

# Analysing Parliamentary Discourse on Forestry Management and Timber Industries in Austria and Germany using BERTopic

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## Abstract

Forestry and wood constitute a vital sector in Austria and Germany, significantly contributing to their economies. Facing the challenge of climate change and growing carbon emissions, these countries are crafting and implementing policies that have major repercussions for this sector. Embracing the Industry 4.0/5.0 paradigm presents valuable opportunities for compliance with these emerging standards and regulations. Yet, the forestry and wood sector has not fully exploited the potential of these technological advancements. This paper utilises topic modelling (BERTopic) to identify what is being discussed regarding forestry and wood in the national parliaments in Austria and Germany. The researchers aimed to determine if these countries have national digitization strategies for the timber sector. The research indicates that parliamentary discussions concerning forests and wood align with respective national forest policy management strategies: conservation-focused in Germany and business-focused in Austria. Evidence of strategies to digitise the timber sector was not found for any of the countries. Finally, this paper makes a significant contribution to computational text analysis using political speech data. It introduces a strategy for objectively isolating relevant speech fragments containing various themes and then implementing precise parameters to enhance BERTopic's performance.

## Keywords

Forestry, Wood Industry, Sustainability, Policy Agenda, Twin Transition, Topic Modelling,

## 1. Introduction

In the last decade, society has continuously faced unprecedented challenges reshaping the environmental and technological landscapes. Climate change has escalated into a global crisis characterised by rising temperatures, the increased frequency of forest fires, severe biodiversity loss, and the particular devastation brought on by phenomena such as the spread of the bark beetle in forest ecosystems. The recent years leading up to and including 2019 have been recorded as some of the hottest in history, underlining the urgent need for comprehensive climate action. Concurrently, the digital revolution, propelled by Industry 4.0 and 5.0 paradigms, presents opportunities and challenges, offering new pathways for innovation and sustainability.

The wood industry and forestry, encompassing everything from tree farming to producing wood-based materials and bio-energy, constitute an important share of the European economy and play a key role in pursuing climate neutrality [1]. This sector significantly contributes to the economies of Austria and Germany and provides essential ecosystem services. However, challenged by climate change, by the need for sustainable management practices, and by the rapid pace of technological advancement, the sector is facing the urgent need for suitable policy solutions.

The European Union (EU), recognising the severity of climate emergencies and the transformative potential of technological solutions, has adopted ambitious strategies, namely the European Green Deal and the Digital Decade. These initiatives aim to achieve climate neutrality by 2050 and to foster the equitable adoption of digital technologies, thereby minimising socioeconomic disparities and contributing to the twin transition. The European Green Deal, introduced in 2019, seeks to position Europe as the first climate-neutral continent [2]. This ambitious plan includes many measures, from

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reducing greenhouse gas emissions to investing in sustainable technology and preserving biodiversity. As part of this strategy, the forestry and wood industry emerge as both a beneficiary and an important contributor. On one hand, wood-based products offer sustainable alternatives to environmentally detrimental materials like concrete and plastic. On the other hand, forests act as crucial carbon sinks, aiding in the decarbonisation efforts of the continent [3].

Despite the forestry and wood industry's significant role in the European economy and its potential in the quest for climate neutrality, the integration of Industry 4.0 and 5.0 innovations presents numerous challenges, particularly for small and medium-sized enterprises (SMEs) that have been slow to adopt these technologies [4, 5]. This is particularly noteworthy, as the forestry and wood industry need to embrace digitalisation as an enabler for sustainability [6] and to cope with the pressure of innovation and staying competitive [7]. As such, the focus on this industry allows for exploring how and whether the parliamentary agenda relating to this traditional and diverse sector incorporates digitalisation and technological solutions.

This paper explores the interplay between climate concerns, technological regulation, and the forestry and wood industry through analysing sector-related parliamentary debates in Germany and Austria. In particular, it aims to answer two research questions:

- RQ1: What are the topics regarding forestry and wood discussed in the Austrian and German parliaments?
- RQ2: Are Austria and Germany discussing strategies to facilitate the adoption of Industry 4.0/5.0 innovations in the forestry and timber sector?

