments, including green ones, through public-private partnerships (PPPs). It is a well-known tenet in the extensive literature on PPPs that the choice between them and direct public procurement should be based on considerations of relative value-for-money and appropriate risk-sharing, rather than just financing conditions.[21] However, in practice governments at all levels often see PPPs as a way of augmenting the financing available for their investments, or even of circumventing restrictions imposed by fiscal rules limiting or prohibiting borrowing. PPPs entered into without appropriate processes of project selection, risk-sharing arrangements, and monitoring of implementation often result in costly renegotiations or even costlier early terminations.[22] These complexities apply to all levels of government, and they are particularly challenging for SNGs, given the technical and human capital capacity constraints they frequently face.

[20] The Principles can be found at https://www.lma.eu.com/application/files/9115/4452/5458/741_LM_Green_Loan_Principles_Booklet_V8.pdf.

[21] Sovereign, and frequently sub-sovereign, borrowers typically enjoy lower financing costs than private ones.

[22] Herrera Dappe et al. (2023) provides empirical evidence of significant fiscal risks from inappropriate PPPs in a range of emerging economies.

The following guidelines should be useful for SNGs engaging in PPPs, to mitigate the fiscal risks and maximize the value for money of such arrangements:

- Adopt accounting rules (such as IPSAS32) that do not create inappropriate incentives to choose between PPPs and direct public procurement of infrastructures.
- Establish a "gateway" process for the approval and monitoring of PPP projects, preferably centered on the governmental unit (ministry or secretariat) responsible for finance.
- Develop appropriate technical capacity in the gateway entity to evaluate PPP project proposals, tenders, and contracts, and to assess their fiscal costs and risks.
- Eschew unsolicited PPP proposals.
- Develop a framework for risk sharing, in line with sound allocation principles[23].
- Adopt and publicize clear regulations for contract renegotiations, dispute resolution and project termination.
- Ensure adequate disclosure of PPP contract terms and their future (certain and contingent) fiscal costs; and
- Set appropriate limits on the stock of guarantees and on annual or multiannual availability payments for PPPs.

[23] See e.g., the OECD's Principles for Public Governance of PPPs (OECD, 2012).

V. Governance issues

1. The need for intergovernmental coordination in mitigation and adaptation

The previous sections have focused on the role of SNGs, and in particular their investments, in CC mitigation and adaptation. They have highlighted the fact that such role varies widely both among and within countries, depending on a range of economic and institutional factors, notably the assignment of expenditure and revenue responsibilities, and of regulatory powers among the different levels of government. Even in very decentralized countries, however, there is a compelling case for involvement of the NG in the SNGs' climate change-relevant activities and investments, and consequently for strengthening intergovernmental cooperation in these areas.

First, NGs are responsible for defining and delivering on any international commitment to reduce GHG emissions, such as those undertaken in the context of the Paris Agreement. There is therefore a case in principle for utilizing any scope afforded to them by prevailing legislation, including in their relations with their SNGs, to implement those commitments. The main economic case for the NGs' involvement rests, however, in the fact that subnational activities that affect emissions have potentially significant spillovers beyond the borders of the jurisdiction undertaking them. Even activities undertaken by SNGs for adaptation, such as water management, and flood and fire prevention (or the lack thereof), can have adverse consequences for nearby jurisdictions. Therefore, national governments may wish to avoid, or at least limit such spillovers, if adverse, and support them, if favorable.

Moreover, SNGs could use their regulatory powers to lower emission and energy efficiency standards in efforts to attract private investment, which would result in a sort of "race to the bottom" that would be undesirable from the point of view of reducing emissions for the country as a whole. Such policies may reflect political ideologies and pressures, as well as economic and

fiscal considerations. A case can therefore be made for NGs to limit the scope for such predatory competition, if it generates significant externalities, and/or it conflicts with national emission-reduction goals.

For this purpose, NGs can set nationwide minimum standards for public and private activities that have significant impact on emissions, while allowing the SNGs to go beyond such standards, if they so wish. However, such national mandates could be subject to legal challenges in some federations, highlighting the need for intergovernmental dialogue and consultation prior to their imposition. Intergovernmental dialogue is anyway desirable also in unitary states to ensure that some relevant local specificities are given due consideration in the formulation of the mandates, and that SNGs are compensated for any significant financial burdens imposed on them by such mandates. In any case, the ability of NGs to set national standards depends on the specific political arrangements in place in different countries, which shape the balance of power between national and subnational jurisdictions, their own and shared responsibilities in the relevant policy areas, and the ability of subnational jurisdictions to influence national policy.

