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Lesnikowski, A, Biesbroek, R, Ford, JD orcid.org/0000-0002-2066-3456 et al. (1 more author) (2020) Policy implementation styles and local governments: the case of climate change adaptation. *Environmental Politics*. ISSN 0964-4016

<https://doi.org/10.1080/09644016.2020.1814045>

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Policy implementation styles and local governments: the case of climate change adaptation

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ABSTRACT: Adaptation to impacts of climate change is a key pillar of climate change governance, and local governments have historically played a major role in the design and implementation of these policies. An array of political, economic, institutional, social and individual factors influence adaptation policy instrument choice. At the local government level, these choices also reflect inter-governmental dynamics that can constrain or support local efforts. We analyze eight hypothesized drivers of local adaptation policy instrument choice using fractional regression analysis and multilevel modelling. Local governments are pursuing diverse adaptation policy implementation styles that are associated with different levels of internal capacity, local political economies and problem perception. Dependency on national governments, the presence or absence of national adaptation mandates, national decision-making traditions and national adaptation policy approaches are also associated with some local policy instrument choices.

KEYWORDS: Climate change; adaptation; policy implementation; policy formulation; policy instrument; local government

WORD COUNT: 7457

Introduction

Policies to adapt to the impacts of climate change are rapidly emerging across countries, sectors and levels of government. While greenhouse gas emissions reduction policies have historically emerged from more centralized decision-making processes, adaptation emerged largely from autonomous and bottom-up processes (Biesbroek and Lesnikowski 2018). Within this diverse policy landscape, the adaptation scholarship positions local governments as key agenda-setters and implementors.

There is a substantial literature concerned with the emergence of adaptation on local policy agendas, and how political, economic and social factors facilitate or constrain policy adoption (Hughes 2017, Reckien *et al.* 2015). Less is understood, however, about how individual policies are accumulating over time into different policy mixes, and what factors explain these patterns across contexts. Policy instrument perspectives on adaptation form an important analytical link between debates about different forms of adaptation governance and specific instances of policy adoption (Henstra 2016). While the empirical study of policy instruments is well-developed in climate change mitigation and sustainability research (for example Rogge *et al.* 2017, Schaffrin *et al.* 2015, Jordan *et al.* 2013), instruments perspectives are still scarce in the empirical adaptation literature (but see Keskitalo *et al.* 2016, Macintosh *et al.* 2015, Macintosh *et al.* 2014, Thistlethwaite and Henstra 2017).

Our contribution examines local adaptation policy instrument mixes within five countries that scholars generally consider to be national leaders among industrialized countries on adaptation planning: Canada, France, Germany, Netherlands and the United Kingdom (Lesnikowski *et al.* 2016). ‘Instrument mixes’ refer to bundles of individual policy instruments that governments adopt in response to a particular policy problem; these mixes can emerge

through the deliberate design of new policy portfolios or incrementally over time (Howlett and Mukherjee 2014). We examine these mixes from the perspective of policy implementation styles and specify eight hypotheses about how local and national policy contexts may influence local adaptation policy choices. The analysis draws from a unique dataset of local adaptation policy instruments that we use to operationalize a taxonomy of policy implementation styles.

Local adaptation policy instrument choice

The literature on policy instruments theorizes several predictors of policy instrument choice, including the nature of policy problems, the character of instruments, actor perceptions and preferences, policy legacies and processes of policy diffusion (Linder and Peters 1989, Landry and Varone 2005, Knill 1998, Holzinger *et al.* 2011). We empirically develop this work in the context of climate change adaptation and local governments, which must further contend with the influence, decisions and mandates of higher levels of government (Loughlin *et al.* 2011).

We operationalize a model of policy implementation styles that proposes four approaches to policy implementation (Howlett *et al.* 2009): i) directed subsidization, ii) public provision and oversight, iii) institutionalized voluntarism and iv) regulatory corporatism (Table 1). Each style represents a distinct combination of substantive and procedural policy instruments, wherein substantive instruments correspond to the direct provision of goods and services in society by governments, and procedural instruments correspond to efforts to build constituencies around issues and indirectly affect the behaviour of different actors (Schneider and Ingram 1990). Public provision and oversight, for example, could include efforts to build new coastal protection infrastructure, upgrade government-owned buildings and infrastructure to more resilient building standards and conduct research and training on the impacts of climate change. Local regulatory corporatist approaches rely on land use planning and building standards to enforce policy targets,

as well as softer instruments like strategic plans and the creation of multi-stakeholder advisory groups. Directed subsidization relies on market-based instruments such as taxes, subsidies and loan programs to implement policy targets. Institutionalized voluntarism relies on information-based tools monitoring or labelling programs and public outreach to encourage behavioural change. We can also consider these implementation styles in the context of different modes of governance, with public provision and oversight associated with more traditional government intervention in society (Peters and Pierre 1998), and regulatory corporatism, directed subsidization and institutionalized voluntarism reflecting different types of governance, namely hierarchical, market and network (Bednar and Henstra 2018).