To do that, we employ an innovative approach by compiling a database of parliamentary speeches and integrating advanced Topic Modelling techniques with a novel method for precise parameter tuning. This technique is used to analyse the legislative discourses on the forestry and wood sector, providing insights into how Germany and Austria navigate the challenges and opportunities of climate change and the digital transition.

## 2. Case description

Austria and Germany's forestry and timber industries are pivotal to both countries' transition to bioeconomy [8, 9], which, in turn, allows for the transition towards sustainability. These sectors contribute significantly to national GDPs and support hundreds of thousands of jobs [10, 11], reflecting their immense socioeconomic importance for these countries. Our study focuses on a period marked by the presence of the Green parties in the government of both countries, gaining political opportunities to pursue their agenda. After the snap election in September 2019, the Austrian Greens became a minor coalition partner. In Germany, the 2021 election resulted in a so-called traffic light coalition in the government, an alliance between the Social Democratic Party, the Liberals, and the Greens. Thus, both countries present a perfect case for studying the forestry and wood sector. This paper examines the priorities and approaches of Austrian and German political actors in the parliamentary arena regarding this sector. It further explores how these politicians address technology regulation and the promotion of digitisation within the sector.

Germany's approach to forestry management is encapsulated in the principle of "Conservation Through Utilization" (*Schutz durch Nutzung*), which aims to harmonise wood production with conservation efforts within an urbanised societal context [12]. This model has been praised for balancing diverse demands, enabling sustainable wood production alongside recreational use and biodiversity conservation. However, this integrative approach has not been without criticism. Scholars have pointed out the inherent challenges in assuming that all societally relevant services follow timber production, often leading to obscured trade-offs between economic, recreational, and ecological interests. The German forestry model, therefore, finds itself at the nexus of competing demands: the wood industry's push for market-oriented reforms and intensified management practices and the environmental movement's call for more conservation-focused management.

In Austria, the timber industry and forestry sector play a crucial role in the national economy, with the entire wood processing value chain encompassing 172,000 businesses and providing employment for approximately 300,000 people [11]. This accounts for one in every fifteen jobs in the country, highlighting the sector's significance as one of Austria's largest employers. The industry's impact is particularly pronounced in rural areas, where it is a vital source of employment and regional value creation [13]. With such a substantial economic contribution, Austrian forestry and wood policies are instrumental in shaping the sector's sustainability practices, technological adoption, and international competitiveness.

### 3. Data and method

This paper employs Topic Modelling, specifically BERTopic, to identify the principal topics discussed in the German and Austrian parliaments regarding Forestry and the Wood Industry. Our methodological approach involves careful document selection and fine-tuning BERTopic's parameter sets on manually edited speech data to optimise the application of BERTopic. The measures implemented aim to create optimal conditions for the use of BERTopic.

We utilised Python libraries, Python library requests, and BeautifulSoup to collect the necessary parliamentary speech data, enabling us to access and process speeches from the Austrian and German government's APIs. This data consists of political speeches made by national deputies and ministries in the *Nationalrat* (Austria) and *Bundestag* (Germany). Our analysis primarily targets general speeches that outline the political stance on various issues. It does not include the technical discussion of laws, which takes place in committees.

