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To cite this article: Lucas Geese, Chantal Sullivan-Thomsett, Andrew J. Jordan, John Kenny & Irene Lorenzoni (2024) Measuring climate mitigation policy content in text-as-data: navigating the conceptual challenges, Political Research Exchange, 6:1, 2387120, DOI: [10.1080/2474736X.2024.2387120](https://doi.org/10.1080/2474736X.2024.2387120)

To link to this article: <https://doi.org/10.1080/2474736X.2024.2387120>



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Published online: 06 Aug 2024.



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RESEARCH NOTE



Measuring climate mitigation policy content in text-as-data: navigating the conceptual challenges

Lucas Geese , Chantal Sullivan-Thomsett , Andrew J. Jordan , John Kenny 
and Irene Lorenzoni 

School of Environmental Sciences and Tyndall Centre for Climate Change Research, Norwich Research Park, University of East Anglia, Norwich, UK

ABSTRACT

A burgeoning comparative politics literature investigates the role of key political actors, such as political parties and members of parliament, in the global challenge of tackling climate change. While text-based indicators of political behaviour, such as parliamentary speeches, questions or social media, provide abundant sources of data for comparative research, much remains to be learned from the rigorous large-scale quantitative analysis of political text in relation to climate change. As a typical first step of text-as-data (TADA) workflows, the isolation of climate-related content is crucial. Yet it is also bedevilled by crucial conceptual complexities inherent to the nature of climate change as a global policy problem. In this note, we unpack these complexities in order to urge future TADA research to be mindful of them. We argue that, especially in comparative research settings, TADA analysts must find means to attenuate the tension between 'overlooking' and 'overstretching' climate-related text content. An illustrative example drawing on more than 400,000 parliamentary questions in the UK and Germany suggests that a thoughtful combination of off-the-shelf methods can be usefully leveraged to address this important challenge in applied political research.

ARTICLE HISTORY



Received 17 October 2023
Accepted 26 July 2024


KEYWORDS

Climate change; comparative politics; text-as-data; parliaments; parties

Introduction

While climate change was long considered a remarkable blind spot of political science (Javeline 2014; Keohane 2015), there is now a burgeoning comparative literature investigating the role of key political actors, such as political parties and members of parliament (MPs), in the grand societal challenge of tackling climate change (Moore et al. 2024). Understanding how these actors engage with the escalating climate crisis across (sub)national and supranational (e.g. EU) levels is an urgent matter. The 2015 Paris Agreement assigned signatories (currently 195 countries plus the EU) the political responsibility to

CONTACT Lucas Geese  l.geese@uea.ac.uk  School of Environmental Sciences and Tyndall Centre for Climate Change Research, Norwich Research Park, University of East Anglia, Norwich NR4 7TJ, UK

 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/2474736X.2024.2387120>.

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cut greenhouse gas (GHG) emissions and thereby invoked a stream of long-term climate mitigation pledges across those jurisdictions (Green and Reyes 2023; Tosun and Peters 2021; Victor et al. 2017). Importantly, climate change is essentially a long-term policy problem requiring a substantial and sustained degree of political commitment for decades to come (Boasson and Tatham 2023; Jordan et al. 2022). Therefore, studying what keeps parties and politicians (un)committed to climate action across different contextual settings holds crucial implications for the achievement of national climate objectives and ultimately the goals of the Paris Agreement.

However, although the existing literature has made important inroads into this field of study, relatively little use has been made of voluminous political text corpora in comparative research settings.¹ To be sure, the improved digital availability and accessibility of the behavioural traces of political actors in institutional online archives and social media has advanced profoundly over the past decade and thus holds great promise for studying political behaviour across country contexts through the use of quantitative text-as-data (TADA) methods (e.g. Benoit 2020; Schwalbach and Rauh 2021; Wilkerson and Casas 2017). Yet extant cross-country research on party behaviour in climate politics has largely relied on qualitatively coded party manifestos (e.g. Carter et al. 2018; Farstad 2018; Huber et al. 2021; Schwörer 2024). Meanwhile, the large-scale quantitative analysis of other types of political text in relation to climate change-related political behaviour, such as parliamentary speeches or social media communication, has mainly featured in single-country studies examining the climate-related behaviour of individual politicians (e.g. Barrie, Fleming, and Rowan 2023; Debus and Himmelrath 2022; Finseraas, Høyland, and Søyland 2021; Guber, Bohr, and Dunlap 2021; Hopper and Swift, 2022; Schaefer et al. 2023; Schürmann 2023).

The dominance of party manifesto data in comparative research settings might be understandable since the lower volume of text data (compared to for example parliamentary speeches) makes the qualitative assessment of individual statements more manageable for researchers. However, party manifestos are a time-limited data source typically produced at the end of election cycles and often for the strategic purpose of creating a certain public image that party leaders want to convey during election campaigns. Moreover, they cannot capture important intra-party variation among politicians of the same party; after all, political parties do not always act as unitary actors but are often sites of internal contestation among their members and representatives (Schumacher and Elmelund-Præstekær 2018). In contrast, more voluminous text-based sources of party and politician behaviour, such as parliamentary questions (PQs), provide more fine-grained observational data between elections and can thus provide more time-sensitive and data-rich details of elite-level climate politics. Climate politics researchers are therefore well advised to consider these alternative sources of text data in addition to party manifestos when endeavouring to conduct comparative research.

Yet considering more voluminous TADA sources in comparative research settings requires researchers to devise analytical tools to gauge climate-related aspects of political behaviour that can travel across country boundaries while also remaining sensitive to specific time and country contexts (Adcock and Collier 2001, 535; Sartori 1970). This creates conceptual and methodological challenges of its own, which are not only related to the sheer amount of text but also to the multifaceted nature of climate policy and the conceptual question of what climate policy actually is (Carter et al. 2018;

Dubash 2021; Sartori 1970). Unfortunately, TADA methods come with notable pitfalls (Grimmer and Stewart 2013), and many of these are particularly relevant in regard to these key conceptual complexities of climate policy.

In this research note, we, therefore, engage with the challenge of delineating climate-related content in large political text corpora in comparative research settings. We focus on political actors' *issue attention to climate change mitigation policy*, wherefore the text coding challenge considered is a binary *classification* problem. Given that the examination of more fine-grained research questions (e.g. in terms of specific climate policy positions or communicative 'frames') depends on the delineation of climate-related from other content, this is an important measurement task potentially guiding succeeding research in crucial ways.

