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policy instruments and targets*

by

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Regional climate change policies: an analysis of commitments, policy instruments and targets

Giulia Gadani^a, Ibon Galarraga^b, Elisa Sainz de Murieta^c

Abstract

Regional governments represent an increasingly relevant component in climate change policies, which showcase a high interest in the climate change sphere and provide several benefits connected with their governance. This study aims to shed light on this scale of governance by describing the climate change policies of 61 regions from all over the world and by analysing the possible connections between the regional environmental policy instruments and the level of mitigation and adaptation commitment. The results show that the regional governments of this work appear to be an active component in climate policy, since they all have their own GHG emission reduction targets, devise their own climate policies and instruments and participate in international climate networks. All regions have reported mitigation and adaptation commitments, with different levels of ambition. In addition, it is observable that while some regions (mainly the North) focus mostly on mitigation targets, other (the South) focus on adaptation. Finally, there does not seem to be a connection between the level of climate commitment and the preference for some policy instruments.

Keywords: Climate change governance, regional climate change policy, climate change commitment, mitigation, adaptation

Jel classification: Q54, R11, Q58

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1. Introduction

Consideration of the regional level of governance in climate change policies has been becoming more and more relevant over the years, not only from the point of view of the climate policy design and research, but also given the importance that this lower level of governance is attaching to mitigation and adaptation and to the implementation of the Paris Agreement⁴. The benefits of this level of governance are several, and range from their capacity to tailor better-informed policy decisions and to be committed in an ambitious and policy-innovative way, to the fact that they are the real climate change policies implementers, since they have competencies in areas very much connected to climate change (Galarraga *et al.*, 2011; Sovacool, 2008) and that they might affect national decisions through the example of accomplished successful climate policies (Bernstein and Hoffmann, 2018; Mcewen and Bomberg, 2014; Hsu *et al.*, 2019). These areas include environmental policy, transport, agriculture, infrastructure planning, health and sometimes even energy policy and fiscal policy.

Moreover, subnational governments (together with non-state actors) may support countries to achieve or overachieve their Nationally Determined Contributions (NDCs)⁵ through their ambitious efforts and, at the same time, they might leverage the national climate policy ambition given the consideration by the central government of a higher number of committed actors (NewClimate Institute *et al.*, 2019).

However, some authors argue that the effect that regions could provide is not always beneficial. For example, a negative effect could arise from the overlapping of instruments at different scales of governance or from the regions' deceleration of national policy (see, for instance, Goulder and Stavins, 2010; Casado-Asensio and Steurer, 2016). Non-state actors, including regions, could bring non-negligible risks related to the rise of politically contentious, geographical-dependent and over-estimated outcomes (Chan *et al.*, 2019). Therefore, the orchestration of the efforts at different levels of action becomes crucial (Chan *et al.*, 2015; Schreurs, 2008). Such coordination can be fostered by so-called orchestrators that can promote policy learning and innovation, create international climate change networks and coordinate climate policy initiatives (Abbott, 2017).

The purpose of this research is, first of all, to shed light on a less debated policy scale for climate action by analysing, in a descriptive way, the climate change policies of 61 regions from 5 different geographical areas, Europe, Latin America, North America, Africa and Asia Pacific.

Secondly, this research aims to detect the potential connection between different variables built on the data collected in this study. Attention will be given to the

⁴ <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>.

⁵ Nationally Determined Contributions (NDCs) refer to country-level climate change targets and contributions to the Paris Agreement set on a voluntary basis for the post-2020 period. See <http://spappssecext.worldbank.org/sites/indc/Pages/INDCHome.aspx> for additional information.

analysis of the relationships between the policy instruments and the level of mitigation and adaptation commitment, keeping into account the geographic features of regions, as well.

It is hypothesised that there might be a connection between the level of climate commitment and the choice of policy instruments. According to Matthes (2010, p. 13) a subsequent instrument choice might be set depending on “the ambitiousness of the targets and the time available for implementing them”. More “ambitious” policy instruments, such as taxes, which deal with an elevated number of critical design issues and barriers (OECD, 2017), could be chosen especially by highly climate change committed regions. Keskitalo *et al.* (2016) analyse the policy instruments in adaptation policies in the Nordic context and highlight the prevalence of soft and guiding instruments, which may present some limits: these types of instruments in climate policies are given less attention and are de-prioritised if other mandatory non-climate-related requirements set at national level holds.

Moreover, regions are often depicted as ambitious and policy innovators, so, if this characteristic could effectively be verified, leveraging their influence and importance in the international sphere would become crucial in order to increase the ambition of the Paris Agreement.

This work is structured as follows: section 2 presents an overview of the literature about the role and importance of regions in climate change, while section 3 explains the data and the methodology. Section 4 presents the results, which are discussed in section 5, which also includes further policy-related reflections and some suggestions for future research.

2. The role of regions in climate policy

In the climate change policy literature, country-level studies receive widespread attention. In recent years, cities have also received increasing interest as climate actors, while, in contrast, the studies addressing adaptation and mitigation policies in regions are scarcer.

If traditionally climate change mitigation has received a broad attention, at national and international level (e.g. the Kyoto protocol and the Paris agreement), and a smaller one at a lower levels of governance, there is, by contrast, a larger consensus that adaptation policies must be designed at local and regional level, given the geographical heterogeneity of impacts (Termeer *et al.*, 2011; Adger, 2001) and the fact that the benefits of the related actions remain at a local level/community (Wilbanks, 2007). In addition, even though the scale at which GHGs are generated the most is the small one, constituted of families and companies (Ostrom, 2009), “the benefits are distributed across scales – from the household to the globe” (Ostrom 2009, p. 28).

There is a wide range of representative cases of climate international networks, initiatives and arrangements which involves a multi-level approach and the

participation of regions. Recently, as for mitigation, the Under2MoU⁶, the Compact of Mayors⁷, and the Compact of States and Regions⁸ have been set up.

The Under2MoU is an arrangement which commits the signatory governments to reducing emissions by 80-95% compared to 1990 levels, or to limiting them below 2 annual metric tons per capita by 2050, which represents the GHG emissions reduction required not to exceed the 2 degrees rise in temperatures by 21st century⁹. The Under2Mou signatory governments, together with the supporting and endorsing regions, are part of the Under2 Coalition¹⁰, an international community of climate ambitious states and regions.