Table 1. Policy implementation styles.

		Policy environment complexity	
		<i>High</i>	<i>Low</i>
Government capacity	<i>High</i>	<i>Directed subsidization</i> User charges; grants and subsidies; loans; research funding	<i>Public provision and oversight</i> Direct spending; institutional reforms; mandates; demonstration projects; operations; facilities; advice-giving; personnel education and training; reports and assessments
	<i>Low</i>	<i>Institutionalized voluntarism</i> Public outreach; policy networks; public exhortations; monitoring and evaluation; conferences and workshops; inter-governmental agreements; labelling	<i>Regulatory corporatism</i> Spatial planning laws; infrastructure standards; building regulations; strategic plan adoption; advisory group creation; public hearings

Adapted from Howlett et al. (2009). Examples of commonly used local policy instruments.

Explanations of local adaptation policy adoption commonly rely on the heuristic notion of adaptation drivers and barriers, and explain the presence or absence of formalized policies by pointing to various constraints on adaptive capacity, such as material resources, informational resources, leadership and institutional structures (Eisenack *et al.* 2014, Measham *et al.* 2011,

Biesbroek *et al.* 2013). Comparative studies tend to focus especially on material dimensions of local adaptive capacity (Bossio *et al.* 2019); accordingly scholars often observe adaptation planning in large cities, which have bigger tax bases and can more easily access and mobilize resources (Paterson *et al.* 2017, Araos *et al.* 2016). Governance contexts strongly influence the material capacity of cities. Local governments are generally the most constrained level of government with regards to their formal jurisdiction and powers, and the decisions of higher levels of government often influence local adaptation policy priorities and resources (Westerhoff *et al.* 2011, Keskitalo 2010). Dependence on national governments does not necessarily restrict room for ambitious local adaptation policies, however, and there is evidence suggesting that, where local governments receive more support from senior levels of government, they are better able to pursue ambitious adaptation policy (Eckersley 2018).

Our understanding of how the informal dimensions of national governance environments influence local adaptation policy choices is less developed. Past studies have found that national decision-making traditions exert influence over the framing, deliberation and adoption of adaptation policy at the national level (Vink *et al.* 2015, Biesbroek *et al.* 2018), and studies from Australia on adaptation planning in the spatial planning sector indicate that these traditions may exert a similar influence at the local level (Macintosh *et al.* 2014, Macintosh *et al.* 2015). The concept of policy styles articulates broad variations in how governments resolve policy issues across places, levels of government and sectors (Richardson *et al.* 1982). It emphasizes that most policy decisions occur in the context of established norms and processes, and so legacies of past decisions influence present policy decisions (Pierson 2000). We follow Howlett and Tosun's definition of policy styles as 'the manner in which policy deliberations take place and the kinds of actors and ideas present' (Howlett and Tosun 2018, p. 5). Scholars describe policy styles both

as national and sector-specific characteristics (Freeman 1985), and so we consider both overarching national decision-making traditions and specific national adaptation policy approaches. This study therefore contributes to discussion about how both local and national policy environments influence local adaptation policy choices, and examines local adaptation policy instrument mixes from a comparative perspective. The following sub-sections describe the hypothesized predictors of local adaptation policy instrument mixes that we test here.

Hypothesizing local predictors of local adaptation policy instrument mixes

We characterize local predictors of adaptation policy instrument mixes along two dimensions: i) the capacity of the state to act and ii) the complexity of the policy environment in which decisions are made (Howlett *et al.* 2009). Capacity encompasses both the material capacity of governments to formulate and implement policy, and the extent to which external actors perceive government action on adaptation to be legitimate. The complexity of the local policy environment captures more sector-specific dynamics, including the diversity of interests operating within decision-making processes and the perceived difficulty of responding to climate change impacts. Based on these dimensions, we identify four local hypotheses on local policy instrument mix development (Table 2).

Table 2. Description of hypotheses.