In the next section, we discuss how the well-known conceptual trade-off in comparative politics between 'overlooking' and 'overstretching' relevant empirical manifestations (Sartori 1970) is especially pertinent when seeking to identify climate policy-relevant content in spoken and written political language. In short, attention to climate change mitigation is difficult to grasp conceptually due to its versatile nature as an issue that crosscuts several traditional policy areas, which all have varying levels of ambiguity regarding their relatedness to GHG emissions cuts and considerable country-contextual specificities.

We then discuss in Section 'Strengths and weaknesses of off-the-shelf TADA methods to tackle the conceptual challenge' strategies to take into account the conceptual hurdles in applied TADA research. We find that although many 'off-the-shelf' methods have notable deficiencies in grappling with the aforementioned conceptual complexities, recent methodological advances that combine different TADA methods suggest means to handle the challenge far better.

Finally, as an illustrative example, in Sections 'Using the keyword discovery algorithm of King, Lam, and Roberts (2017) to identify climate-related content in quantitative text corpora' and 'Findings', we showcase and validate a specific combination of TADA methods – the semi-supervised text analysis workflow proposed by King, Lam, and Roberts (2017) – for the purpose of delineating climate policy-related content in a corpus of more than 400,000 written PQs tabled by MPs in the British House of Commons (2010–2019) and the German Bundestag (2013–2021). The results of this endeavour suggest that a thoughtful combination of different TADA approaches can usefully attenuate the severity of the conceptual trade-off and thereby facilitate quantitative research on climate-related political behaviour from a comparative perspective. Thereafter, Section 'Conclusion' concludes.

The conceptual trade-off: overlooking relevant variation vs. conceptual stretching

Climate change is a long-term, highly complex and difficult-to-comprehend problem that cuts across several socioeconomic sectors; it is certainly not always immediately evident what policies are needed, when, and in which country context to effectively cut GHG emissions (Carter et al. 2018; Dubash 2021; Vandeweerd, Kerremans, and Cohn 2016, 268; Willis 2018).

Central to the challenge of scoping issue attention to climate change in political text is thus what climate policy is and when actors can be reasonably assumed to have climate

change on their minds when acting politically. Mostly implicitly, existing research has answered these questions in two broad ways.

The first approach has focussed on empirical manifestations in which actors *explicitly* consider climate change as a policy issue. This analytical strategy is common in research studying party manifestos, legislative speechmaking or bill sponsorship. Here, researchers typically assume that politicians or parties consider climate policy whenever they unambiguously refer to climate change (e.g. Bromley-Trujillo, Holman, and Sandoval 2019; Häussler et al. 2016; Hopper and Swift, 2022; Schwörer 2024).

The second approach has focussed on *specific aspects* of climate legislation. Kinski and Ripoll Servent (2022), for example, examine European Parliament debates around the European Climate Law to understand politicians' use of policy frames in those debates. Similarly, research on roll-call voting behaviour in the USA has most notably studied bills on carbon pricing, such as gas taxes and cap-and-trade emissions trading systems (e.g. Anderson et al. 2023; Vandeweerd, Kerremans, and Cohn 2016).

Both approaches have their merits and, depending on the specific research question, could be adequate choices. The former is perhaps appropriate when researchers are interested in political communication strategies, i.e. direct climate-related signals to other actors, such as constituents, government departments or other parties/politicians. The latter approach, by contrast, provides better insights into actors' decision-making preferences in specific areas of climate policy.

However, both approaches also have limitations. For one, they are highly likely to overlook potentially crucial manifestations of climate-related content. Indeed, qualitative research suggests that focussing on explicit mentions of climate change (the former approach) will likely uncover only the 'tip of the iceberg' of relevant content. In particular, Willis' in-depth interviews with British MPs suggest that they often do not refer explicitly to climate change when advocating for climate policy, but instead mention economic 'co-benefits' or other 'surrogate' aspects of such policy proposals (Willis 2018). Likewise, focussing on a specific aspect of climate legislation (the latter approach) will by definition leave other debates or types of climate policy untouched.

According to Dubash, the challenge of defining the universe of climate policy statements oscillates between defining it (too) narrowly as those 'that exclusively, and intentionally, address climate change', or (too) widely as those that have the capacity of 'impacting climate outcomes', i.e. principally by affecting GHG emissions. While the 'former option risks being unduly limiting (...), the latter risks creating an intractably large set of [policy] institutions' (Dubash 2021, 3–4).

Even though climate change mitigation essentially requires the reduction of GHG emissions in the global atmosphere (UNFCCC 2009), the potential relatability of policy statements to GHG emission levels might most usefully be understood as a *necessary*, but certainly not sufficient, condition for defining climate-related policy proposals. Unfortunately, relying on a policy statements' relatability to GHG emissions as a yardstick for climate policy would 'stretch' the concept beyond comprehensibility because myriad aspects of contemporary human activity have consequences for GHG emissions, hence why some refer to it as a wicked problem (Carter et al. 2018, 739; Lazarus 2009). This would, in Sartori's words, generate a universal concept that lacks empirical value by indiscriminately pointing to *everything*; a situation that is 'dangerously conducive to a Hegelian night, in which all the cows look black (and eventually the milkman is taken for a cow)'

(1970, 1040). Consider, for example, the ‘lockdown’ policies implemented in countries across the world during the peak of the Covid-19 pandemic. While these had a profound impact on global emission levels (Le Quéré et al. 2020), considering them as climate policies would arguably obscure what policymakers had in mind when adopting them.

In order to undertake comparative research, we thus need to climb ‘the ladder of abstraction’ in a manner that adequately ‘broaden[s] the extension of a concept by diminishing its attributes or properties’ (Sartori 1970, 1041). ‘But how high?’ is essentially the question central to the conceptual trade-off. Analysts need to climb the ladder high enough so as to not overlook many potentially relevant context-specific manifestations but not too high so as to have engaged in conceptual stretching. Therefore, the optimization task is to locate the level of abstraction that minimizes overlooking relevant empirical information, while still affording the concept the ability to adequately broaden its extension and make it accessible for comparative research.