The second initiative, instead, was instituted by the United Nations and aims at collecting more information at an urban level with regards to GHG emissions, so as to assess the contribution of cities, give them a higher visibility and encourage their interest towards ambitious policy goals¹¹. The Compact of States and Regions promotes, similarly, to step up regional climate ambition and offers a transparent overview about the sub-national governments' efforts in tackling climate change using a standardised approach.¹² It was introduced during the UN Climate Summit in New York.

As for adaptation, an important initiative is RegionsAdapt¹³, an international network which shares the objectives of promoting and showcasing regional climate change commitments and achievements and regional data tracking, is open to governments belonging to a level ranging between the urban and national level and promotes collaborations in 7 priority fields of action through information exchanges and training (Galarraga *et al.*, 2017).

The benefits, characteristics and potential of a regional climate change policy design

Although few studies warn us of the potential overlapping problems between regional and federal governments, many authors stress the importance of the role that regions have in addressing one of the most important challenges of the present and past centuries and highlight the positive aspects and advantages that regional-level climate change policies can bring, both for mitigation and for adaptation (Galarraga *et al.*, 2011; Chan *et al.*, 2019; Engel and Orbach, 2008).

First of all, regions operate in strategic areas affecting climate change, such as transport, energy and environment (Galarraga *et al.*, 2011). As remarked by the same

⁶ For further information see: <https://www.under2coalition.org/under2-mou>

⁷ <https://www.c40.org/programmes/compact-of-mayors>.

⁸ <https://www.cdp.net/en/cities/states-and-regions>.

⁹ <https://www.under2coalition.org/under2-mou>

¹⁰ <https://www.under2coalition.org/about>.

¹¹ <https://www.c40.org/programmes/compact-of-mayors>.

¹² See <https://unfccc.int/news/compact-of-states-and-regions-subnational-initiatives-driving-climate-ambition> and <https://www.theclimategroup.org/news/compact-states-and-regions-2016-disclosure-report>.

¹³ <http://www.nrg4sd.org/climate-change/regionsadapt/>.

authors, regions tending to have a higher proximity of citizens, are more flexible and have a higher stock of information (concerning e.g. environmental related needs, risks and vulnerability problems) of the area they govern, and this allows them to design ad-hoc policies (Galarraga *et al.*, 2011). Secondly, if a regional policy is successful, it will be likely that international actors, companies and groups of environmentalists will strive to influence, through various channels, the central government to make further efforts towards climate change (Engel and Orbach 2008; Ostrom, 2009). Moreover, they can lead a sustainable transition accompanied by a green and resource-efficient economic growth (Liargovas and Apostolopoulos, 2014; Mazzanti, 2018). Plus, it is asserted that regions can potentially generate a high aggregate effect to considerably reduce GHG emissions (Hsu *et al.*, 2019) and, if direct impacts (concerned with reducing greenhouse gases) are very relevant, the indirect ones, such as the benefits provided by policy innovation and experimentation, might be even greater (Hoffman, 2011).

However, Chan *et al.* (2015) assert that there is no certainty that the sub-regional climate change actions will generate benefits, and this is also because often regions and cities are reluctant in setting well-defined GHG reduction targets and quantitative policy goals (Hsu *et al.*, 2015).

Chan *et al.* (2019) explain that non-state actions provide several benefits (e.g., they can close governance gaps, foster confidence and produce replicable and scalable outcomes), as well as non-negligible risks, such as the fact that they might lead to politically contentious results, geographical-dependent outcomes and that there could be an overestimation of benefits due to incorrect accounting and aggregation procedures. In order to minimize these risks, the authors (2019) suggest the importance of boosting non-state participation in order to induce developing countries' actions, knowledge promotion, high-level recognition and commitment beyond pioneers and first-movers. Finally, Happaerts (2015, p. 297) analysed the Belgian federal states' ambition and concluded that "sub-national policy-making autonomy in a multi-level setting not only offers opportunities for environmental governance, but that it can also have a limiting effect".

The role of regions as pioneers and the determinants of their ambitious actions

A factor concerning regions is that they promote experimentation through the implementation of policies that are not in the national agenda. Moreover, one can consider the development of best practices that can be transmitted and be an example to national governments and to other regions (Bernstein and Hoffmann, 2018; Mcewen and Bomberg, 2014). This spill-over effect is especially fostered by data and knowledge dissemination (Selin and Vandever, 2005).

Pioneers are also, apart from policy forerunners and experimenters, those who set more ambitious policy goals (Hoffman, 2011). Mcewen and Bomberg (2014) researched the reasons explaining why a region is a climate pioneer and concluded that the latter may decide to reach or even surpass the national or international target to distinguish its own territory from the belonging country. More recently, Royles and Mcewen (2015) studied the relationship between the regional climate policy ambition and constitutional powers and found a moderate and positive relationship.

In addition, the authors stated that the “territorial distinctiveness and the politics of territorial identity can [...] interact with the degree of constitutional autonomy, especially in shaping the level of ambition in policy goals” (Royles and Mcewen 2015, p. 1048).

However, Happaerts (2015) analysed the degree of policy experimentation of the Belgian sub-national governments and discovered that, in this case, such governments are not policy innovative. The reasons are to be found in the fact that the country itself has not devised ambitious policy, in the lack of political will of the Belgian politicians, which do not promote ambition, in the features of the country’s federalist system and in the belief that efforts should be made by other parties.

Moreover, several authors present the reasons behind the local/state interventions, which range from the desire to exploit a technological advantage and gain economic benefits to the urgency of addressing climate change problems (see Schreurs, 2008; Byrne *et al.*, 2007; Engel and Orbach, 2008 for an overview).

Scales and directions to deal with climate change

A relevant literary field is the one that addresses, in a broad way¹⁴, the choice of scale in climate governance and policy design (Ostrom, 2009; Termeer *et al.*, 2011; Trisolini, 2010) and that researches which governance direction should be the most appropriate (Rayner, 2010; Trisolini, 2010; Schreurs, 2008).