Theoretical hypotheses	Analytical hypotheses
<p><i>Local policy context</i></p> <p>H1 Higher resource capacity is positively associated with directed subsidization and public provision and oversight.</p>	<p>Larger local populations are positively associated with implementation via directed subsidization and public provision and oversight.</p>

H2	Higher sectoral legitimacy is positively associated with directed subsidization and public provision and oversight.	ICLEI membership is positively associated with implementation via directed subsidization and public provision and oversight.
H3	Higher complexity of the policy environment is positively associated with directed subsidization and institutionalized voluntarism.	A larger local manufacturing economy is positively associated with local adaptation policy implementation via directed subsidization and institutionalized voluntarism.
H4	Higher complexity of the policy problem is positively associated with directed subsidization and institutionalized voluntarism.	Perception of greater diversity in climate change risks is positively associated with local adaptation policy implementation via directed subsidization and institutionalized voluntarism.
<i>National policy context</i>		
H5	Greater decentralization of authority is positively associated with local implementation by directed subsidization and public provision and oversight.	Lower dependency on intergovernmental resource transfers is positively associated with local adaptation policy implementation via directed subsidization and public provision and oversight.
H6	Exercise of top-down authority on a policy issue is positively associated with local implementation by regulatory corporatism.	National mandates on local adaptation are positively associated with regulatory corporatism.
H7	Local policy implementation styles are positively associated with national decision-making traditions .	Neo-corporatist decision-making cultures are positively associated with local adaptation policy implementation via regulatory corporatism and institutionalized voluntarism.
H8	Local policy approaches are positively associated with national policy approaches on a given issue.	National adaptation policy implementation styles are positively associated with local adaptation policy implementation styles.

To test whether higher governing capacity predicts local instrument mixes we adopt a proxy variable for local governing capacity that we assume co-varies with the ability of local governments to leverage skills and resources in designing adaptation policies: *local population*.

We assume that larger local governments have higher organizational and fiscal capacity, resulting in higher internal policy capacity. We expect that higher resource capacity will be

positively associated with implementation approaches that require more organizational ability, specifically directed subsidization and public provision and oversight (H1).

Beyond material capacity, however, political consensus around the legitimacy of adaptation as a policy issue also influences local willingness to adopt adaptation policies (Fünfgeld and McEvoy 2014, Kalafatis 2018, Wang 2013). We expect that where adaptation is highly contested in the eyes of local actors, governments will work to build consensus around the need for government action by adopting informational and voluntary instruments (Schneider and Ingram 1990). The literature on urban climate change networks argues that these organizations are important for building political will on climate action, and contribute to establishing shared norms and expectations about climate change policies (Betsill and Bulkeley 2004, Fünfgeld 2015, Hakelberg 2014). We therefore use municipal or metropolitan *ICLEI-Local Governments for Sustainability (ICLEI) membership* as a proxy measurement for the perceived legitimacy of adaptation action. ICLEI is one of the most established urban sustainability and climate change networks and has a global reach through its membership list. Joining a high-profile network such as ICLEI signals political acknowledgement that climate change is an important local issue, and we expect to find a positive association between ICLEI membership and directed subsidization and public provision and oversight (H2).

We interpret the complexity of local policy environments along two lines: the types of actors participating in the political system, and the perceived complexity of addressing local climate change risks. Due to data constraints we interpret the complexity of actor environments narrowly as the “degree of difficulty in negotiating agreements among the parties involved” in solving a policy problem (Peters 2005, p. 358). Data sources with comprehensive coverage of local voting behaviour or interest group preferences on climate change policy-making are non-

existent across the countries considered here, so we are unable to model other key dimensions to this variable, such as local electoral competition or the heterogeneity of actors involved in decision-making. We therefore use a demographic indicator that United States-based studies have found to be associated with positive attitudes on environmental policy: the extent to which the local employment is *dependent on manufacturing*. We assume larger manufacturing sectors to be associated with more pro-business attitudes, lower acceptability of environmental regulation and a generally lower emphasis on environmental policy agendas (Krause 2011, Portney 2003). Where there is a larger local manufacturing economy we expect to observe greater adoption of directed subsidization and institutionalized voluntarism (H3).

Finally, we expect that governments are more likely to use either regulatory instruments or public provision and oversight where they perceive policy problems to be less complex and more bounded in scope (H4) (Howlett 2005). Here we assume that where decision-makers perceive climate change to be a complex challenge with multiple dimensions, cities are more likely to adopt adaptation policies that address multiple risks. We calculate a *Simpson's Diversity Index* score for the diversity of climate change risks addressed in policy instrument mixes and use this as a proxy measurement for perceived issue complexity (Simpson 1949).