Fundamentally, the crux of the matter lies in identifying policy statements that can be labelled as climate-related, even when they don’t explicitly mention climate change but establish this connection *implicitly*. This is a complex undertaking not only because climate policy transcends traditional policy boundaries (e.g. Carter et al. 2018; Scotford and Minas 2019, 71) but also because climate policy is inherently ‘polycentric’ (Dubash et al. 2013, 650–651; Jordan et al. 2015). In fact, countless opportunities exist for politicians to contemplate and propose innovative policy solutions depending on distinct geographical contexts. For example, in countries where energy production relies heavily on fossil fuels rather than renewables, the discourse may revolve around substantial investments in new nuclear power plants (Carter et al. 2018). Conversely, nations with extensive forested areas may prioritize discussions surrounding deforestation (Iacobuta et al. 2018), further highlighting the diversity of climate-related concerns. This challenge of achieving equivalence across various country contexts without sacrificing sensitivity to each unique context is a well-recognized dilemma in comparative politics (Adcock and Collier 2001, 134–136; Przeworski and Teune 1970; Sartori 1970) but has yet to be fully acknowledged in the literature on comparative climate politics (but see Carter et al. 2018).

Doubtlessly, pre-defining all possible manifestations of climate policy across country contexts soon becomes intractable and therefore hopeless. Yet it appears at least plausible that certain policy realms are universally (i.e. across country and time contexts) too important for the purpose of decarbonizing societies, such that a reference to those could be considered ‘climate-related’ even if relevant actors do not mention the goal of climate change mitigation explicitly. Policy studies are important cue-givers for what those policy realms might be. Energy consumption and generation are major sources of global GHG emissions in most countries (e.g. Iacobuta et al. 2018, 1118), such that there is a widespread agreement to consider policies concerning *energy efficiency*, *renewable energy* and *low-carbon transport* (e.g. electric vehicles) as intimately related to climate change mitigation (Averchenkova, Fankhauser, and Nachmany 2017; Carter et al. 2018; Compston and Bailey 2016; Farstad 2018; Iacobuta et al. 2018; Schaffer, Oehl, and Bernauer 2022). Likewise, *carbon pricing policies*, such as taxes on fossil fuels or carbon emissions trading schemes, as well as specific *technological climate solutions*, such as carbon capture-and-storage (CCS), can be plausibly argued to have the implicit intention to mitigate climate change (Averchenkova, Fankhauser, and Nachmany 2017; Compston and Bailey 2016; Farstad 2018; Keohane 2015).

Table 1. Levels of ambiguity of the climate relatedness of policy areas.

Unambiguous	Policy explicitly aiming at climate change mitigation or GHG emissions
Little ambiguity	Energy efficiency (e.g. heat pumps) Renewable/green energy transition (e.g. wind power) Low-carbon transport (e.g. electric vehicles) Carbon pricing (e.g. emissions trading schemes) Climate techno-fixes (e.g. CCS)
More ambiguity	Deforestation/ land-use Agriculture Institutionalized funding/ R&D Buildings/housing Waste

Note: Own composition based on the conceptual analysis and reviewed literature.

In contrast, less prevalent in the existing policy literature is the consideration of policies aimed at reducing emissions from *deforestation* and land-use (e.g. Averchenkova, Fankhauser, and Nachmany 2017), *agriculture* (e.g. Carter et al. 2018), institutionalized *funding* (e.g. research and development) (e.g. Averchenkova, Fankhauser, and Nachmany 2017), *buildings and housing* (e.g. Schaffer, Oehl, and Bernauer 2022) or *waste* (e.g. Compston and Bailey 2016, 150); most likely because the significance of such areas as sources of GHG are more context-dependent and not always unambiguously related to climate change mitigation.

Table 1 provides an overview of these lessons, indicating broad levels of ambiguity for the climate relatedness of different policy sectors. When the delineation of general climate policy-related content is the analytical goal, scholars ought to consider policy statements that are ‘unambiguously’ related to climate change mitigation as well as those that are of ‘little ambiguity’. The latter class of policy realms can be reasonably expected to be universally linked to GHG reductions across time and space. In contrast, extending the empirical scope to policy realms listed under the ‘more ambiguity’ category carries a greater risk of falling into the trap of the conceptual overstretch, although doing so may nevertheless be justifiable depending on the specific research question and set of countries under study.

Therefore, when attempting to conceptualize and operationalize actors’ attention to climate policy, researchers should not only be mindful of the analytical opportunities, limitations and risks of conceptual overlooking vs. overstretching but also seek to maximize the relatability of their own to other research contexts. To that end, scholars need to make sure that their analytical choices and underlying assumptions are transparent to others, even if a given research project examines the experience of a single country at a specific moment in time. Put differently, the concepts and measurements underpinning our research questions must be crafted in a manner that facilitates the study of the same research questions across a broader spectrum of comparable cases. This would be conducive to the development of a coherent and generalizable body of comparative research encompassing diverse national experiences (Laver and Shepsle 1996, 7–8; Morton 1999, 36) – a highly desirable undertaking in order to do justice to the global nature of climate change.

Addressing the conceptual challenge in political TADA research

The conceptual challenge of measuring issue attention to climate mitigation policy becomes particularly evident when employing quantitative TADA methods. To shed

light onto the methodological challenge in applied research, we begin this section by reviewing the strengths and weaknesses of state-of-the-art or 'off-the-shelf' TADA methods vis-à-vis the conceptual challenges outlined above and reference their use in the existing literature on parties and politicians' role in climate politics. Thereafter, we report our experience with a useful combination of such methods, that is, the computer-assisted keyword discovery workflow proposed by King, Lam, and Roberts (2017).

Strengths and weaknesses of off-the-shelf TADA methods to tackle the conceptual challenge

The available menu of conventional computational approaches to document classification consists of simple key term matching methods based on pre-defined dictionaries as well as supervised and unsupervised machine learning algorithms (Benoit 2020; Grimmer and Stewart 2013). However, when the identification of climate policy-related content is the measurement task, each of those approaches have different (dis)advantages (Grimmer and Stewart 2013; Wilkerson and Casas 2017).