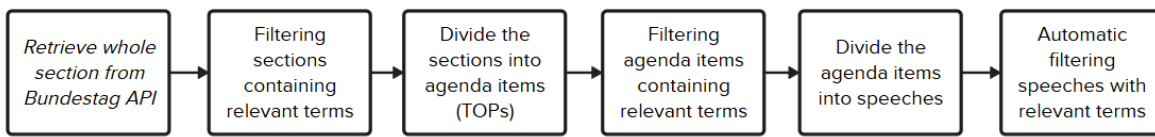
In turn, the filtering process utilises a function specifically designed to pinpoint texts that include one or more terms associated with wood or forestry, thereby selecting content that may be pertinent to the research. This function operates through a two-step filtering process. First, the function scans for and retrieves data containing keywords from a predefined list. This pre-defined list was drawn up by partners who specialise in public policy in this sector and who had access to the speeches collected. It comprises terms related to wood and forestry, employing regular expressions to capture various permutations of the terms. Subsequently, the function compares these instances against a list of forbidden terms. This list encompasses specific names or terms (such as the Austrian village *Walddorf*) which, despite including relevant keywords like "*Wald*," are deemed irrelevant to the research objectives. The filter then keeps only the data which exhibits matches even after excluding forbidden terms.

Figure 1 shows the difference between the data retrieving processes in Austria and Germany. For Austria, we first accessed the *Nationalrat* API to obtain the session (*Sitzungen*) URLs. We automatically accessed these URLs to fetch the individual URLs for each speech during the sessions. Following this, another request to each speech URL allowed us to retrieve the full text of the speeches and information about the speakers. Finally, after collecting all the speech texts, we applied the filter process to retrieve only the speeches with terms associated with wood and forestry. Later, the relevance of these filtered speeches was established through manual checks.

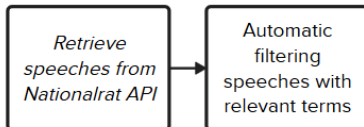
The data collection process for Germany was slightly different, as the API could retrieve entire sections but not individual speeches. Thus, rather than retrieving all speeches and filtering them afterwards, we need to retrieve entire sections and filter first the agenda points containing the terms in our filter and then filter the speeches within the agenda points containing the terms. More specifically, after collecting all records of the German parliamentary sessions (*Plenarprotokolle*), we filtered the sessions and saved them as text documents. To divide the sessions into individual speeches, we started by manually identifying and labelling the start and end of each agenda topic's text (*Tagesordnungspunkte* or TOPs) within the text documents of the sessions. These documents were then re-imported for automatic segmentation. Following that, we reapplied the filtering process to the TOPs and performed automatic segmentation of speeches within the filtered TOPs. Finally, we conducted a last round of filtering on these speeches. Once again, the relevance of the filtered speeches was checked manually.

Figure 2 shows the process of identifying the best-fitting model to find the topics related to wood

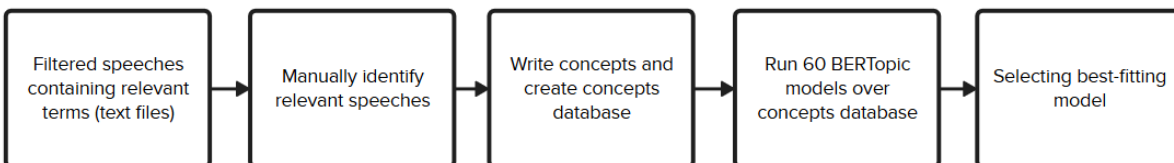
## GERMANY



## AUSTRIA



**Figure 1:** Data retrieving process from Austrian *Nationalrat* and German *Bundestag*



**Figure 2:** Process to identify the best-fitting BERTopic Model

and forestry in the parliamentary speeches. First, we manually checked the relevance of the filtered speeches. We stored the filtered Austrian and German speeches in separate text files to do that. Each speech underwent a review to identify pertinent segments, i.e. the text chunk containing the part in which the parliamentary mentioned something relevant regarding forestry and wood. For these segments, we crafted summaries (concepts) that capture the essence of the speaker's intent and the connection of their segment to the policy. For example, an Austrian deputy's statement favouring a farmer's relief law was grasped with the concept: "Amendment to the Valuation Law to simplify administration and reduce costs in the agricultural and forestry sector". All concepts were written in German to avoid losing the original meaning of the speech.