Various authors assume the position which describes the importance of the interplay between regional and national level, since the presence of only one of them would not lead to an optimal solution. In particular, according to Schreurs (2008), Termeer *et al.* (2011) and Trisolini (2010), the relevance of a lower scale of governance must be enhanced, although the mere presence of the latter does not result in sufficient dealing with climate problems and cannot be a substitute to federal or national policies, since most national governments provide relevant fiscal regulative conditions to regions (Trisolini, 2010)¹⁵. Engel and Orbach (2008) assert that the international scale of climate change governance would be the first-best solution which would permit in an adequate way to reduce GHG emissions (while the sub-national aggregate actions would be insufficient). However, local solutions do play a major role, given the fact that the global solution has been unavailable so far and that local policy implementations are able to influence the federal government, and therefore, indirectly, the international level¹⁶ (Engel and Orbach, 2008). Moreover, Galarraga *et al.* (2011) affirms that coordinating different scales of action is a key issue, since the agreements and targets are decided at international

¹⁴ Not limiting the analysis to a federal context or to a specific country.

¹⁵ Note that some regions such as the Basque Country and Navarra in Spain also have the right to set their own income taxes.

¹⁶ According to the Engel and Orbach’s work (2008), the local and national levels are primarily functional to the global one. Moreover, a global scale of action is visible and trackable in the international agreements and can be promoted by countries, which, as stated by the same authors (2008), can be influenced by the local scale.

or national level, while regions are the effective actors taking actions to implement policies; this is what they name as the “lent target paradox”. In this study the central government deficit in designing climate change policy alone is underlined, too.

Finally, the importance of addressing the climate change problem using multiple scales (including also the local and regional ones) and not solely focusing globally is emphasized by Ostrom (2009) and Trisolini (2010), which advocate the need for a polycentric approach. In order to orchestrate the polycentric efforts¹⁷ of several levels of governance, Abbott (2017) suggests that climate orchestrators ought to direct actors by promoting policy innovation and learning, by coordinating climate initiatives (where progress is tracked and priorities are fixed) and by creating international climate networks. Nevertheless, a multi-level approach presents several limits: for example, the benefits and costs deriving from the increased number of policy agents might be very difficult to assess (Dorsch and Flachsland, 2017). Dorsch and Flachsland (2017) also acknowledge the great contribution and potential that subnational actors have but remark the fact that the country has legal and financial powers and a crucial role in international negotiations.

As for the choice between a bottom-up or top-down approach in climate change target setting, Rayner (2010) strongly promotes the former, explaining that local targets are more feasible to realise and easier verifiable, compared to the international ones, and indicates that the difficulties in shifting towards a bottom-up approach are given by the fear of losing political credibility and by the existence of sunk costs. In addition, Averchenkova and Bassi (2016) highlight a relation among regional targets and credibility and stress the importance of a regional target-setting, specifying that the role of cities and other sub-national governments in fixing their own targets represents a significant bottom-up approach, able to enhance the credibility of the country’s commitments. Wolkingner *et al.* (2012) advocate the setting of regional emission reduction targets, sharing the view that targets are a way of enhancing a regional commitment and responsibility towards climate change, and provide a framework for the implementation of climate policy action. This process should start, according to the authors (2012), from the translation of the national target into the regional ones, following, therefore, a top-down approach.

On the contrary, Trisolini remarks the importance of having a bidirectional – top-down and bottom-up – view of the climate change governance issue since “multiple levels of government can play complementary roles under a model of bidirectional climate change policy-making and regulation” (2010, p. 675) and “federal climate change policy will be more likely to succeed if its architects recognize this potential local contribution and facilitate the reductions local governments have begun to implement” (2010, p. 675).

Finally, it is worthwhile to remark that there is a vast strand of literature that analyses the subnational governments in the light of the transnational climate governance context (Andonova *et al.*, 2017; Hsu *et al.*, 2017), where orchestration

¹⁷ Such multi-level (country/region/city/companies) efforts are concerned with greenhouse gases reduction.

and cohesion must be promoted and partnerships assume a relevant role (see for example Abbott, 2017; Selin and Vandevveer, 2005).

State, federal or coexistent climate governance? A focus on federal countries

Another remarkable field of analysis is the one investigating if climate change can be better tackled in a decentralised, centralised or interactive form in a federal country (Steurer and Clar, 2015; Casado-Asensio and Steurer, 2016; Goulder and Stavins, 2010)¹⁸.

Sovacool (2008) and Sovacool and Brown (2009) state that, on the one hand, a decentralised governance and a local/state level of climate change intervention can lead to tailor better policies on the basis on the region's characteristics and preferences,¹⁹ and creates policy design innovation, where ecologies of scale can enhance the social welfare to the maximum level, while reducing the cost to a minimum. On the other hand, the same authors (Sovacool, 2008; Sovacool and Brown, 2009) affirm that centralisation in federal countries produces certainty and accuracy to investors and stakeholders²⁰, and can better address such an important problem – the climate change one – that goes beyond borders and distinct geographical areas, generating economies of scale in relation to R&D activities and data collection and disincentivizing the creation of “pollution havens”.

Steuer and Clar (2015) discovered that Austrian provinces are reluctant to experiment and learn from other regions and tend to be passive and mere executors of the EU policy. Moreover, decentralisation hindered the greening of the building sector. The same conclusions apply to the Swiss case (Casado-Asensio and Steurer, 2016), where most of the cantons have decelerated the federal policies or have not taken them into account.

Steurer *et al.* (2019), who compared the policies in the building sector in Austria and Switzerland, explain that federalism promoted neither a race to the top nor a race to the bottom. They add that given the small population of the two countries a decentralised building policy has not been functional. What is more, they add that the difficulty in applying the Kyoto protocol was because of the federal government having adopted this treaty without consulting regions.

In addition, authors such as Goulder and Stavins (2010) and Sovacool (2008) focus specifically on the interaction between federal and state (national and regional) climate change policies and what emerges is that this interplay can be beneficial or not, depending on the kind of instruments applied and to the degree of severity of the state and federal policies (Goulder and Stavins, 2010). They report that there are

¹⁸In detail, Sovacool (2008) analyses the United States of America, Steuer and Clar (2015) study Austria, Casado-Asensio, Steuer (2016) observe Switzerland and Happaerts (2015) analyses Belgium. Goulder and Stavins (2010), do not study a particular country, although there are several referrals to the United States of America.

¹⁹ Given the higher stock of territorial information.