Unsupervised document classification algorithms, such as topic models, have found some application in the existing literature on politicians' engagement in climate politics. For example, Finseraas, Høyland, and Søyland (2021) were able to identify parliamentary speech content in relation to green industries and the reduction of oil production in Norway through the use of structural topic models (Roberts et al. 2014). Similarly, Guber et al. used structural topic models to analyse US Congressional floor speeches that made a reference to one of three key terms ('climate change', 'global warming' and 'greenhouse gas') and overall identified 18 different 'topics', such as denialist narratives, carbon pricing and climate impacts amongst others. While topic models are the appropriate choice of model when researchers want to discover document categories from a text corpus, they are less useful when researchers seek to measure a pre-defined class of documents (Grimmer and Stewart 2013, 281). Given that there is no guarantee that topic models will discover a specific concept in any one corpus (Grimmer and Stewart 2013, 269; Reveilhac and Morselli 2022), it appears unlikely they can discover the same concept to the same extent in two different text corpora (e.g. from different country and/or language contexts) (see also Wilkerson and Casas 2017, 535).

Supervised document classification algorithms, by contrast, such as the Naïve Bayes classifier, are specifically designed to assign documents to pre-defined concepts. In a nutshell, this class of TADA methods requires researchers to hand-code a random subset of documents, from which the algorithm learns the relationship between words and categories to then machine-code the remaining documents in the corpus (e.g. Benoit 2020; Grimmer and Stewart 2013, 275–800). Yet a persistent challenge in using supervised document classification algorithms is that their performance depends considerably on how uniform the categories of interest are distributed across the corpus (Watanabe 2018, 297). When categories are relatively sparsely distributed across the corpus, training the classification algorithm will require many more training examples compared to when the category of interest features, say, half of the text corpus (Laurer et al. 2024; Reveilhac and Morselli 2022). Unfortunately, climate policy-related issues are relatively infrequently discussed in text-based indicators of political behaviour given the plethora of other political issues featuring on the political agenda (e.g. Farstad 2018). Hence, solely relying on

supervised document classification algorithms to identify climate policy-related content in large political text corpora would require researchers effectively to hand-code thousands of training examples, which ‘makes them a nonstarter for many researchers and projects’ (Wilkerson and Casas 2017, 533). However, Wilkerson and Casas also note (533) that there are often creative ways to make use of this class of TADA methods to reduce the effort required. As we will outline in the following section, the keyword discovery algorithm proposed by King, Lam, and Roberts (2017) is one of those creative ways.

Key term dictionary methods enjoy popularity in existing climate-related research, either for the purpose of narrowing down a set of documents for further analysis (Bromley-Trujillo, Holman, and Sandoval 2019; Guber, Bohr, and Dunlap 2021; Häussler et al. 2016; Hopper and Swift, 2022; Schwörer 2024; Wendler 2022) or to directly measure issue attention (Barrie, Fleming, and Rowan 2023; Debus and Himmelrath 2022; Schürmann 2023). As an example of the former, Häussler et al. used the key terms ‘climate change’ and ‘global warming’ (and their German translations) to identify legislative debate documents from the plenary sessions and from legislative committees in Germany, Switzerland, the UK and the USA, between 2012 and 2013 before qualitatively coding the use of communicative frames in those selected documents. Similarly, Schwörer (2024) used six key terms (‘clima’, ‘warming’, ‘greenhouse’, ‘heat’, ‘cafeaction’ and ‘temperature’) and their respective translations to identify climate-related content in party manifestos in 10 Western European democracies between 1990 and 2022 before coding that content manually to obtain parties’ climate policy positions. As an example in which dictionaries were used to directly measure issue attention to climate-related content, Schürmann (2023) used the ‘Environmental Policy’ section of the EuroVoc dictionary – a selection of over 200 key term strings available in all EU languages – to filter German MPs’ Facebook posts and parliamentary speeches between 2017 and 2020.

Although these studies contributed significantly to the existing literature, it is important to note that dictionary methods can have several flaws depending on how the key term lists are created. Off-the-shelf dictionaries developed for other text data are not necessarily suitable for new applications, thereby creating a potential for serious measurement error (Grimmer and Stewart 2013, 274; Hillard, Purpura, and Wilkerson 2008, 33). Crucially, as explained in the previous section, using certain key terms can introduce serious biases due to overlooking or overstretching important empirical manifestations of climate policy content. For example, the EuroVoC dictionary on Environmental Policy includes several key terms that relate to general environmental aspects ambiguously related to climate change, such as ‘animal welfare’ or ‘environmental protection’, thus creating a potential to overstretch the concept. Creating key term lists from scratch without knowing what is in the data is also highly deficient (Hillard, Purpura, and Wilkerson 2008). For one, some potential key terms (e.g. ‘climate’) have ambiguous meanings (e.g. ‘climate of fear’ vs. ‘climate change’), thus creating scope for overstretching and identifying many false positive documents, though there are means to reduce ambiguity through the use of bi- or trigrams following a check of their semantical context in which a potential key word appears, or via ex-post qualitative checks. Furthermore, putting the issue of key term ambiguity to the side, it is actually no easy task to come up with a comprehensive list of key terms for a policy issue as versatile as climate policy. As King et al. show, humans are actually highly unreliable at selecting appropriate

key term lists from scratch. Not only do the key term list selections of two individuals familiar with the same subject area hardly overlap, but key term lists chosen collectively by several human users also miss many words that would be instrumental to select the relevant set of documents (King, Lam, and Roberts 2017, 973–975). This, in turn, would create a lot of false negative documents and hence raise the odds for overlooking relevant content. This bias is particularly magnified when only few key terms are selected that very obviously relate to climate change (e.g. ‘climate change’ and ‘global warming’). As already mentioned, especially for an issue as multifaceted and context-dependent as climate policy, it becomes basically intractable for humans to pre-define all those possibilities through key terms.