Hypothesizing national predictors of local adaptation policy instrument mixes

We employ two constructs to examine linkages between national policy context and local instrument choices: i) state-local relationships and ii) national policy styles. We use *vertical fiscal imbalance (VFI)* to measure state-local relationships, which captures asymmetries in the fiscal capacities of subnational government *vis à vis* national governments (Aldasoro and Seiferling 2014). We expect local governments to rely on their authority to spend and tax

(directed subsidization) and to directly deliver adaptation goods and services (public provision and oversight) where subnational independence over taxing, spending and borrowing is relatively high (as in the case of more decentralized democracies like Canada and Germany) (H5).

Conversely, we expect to see more reliance on regulatory or voluntary measures where fiscal independence is lower (e.g. the Netherlands or the United Kingdom). Where fiscal capacity is low, we also expect to see an increased influence from top-down leadership on adoption of substantive local adaptation.

Our second national-level hypothesis predicts that national mandates can increase local government engagement with adaptation policy-making even where local governments may otherwise not act by compelling policy innovation and also giving political cover for risk of failure (Howlett 2014, Homsy and Warner 2015). We therefore expect to find that national mandates are positively associated with regulatory corporatism (H6). We use a dummy variable to capture the presence or absence of national mandates on local adaptation policy. Of the countries represented in this dataset, France, Germany and the United Kingdom have national mandates for local action on adaptation, while Canada and the Netherlands do not.

To operationalize differences in national decision-making traditions, we focus on the relationship between public and private actors in political systems, which is an important explanatory variable for understanding public policy outcomes (Lijphart 1999, Loughlin *et al.* 2011). These institutional arrangements are typically juxtaposed between two types of relationships: neo-corporatism and pluralism. Neo-corporatism is associated with stronger traditions of cooperation and consensus-building and involves more centralized negotiation between the state and small numbers of interest groups (Jahn 1998). In contrast, pluralist traditions are more open, with a larger number of societal interests competing for power and the

ability to influence policy agendas (Lijphart 1999). We expect that, in more neo-corporatist environments (e.g. the Netherlands or Germany), local governments adopt more regulatory corporatist or institutionalized voluntary styles of adaptation policy implementation (H7), and that the capacity of local governments to adopt ambitious policies may explain the tendency towards one or the other approach. We test only the *degree of neo-corporatist arrangements* here due to collinearity between pluralism and neo-corporatism in our dataset (Biesbroek *et al.* 2018, Jahn 2016).

We draw from a previous study of the sixth national communications to the United Nations Framework Convention on Climate Change (UNFCCC) that identified key adaptation actions being undertaken by national governments to identify *national adaptation policy styles* (Lesnikowski *et al.* 2016). Actions recorded in that dataset were re-coded according to the taxonomy used here, and then aggregated using the policy implementation styles model. The national adaptation policy portfolios of Canada, France, Germany, the Netherlands and the United Kingdom all emphasize public provision and oversight, but they differ in the relative prominence of the remaining implementation styles. We expect to find positive associations between national adaptation policy styles and local adaptation policy styles (H8), which indicates a shared approach to climate change across government levels within a country.

Methods

We apply a systematic content analysis approach to identify local adaptation instrument mixes. This approach required taking an inventory of climate change adaptation policies adopted by local governments between 2010 and 2017. We use domain-specific key words ('climate change' and 'adaptation') to identify relevant policy documents, and then analyzed and coded each document according to a deductively determined list of local policy instruments (see Appendix

A for details on policy instrument categories). We grouped policy instruments based on the policy implementation style categories described in Table 1, and measured the overall presence of each approach within local policy instrument mixes based on the ratio of that style to the other styles.

Case selection

We draw on a dataset of adaptation policy instruments collected from 125 local governments in Canada, France, Germany, the Netherlands and the United Kingdom. The dataset provides comprehensive information on adaptation policy choices made between 2010 and 2017 (Lesnikowski *et al.* 2019). We followed a variation-finding approach to specify the countries where we would collect data from (Tilly 1984) using Lijphart's basic principles for classifying majoritarian and consensus-based democracies: federal-unitary organization and executive-party relationship (Lijphart 1999). Based on these principles, each country included here embodies a different model of state structure, with Canada and Germany being federal and decentralized, the Netherlands being semi-federal, the United Kingdom being increasingly unitary and decentralized, and France being unitary and centralized. The countries also differ with respect to electoral and party systems, interest group mediation and concentration of power. Germany and the Netherlands tend towards more consensus-style politics and Canada, France and the UK tend towards more competitive politics. Finally, the language abilities of the research team were an important consideration given the need to code primary policy documents.