Another reason for NGs' involvement is the fact that some mitigation policies are likely to have different distributional effects across the national territory. For example, closing a coal mine, or phasing out other especially polluting industries, may impact some communities (regions or localities) especially strongly. The national government is better placed than the affected SNGs to support those sectors of the economy and the social groups most adversely affected by those transition costs. Support can be provided in the form of temporary targeted assistance to businesses and households, active labor market policies to facilitate job matching and search, training and re-training programs for displaced workers, and tax or other financial incentives for new green investments in the region. Tailoring these initiatives to the needs and preferences of

the regions in need would help reconcile nation-wide mitigation ambitions with regional asymmetries in the incidence of transition costs.

As mentioned in Section IV above, NGs can support subnational investments in mitigation and adaptation a) by assigning adequate own revenue sources to SNGs, and helping strengthen their revenue mobilization efforts through appropriate incentives, and through technical cooperation with subnational revenue administrations; b) through a steady and predictable provision of special-purpose grants; c) by adopting fiscal rules that allow SNGs' access to financing in line with their debt servicing capacity and liquidity needs; and d) by supporting the development of orderly and liquid markets for subnational debt instruments. An effective fulfilment of such roles by the NGs is facilitated by improved alignment of subnational investment plans with national objectives and plans, especially for mitigation.

It is clear from the considerations above that an effective alignment of national and subnational climate-relevant policies requires an open and fluid intergovernmental dialogue whereby different perspectives can be discussed and brought to bear on the decision-making process of governments at all levels in areas of joint responsibility. International experience shows that the institutionalization of such dialogue through the creation of intergovernmental cooperation fora is important to its effectiveness.[24]

High-level vertical cooperation fora are the appropriate venues for discussion of broader reforms of intergovernmental systems that may be needed to ensure clarity of responsibilities of the different levels of government, avoid unfunded mandates, promote adequate fiscal autonomy of

[24] Ter-Minassian and de Mello (2016) discuss in some detail the benefits of vertical (among different levels of government) and horizontal (among governments at the same level) cooperation fora and provide a range of examples of such fora in advanced countries and selected emerging-market economies.

SNGs, and align investment priorities in the CC agenda. More focused sectoral cooperation fora in the relevant spending areas (energy, transport, water management, and buildings) can help ensure that agreed mitigation and adaptation objectives are translated into specific sectoral agendas, and that their implementation is transparent and monitored by all parties concerned.

Effective horizontal cooperation in CC-relevant policies is especially important among the constituent municipalities of metropolitan areas. The socio-economic flows within these areas, in particular those related to commercial activities and mobility patterns which need to be decarbonized, do not necessarily match administrative municipal boundaries. Institutions (metropolitan governance structures, or at least well-functioning cooperation fora) that facilitate the achievement of intermunicipal consensus on relevant spending, revenue, and regulatory policies can be instrumental in the success of mitigation and adaptation within metropolitan areas. Both vertical and horizontal cooperation fora can also be very useful vehicles for sharing knowledge, good practices, successful experiences, and lessons from unsuccessful ones. Cooperation fora can also promote positive demonstration effects. OECD analysis (OECD, 2015) shows that the presence of interjurisdictional cooperation fora in metropolitan areas is particularly important with respect to land use and transport, which play a central role in climate change mitigation and adaptation.

2. *Strengthening the management of subnational green investments*

It is a well-documented fact in both the literature and in international experience that a range of weaknesses in public investment management (PIM) significantly reduce the value-for-money of investment spending. For example, IMF research suggests that, on average, countries lose as much as one-third of the resources spent on public investments to inefficiencies in their PIM processes (Schwartz and others, 2020.

Although rigorous empirical evidence on the extent of PIM weaknesses at the subnational level of government is lacking, anecdotal and survey-based evidence[25] suggests that they are even more pervasive and significant for SNGs than for NGs, albeit with considerable variance across and within countries.[26] The challenge for SNGs to improve the efficiency of their investments is further complicated by the increasing need to integrate CC considerations in their PIM. Improving the quality and transparency of subnational investments in mitigation and adaptation is key to both increasing the fiscal space to meet such investment needs and improving access to market and multilateral sources of financing, including international Climate Funds.