Using the keyword discovery algorithm of King, Lam, and Roberts (2017) to identify climate-related content in quantitative text corpora

To advance existing TADA research on party and politician behaviour in relation to climate policy, scholars should hence seek to attenuate as much as possible the conceptual tension between overlooking and overstretching climate-relevant content. That is, they should strive to identify previously unknown manifestations of climate policy statements within specific contexts while also achieving equivalence across time and country contexts without overstretching its concept. Although the weaknesses of *individual* TADA methods for document classification may appear off-putting against this formidable challenge, TADA methodologists have noted that a thoughtful *combination* of methods can be leveraged to rectify the weaknesses of individual approaches (Grimmer and Stewart 2013, 270; King, Lam, and Roberts 2017; Reveilhac and Morselli 2022). This, we argue, applies also to the conceptual challenge at hand. To showcase this, we report our experience with a specific combination of TADA methods – the computer-assisted keyword discovery workflow developed by King, Lam, and Roberts (2017) – to gauge climate-related content from more than 400,000 written PQs tabled by legislators in the UK House of Commons (2010–2019) and the German Bundestag (2013–2021).²

We focus on written PQs as a behavioural indicator that has been relatively underutilized in existing research on the role of parties and politicians in climate politics. Leveraging PQs more strongly in future research could provide important analytical advantages supplementing insights from the study of party manifestos and parliamentary debates. Similar to floor speeches, written PQs exist almost ubiquitously in parliamentary systems beyond Germany and the UK (Russo and Wiberg 2010). PQs are primarily a political tool that MPs and their parties can use to publicly elicit information from government departments and thereby hold them accountable in front of the public eye (Wiberg 1995). As such, extant political science research has relied on PQs to study how parties in government coalitions keep tabs on government portfolios controlled by their coalition partners (Höhmman and Sieberer 2020) or how they use PQs for the purpose of issue competition and negative campaigning in relation to other parties (Otjes and Louwse 2018) albeit not specifically in relation to climate change.

Moreover, as PQs are commonly used by individual MPs to signal their issue priorities and responsiveness to voter demands, they could provide crucial insights into the policy motives of individual politicians (Martin 2011). Analytically, written PQs also provide important advantages when seeking to study MPs’ individual preferences compared to

parliamentary speechmaking and oral question time. While the access to speaking time in plenary debates and oral questions is time-constrained and thus more strongly regulated by the parliamentary frontbench depending on political system characteristics (Cox 2009; Keh 2015; Proksch and Slapin 2015), written PQs are the least party-controlled parliamentary instruments that MPs across different countries have at their disposal to demonstrate their individual policy priorities in addition to those of their parties (Keh 2015). As such, PQs have been rigorously analysed, for example, in the study of individual MPs' responsiveness to local ethnic minority communities (e.g. Geese and Schwemmer 2019), but not yet in relation to climate policy.

Our text corpora consist of 379,619 and 39,688 PQs³ tabled by MPs in the UK and Germany, respectively. The following two examples of climate-related PQs from Germany and the UK further indicate that written PQs tend to be formatted in a comparatively similar, concise way.

John McNally (Scottish National Party), 13 December 2017: To ask the Secretary of State for Business, Energy and Industrial Strategy, what steps the Government is taking to ensure that there is sufficient low carbon electricity generation in the UK to meet the requirements of the fifth carbon budget.

Annalena Baerbock (Bündnis 90/ Die Grünen), 24 June 2016: What is the current timetable for the dialogue on the coal phase-out announced by Federal Minister of Economics Sigmar Gabriel, and which stakeholders are to be invited to this?⁴

We choose Germany and the UK as cases that differ on a number of pertinent dimensions related to the conceptual challenge in applied TADA research. Thus, showing the validity and plausibility of the approach across these cases should increase our confidence in its utility for future research. First, analysing Germany and the UK provides useful variation in terms of language, with the German use of compound words offering a significant linguistic contrast to the English language (Reber 2019, 106). Second, crucial institutional differences between the two countries (e.g. first-past-the-post vs. mixed-member proportional representation) arguably lead to significantly different politics in terms of government-opposition, party competition and legislator-constituency dynamics (e.g. Carey 2009) with the differentiation between a debating (UK) and a working (Germany) parliament being another crucial difference (e.g. Proksch and Slapin 2015). Third, both countries differ notably in their approach to energy transitions as a cornerstone of climate change mitigation (Gransauß, Rhodes, and Fairbrother 2023). For example, the UK relies more strongly on nuclear energy in order to decarbonize the energy system, whereas Germany effectively exited this technology in April 2023.

The workflow of King et al. essentially combines supervised document classification and human key term selection to discover a comprehensive and unambiguous list of key terms related to a specific concept (here: climate policy). It can be described as semi-supervised because it is human-led and computer-assisted rather than fully automated (King, Lam, and Roberts 2017, 976). It is iterative in that humans interact iteratively with an automated classification algorithm to continually improve a list of key terms supposed to measure a specific concept from text data (977).

In the first step of the semi-supervised workflow, researchers need to separate a corpus of documents into two sets – a reference and a search set (King, Lam, and Roberts 2017, 977). The *reference* set should mainly consist of documents that are likely to have a higher

prevalence of some aspects of the concept of interest. The *search* set consists of all remaining documents, although many of those are likely to contain other (a priori unknown) aspects of the concept. Identifying the key terms that point to all the documents that contain conceptually relevant content is the overall task to be achieved. Following King et al., who indicate that a simple keyword search is a viable approach to separate the two document sets initially and get the workflow going (2017, 978), we start the first iteration by separating each country corpus into a reference and a search set by utilizing a very basic character string search: ‘climate’ in the English corpus and ‘*klima*’ in the German corpus. The first reference sets thus contain PQs containing relevant key terms such as ‘climate change’ (German: ‘*Klimawandel*’) or ‘climate emergency’ (German: ‘*Klimanotstand*’), whereas the first search sets contain remaining PQs, many of which contain other relevant yet unknown key terms. By using this basic initial character string search, the automated classification algorithm departs from the same starting point to maximize comparability of the analysis across both country corpora.

In the second step, a(n ensemble of) supervised document classification algorithm(s) (see Grimmer and Stewart 2013 for more detail) is trained on the reference set and an equal number of randomly chosen documents from the search set. The classification algorithm is trained with the goal of predicting documents in the reference set based on a list of key terms. After training, the classifier is applied to the *entire* corpus to identify the *target* set, that is, a newly discovered set of documents that ‘reveal similarities to the reference set, and so they likely contain new keywords we can harvest to better represent the concept of interest’ (King, Lam, and Roberts 2017, 978). In our running example, we utilize an ensemble of three supervised document classification algorithms (Naïve Bayes, Support Vector Machine and LASSO regression) to identify the *target set*. The three classification algorithms are implemented as part of the R package bundle *quanteda* (Benoit et al. 2018). Following the suggestions of King, Lam, and Roberts (2017, 979), we consider a PQ to be in the target set if at least one classifier in our ensemble suggests so.