Several rules for writing the concepts were followed to ensure consistency. Firstly, it was recognised that a single speech could contain multiple statements, each containing several concepts. Second, marking entire text passages was crucial to grasp the meaning and implications of the concepts fully. Lastly, special consideration was given to the protocols of certain Austrian speeches, which included full-text legislative proposals attached to the speeches. In such cases, the focus was solely on the speeches, excluding the attached legislative texts from the analysis.

The data encompasses the period of January 2019 to March 2023. This time limitation is due to data availability: At the time of data collection (March 2023), the Austrian *Nationalrat* API only had data from speeches up to January 2019. In this period, the first filtering round led to 253 speeches from Austria and 68 from Germany. This means that from all the speeches given between January 2019 and March 2023, relevant terms regarding forestry and wood were mentioned in 253 speeches in Austria and 68 speeches in Germany. After manually reviewing the relevance of the filtered speeches to ensure they were indeed about forestry and/or wood, some speeches were found to be irrelevant. Specifically, 129 Austrian speeches (50%) and 23 German speeches (34%) were excluded. From the remaining relevant speeches (124 in Austria and 45 in Germany), the analysis produced 239 concepts from Austrian speeches and 182

concepts from German speeches. As mentioned earlier, a discourse can contain one or more concepts. This data shows that although the number of discourses was not very high, each discourse dealt with different aspects of the timber industry. These concepts were used for the topic modelling.

We utilised Topic Modeling (TM) to analyse Austrian and German parliamentary speeches, specifically opting for BERTopic over other TM methods. Compared to other TM methods, BERTopic has proven robust for generating new insights and achieving better performance [14, 15]. Due to its capacity to comprehend text within a context, it has increasingly been used in the social sciences [16, 17]. BERTopic uses three steps to build topics: each corpus is converted into an embedding representation (numerical data), then the number of dimensions of the embedding representations is reduced, and finally, the topics are extracted [18]. The Python library BERTopic supports automated or batch processing for topic modelling and allows using various transformer models for improved outcomes. Its modular design offers extensive customisation through parameters from modules like UMAP and HDBSCAN, impacting result quality [18].

However, due to a lack of guidance in the literature on parameter selection, there is no way to anticipate the best parameter combination for a given data set. Therefore, we conducted experiments to select the best parameters, using varying parameters for UMAP (`n_neighbors` and `min_dist`) and HDBSCAN (`min_cluster_size` and `min_samples`) without specifying topic limits. This led to 60 models, i.e. 60 different parameter combinations. For the combinations that were executed successfully, we analyzed the coherence, similarity, and distribution of topics for each combination. The Python library `gensim` was used to calculate the average topic similarity and topic coherence. We selected combinations that exhibited high coherence and low topic similarity, prioritising low topic similarity over high coherence. For each chosen combination, we created two visualisations: a Similarity Matrix Heatmap to compare topics and a Topic Mapping to observe topic distribution and manually identify the most relevant ones for analysis.

## 4. Results

The success rate is determined by how often BERTopic operated successfully with the specified parameters out of the total 60 models tested for both the Austrian and German databases. These tests were conducted four times to ensure that technical issues did not affect the results, meaning that we ran the 60 models for both databases on four separate occasions for each database. In all cases (four times for the Austrian database and four times for the German database), the 60 models ran in the same way. The Austrian database achieved a 35% success rate. This means that out of the 60 different parameter combinations, 21 were successfully executed, while 39 combinations failed to run in the program. In contrast, the German database reached 90%; that is, 54 combinations produced results, and another 6 did not run.

The amount of input data appeared to have no positive effect on the success rate. The Austrian Database contained 239 documents with an average corpus length of 100 characters, while the German Database comprised 182 documents with an average length of 70 characters. Further investigation is required to understand how data elasticity can be influenced to accommodate different models containing varied sets of parameters for `n_neighbors`, `min_dist`, `min_cluster_size`, and `min_samples`.