We define 'local government' as the lowest tier of government that has responsibility over land use planning, building and all or most local service provision. This includes municipalities (Canada, Germany, the Netherlands), communes (France) and local authorities/metropolitan districts/London boroughs (United Kingdom). We collected data from

the largest 25 local governments in each of these countries, with the expectation that large cities are more likely to be engaged in climate change adaptation (Paterson *et al.* 2017). Nonetheless, the population range is wide and includes both large and medium size local governments (maximum population: 2,731,571; minimum population: 108,915). We identified policy instruments in 119/125 of these local governments, for a final dataset of 119 local governments (see Appendix A for the list of cities).

Independent variable measures

We integrated independent variable data from several major databases to operationalize the proxy variables specified above. These sources include national statistics offices, the Organisation for Economic Co-operation and Development (OECD), an index of neo-corporatism from Jahn (2016), the Centre for Cities European Cities Data Tool, our previous dataset on adaptation in the Sixth National Communications to the UNFCCC and our own dataset of local government policy instruments (Appendix B).

Data analysis

We used fractional logistic regression modelling and mixed effects modelling to test the hypotheses described above. Fractional regression modelling is advisable where independent variables are fractional variables bounded between, and including, 0 and 1 (Papke and Wooldridge 1996, Murteira and Ramalho 2016). We applied clustered fractional regression modelling for within-group variation to our local-level hypotheses to control for variance related to country clustering using the *frm* package (Version 1.2.2) in RStudio (Ramalho 2015). We then applied random intercept mixed effects modelling to the country-level hypotheses, which accounts for the hierarchical nature of the dataset where governments are clustered within countries (Hox *et al.* 2010). The *frm* package does not have mixed effects capabilities, so we ran

generalized linear mixed effects models (GLMM) using the *lme4* (Version 1.1-9) package in RStudio (Bates *et al.* 2015). We ran GLMM models in which we converted the dependent variables in these models to binary variables (where $0 < \text{mean portfolio share}$; $1 \geq \text{mean portfolio share}$) due to the small sample size and few groups at level 2 of these models ($j = 5$).

We did not run combined models for our local and national predictors due to concerns of overfitting, and so cannot draw any firm conclusions regarding interactions between variables at different levels. Instead we interpreted findings from both sets of models in light of empirical insights from the adaptation literature and the implementation styles model, which suggest promising directions for further investigation of the interactions between local and national predictors. Given current debates about network-specific effects on local climate change policies (Yi *et al.* 2017, Kern 2019), we also ran sensitivity analyses on the local-level models to determine whether the results are sensitive to the selection of a different urban climate change network. To do this we substituted membership in the Global Covenant of Mayors for Climate and Energy for ICLEI membership, which also has a global membership reach and has been found to have a generally positive impact on political commitment to climate change planning (Domorenok 2019). We summarize these results below and in Appendix C of the Supplemental Materials. Finally, we standardized the local population variable due to the wide range of values on this predictor. No other variables were scaled or centered.

Results

Descriptive results

The average number of policy instruments identified for each local government is 26.62 (st. dev: 31.68). We observe a positive correlation between policy instrument accumulation (i.e. total policy instruments

adopted) and the diversity of policy instrument types represented in local instrument mixes (Kendall's $\tau = 4.70$, $p < 0.001$). Consequently, few local governments have an implementation approach that consists of just one implementation style, and those that do tend to have very few instruments ($n < 5$) within their policy portfolios.

We observe that public provision and oversight, regulatory corporatism and institutionalized voluntarism are widespread among the local governments surveyed, with 80-87 percent of local governments including these approaches in their policy instrument mixes. We find far fewer local governments to have instrument mixes containing a direct subsidization implementation style (35 percent). The largest number of local governments with directed subsidization instruments are located in Canada (14 of 44), and the fewest are located in the Netherlands (5 of 44). Additionally, among those local governments that do have a policy implementation approach that includes directed subsidization, it constitutes a much lower share of their overall profile compared to the other implementation styles. Table 3 provides the mean values of each implementation style by share of total local policy mix disaggregated by country.

Table 3. Average composition of local instrument mixes by country (%).

	Public provision and oversight	Regulatory corporatism	Directed subsidization	Institutionalized voluntarism
Canada	0.37	0.23	0.04	0.36
France	0.36	0.31	0.03	0.30
Germany	0.41	0.23	0.02	0.17
Netherlands	0.27	0.40	0.02	0.23
United Kingdom	0.45	0.41	0.01	0.12

Local-level predictors of local policy instrument mixes

We estimated four fractional regression models, one per theorized implementation style, to assess whether governing capacity and the complexity of policy environments predict local adaptation instrument mixes (Table 4a). The predictive power of each model ranges across implementation styles but is generally low. The significance of individual predictors also varies across models.