In the third step, a statistical likelihood score is used to facilitate the identification of key terms that discriminate most strongly between the documents in the target set and in the remaining corpus and are, therefore, likely to be related to the concept of interest. In our running example, we use again the *quanteda* package to calculate keyness scores for each term rather than simply comparing relative word frequencies. Keyness reports a word token’s association with a document set relative to another document set as well as the statistical significance of that association based on a signed chi-square test (Scott 2000). Terms with high keyness appear significantly more frequently in the target set than expected, given their relative frequency in the rest of the corpus. We calculate keyness scores for unigrams (e.g. ‘co2’), bigrams (e.g. ‘climate change’) and trigrams (e.g. ‘carbon dioxide emissions’) in order to be able to identify unambiguous multiword expressions and to make the discovery across the two languages (English and German) comparable.⁵

In the fourth step, that list of candidate key terms is presented to the human user to choose key terms that obviously describe well and unambiguously the concept of interest, including already known (e.g. ‘climate change’) as well as previously unknown/not recalled traits (e.g. ‘air passenger duty’) of the concept. Essentially, terms with high keyness can be viewed as ‘suggestions’ made by the algorithm, which we, as human users, can then explore in order to find different and/or not previously recalled meanings

of the climate policy concept (King, Lam, and Roberts 2017, 979). In our analysis of UK and German PQs, we explore the first thousand key terms in each target set with the highest keyness scores to select those that are unambiguously relevant to the different features of the climate policy concept as depicted in Table 1.

This new list of key terms is then used to restart the first step of the workflow in order to separate a reference from a search set and ultimately (after the second iteration of the fourth step) generate another updated list of key terms. This newly updated list of key terms is then used to restart the workflow again, and so on. After several iterations, when no substantial improvements to the key term list can be made anymore, the key term discovery workflow can be considered finished, and the final list of key terms can be used to separate conceptually relevant from irrelevant documents. In our running example, this happened after the fourth iteration for the UK corpus and after the third iteration for the German corpus.

Findings

We find that the iterative interaction between algorithm and human researcher ensures that the latter remains in the 'driving seat' to steer the discovery of previously unknown key terms as manifestations of the highly versatile and context-dependent concept of climate policy. Rather than confronting human researchers with the unsolvable task of pre-defining all relevant empirical manifestations of the concept and potentially introducing severe 'overlooking' biases, the computer-assisted workflow allows researchers to *discover* these manifestations from the text corpora under consideration. The researcher is actually required to assess the suggestions made by the algorithm and can thereby, based on his/her knowledge of the country context, safeguard that only key terms are considered that have no or little ambiguity in terms of their climate relatedness. This appears to be useful practice to keep at bay not only the possibility of a 'conceptual overstretch' but also the bias of 'overlooking' useful content to remain sensitive to the specificities of different country contexts.

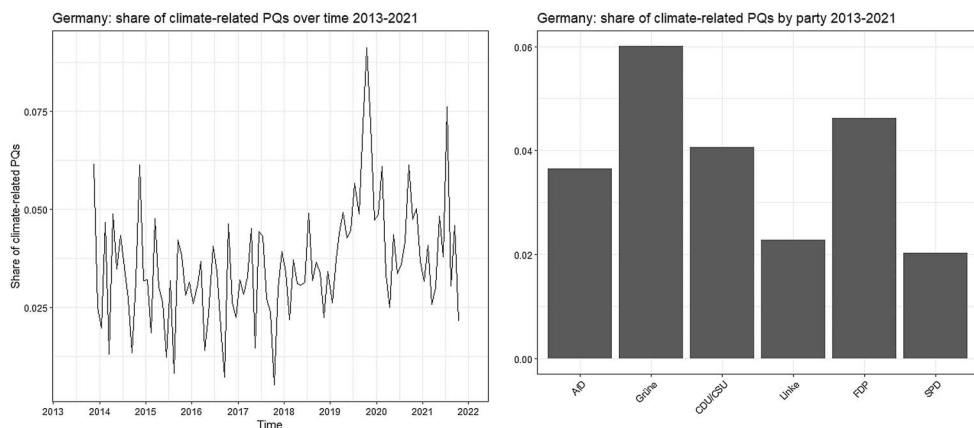
Table 2 exemplifies this by showing how the resulting list of key terms from both country corpora map onto the categories developed in Table 1.⁶ As expected, the key terms refer mainly to policy sectors that were labelled 'unambiguous' or 'of little ambiguity' in Table 1⁷, even though the specific categories were not a priori defined in the algorithm. Despite this, however, the discovered key terms appear highly comparable, yet context-sensitive, across both countries. On the one hand, comparability across both lists seems to be given as several key terms, i.e. their equivalent translations were found in both country corpora, for example, the key terms 'greenhouse gas' ('Treibhausgas'), 'energy efficiency' ('Energieeffizienz'), 'wind power' ('Windkraft'), 'electric vehicle' ('Elektroauto') or 'emissions trading' ('Emissionshandel'). On the other hand, however, both lists also appear to be sufficiently context-sensitive given that some key terms in both lists have no equivalent translation in the respective another list, for instance, the German 'Energiewende' and 'Kohleausstieg' (in English: 'energy transition' and 'coal phase-out') or 'net zero' and 'carbon capture and storage' in the UK.

Based on these key terms, we find that in the UK only 2.5% and in Germany only 3.8% of MPs' PQs were climate change-related. Figures 1 and 2 show over time and party distributions of those. In the UK, the spike in 2011 coincides with the publication of the

Table 2. Final list of unambiguous climate-related key terms in German and UK PQs.