**Table 1**  
Best fitting models for Austria and Germany

Parameter	Austria	Germany
<code>n_neighbors</code>	20	7
<code>min_dist</code>	0.25	0.25
<code>min_cluster</code>	10	10
<code>min_sample</code>	2	2

Table 1 presents the best-fitting model parameters for Austria and Germany. The best-fitting models



present high coherence, low topic similarity and additionally, whose topics align most closely with the research objectives as interpreted by the researchers. Given the similar data volume and length in both databases, a similar final set of parameters was expected. It is interesting to observe that both models are indeed quite similar: all the parameters remain the same, except for `n_neighbors`, which differs drastically between both models.

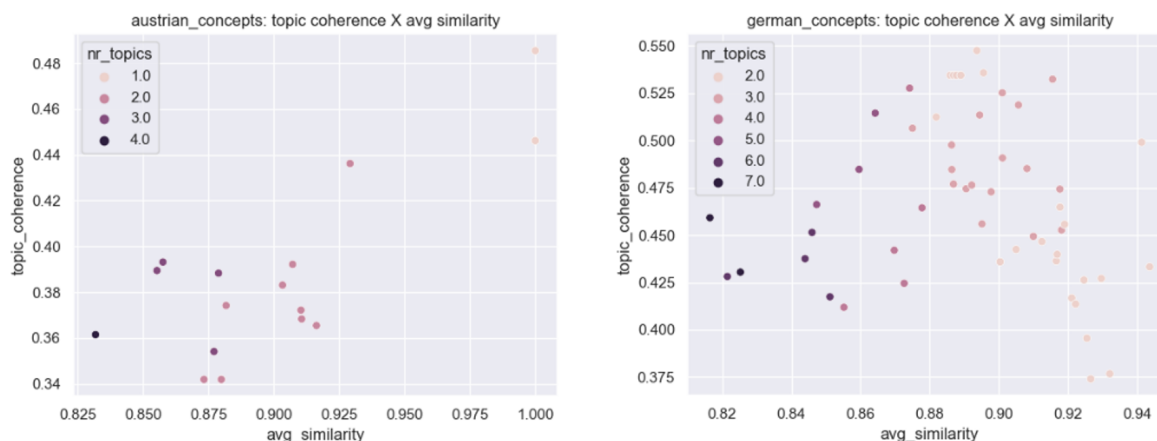
**Table 2**  
Distribution of Topics – Austria

Number	Description	Percentage (%)
0	Debate on the management of the Forest Fund (Waldfond), the role of the fund and forestry centres, and usage of the fund for addressing the impacts of COVID-19.	41.18
1	Discuss promoting biomass as a sustainable energy source and Austria's position as a wood supplier.	20.59
2	Discussion over amendments in the Wood Trade Monitoring Law (Holzhandelsüberwachungsgesetz), discussion on the growth of penalties.	16.18
3	Discussion over increasing transparency of wood, wood use and its impact on wood prices.	14.71
	Outliers	7.35

**Table 3**  
Distribution of Topics – Germany

Name	Description	Percentage (%)
0	Discussion of laws relevant to forests, such as the Hunting Law (Järgesetz), Insect Protection Package (Insektenschutzpaket), and Forest Damage Compensation Law (Forstschadensausgleichsgesetz), and the need for additional regulations. Also, there is a discussion on the use and storage of damaged wood.	15.98
1	Reforestation and monitoring of risks and the impacts of human activities on forests.	11.81
2	Contribution of forests to climate protection and its role in climate change.	10.42
3	Impact and requirements for forest conservation policies, like the Forest premium (Waldprämie).	10.42
4	The role of forests in the climate crisis.	9.73
5	Amendment of the Forestry Act and criticism of the reduction of the forestry personnel.	6.94
6	Forest Investment Programme (Investitionsprogramm Wald) and investments for Forestry Conversion (Waldumbau).	6.94
	Outliers	27.78

The `n_neighbors` parameter controls the scope of data analysis: a higher value provides a broader view by including more documents per topic. In comparison, a lower value offers a more detailed view, resulting in more specific topics with fewer documents each. Examining Tables 2 and 3, the German topics (Table 3) are more detailed, with topics like 2 and 4 exploring various aspects of forestry's impact



**Figure 3:** shows the distribution of outcomes from BERTopic models using Austrian and German datasets, plotting topic coherence against average topic similarity. Each point in this scatter plot is one model.

on climate change and ecosystem roles. On the other hand, the Austrian topics (Table 2) present more narrowly defined subjects per topic. The outliers in these tables refer to speeches that could not be included in any of the topics.