²⁰ This is given, for example, by the homogeneity in all the country of rules/regulations, such that “regulatory efficiency” is promoted (Sovacool and Brown, 2009).

some well-defined cases where the state interacting with country policies can lead to an inefficiency, as states are not adequate in reducing GHGs in order to affect the national level. Moreover, Sovacool (2008, p. 476) suggests that “interactive federalism”²¹ results to be the best option when:

- (i) existing state actions are insufficient to promote environmental policy goals;
- (ii) the states face constitutional challenges to addressing an environmental problem individually;
- (iii) the state regulatory environment imposes additional costs on businesses and consumers; and
- (iv) the presence of interstate spill-overs and externalities suggests the need for national action.

3. The data

The statistical population of this research consists of 61 sub-national governments at a level ranging between the local and country one (e.g., regions/provinces/states/Länder/autonomous communities/cantons). This intermediate scale is referred in this study as “region” and is comprehensive of all the typologies of governance at this level. These regions are part of 22 different countries belonging to 5 different geographical areas: North America, Europe, Latin America, Africa and Asia Pacific. Specifically, there are 34 European regions, 14 North American regions, 6 Latin American regions, 4 Asia Pacific regions and 3 African regions (Figure 1). The statistical units have been extrapolated based on the regional climate mitigation data availability (see in Appendix 1 the list of regions and belonging country).

Table 1 presents an overview of the information analysed in this study, illustrating each variable’s typology and data collection methodology. The regional variables are the following: GHG emission reduction targets, mitigation commitment, adaptation commitment and environmental policy instruments in climate policies.

²¹ It occurs when both the states and the federal governments have competences in the same policy area.

Figure 1. Map of regions included in the dataset

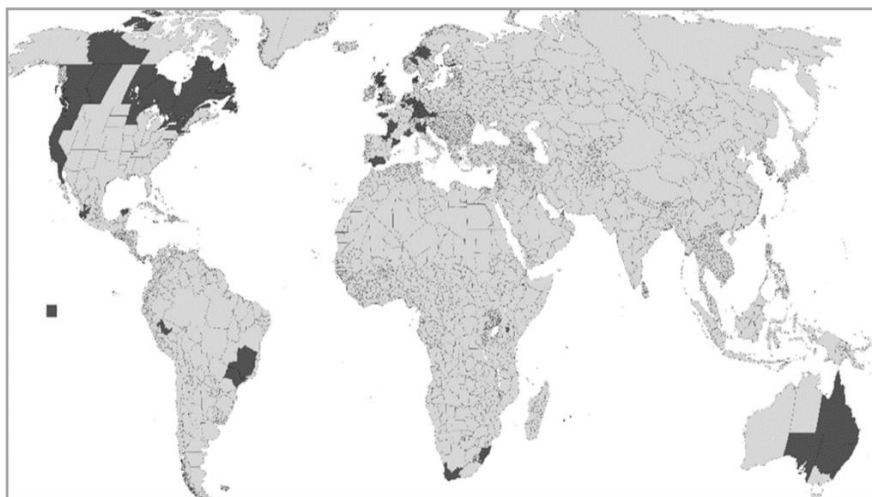


Table 1. Variables collected in the study

Variable	Type of variable	Description
GHG emission reduction targets	Percentage	Percentage of GHG emissions as total regional value. The target years are 2020, 2030 and 2050.
Level of mitigation commitment	Index	Index composed of 3 numbers accounting for temporal proximity and number of targets.
Level of adaptation commitment	Dummy variable	It tracks if a region is part of the international adaptation network RegionsAdapt or not.
Environmental policy instruments	Dummy variable	12 instruments selected based on Galarraga <i>et al.</i> (2011) in mitigation and adaptation policy. It tracks if an instrument has been devised or not.

The information concerning the regional GHG emission reduction targets comes from the global states and regions annual disclosure – 2017 update annex²² and the CDP 2017 states and regions GHG emission reduction targets dataset²³ (base year intensity goals and fixed-level goals have not been considered in this work), while

²²The website is: <https://www.theclimategroup.org/news/annual-disclosure-2017-update>.

²³ For the full dataset see <https://data.cdp.net/Emissions/2017-States-and-Regions-GHG-Emissions-Reduction-Ta/v428-ct8k>.

the adaptation commitment variable is based on the information obtainable from the website of the network Regions4²⁴. Both academic and grey literature have been used to complete the remaining information.

The mitigation commitment variable has been created starting from the previously collected regional GHG emission reduction targets. For its creation it has been assumed that the higher the number of targets, the greater the climate ambition, since a quantifiable mitigation target showcases responsibility and represents a signal of political commitment (Nachmany *et al.*, 2015). Moreover, it has been hypothesized that the timeframe signalling the greatest mitigation commitment ambition is the short-term, followed respectively by the intermediate and by the long-term one. The reasons are the following: it's harder to decarbonise an economy and for a government to take a commitment (and related responsibility) in the short term. As for the creation procedure of this index, firstly, each GHG emission reduction target has been assigned a given number of points on the basis of its time-horizon. Then, for each region, all the targets' points have been summed (if a region has more than one target). Finally, an index made of three numbers has been created and each regional government has been assigned to one of the three categories of the index (high, moderate and low mitigation commitment) according to the final score achieved.

Finally, with reference to the regional environmental policy instruments²⁵ used in climate policies, they are the following: taxes, tax exemptions, subsidies, cap and trade, voluntary agreements, standards, certification/labels, prizes/awards, legislation, information and training, public procurement and public system.

The information concerning the instruments has been obtained consulting the Under2 Coalition²⁶ and The Climate Group²⁷ websites and several reports and official policy plans publications released in governmental websites (see Appendix 2 for some examples of websites and documents used to gather policy instruments information). In this work, all these instruments have been tracked, looking at the policy instruments through which regions have planned to achieve future and past climate goals. An important theorisation connected to the consideration of the past policy instruments (in addition to the future ones) is that “many policy decisions exhibit a degree of path dependence (i.e. influenced by decisions taken in the past)” (Stead, 2018, p. 2447). Finally, the climate areas considered in the instruments tracking, based on Galarraga *et al.* (2011), are: energy efficiency, renewable energy, transport, forestry and land-use, sustainable agriculture and waste management.

²⁴ <https://www.regions4.org/project/regionsadapt/>.

²⁵ Environmental policy instruments are tools used to avoid or control damages of the environment and to reach environmental policy objectives. See <http://www.oecd.org/environment/tools-evaluation/> to have an overview of the different typologies of instruments and for additional material.

²⁶ <https://www.under2coalition.org/members>.