A careful diagnosis of the main existing flaws in the planning, budgeting, appraisal and selection, procurement, execution, ex-post evaluation and risk management of green investments is an essential first step to develop well-tailored strategies to address such weaknesses. In the last few years, multilateral institutions have been increasingly active in integrating climate considerations in their public financial management (PFM) and PIM diagnostic tools. In particular, the World Bank has developed a new module in its *Public Expenditure and Financial Accountability (PEFA)* diagnostic to assess the responsiveness of the overall PFM framework to a country's climate objectives. The IMF's *Green PFM* goes beyond the PEFA assessment and aims at adapting existing PFM practices to support climate-sensitive policies in key stages of the budget cycle (Gonguet and others, 2021). The most comprehensive diagnostic to date is the IMF's still-evolving new climate module of the PIMA. The C-PIMA assesses to what extent countries are ready to manage their public investment with a focus on building green and

[25] See, for example, Mizell and Allain-Dupre (2013). Ter-Minassian (2016) discusses in some detail main PIM weaknesses at the municipal level of government.

[26] Some regional governments and cities may be more efficient at managing their investments than the respective national governments, but this tends to be the exception, rather than the rule.

resilient infrastructures, and provides them with a reform roadmap in that direction. The C-PIMA has been utilized so far only at the national level, but could be easily adapted for use by SNGs, especially regional governments and medium and large cities.[27]

These initiatives highlight the centrality of appropriate planning and budgeting, as well as evaluation, in mitigation and adaptation programs. Planning is important to ensure consistency among climate mitigation and adaptation goals, including international commitments enshrined in countries' NDCs; how climate related investment plans are translated into sectoral policies; and whether there is unified guidance provided to spending units on planning green and climate-resilient investments.

A key tool for ensuring that national, subnational, and sectoral plans (including climate-related investment plans) are consistent with macroeconomic and fiscal sustainability constraints is to reflect them in medium-term fiscal frameworks (MTFFs) and more detailed medium-term expenditure frameworks (MTEFs). These frameworks (which are generally of a rolling nature, updated each year to reflect relevant macroeconomic and policy developments) provide top-down guidance to the annual budget process. They are important to reduce the risk of procyclicality in public investments, including climate-related ones, and to avoid situations in which fiscal adjustment, when needed, is carried out predominantly on the back of capital spending, which is typically easier to cut than current outlays. More or less developed MTFFs

[27] C-PIMA involves an assessment of the five institutions that incorporate the most critical climate-relevant elements from the PIMA, namely climate-aware planning, coordination with other entities, project appraisal and selection, budgeting and portfolio management, and risk management. In all the five modules, the C-PIMA assesses the robustness of the legal framework and information systems underpinning the investment management processes being analyzed, as well as the evidence on the state of governmental capacities to design and implement the reforms needed to address the weaknesses identified by the diagnostic.

and MTEFs are increasingly common at the NG level in both advanced and developing countries, but much less so at the subnational level.

By the same token, 'green budgeting' is gaining prominence in many countries as a related tool to inform policymaking of the environmental and climate impacts of budgeting choices. Beyond facilitating policy coherence and interjurisdictional coordination, green budgeting provides a mechanism to gather evidence of policy impacts and facilitate reporting for enhanced accountability and transparency. This is particularly important for capital spending, given the large investments needed for CC mitigation and adaptation. Systems are therefore needed to identify budgeted climate-related investment projects and to track those expenditures and their financing. OECD analysis shows that close to two-thirds of OECD countries practice some form of green budgeting (OECD, 2023) (Table 1).[28]

Efforts in these areas are particularly welcome, as Ministries of Finance worldwide are taking an increasing role not only in the development of national climate agendas, but also in coordinating the inputs of other NG agencies and SOEs into this agenda and its implementation. Ministers of Finance from some 80 countries have joined the Coalition of Finance Ministers for Climate Action and endorsed the six Helsinki principles that promote national climate action, especially through fiscal policy and the use of public finance.[29] This provides a model for the units (Ministries or Secretariats) that oversee the public finances of regional and local governments, especially cities.

[28] See Blazey and Lelong (2022) for further discussion and discussions of country examples.

[29] The report of the Coalition outlining these principles can be found at: Coalition of Finance Ministers (financeministersforclimate.org).