Table. 4a Local predictors of local adaptation policy implementation styles.

	Implementation styles			
	Public provision and oversight	Regulatory corporatism	Directed subsidization	Institutionalized voluntarism
<i>Population</i>	0.13 (0.09)	-0.08 (0.08)	0.15 (0.09)*	-0.15 (0.07)**
<i>ICLEI</i>	0.24 (0.23)	-0.43 (0.11)***	0.47 (0.48)	0.07 (0.22)
<i>Manufacturing</i>	0.00 (0.01)	-0.04 (0.00)***	0.01 (0.03)	0.04 (0.02)**
<i>Risk profile</i>	0.20 (0.62)	1.08 (0.39)***	-0.71 (0.72)	-1.11 (0.27)***
Constant	-0.69 (0.59)	-0.67 (0.16)***	-3.57 (0.78)***	-1.01 (0.55)*
R ²	0.05	0.15	0.04	0.14
Observations	119	119	119	119

Table. 4b National predictors of local adaptation policy implementation styles.

	Implementation styles			
	Public provision and oversight	Regulatory corporatism	Directed subsidization	Institutionalized voluntarism
STATE STRUCTURE				
<i>VFI</i>	-0.01 (0.01)	0.02 (0.01) ^{1,***}	-0.03 (0.01) ^{1,***}	-0.01 (0.01)
Constant	0.49 (0.41)	-1.11 (0.38)***	-0.03 (0.38)	0.47 (0.56)
<i>Mandate</i>	0.57 (0.38) ¹	0.16 (0.65)	-0.46 (0.57)	-0.48 (0.62)
Constant	-0.08 (0.29)	-0.25 (0.50)	-0.73 (0.43)*	0.25 (0.48)
NATIONAL POLICY STYLE				
<i>Corporatism</i>	-0.12 (0.19)	0.25 (0.27)	0.06 (0.27)	0.03 (0.29)
Constant	0.23 (0.21)	-0.10 (0.30)	-1.00 (0.31)**	-0.02 (0.33)

<i>National policy mix</i>	-3.35 (1.95) ^{1,*}	5.64 (2.27)**	-1.96 (4.39)	13.37 (7.42)*
Constant	2.30 (1.21)*	-1.27 (0.50)**	-0.87 (0.43)**	-1.55 (0.88)*

Standard errors in parentheses; $p \leq 0.10^$; $p \leq 0.05^{**}$; $p \leq 0.01^{***}$*

¹ *Singular fit*

We find mixed support for our local-level hypotheses. Local capacity is generally consistent with the theoretical model of implementation styles, with local population and ICLEI membership positively associated with public provision and oversight but insignificant (H1 and H2). Contrary to our expectations, however, we find that public provision and oversight is associated with higher complexity of the local policy environment (larger manufacturing base and more diverse risk profile), rather than lower complexity (H3 and H4).

As predicted, we find that regulatory corporatism is generally associated with lower resource capacity (H1) (non-significant) and non-membership in urban climate networks (H2) (highly significant), and also a smaller presence of traditional economic interests (H3) (highly significant). However, we also find that regulatory corporatism is positively associated with the perception of adaptation as a more complex policy issue (H4) (highly significant). This suggests that low levels of material capacity and lack of network membership do not necessarily constrain the adoption of authoritative policy instruments, but that recognizing climate change adaptation as a complex policy problem and having fewer traditional economic interests represented in the local economy increases the likelihood of regulatory policy adoption. It may therefore be the case that local adoption of regulatory instruments is more likely when two conditions are met: decision-makers have a higher perception of issue urgency, and local stakeholders have a higher tolerance for coercive government intervention on climate change issues.

The directed subsidization style represents the use of market-based mechanisms to influence the behaviour of individuals, households, the private sector and other actors. As expected, we find that this approach is associated with higher local government capacity (H1) and consensus on climate change (H2) (borderline and non-significant, respectively), and also the presence of larger traditional economic interests (H3) (non-significant). This is consistent with our findings regarding regulatory policy approaches; where there is a larger presence of traditional economic interests, we observe a stronger preference for market-based approaches rather than regulatory approaches. Contrary to our expectations, however, we also find that directed subsidization is associated with a narrower focus on climate risk (H4), most likely reflecting a strong association between directed subsidization and flood risk management in Canadian local governments (Lesnikowski *et al.* 2019).