²⁷ <https://www.theclimategroup.org/partnerships/government>.

Limitations of the data

There are several data issues that are worthwhile to consider. First of all, the lack of data availability has proved to strongly influence the data collection choices and methodology, for instance, through the creation of several dummy variables. Furthermore, the statistical population, which has been chosen according to the available information, may not be a fully representative sample of the population with reference to the mitigation commitment: the higher the regional ambition, the higher the willingness to disclose data. The tracking of the past policy instrument implementations has also been partially due to the lack of data availability, which has been reinforced by the need to collect information for a high number of policy instruments. However, this methodology is coherent with the theory about the policy instruments path dependency. Moreover, it is to be reminded that it is not possible to account for the stringency of an instrument since dummy variables are used. Dummy variables basically informs whether the instrument has been used or not with no additional information on how this has been applied.

Secondly, the information about the regional policy instrument implemented does not pretend to be exhaustive; its aim is to provide a general overview about the regional preferences in the environmental policy instruments' sphere. Then, a relevant caveat holds with respect to the cap and trade instrument tracking: all the EU regions have been considered as implementing this instrument just for the fact that they belong to the European Union (which adopts the EU ETS).

Thirdly, the consideration of an index to represent the level of mitigation commitment and of a dummy variable to measure adaptation commitment may not be exhaustive enough from an informative point of view. However, this simplification has allowed us to proxy these indirectly observable variables in a manageable way. One should acknowledge that many other factors can be considered in order to provide information about the level of climate mitigation commitment such as stringency of climate policies and the health of the economy. Finally, having an index composed of three numbers and a dummy variable for the climate commitments may provide too few nuances of differences among regions and too few possible classifications.

4. Findings: regional climate change policies

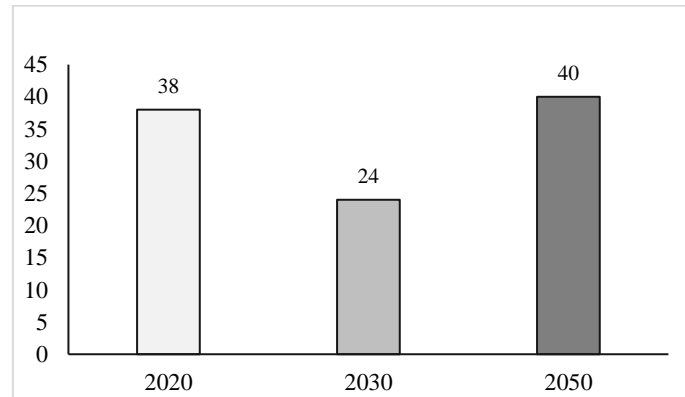
GHG emission reduction targets

Greenhouse gas reduction targets represent an important source of information about the climate strategy of regions. The following graphs will provide useful insights about the timeframe of regions' targets, their temporal distribution and the number of targets.

Figure 2 shows the number of regions having a GHG reduction target in the years of analysis – 2020, 2030 and 2050. Since regional governments can have more than one temporal commitment, the number of regions per every target year can be higher than 61. The GHG reduction target year which has been used as reference by the highest number of regions (40 out of 61 have chosen it) is 2050,

followed by the short-term target, 2020, which has been set by 38 regions. The less preferred target year is the 2030 one, with 24 regions having a quantitative intermediate goal.

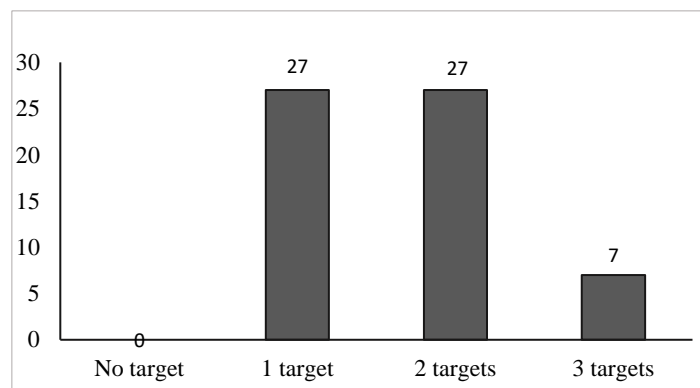
Fig.2. Number of regions having 2020, 2030 and 2050 targets



Source: own elaboration based on data from the Climate Group and State and Regions disclosure data 2017.

As observable in Figure 3, all the regions analysed in this study have at least a target and most of them have one (27 regions) or two GHGs reduction goals (27 regions). Only 7 regions have decided to have a short, intermediate and long-term quantifiable reduction target.

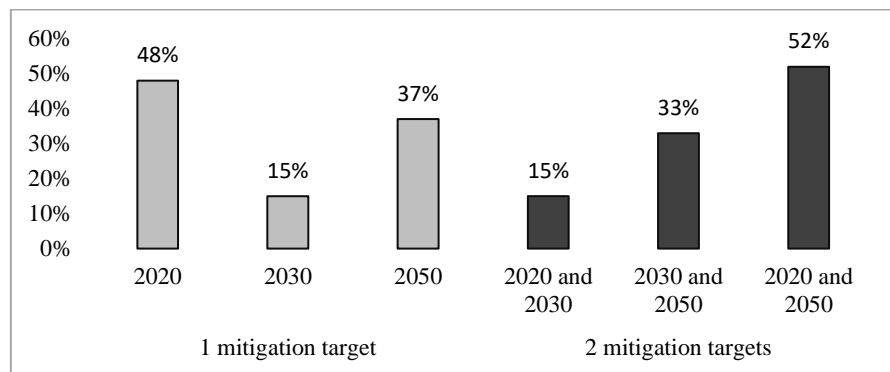
Fig. 3. Number of regions having 1,2 or 3 mitigation targets



Source: own elaboration based on data from the Climate Group and State and Regions disclosure data 2017.

Looking in detail at which is the most fixed target year by those regions having only one temporal CO₂e reduction target (Figure 4), it is remarkable to cite that almost half of these sub-national governments (48%) have set the 2020 targets, while 37% of them have established the longest-term one. With regards to 2030, instead, only 15% of the regional governments have set this target year. Moreover, with respect to the regions/states having two climate change mitigation goals, the two shortest-term targets result in being the less established ones. 2030 and 2050 have been established by 33% of regional governments and 2020 and 2050 by 52% of them. Therefore, having a short and long-term quantifiable emissions reduction goal results in being the most chosen option among the regions with 2 mitigation targets.