Table 1. Green Budgeting: Methods and Tools, 2022

Country	Carbon pricing instruments	Environmental impact assessments	Sovereign green bonds	Green budget tagging	Review of harmful tax expenditures	Environmental cost benefit analysis	Green in multi-annual budgets	Green perspective in spending review	Carbon budget
Austria	●	●	●					●	
Canada	●	●	●		●				
Chile	●		●	●		●			
Colombia			●						
Denmark	●	●	●			●			
Finland	●	●		●	●				
France	●	●	●	●	●	●			●
Greece	●			●				●	
Ireland	●	●	●	●	●	●	●	●	●
Israel	●	●	●		●	●			
Italy	●	●	●	●	●		●		
Korea	●	●	●	●				●	
Lithuania	●	●	●			●			
Luxembourg	●	●	●	●			●		
Mexico	●	●	●	●	●				
Netherlands	●	●	●		●	●			
New Zealand	●	●				●	●		●
Norway	●	●		●	●	●		●	●
Slovak Republic	●				●		●		
Spain	●	●	●	●					
Sweden	●	●	●	●	●				
Switzerland	●		●				●		
Türkiye						●	●		
United Kingdom	●	●	●	●	●	●	●	●	●
OECD Total									
● Yes	22	18	18	13	12	11	8	6	5

Source: OECD Government at a Glance database (2023)

Related to appropriate planning and budgeting is the need to ensure that CC considerations feature in the appraisal and selection of individual proposed investments. This requires systematic use of standardized and technically sound methodologies to assess the impact of proposed new or retrofitted infrastructures on emissions and their resilience to climate risks. Much work remains to be done in this area, given a dearth of evidence on the effects of specific mitigation policies, including market and non-market instruments, on emissions and the economy at large. Several modeling gaps need to be overcome, and a solid base of evidence needs to be put together based on past and recent policy initiatives and their effects on emissions,

so that comparable information can be used in ex-ante analytical models and ex-post policy evaluations. [30]

Governance arrangements vary in this area. For example, according to the 2022 OECD Survey on the Governance of Infrastructure, most OECD countries are aware of the importance of sound planning for environmentally sustainable and climate-resilient infrastructure and many have developed guidelines for covering climate change adaptation, and to a lesser extent mitigation and biodiversity considerations (Table 2). Gaps nevertheless remain, not least in the use of methodological tools to integrate environmental and climate considerations into project selection and prioritization. For example, less than one-half of OECD countries require climate change adaptation measures to be integrated into the design of transport infrastructure projects.

[30] A discussion of the challenges in developing and applying such methodologies can be found in Minh Le et al. (2020). See also Hallegatte et al. (2021). Pisu et al. (2023) discuss extensively alternative modeling strategies and gaps that need to be addressed to improve the evidence base on the effects of different mitigation policies and its use in policy evaluation.

Table 2. Infrastructure Planning and Appraisal: Environmental and Climate Considerations, 2022

Country	Infrastructure guidelines	Environmental Impact Assessment of transport infrastructure	Climate impact assessment of transport infrastructure	Integration of adaptation measures into design of transport infrastructure
Austria	■□▲	●	●	●
Belgium (Flanders)	▲	●	..	..
Canada	■□▲△	○	○	◊
Chile	■ △	○	◊	◊
Colombia	■□▲	●	●	●
Costa Rica	■□▲	○	○	○
Czech Republic	■□△	○	◊	◊
Estonia	■□	○	○	◊
Finland	■□▲△	●	●	◊
France	✕	●	◊	◊
Iceland	□▲△	●	◊	◊
Ireland	■□	●	●	◊
Italy	■□△	●	●	●
Japan	▲	..	..	..
Korea	■▲△	●	●	◊
Latvia	✕	○	◊	○
Lithuania	■□△	●	●	●
Mexico	✕	●	◊	◊
New Zealand	■□△	○	◊	◊
Norway	□▲△	●	●	..
Poland	■ △	○	○	○
Portugal	■□	●	◊	●
Slovak Republic	■□▲△	●	●	●
Slovenia	✕ △	●	◊	◊
Spain	■□ △	○	○	●
Sweden	■□▲	●	●	●
Switzerland	■□▲ △	●	◊	◊
United Kingdom	✕	●	●	●
United States	■□▲	●	●	◊
OECD Total				
■ Adaptation	20			
□ Mitigation	19			
▲ Integrating NbS into infrastructure design	14			
Integrating biodiversity considerations into infrastructure planning	16			
✕ None	5			
● Required, and used for project selection and prioritisation		19	12	9
○ Required, but not used for project selection and prioritisation		9	5	3
◊ Not required			10	14
.. Not available		1	2	3