Climate-related realm	Germany	UK
Climate change and GHGs	klimaschutz, co2, klimawandel, climate, klimaziel, treibhausgas, klimakrise, carbon, for_future, klimapolitisch, klimapolitik, klimarelevant	climate_change, carbon_emission, green_deal, carbon_dioxide, carbon_dioxide_emission, greenhouse_gas, low-carbon, carbon_reduction, carbon_offsetting, methane, decarbonis, net_zero, zero_carbon, carbon_budget, paris_agreement, co2
Energy efficiency	energieeffizienz, kraft-wärme-kopplung, kwk, energieeinsparung	energy_efficien, smart_meter, heat_pump, renewable_heat_incentive, energy_saving, heat_and_power, clean_growth, green_economy, energy_performance
Renewable/green energy transition	energiewende, eeg, erneuerbare, wasserstoff, strukturwandel, windenergie, kohleausstieg, strukturstärkungsgesetz, windkraft, photovoltaic, kohleverstromung, kohlekommission	renewables, renewable_energ, feed-in_tariff, biomass, offshore_wind, onshore_wind, renewable_heat, decommissioning_date, photovoltaic, pv, solar_power, solar_pv, biofuel, wind_turbine, wind_farm, renewables_obligation, solar_panel, wind_power, hydrogen, biodiesel, solar_industry, solar_energ, wind_energ, renewable_electric
Low-carbon transport and infrastructure	elektromobilität, infrastrukturabgabe, ladeinfrastruktur, ladepunkt, elektroauto, elektrofahrzeug, ladesäule, e-auto,	renewable_transport, electric_vehicle, air_passenger_dut, vehicle_excise_dut, charging_point, low_emission_vehicle
Carbon pricing	co2-bepreisung, emissionshandel, behg, co2-preis, brennstoffemissionshandelsgesetz	emissions_trad, carbon_pric, fuel_duty, carbon_floor, air_passenger_dut, vehicle_excise_dut
Geoengineering/ techno-fixes		carbon_capture, capture_and_stor
Forestry, Land-use, Agriculture, Fisheries, Food	redd+	
R & D, institutional funding	klimafinanzierung	green_investment, climate_fund, green_deal_finance
Buildings/ housing		wall_insulation
Waste		

Note: Country and policy-specific lists of key terms identified with King, Lam, and Roberts (2017) TADA algorithm.

**Figure 1.** Over-time and party-related trends of climate-related PQs in Germany, 2013–2021.

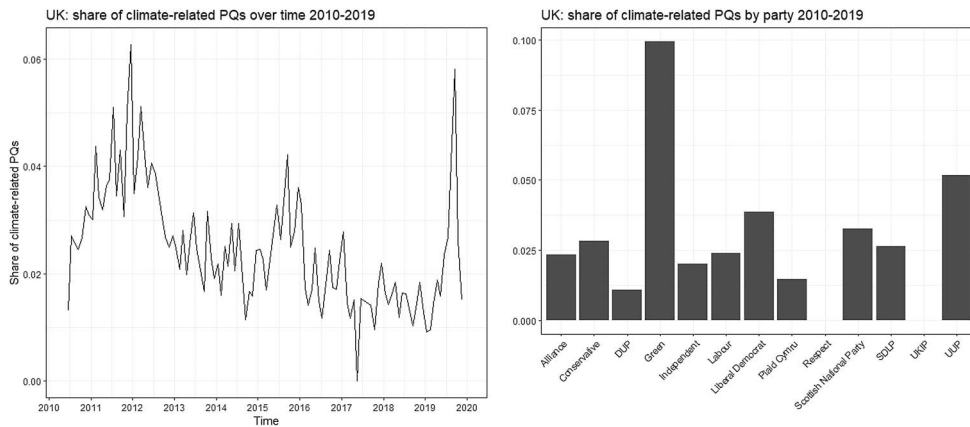


Figure 2. Over-time and party-related trends of climate-related PQs in the UK, 2010–2019.

government’s Carbon Plan for reducing emissions (UK Government 2011), while it then tails off over the rest of the lifetime of the 2010–2015 coalition government between Conservatives and Liberal Democrats in line with climate change being largely deprioritized by the Conservative party (Carter and Clements 2015). The uptake in summer 2015 follows the Conservative’s first budget after winning an overall majority in the general election, who – no longer having to compromise with the Liberal Democrats on the direction of climate policies – announced that renewable energy sources would no longer be exempt from the Climate Change Levy, while, at the same time, expanding tax relief for oil and gas exploration (Evans 2015; Seely and Ares 2016).

In both countries, the increase towards climate change towards the end of 2015 coincides with increased attention dedicated to the 21st Conference of the Parties negotiations which resulted in the Paris Agreement. The over-time trends in both countries also indicate peaks in late 2019 which happened shortly after the largest to date Fridays for Future global youth strike in September 2019 (Euronews Green 2023).

In Germany, the 2019 spike may also reflect parliament’s scrutiny of Germany’s framework climate law, the Federal Climate Protection Act, which set sectoral targets to enable Germany to reach net zero emissions by 2050, in line with their commitments to the Paris Agreement (Flachsland and Levi 2021). Lastly, the peak of issue attention towards climate change in Germany in mid-2021 is consummate with a time period in which climate change was high on the public agenda due to the Federal Constitutional Court taking a pathbreaking decision in Spring to urge the government to scale up the Federal Climate Protection Act as well as due to severe rainfalls leading to disastrous floods in many German regions in July 2021 resulting in over 180 deaths (Töller 2023).

To investigate party differences, we report the share of climate-related written PQs among all written PQs tabled by MPs of each party group per country. Reporting the share rather than the absolute number of climate-related PQs allows us to take into account factors that drive the overall number of PQs per party, e.g. party group size, government-opposition status and cross-country institutional differences regarding how many PQs MPs can ask per month (see footnote #3). In both countries, it is unsurprising that MPs from Green parties have the highest share of climate-related PQs. Of the main

political parties in the UK, it is further notable that the Liberal Democrats tend to have a relatively stronger focus on climate policy than the Conservatives and Labour. However, it is important to note that in absolute terms, Labour MPs have asked by far the most PQs in relation to climate change (5,379) in the observation period and more than double the number asked by Conservative MPs (2577), which is plausible given the former's status as opposition and the latter's status as government party throughout the observation period. Similarly, in Germany, the liberal FDP is somewhat more active in the climate policy realm than other parties (with the exception of the Greens). Interestingly, of the mainstream parties comprising the – at the time – 'Grand' government coalition, the centre-right CDU/CSU appears to have a stronger climate-focus in their written PQs than the centre-left SPD. This pattern can be explained by the well-known tendency of coalition parties to use written PQs to keep tabs on the respective partner's government portfolios (Höhmman and Sieberer 2020). With the SPD being in charge of the Ministry of Environment from 2013 until 2021 and of the Ministry of Economy and Energy between 2013 and 2017, it is plausible that CDU/CSU MPs had overall a relatively stronger climate focus in their PQs than SPD MPs.