Fig. 4. Temporal distribution of targets for regions having one or two targets



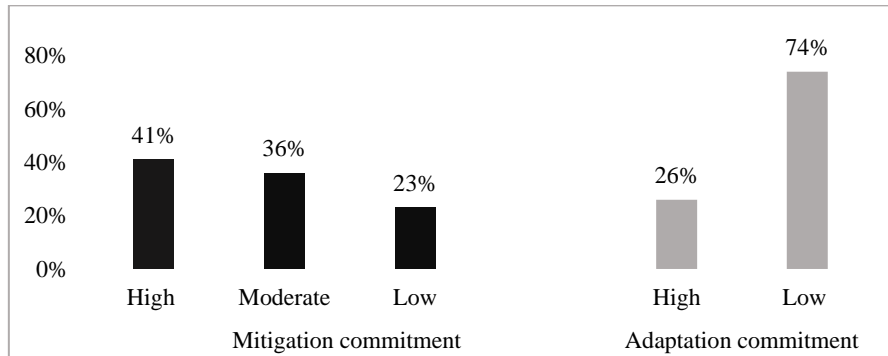
Source: own elaboration based on data from the Climate Group and State and Regions disclosure data 2017.

Climate change mitigation and adaptation commitment

Figure 5, 6 and 7 show the analysis of the commitment of regions, highlighting the differences in mitigation and adaptation terms and making a geographical comparison with reference to climate commitment.

Figure 5 analyses the percentage of regions being highly, moderately and lowly committed to climate change mitigation and the percentage of regions being highly or lowly committed to climate change adaptation. It is observable that 41% of them are highly ambitious in their climate change mitigation plans, whereas 36% is moderately ambitious. There is, instead, a low level of climate mitigation commitment in 14 regions (23%). With regards to the percentage of highly committed to adaptation regions, only 26% of them participate in the transnational network RegionsAdapt. Therefore, a relevant difference is detected comparing mitigation and adaptation commitment, with the first type of climate focus being highly considered and the second one receiving less consideration by the statistical population of this research.

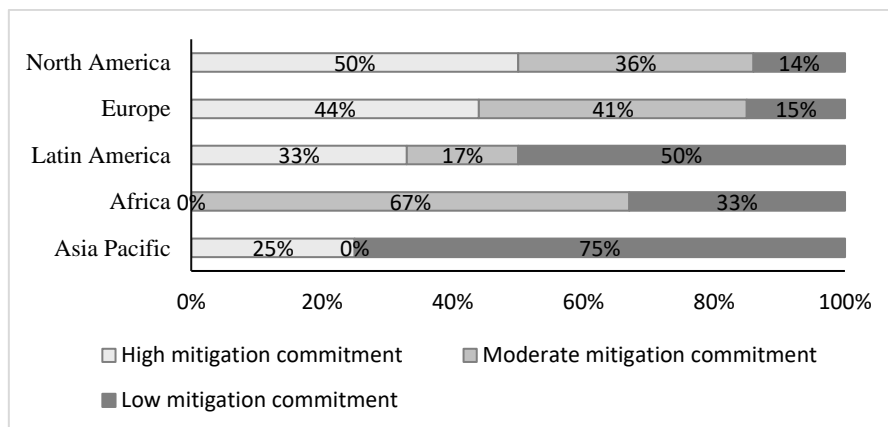
Fig. 5. Percentage of regions belonging to each mitigation and adaptation commitment level class



Source: own elaboration based on data from the Climate Group and State and Regions disclosure data 2017.

Considering Figure 6, it is remarkable to say that North America and Europe are the territories having the highest percentages of highly committed regional governments in mitigation terms (50% and 44%, respectively), whereas in Latin America and Asia Pacific, there is a prevalence of the low level of GHG emission reduction commitment in the sub-national governments (50% and 75% respectively). The African regional governments are lowly or moderately committed to mitigation, with none of them being highly ambitious. This might be explained by a more adaptation-focused climate policy due to their higher degree of vulnerability and low or very low contribution to global GHG emissions. The low level of mitigation commitment category, instead, is the most present one in the Asia Pacific regional governments (75%).

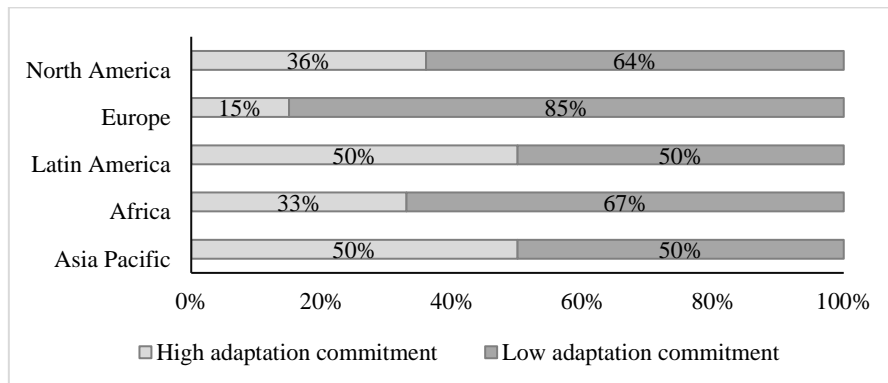
Fig. 6. Percentage of regions committed to mitigation in every geographical area



Source: own elaboration based on data from Regions4.

With respect to the percentage of regional governments that in every geographical area has decided to be committed to adaptation (Figure 7), 50% of them in both Asia Pacific and Latin America areas have, whereas in Europe, unexpectedly, only 15%. Finally, in Africa and North America about 1/3 of the studied statistical units have become part of RegionsAdapt (33% and 36% respectively). Therefore, comparing the two graphs about the level of mitigation and adaptation commitment, it is possible to affirm that, as one could expect, mitigation is a crucial matter in climate policy especially in Europe and North America, whereas climate change adaptation is given more importance in Asia Pacific and Latin America, compared to Europe and North America.