Source: OECD Government at a Glance database (2023)

There are good examples of centralized guidance in the area of public investment. *The Green Book: Central Government Guidance on Appraisal and Evaluation*, produced by the UK Treasury, sets standardized requirements for government agencies in the cost-benefit analysis of proposed investment projects, and provides guidance on how to incorporate in this analysis considerations of climate impact and resilience. This guidance is developed in greater technical detail by the Departments of Business, Industry, Energy and Industrial Strategy and of Environment, Food and Rural Affairs.[31] Moreover, the World Bank and other MDBs have been

[31] Information on these guidelines can be found at : UK Treasury, *The Green Book: Central Government Guidance on Appraisal and Evaluation*, updated December 2020; UK Department for Business, Industry, Energy and

mainstreaming CC into their analysis of infrastructure project proposals by: a) screening for climate risks and building-in appropriate risk mitigation measures, b) conducting GHG accounting, namely quantifying and disclosing the impact of a project on GHG emissions, and c) applying a shadow carbon price for all investments of significant size.[32]

Related to the above is the ability of governments to identify and manage their exposures to CC-related fiscal risks in public investment. This requires technical capabilities and appropriate disclosure of these risks, once identified, in stress tests and other diagnostics, as well as in national risk mitigation and adaptation strategies. It also requires the identification of financing modalities and other response mechanisms that can be put in place to cope with the impact of natural disasters on the country's infrastructure. [33]

VI. Conclusions

SNGs play an important—and thus far not adequately recognized and documented in the fiscal federalism literature—role in mitigating and adapting to CC. Their involvement reflects the fact that they are typically responsible for a large share of spending and investment in sectors (energy, transportation, buildings, water management, and land use) that are both major generators of GHG emissions and significantly affected by CC. Moreover, SNGs wield significant power to affect both mitigation and adaptation through taxation, user fees, and regulation. Also, because the impact of CC typically varies substantially across a national territory, and because SNGs typically have better knowledge of regional and local conditions

Industrial Strategy, *Valuation of energy use and greenhouse gas* (and supporting toolkit), updated July 2021; UK Department for Environment, Food and Rural Affairs, *Accounting for the Effects of Climate Change Supplementary Green Book Guidance,* updated November 2020; UK Department for Environment, Food and Rural Affairs, *Enabling a Natural Capital Approach*, updated August 2021.

[32] Details can be found at https://climatescreeningtools.worldbank.org/. See also ADB (2023).

[33] For a more detailed discussion of how to manage fiscal risks from natural disasters, see Cevik and Huang (2018).

than NGs, they must be involved in the design and implementation of national place-based policies to address the consequences of CC.

At the same time, there are various reasons for NGs' involvement in subnational policies to cope with CC. NGs can oppose, and in many cases prevent, adverse spillovers from one subnational jurisdiction's CC-relevant policies onto other jurisdictions. More importantly, they can support mitigation- and/or adaptation-friendly subnational policies and investments in a number of ways, including through appropriate fiscal rules; by assigning SNGs adequate revenue-raising handles and cooperating effectively with subnational tax administrations; through grants earmarked for green projects; and by facilitating responsible access by SNGs to financing for green investments. Similarly, in federations where regional governments have responsibility and oversight over local ones, they can monitor and support CC-relevant local activities.

These considerations highlight the importance of effective cooperation among the different levels of government in combating CC. International experience suggests that institutionalizing such cooperation with well-functioning vertical and horizontal cooperation fora, especially sectoral ones in the most CC-relevant areas, can significantly enhance the effectiveness and durability of such cooperation.

The preceding sections of this paper have highlighted the fact that subnational needs for green investments (albeit difficult to quantify, especially in light of current deficiencies in the relevant data) are likely in the next decades to be multiple of the levels in recent ones, thus posing major funding and financing challenges for SNGs, especially in developing countries. These challenges are made more acute by the very limited fiscal space of most NGs post-Covid pandemic.