Institutionalized voluntarism represents the exercise of soft powers to shift the behaviours of non-state actors through instruments such as voluntary measures, information campaigns and normative appeals that are typical of network governance approaches. The direction of model coefficients for institutionalized voluntarism are similar to those of directed subsidization but with the key exception of resource capacity. Institutionalized voluntarism appears most associated with lower governing capacity (H1) (borderline significant) and narrower perceived risk complexity (H4) (highly significant), but higher likelihood of ICLEI membership (H2) (non-significant) and a larger traditional economic base (H3) (significant). This suggests that local governments that have a desire to act on climate change but face greater resource constraints and have more traditional economic sectors may adopt soft instruments to encourage behavioural changes in more specific areas of climate risk. Along with the directed subsidization model, this

suggests that there is an important relationship between the composition of local economies and adaptation policy choices.

We conducted sensitivity analyses for all four models to determine whether the selection of a different urban climate change network would affect the analysis results. Results were consistent across all four models in these sensitivity analyses, with somewhat higher model fit in the regulatory corporatism model (see Appendix C for results table).

National-level predictors of local policy instrument mixes

We apply mixed effects models to examine whether country-level characteristics influence local implementation styles. Owing to concerns of overfitting with such a small number of Level-2 groups ($j = 5$), we ran 16 separate mixed models for each national-level predictor (Table 4b). Several models were flagged with singular fit errors that indicate possible overfitting but, given that each model contains only one predictor variable, greater parsimony is not achievable here.

As hypothesized in H5, we observe that less dependence on fiscal transfers from national governments is positively associated with adaptation via public provision and oversight (non-significant) and directed subsidization (highly significant), while greater dependence is positively associated with regulatory corporatism (highly significant). We also observe that lower dependence on vertical fiscal transfers is associated with institutionalized voluntarism (non-significant). Overall this suggests that stronger hierarchical relationships between national and local government are associated with greater uptake of regulatory policies at the local level, while less dependency is associated with greater use of direct provision, market-based, or voluntary instruments. Greater local dependence on national governments therefore appears to be a predictor for the local adoption of regulatory policy instruments, indicating that local resource

constraints are not necessarily an impediment to substantive policy adoption. It is possible, however, that national mandates behave as a mediating variable in this relationship by creating obligations for national governments to support local adaptation efforts (H6). Though we were unable to examine interactions between our two measures of state structure, our findings suggest that national mandates do influence the uptake of different policy approaches involving public provision and oversight and regulatory corporatism. In the absence of these mandates, local governments rely more heavily on market-based or voluntary instruments.

Findings on the relationship between national policy styles and local implementation styles are mixed. Consistent with H7, we observe that corporatist decision-making traditions are positively associated with regulatory corporatism and institutionalized voluntarism (both non-significant), and negatively associated with public provision and oversight (non-significant). Contrary to our expectations, we find that corporatism is positively associated with directed subsidization, however, this finding is insignificant ($p = 0.84$). We observe positive associations between only two national and local policy instrument mixes (H8), regulatory corporatism and institutionalized voluntarism. We find negative associations between public provision and oversight (significant at a 90 percent confidence level) and directed subsidization (non-significant). Some aspects of local policy choice therefore appear to reflect national policy styles, with more corporatist national decision-making traditions associated with more corporatist and network-based instrument choice at the local level. The negative association between national and local directed subsidization may reflect sector-specific approaches to flood risk management that are typical in Canadian cities, which we observed are the most likely in our dataset to adopt market-based policy instrument approaches.

Discussion

This work contributes to a growing body of explanatory research on adaptation policy choice. The statistical power of the models summarized here is generally low, but nonetheless these results provide useful insights for refining our understanding of adaptation policy instrument choice. Unsurprisingly, we found that most local policy approaches represent hybrid forms of the four types of policy implementation styles. Public provision and oversight, regulatory corporatism and institutionalized voluntarism have higher uptake among local governments, while directed subsidization constitutes a much smaller share of local policy approaches.