Similarly, Figure 3 demonstrates that the topics elaborated for both datasets vary. The Austrian Dataset allows for a range from 1 to 4 topics, while the German Dataset permits a range from 2 to 7 topics. The analysis of this figure suggests that the differing topics resulting from the best-fitting models applied to the Austrian and German datasets represent the datasets themselves and not merely the outcome of parameter selection. In other words, the difference in the `n_neighbors` is in line with the characteristics of the two databases.

Extracting the concepts from parliamentary speeches proved to be an efficient solution for addressing the core topics in speeches that encompass many subjects, as is the case with parliamentary speeches. These speeches are typically broad in scope since they serve as an advocacy channel for current supporters and promotional material for potential voters. Politicians are encouraged to talk about the agenda item, position themselves vis-à-vis the government, and discuss other issues that, although unrelated to the agenda, can generate public interest and engagement on social networks or resonate with the inhabitants of a specific region. In this scenario, the extracted concepts removed the noise, allowing the Topic Modeling (TM) to identify the topics that mattered.

Regarding the content of the speeches, it is evident that forestry discussions in both Austria and Germany focus on country-specific policies, as indicated by the absence of terms like 'Europe' and 'European Union' in the concepts and the prevalence of several names of local laws and policies. It is also clear that both countries have distinct forestry and wood sector agendas, at least in their parliamentary speeches. Austria's parliamentary speeches emphasise economic interests, advocating for wood producers by addressing issues such as wood import and trade, the impact of insect infestations on wood quality and prices, and using forest funds to alleviate the economic effects of the COVID-19 crisis on the forestry and wood sector.

The German parliamentary agenda, in turn, prioritises the solutions to the climate crisis by promoting biodiversity protection and forest conversion initiatives. Additionally, there is some discussion about forest personnel. While the COVID-19 crisis and forestry were mentioned in some speeches, these mentions were not frequent enough to form a distinct topic.

Finally, digitalisation in the wood and forestry sector is minimally addressed in the parliamentary speeches of both Austria and Germany, which does not allow for identification as a topic. There is little significant discussion or association with digitalisation and automation laws.

## 5. Discussion

The analysis of parliamentary speeches from 2019 to March 2023 reveals a strong alignment between the legislative stances of Austria and Germany and their national positions in the forestry and wood sector.

The German parliamentary agenda for this sector follows the “Conservation Through Utilisation” principle. This alignment is evident in the predominance of discussions on biodiversity impact measures rather than market-oriented reforms in the wood and forestry sector. Key topics include the Hunting Law (*Jägergesetz*), Insect Protection Package (*Insektenschutzpaket*), Forest Damage Compensation Law (*Forstschadensausgleichsgesetz*), Forest Investment Program (*Investitionsprogramm Wald*), and Forestry Conversion investments (*Waldumbau*).

On the other hand, Austria’s parliamentary agenda is strongly market- and business-oriented, addressing the wood trade and prices. All the topics identified in our research relate to the impact of forestry management on the forestry and wood sectors. Notably, three out of the four topics focus specifically on the wood industry, covering the promotion of biomass for energy generation, discussions on amendments to the Wood Trade Monitoring Law (*Holzhandelsüberwachungsgesetz*), and the enhancement of transparency and price control within the industry. Although biomass as an energy source aligns with the sustainable transition policies introduced by the conservative-green Austrian government, in the context of the energy price crisis, it also has significant implications for energy security and the economy.