Addressing such challenges will require significant reforms in the subnational finances, including increases in subnational own-revenues (especially through increased use of green taxes, as discussed in Section IV above); a better targeted use of intergovernmental transfers; improved coordination of national and subnational investments, to avoid duplications and maximize synergies; and a sustained effort by SNGs to diagnose and remedy the main weaknesses in their PIM systems (as discussed in Section V above).

Improved prospects for funding subnational green investments are key to unlocking increasing flows of sustainable and fiscally responsible financing from multilateral sources as well as from financial markets. Financial innovations such as the growing green loans and bonds can help in this respect but are unlikely to fill the prospective financing gaps in the absence of the aforementioned reforms.

References

Aligishiev, Z., Bellon, M. and E. Massetti (2022), "Macro-Fiscal Implications of Adaptation to Climate Change", IMF Staff Climate Note 2022/002, International Monetary Fund, Washington, D.C.

Ambrosanio, M. F. and Bordignon, M. (2006), "Normative versus Positive Theories of Revenue Assignments in Federations", in E. Ahmad and G. Brosio (Eds.), *Handbook of Fiscal Federalism*, 2006.

Asian Development Bank (2023), "Green Public Investment Management - Governance Aspects of Strengthening Infrastructure Sustainability", ADB Governance Brief, No. 50, Asian Development Bank, Manila.

Bird, R. (2010), "Subnational Taxation in Developing Countries: A Review of the Literature," *World Bank Policy Research Working Paper*, No. 5450, World Bank, Washington, D.C.

Black, S., Parry, I., Mylonas, V., Vernon, N. and K. Zhunussova (2023), "The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change", *IMF Working Paper*, No. 23/128, International Monetary Fund, Washington, D.C.

Blazey, A. and M. Lelong (2022), "Green Budgeting: A Way Forward", *OECD Journal on Budgeting*, Vol. 2022/2, pp. 1-18.

Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., Tolentino, R. and C. Wetherbee (2019), "Global Landscape of Climate Finance 2019", Climate Policy Initiative.

Cevik, S. and G. Huang (2018), "How to Manage the Fiscal Costs of Natural Disasters", *IMF How-to-Note*, No. 18/03, International Monetary Fund, Washington, D.C.

Cortellini, G. and I.C. Panetta (2021), "Green Bond: A Systematic Literature Review for Future Research Agendas", *Journal of Risk and Financial Management*, December 2021.

D'Arcangelo, F., et al. (2022), "Estimating the CO2 emission and revenue effects of carbon pricing: New evidence from a large cross-country dataset", *OECD Economics Department Working Papers*, No. 1732, OECD, Paris.

de Mello, L. (2023), "Real Estate in a Post-Pandemic World: How Can Policies Make Housing More Enviromentally Sustainable and Affordable?," *Review of Public Economics*, Vol. 244, pp. 111-39.

de Mello, L. and J.T. Jalles (2023), "Natural disasters, epidemics and intergovernmental relations: More or less decentralization?", *Working Paper*, No. 23-01, International Centre for Public Policy, Andrew Young School of Policy Studies, Georgia State University, Atlanta, GA.

de Mello, L. and D. Sutherland (2015), "Financing Infrastructure", in J. Frank and J. Martinez-Vazquez (Eds.), Decentralization and Infrastructure in the Global Economy: From Gaps to Solutions (Routledge), pp. 146-70.

de Mello, L. and T. Ter-Minassian (2023): "Decarbonisation and intergovernmental fiscal relations: Policy challenges and reform options," *OECD Working Papers on Fiscal Federalism*, No. 43, OECD, Paris.

Dougherty, S. and A. Montes Nebreda (2023), "The multilevel fiscal governance of the ecological Transition," *OECD Working Papers on Fiscal Federalism*, No.44, OECD, Paris.

Fretes, V. and T. Ter-Minassian (Eds.) (2015), "Decentralizing Revenue in Latin America—Why and How", *Interamerican Development Bank*, Washington, D.C.

Global Commission on Adaptation (2019), "Adapt Now: A Global Call for Leadership on Climate Resilience".

Gonguet, F., Wendling, C., Aydin, O. and B. Battersby (2021), "Climate-Sensitive Management of Public Finances - Green PFM", *IMF Staff Climate Note*, No. 2021/002, International Monetary Fund, Washington, D.C.