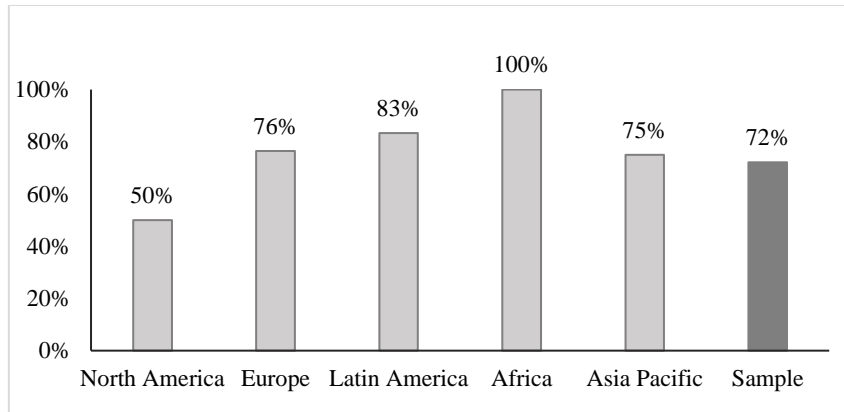
Fig. 7. Percentage of regions committed to adaptation in every geographical area



Source: own elaboration based on data from Regions4.

As for the rate of participation in the Under2 Coalition, it is observable, considering the whole sample of the population, that 72% of the statistical population is part of the coalition. All the African sub-national governments are signatories, followed by the Latin America (83%) and European (75%) ones. It is remarkable to cite that the North American rate of participation (which is the lowest rate and amounts to 50%) is particularly penalised by the complete absence of the Canadian regions as signatory governments in the Under 2 Coalition.

Fig. 8. Percentage of regions participating in the Under2 Coalition



Source: own elaboration based on data from Under2 Coalition

Environmental policy instruments in climate policies

The collection of information about the use (or not) of an environmental policy instrument by each region has enabled two types of analysis. The first one is about the rate of adoption of each instrument considering the whole statistical population, whereas the second one deals with the geographic preferences and differences with respect to the most implemented instruments.

The focus of Table 2 is to present in a graphical way the number of regional governments that are adopting/planning to adopt each of the 12 environmental policy instruments to reach their GHG emission reduction targets. What is observable is that the most used instruments are subsidies and information and training, (both used by 84% of regional governments), which precede cap and trade, accounted by 74% of sub-national governments, legislation, by 66% of them, and public system, with 36 adopting regions (59%). The instruments, on the contrary, receiving the lower attention by regions are prizes/ awards (11%) tax exemptions (16%) and certifications/labels (34%).

Table 2: List of policy instruments used in the dataset, adoption rate and examples of instruments

<i>Environmental policy instrument</i>	<i>Rate of adoption</i>	<i>Examples of policy instruments</i>
Taxation/Fees	36%	Carbon levy (Alberta), Québec carbon tax (Québec)
Tax exemptions	16%	Tax reductions for clean industrial technologies (Basque Country)
Subsidies	84%	The Clean Energy Development Fund (Vermont)
Cap and Trade	74%	EU ETS (European Union), Regional Greenhouse Gas Initiative (Connecticut and New York State)
Voluntary agreements	51%	Bavarian Climate Alliance (Bavaria)
Standards	54%	Renewable fuels standard (Washington), Clean Vehicle standards (California)
Certifications/labels	34%	Energy and environmental sustainability building certification (Veneto)
Prizes/awards	11%	Saltire Prize (Scotland)
Legislation	66%	State Climate Change Action Law (Jalisco), The Climate Change and Emissions Reductions Act (Manitoba)
Information and training	84%	California climate adaptation planning guide (California) Regional Clean Energy Program (New South Wales)
Public procurement	56%	Public procurement plan (Emilia-Romagna)
Public system	59%	ChargeNY initiative (New York State), Hydrogen HyWay (North Rhine-Westphalia)

Source: own elaboration based on data from Under2 Coalition, The Climate Group and regional governments' climate plans.

Table 3 presents the ranking of the most 5 popular instruments for the regional governments of each geographical area. At a first glance, subsidies and information and training are among the most implemented instruments in almost all areas. Putting a price on GHG emissions has a great importance in Europe, thanks to the cap and trade system, and in North America. Public instruments play a major role in Europe and Africa, where both public system and public procurement are quite popular among regions. With respect to standards and legislation, they are part of the climate change plan of many regions in North America. Finally, a voluntary/soft/social approach is typical of the regions of Latin America and Africa, since voluntary agreements and information and training are in the top 5 instrument use ranking (certification/labels are among the most used tools in Latin America too).

Table 3. Ranking of the most implemented instruments among regions in each geographical area

<i>Instrument ranking</i>	<i>Geographical area</i>				
	Europe	North America	Latin America	Africa	Asia Pacific
1	Cap and trade	Subsidies	Information and training	Voluntary agreements	Subsidies
2	Subsidies	Standards	Subsidies	Information and training	Legislation
3	Information and training	Legislation	Voluntary agreements	Public system	Information and training
4	Public system	Information and training	Legislation	Public procurement	Public procurement
5	Public procurement	Tax	Certification/labels	Tax	Standards

Source: own elaboration based on data from Under2 Coalition, The Climate Group and regional governments' climate plans.

5. Discussion and conclusions

This research has enabled us to offer a comprehensive picture of the information existing about the sub-national or regional climate policies. Our results show that regional governments are an active component in climate change policies: they adopt their own regional GHG emission reduction targets and climate policy strategies, they implement their own instruments and participate in international networks. Other findings are explained below.

Geographical unbalance and instrument choice

The data observation and the descriptive evidence suggest several possible connections among the variables of this study. Regional characteristics, which differ among geographical areas, could play an important role in affecting some of our variables.

Regions in developing and fast growing countries have a low share of global GHG emissions, but they are, at the same time, particularly vulnerable and exposed to the most severe effects of climate change and, therefore, adaptation becomes particularly important (Abeygunawardena *et al.*, 2009; Sainz de Murieta *et al.*, 2014). According to our data, regions in Africa and Latin America are indeed more concerned about adaptation than adopting ambitious mitigation targets. On the contrary, regions in developed countries (the North American and European regions in our study), responsible of the largest share of GHG emissions, are highly committed to mitigation and less to adaptation. As for Asia Pacific regions (which all belong to Australia), they are not particularly ambitious in mitigation terms and half of them are committed to adaptation.