Moreover, to illustrate the validity of the semi-supervised keyword discovery approach, we validate the result of the automated key term labelling against the 'gold standard' provided by two human hand-coders, results of which can be inspected in Supplementary Material B. Here, we also provide points of comparison against other dictionaries used in the literature that authors have provided in both German and English (Häussler et al. 2016; Schürmann 2023; Schwörer 2024).

Conclusion

Given that the 2015 Paris Agreement assigned the political responsibility for addressing climate change to national and EU-level politics, there is an academic need to develop a cohesive body of comparative research on the role of key political actors, such as parties and MPs, to do justice to the global nature of the climate change challenge. At present, the existing literature has underutilized quantitative political text data as a research resource in comparative research settings, even though such research data holds particular promise for advancing the state-of-the-art due to the increased digital availability of text-based indicators of political behaviour and the expanding arsenal of TADA methods in the Social Sciences (Benoit 2020; Schwalbach and Rauh 2021).

In this article, we argue that in order to use the TADA approach in comparative climate politics research, scholars must be acutely aware of and equipped with analytical tools to navigate the tension between 'overlooking' and 'overstretching' pertinent empirical manifestations of political actors' climate-related activities (Sartori 1970). As Adcock and Collier note, to the extent that the measurable phenomenon 'is heterogenous in ways that may affect measurement validity, it is essential to (1) assess the implications for establishing equivalence across these diverse contexts and, if necessary, (2) adopt context-sensitive measures' (Adcock and Collier 2001, 535). Drawing on this understanding, we posit that striking a balance across the goals of cross-contextual equivalence and context-sensitivity is particularly tricky in climate-related TADA research and thus needs to be given special attention by political researchers.

Our illustrative example of delineating climate-related content from a vast collection of over 400,000 PQs in Germany and the UK indicates that it is often not a single off-the-shelf method but a thoughtful combination of different TADA methods (King, Lam, and Roberts 2017) that can effectively attenuate the tension between ‘overlooking’ and ‘overstretching’. As political researchers are becoming increasingly familiar with a standard set of TADA methods, we are optimistic that this research note will become a useful reference point for many interested in applying these in the study of climate politics and beyond.

However, we realize that the field of TADA methodology is rapidly developing with new methods being designed to technically address problems of training data size for supervised machine learning or key term ambiguity, for example, word embeddings, guided topic modelling and deep transfer learning techniques (e.g. Devlin et al. 2018; Grootendorst 2022; Laurer et al. 2024; Rodriguez and Spirling 2022; Terechshenko et al. 2020). As these new methods become mainstreamed into the arsenal of standard TADA tools used by political scientists, their application could provide alternative solutions to the conceptual challenge outlined in this article.

Nonetheless, even if TADA tools are becoming technically more sophisticated, the present article should remain an important reference point for future TADA approaches to measuring climate mitigation policy content. In particular, it makes a case for the importance of qualitatively assessing the adequacy of the measuring tool across different country contexts and languages. The climate change issue is particularly tricky in this respect due to its versatile nature as an issue that cuts across traditional policy areas, including varying levels of ambiguity across these policy areas and considerable country-contextual dependencies. These features augment the relevance of the conceptual ‘overstretching’ vs. ‘overlooking’ trade-off so well-known in comparative politics.

In fact, because of this, we would argue that a notable requirement of TADA approaches in the study of comparative climate politics is that researchers need to gain a sufficient qualitative understanding of the nature of climate politics and policy in the countries they seek to study. While language barriers might be reasonably well addressed by modern machine translation techniques (Reber 2019), there is no easy/automated solution to gaining a deep understanding of the country contexts under study. Without this understanding, researchers using the computer-assisted keyword discovery workflow (or other ‘new’ TADA methods) risk failing to identify climate-related text content that establishes equivalence while remaining adequately sensitive to each country context under study. In other words, there is no ‘one-size fits all’ approach to doing comparative climate politics research using large-scale political text corpora. However, if scholars choose sound comparative research designs (e.g. Przeworski and Teune 1970; Seawright and Gerring 2008) and are willing to obtain the contextual knowledge relevant to their case selection, TADA methods hold great potential to advance the scientific knowledge about climate politics in crucial ways.

Notes

1. Following Seawright and Gerring (2008, 293), our notion of ‘comparative research’ encompasses not only studies across multiple countries or cases but also single-case studies as long as those serve the goal ‘to understand a larger class of similar units’.
2. The dataset has been collected as part of the DeepDCarb project (<https://www.deepdcarb.org/>).

3. The considerable difference between the total numbers of PQs tabled in both countries related to differences in procedural rules in the two parliaments. In the German Bundestag, MPs can table up to four written PQs per months, whereas their use is unlimited in the UK House of Commons.
4. The original German version reads: ‘Wie sieht der aktuelle Zeitplan für den von Bundeswirtschaftsminister Sigmar Gabriel angekündigten Dialog zum Kohleausstieg aus, und welche Interessenvertreter sollen hierzu eingeladen werden?’.
5. In English, the meaning of expressions arises more often from the combination of two or more words (e.g. ‘climate change’), whereas German is known for its usage of longer compound words (e.g. ‘Klimawandel’).
6. Table A1 of Supplementary Material A provides English translations of the German terms.
7. In Tables A2 and A3 of Supplementary Material A, we provide an extended list of key terms featuring more ambiguous examples, showing that the policy sectors labelled ‘more ambiguous’ in [Table 1](#) become more populated when those are taken into account.

Acknowledgements

An earlier version of this article was presented at the Political Studies Association (PSA) Parliaments Annual Conference 2022 in Birmingham. We thank the audience of this conference and three anonymous reviewers for helpful comments and suggestions.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

Funding was generously provided by the ERC (via the DeepDCarb Advanced Grant 882601), and the UK ESRC (via the Centre for Climate Change and Social Transformations (CAST) (Grant ES/S012257/)).

ORCID

Lucas Geese  <http://orcid.org/0000-0002-5085-5029>

Chantal Sullivan-Thomsett  <http://orcid.org/0000-0001-8571-2629>

Andrew J. Jordan  <http://orcid.org/0000-0001-7678-1024>

John Kenny  <http://orcid.org/0000-0001-9401-3555>

Irene Lorenzoni  <http://orcid.org/0000-0001-8226-5755>

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