In both cases, Austria and Germany, no topics were identified that focused on the digitalisation of forestry and the wood industry or the use of technology in forest conservation. At most, there was a vague mention that “automation will be important” without further elaboration on its implementation.

It is possible to raise some hypotheses about why this issue is not being addressed in the parliamentary agenda. One possibility is that politicians speak to different audiences: those discussing topics like digitalisation and artificial intelligence may not engage with the forestry or wood industry, and vice versa. Politicians need to establish very clear communication channels with their voters, and voters more engaged in one theme may be less so in another.

Given this, the themes of digitalisation/automation and the forestry and wood sector only converge in political speeches when they become part of a broader public debate. For instance, this might occur if a country’s wood industry’s competitiveness visibly suffers from not adopting new technologies. Politicians, especially those advocating for forest conservation and the wood industry, would thus only be reacting to the necessity to regulate existing industry practices and, thus, the public agenda rather than setting it.

Another related hypothesis is that discussions on innovation in forest conservation and the wood and forestry industry might occur in different spaces, such as sector associations, and involve actors such as decision-makers, stakeholders, and specialists. In this context, politicians may again respond to these debates over innovation and digitalisation rather than initiate them.

## 6. Conclusion

Our analysis of parliamentary speeches offers valuable insights into how social issues are approached within the political arena. However, working with this material can be challenging, as politicians are encouraged to address multiple topics in a single speech. They use the parliamentary arena to promote their agenda towards their current and potential voters and position themselves regarding the incumbent government and diverse stakeholders.

As our study is embedded into a broader research project, focusing on two cases in a particular time period constitutes an important limitation for generalising the results. Indeed, the results show that the topics identified in the parliamentary agenda are country-specific and rarely overlap. As the COVID-19 crisis dominated the political agenda, it might have impacted the attention to the forest and wood sectors. Furthermore, as digitalisation is a fast-paced process, future research should address



the role of digitalisation for these sectors, focusing on a broader time frame and geographic scope. Additionally, research would benefit from including in the analysis other agendas, such as industry or media agenda and exploring whether they set the tone of the discussion on the issues of sustainability and digitalisation.

This paper's first contribution is demonstrating the benefits of computational text analysis to explore the parliamentary agenda for policy research. We employed a multi-layered approach, starting with speech filtering and concept clustering and followed by advanced topic modelling using BERTopic. We determined the best model by testing and evaluating various parameter combinations based on topic coherence and average topic similarity. This approach allowed us to gather results consistent with existing literature while respecting the overall data structure and specificity.

This paper further contributes to understanding how the Austrian and German parliaments have discussed issues of interest to the forestry and wood industry. Regarding our first research question, namely "*What are the topics regarding forestry and wood that are being discussed in the Austrian and German Parliaments?*", it is generally possible to conclude that debates on these topics in Austria and Germany align with national forest management policies.

The analysis revealed that German parliamentary discussions adhere to the "Conservation Through Utilisation" principle, focusing predominantly on environmental concerns, such as biodiversity and conservation, rather than economic concerns. In contrast, Austrian parliamentary discussions are distinctly market and business-oriented, with all identified topics relating to the impact of forestry management on the forestry and wood sectors from an economic perspective.

Finally, regarding our second research question, namely "*Are Austria and Germany discussing strategies to facilitate the adoption of Industry 4.0/5.0 innovations in the forestry and wood sector?*", it is possible to conclude that there was a notable absence of discussion on the relationship between digitalisation and automation with both forestry and biodiversity conservation policies and the forestry and wood industry.

Despite these findings, our study contributes to the literature addressing the use of digital technologies for sustainability, providing insights into the discussions around a highly traditional industry sector. Further research is needed to identify the lack of attention to digitalisation in parliamentary discussions in Germany and Austria. Politicians may simply address their target audiences and fail to recognise the significant link between these issues and the implications for climate, economic growth, and twin transition.

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