Hallegatte, S., Anjum, R., Avner, P., Shariq, A., Winglee, M. and C. Knudsen (2021), "Integrating Climate Change and Natural Disasters in the Economic Analysis of Projects: A Disaster and Climate Risk Stress Test Methodology", World Bank, Washington, D.C.

Herrera Dappe, M., V. Foster, Musacchio, A., Ter-Minassian, T. and B. Turkgulu (2023), "Off the Books: Understanding and Mitigating the Fiscal risks of Infrastructure", World Bank, Washington, D.C.

IEA (2021), *Net Zero by 2050: A Roadmap for the Global Energy Sector*, International Energy Agency, Paris.

IEA (2022), *World Energy Outlook 2022, An updated roadmap to Net Zero Emissions by 2050*, International Energy Agency, Paris.

IMF (2021), "Strengthening Infrastructure Governance for Climate-Responsive Public Investment", *IMF Policy Paper*, Dec. 2021, International Monetary Fund, Washington, D.C.

IMF (2022), *PIMA: Public Investment Management Assessment Handbook*, International Monetary Fund, Washington, D.C.

Ingram, G.K. and Y.-H. Hong (2012), *Value Capture and Land Policies*, Lincoln Institute of Land Policy, Cambridge, MA.

JRC (2020), *EDGAR - Emissions Database for Global Atmospheric Research*, Joint Research Centre, European Commission, Brussels.

Martinez-Vazquez, J. (2021), "Adapting fiscal decentralization design to combat climate change", *International Center for Public Policy Working Paper*, No. 21-05, Georgia State University, Atlanta, GA.

Minh Le, T., Leow, W-J. And F. Seiderer (2020), "Building Resilience in Infrastructure to Climate Change" in Schwartz and others, op. cit., International Monetary Fund, Washington, D.C.

OECD (2012), "Principles for Public Governance of PPPs", OECD, Paris.

OECD (2015), *The Metropolitan Century: Understanding Urbanisation and its Consequences*, OECD, Paris.

OECD (2019), "Financing climate objectives in cities and regions to deliver sustainable and inclusive growth", *OECD Environment Policy Papers*, No. 17, OECD, Paris.

OECD (2021), *OECD Regional Outlook 2021: Addressing COVID-19 and Moving to Net Zero Greenhouse Gas Emissions*, OECD, Paris.

OECD (2021a), "*Green Budgeting in OECD countries*", OECD, Paris.

OECD (2021b), "Strengthening adaptation-mitigation linkages for a low-carbon, climate-resilient future: Policy perspectives", *OECD Environment Policy Paper*, No. 23, OECD, Paris.

OECD (2022), *Consumption Tax Trends 2022: VAT/GST and Excise, Core Design Features and Trends*, OECD, Paris.

OECD (2022a), *Regions and Cities at a Glance*, OECD, Paris.

OECD (2022b), *Decarbonising Buildings in Cities and Regions*, OECD Urban Studies, OECD, Paris.

OECD (2023), *Government at a Glance*, OECD, Paris.

OECD (2023 a), "Fostering a place-based approach to climate change adaptation: The role of local and national governments", OECD, Paris

Pisu, M., et al. (2023), "Options for assessing and comparing climate change mitigation policies across countries", *OECD Economics Department Working Papers*, No. 1749, OECD, Paris.

Schwartz, G., Fouad, M., Hansen, T. and G. Verdier (Eds) (2020), "Well Spent: How Strong Infrastructure Governance Can End Waste in Public Investment", International Monetary Fund, Washington, D.C.

Ter-Minassian, T. (2015), "Promoting responsible and sustainable fiscal decentralization", in E. Ahmad and G. Brosio (Eds.), *Handbook of Multilevel Finance*, E. Elgar Publishing.

Ter-Minassian, T. (2016), "Promoting effective and fiscally sound local investments in infrastructure", *Brookings Project on 21st Century City Governance*, Washington, D.C.

Ter-Minassian, T. and L. de Mello (2016), "Intergovernmental Fiscal Cooperation: International Experiences and Possible Lessons for Brazil", *Technical Note*, No. IDB-TN-1048, Inter-American Development Bank, Washington, D.C.

Vamalle, C. and I. Bambalaite (2021), "Fiscal Rules for Subnational Governments: The Devil's in the Details", *OECD Working Papers on Fiscal Federalism*, No. 35, OECD, Paris.