Even though the data sample is small, we suggest that there might be a focalization on mitigation and adaptation policy commitments depending on the geographical area where the regions is located. It is remarkable to underline that most of data about the adopted policy instruments belong to the European and North American regions (almost 80% of the regions in our sample are located in these areas), and this provides a picture that is unbalanced towards mitigation in the Global North.

Furthermore, it has not been possible to detect a relationship between the climate policy commitment and the use of certain specific instruments. In other words, regions highly committed to mitigation/adaptation do not prefer the adoption of one type of instruments over others (and the same holds for the moderately and lowly committed regions).

What is more, geographic dependence may be found with respect to the policy instruments because governments of a same geographic area may share a similar socio-economic, political and environmental conditions, which could lead to the choice of similar instruments (Lenschow *et al.*, 2005; Knill, 2005). Actually, in this work the choice of the kind of environmental policy instrument are similar in the same geographical area, whereas they differ from those of the other territories.

Literature connections and suggestions for future analysis

The review of the literature shows that there are both pros and cons of the decentralisation of climate policies. While there are challenges that need to be addressed, e.g. orchestration, we argue that regional governments are in charge of many key policies to climate change mitigation and adaptation. They are also willing to commit, so the question should not be if they need to be considered, but rather how their commitments can be accounted for.

Data availability has resulted in a considerable limitation to the analysis. In order to evolve this study from the point of view of the research quality, the fostering of data collection and public disclosure by international bodies becomes crucial and should be therefore enhanced.

Considering future direction of analysis, it might be relevant to extend this work by creating a framework for the assessment of regional adaptation and mitigation commitments in broader terms (following e.g. Olazabal *et al.*, 2019) and to verify if the level of commitment and type of climate policy preferences are driven by economic and climate vulnerability characteristics.

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Appendix

Appendix 1. Regional governments of this research and belonging country

<i>State or region</i>	<i>Country</i>	<i>State or region</i>	<i>Country</i>
Alberta	Canada	Navarra	Spain
Andalusia	Spain	New South Wales	Australia
Attica	Greece	New York State	USA
Australian Capital Territory	Australia	Newfoundland and Labrador	Canada
Baden Wurttemberg	Germany	Nord Trondelag	Norway
Baja California	Mexico	North Brabant	Netherlands
Basel-Landschaft	Switzerland	North Denmark Region	Denmark
Basque Country	Spain	North Rhine-Westphalia	Germany
Bavaria	Germany	Northwest Territories	Canada
Blekinge	Sweden	Nouvelle-Aquitaine	France
British Columbia	Canada	Ontario	Canada
Brittany	France	Oppland	Norway
California	USA	Oregon	USA
Carinthia	Austria	Provence-Alpes-Cote-d'Azur	France
Catalonia	Spain	Quebec	Canada
Central Denmark Region	Denmark	Queensland	Australia
Connecticut	USA	Sao Paulo	Brazil
Drenthe	Netherlands	Scotland	United Kingdom
Emilia-Romagna	Italy	South Australia	Australia
Helsinki-Uusimaa	Finland	South Holland	Netherlands
Hesse	Germany	Thuringia	Germany
Jalisco	Mexico	Ucayali	Peru
Jamtland	Sweden	Upper Austria	Austria
KwaZulu-Natal	South Africa	Veneto	Italy
La Reunion	France	Vermont	USA
Laikipia County	Kenya	Wales	United Kingdom
Lombardy	Italy	Wallonia	Belgium
Lower Austria	Austria	Washington	USA
Manitoba	Canada	Western Cape	South Africa
Minas Gerais	Brazil	Yucatan	Mexico
Minnesota	USA		

Appendix 2. Policy instruments in climate policies data sources

<i>Policy instruments data sources</i>	
The climate group (examples)	<ul style="list-style-type: none"> • https://www.theclimategroup.org/partner/western-cape (Western Cape) • https://www.theclimategroup.org/partner/state-bavaria (Bavaria) • https://www.theclimategroup.org/partner/province-british-columbia (British Columbia)
Under2 Coalition (examples)	<ul style="list-style-type: none"> • https://www.under2coalition.org/sites/default/files/thuringia-appendix-english.pdf (Thuringia) • https://www.under2coalition.org/sites/default/files/emilia-romagna-appendix.pdf (Emilia-Romagna) • https://www.under2coalition.org/sites/default/files/jalisco-appendix-english.pdf (Jalisco)
Regions' climate policy plans (examples)	<ul style="list-style-type: none"> • http://www.environnement.gouv.qc.ca/changements/plan_action/pacc2020-en.pdf (Québec) • http://www.air-climat.org/wp-content/uploads/2017/02/AVIS_RAPPORT_Adaptation_dereglement_climatique_12-2016_VF.pdf (Provence-Alpes-Côte d'Azur) • https://www.euskadi.eus/contenidos/documentacion/klima2050/es_def/adjuntos/KLIMA2050_es.pdf (Basque Country) • https://www.environment.act.gov.au/__data/assets/pdf_file/0003/1414641/ACT-Climate-Change-Strategy-2019-2025.pdf/_recache (Australian Capital Territory) • https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/nsw-climate-change-policy-framework-160618.pdf (New South Wales)

Appendix 3. Percentage of highly, moderately and lowly committed to mitigation regions adopting each instrument

<i>Instrument implemented</i>	<i>Adopting regions' mitigation commitment level</i>		
	High commitment	Moderate commitment	Low commitment
Taxation/Fees	50%	27%	23%
Tax exemptions	50%	20%	30%
Subsidies	47%	31%	22%
Cap and Trade	49%	36%	16%
Voluntary agreements	35%	42%	23%
Standards	42%	36%	11%
Certifications/labels	48%	38%	14%
Prizes/awards	43%	14%	43%
Legislation	50%	30%	20%
Information and training	43%	33%	24%
Public procurement	44%	38%	18%
Public system	31%	44%	25%

Appendix 4. Percentage of highly and lowly committed to adaptation regions adopting each instrument

<i>Instrument implemented</i>	<i>Adopting regions' adaptation commitment level</i>	
	High commitment	Low commitment
Taxation/Fees	32%	68%
Tax exemptions	50%	50%
Subsidies	27%	73%
Cap and Trade	24%	76%
Voluntary agreements	23%	77%
Standards	30%	70%
Certifications/labels	19%	81%
Prizes/awards	14%	86%
Legislation	25%	75%
Information and training	29%	71%
Public procurement	32%	68%
Public system	22%	78%