We observed that adoption of public provision and oversight instruments are associated with higher government capacity and policy environment complexity, and that the exercise of national authority to mandate local adaptation seems to be important for the emergence of this policy implementation approach. We also found that regulatory corporatist policy approaches are occurring even in the context of lower local capacity, and that national decision-making cultures, greater exercise of top-down authority by national governments and the absence of local oppositional coalitions representing traditional economic interests are likely to facilitate the adoption of these more authoritative instruments (Kalafatis 2018). The role of these variables in local policy choice is also borne out in the institutionalized voluntarism models, where we found a positive association between larger local manufacturing sectors and national corporatist decision-making traditions, an absence of national adaptation mandates and both lower internal capacity and greater independence from national governments with regards to resource transfers. The descriptive results and results from the directed subsidization models suggest that this policy implementation approach tends to emerge particularly where local governments have higher internal capacity but receive little top-down guidance or resources from national governments. It

also seems most closely associated with flood response in Canadian local governments, which have long engaged in market-based approaches to flood risk management and are increasingly linking adaptation planning with flood risk management (Thistlethwaite and Henstra 2017). This indicates that, in some countries, sectoral policy styles influence local adaptation policies where there is an intersection with climate change adaptation planning.

As with all empirical research, however, this work contains several limitations. The lack of comprehensive data on the institutional arrangements and electoral politics of local governments is a major challenge in comparative local policy research (Kantor and Savitch 2005). Here we attempt to overcome these data challenges by compiling a unique dataset of national and local variables from multiple sources (Methods section), but nonetheless we rely on proxy measurements for local variables. The low significance levels for both local and national-level predictors may be attributable to the challenge of operationalizing the concepts described here and future empirical research should compare the sensitivity of our findings to different measurement decisions. Additionally, the small number of non-random groups (countries) in Level 2 of our models ($j = 5$) limit the analytical power of the multilevel models presented here. We therefore caution against generalizing the results of these national models beyond the five countries included in our sample. Results on Level 2 hypotheses are primarily exploratory in nature and need further examination with a larger sample size.

Notwithstanding these limitations, however, this research makes several important contributions to the literatures on climate change adaptation and local policy choice. The results support findings that national institutional contexts, particularly local-national relationships and policy styles, influence local policy choices and that the degree of independence between local and national governments can constrain the local adoption of substantive adaptation policy

(Eckersley 2018). Our results suggest that national mandates on adaptation may play an important role in mediating the relationship between local capacity and policy choice. Where local governments experience lower internal capacity and there is an absence of top-down leadership on adaptation, we observe a higher reliance on procedural policy instruments that are characteristic of network governance. In contrast, however, where there was low internal capacity and stronger dependency on national governments for resource transfers, with the presence of national mandates we observe greater local adoption of authoritative policy instruments. We therefore argue that a lack of material local policy capacity is insufficient for explaining the 'implementation deficient' in adaptation governance (Dupuis and Knoepfel 2013). These findings are consistent with previous work in the US that finds internal drivers to be insufficient in medium and small local governments for the adoption of environmental sustainability policies, and that most local governments are more likely to adopt sustainability policies when higher levels of government play a coordinating role in multilevel governance arrangements (Homsy and Warner 2015). In the Canadian context, Bednar *et al.* (2019) also observed that reliance on network governance arrangements is likely to arise at local and regional levels in the wake of weak senior government leadership on adaptation, which has proven difficult to translate into enforceable adaptation policies.

Furthermore, our findings suggest that local political economies influence adaptation policy choices. While scholars have empirically demonstrated this relationship in the US context (Krause 2011, Kalafatis 2018), here we observe a similar relationship between economic interests and policy choices across different country contexts. These results indicate that the presence of traditional economic interests is not necessarily a barrier to the adoption of substantive adaptation policies, but it is associated with a preference for market- and network-

based instruments or direct government delivery of adaptation (e.g. through infrastructure upgrades) rather than regulatory instruments. The political acceptability of policy alternatives is a well-known driver of policy choice (Linder and Peters 1989, Béland *et al.* 2018), and should be explicitly considered in climate change assessment and planning guidelines (Wellstead *et al.* 2013).

Finally, to our knowledge this contribution is the first to consider the influence of national policy styles on local adaptation policy choice, both from a perspective of overarching decision-making styles and national adaptation policy approaches. We find early signals that both these dynamics may partially explain local policy choices, but a larger multilevel analysis with stronger statistical power is needed to disentangle the relationship between them and their interactions with local-level predictors. It appears, however, that local governments in more corporatist countries are more likely to adopt regulatory corporatist or voluntary approaches to adaptation rather than public provision and oversight, and that in those contexts national policy instrument mixes are more strongly related to local policy instrument mixes.

Acknowledgements

Funding from the Social Sciences and Humanities Research Council of Canada supported this research. Many thanks to Malcolm Araos, Geneva List, Mathijs Veenkant and Florian Dorner for their assistance with data collection. We also very much appreciate the constructive feedback of three anonymous reviewers and the editor, which contributed significant improvements to the manuscript.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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