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Public perceptions of using forests to fuel the European bioeconomy: Findings from eight university cities

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ABSTRACT

The political project on bioeconomy strives to address multiple societal aspirations, namely combine economic growth with environmental sustainability in some socially acceptable manner. The contradictions between the goals and the concrete plans to increase production, processing, and consumption of forest biomass in Europe have however raised sustainability concerns within and beyond its borders. While political actors articulate such contradictions differently and compete for traction for their viewpoints in the public discourse, little is known about how citizens of urban areas perceive this discourse. Conceptualising perception as a multidimensional construct, data from eight European university cities (Bordeaux, Bratislava, Freiburg, Helsinki, Padua, St. Petersburg, Uppsala, Vienna) are statistically analysed to explore its dimensions, the communities of like-minded citizens forming across those dimensions, and the traits associating with membership in each such community. Five communities across six dimensions from biocentrism through distributional aspects to adherence to political goals are identified: adherent-environmentalist, adherent-governmentalist, critical-reformist, critical-agriculturalist, and indifferent. City of residence and perceived familiarity with bioeconomy clearly interact with perception. There is however considerable variation in communities within and across the eight cities, suggesting deeper social tension beyond the public discourse. Much of the within-community variation remains unexplained, though, calling for more work locally. Implications for forest policy are derived.

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1. Introduction

The bioeconomy (BE) refers to an economic system that is based on biological resources (Taylor et al., 2019). Although Nicholas Georgescu-Roegen (1977) coined the term to plot pathways to an alternative society without the growth imperative, numerous political and scientific organisations have adapted the term to depict market-based activities of industrial scale that both complement one another and compete for access to biological resources (Vivien et al., 2019). In European politics, there has been great enthusiasm around its perceived potential for discovering new areas of application for biological resources through modern biotechnology, for boosting green growth and sectoral renewal, and for solving sustainability dilemmas under the framework of existing economic institutions and infrastructures – "more of everything" (Beland Lindahl et al., 2017; Birch and Tyfield, 2013; Kleinschmit et al., 2014). Almost every European country, including Russia, has crafted a nationally adapted strategy to advance the BE (Dietz et al., 2018).

Pursuing economic growth while taming material and energy throughput in some socially just manner however appears contradictory (Creutzig et al., 2021; Grubler et al., 2018; Heck et al., 2018; Hickel and Kallis, 2020; Liobikiene et al., 2019). As Ahlqvist and Sirviö (2019) argue, it is the framing and articulation of such contradictions by political actors that constitutes the politics of BE. Such politics are manifest in the recent disputes over the use of forests, the seemingly abundant resource to fuel (Song et al., 2018), not only in metaphorical sense, the transition to BE in Europe.

Forests sustain the carbon sink that has already made it much easier for Europe to pursue its climate commitments (Nabuurs et al., 2013). The plans to expand the forest bioeconomy (FBE) have nonetheless been vocally contested by climate scientists who argue that increasing harvesting of wood, the material basis of the FBE, dents the sink and makes it much harder to achieve those commitments (Ceccherini et al., 2020; EASAC, 2017; Grassi et al., 2018; Hurmekoski et al., 2020; Naudts et al., 2016; Norton et al., 2019). They also stress that some of the most voluminous wood-based commodities in the market, namely pulp and biofuels, release their carbon content relatively rapidly. Warnings about the long-lasting negative effects of intensifying forestry on forest biodiversity have also been issued (Erb et al., 2018; Eyvindson et al., 2018; Pohjanmies et al., 2021).

Ecology aside, one of the core elements of the BE discourse is its promise to settle the urban-rural tension by reinventing decaying industries in rural areas and by offering jobs to highly skilled labour in urban areas (Ahlqvist and Sirviö, 2019). Analysis on relevant indicators remains scarce, though, prompting open questions about such claims, let alone their implications for justice in and between these areas (Pellow, 2016; Sanz-Hernández et al., 2019). At least recent forest biorefinery investments in northern Europe have geared toward the production of low-value-adding commodities that are likely to require less labour inputs in absolute terms and to promote downstream activities, most of which arguably concentrate in urban centres (Robert et al., 2020; Temmes and Peck, 2020).

Social concerns however extend beyond the borders of Europe. The plans to advance the European BE are bound to require much more importing of biomass (currently 16%) from global resource frontiers, with grim premises for global sustainability (Dorninger et al., 2021; Lühmann, 2021; Malkamäki et al., 2018; Oliveira et al., 2021). For example, the unequal integration of people from the global North and the global South into the production, processing, and consumption of biomass in the global economy raises concerns about the implications of FBE for global justice (Backhouse et al., 2021; Bastos Lima, 2021). Plus, the signal that Europe sends to other countries, particularly in relation to its simultaneous calls to halt tropical deforestation (Bager et al., 2021), is contradictory.

Acknowledging the intricacies of the FBE, previous research has mainly been charting the views of experts and researchers and found considerable variation in the ways in which its ends, means, prospects, political economy, and relationship with nature and markets are interpreted (D'Amato et al., 2019; Hurmekoski et al., 2019). Few studies have however paid attention to public perceptions of the FBE (for a recent review, see Ranacher et al., 2020). For example, Vainio et al. (2019) assessed Finnish students' and citizens' perceptions of the BE, revealing that respondents were critical about its sustainability. While scholars have pointed to the organised power of state, capital and the industry in translating their economic goals into forest policy in the era of BE (Beland Lindahl et al., 2017; Holmgren et al., 2022; Kleinschmit et al., 2018; Kröger and Raitio, 2017), with mainly rhetorical concessions to environmental organisations, citizens are entitled to review and to engage with policies that affect their well-being and opportunities (Mustalahti, 2018; Spaargaren, 2011). Defining justice and sustainability in the context of FBE calls for political contestation and public debate – something that must not be left to politicians, scientists, markets, or technology to decide (Eversberg and Fritz, 2022).

We contribute to this matter by analysing perceptions of the FBE across eight university cities in Europe: Bordeaux, Bratislava, Freiburg, Helsinki, Padua, St. Petersburg, Uppsala, and Vienna. We look into (university) cities due to their greater representation of younger generations (whose voice arguably weighs in terms of intergenerational justice), their key role in mobilising alternative paradigms for sustainability, and their diversity in terms of interests and lifestyles (Gandy, 2018; Kotzeva et al., 2016; Scheurer and Haase, 2018). Through their actions as voters, campaigners, activists, influencers, and consumers of much of the BE output, citizens of urban areas in particular could shape their societies, including toward sustainability. While understanding their perceptions of the FBE clearly matters, worth pointing out is that their possible disconnection with its production side could also constrain them from voicing concerns about its justice and sustainability (see Bashan et al., 2021).

Based on a post-hoc analysis of samples comprising survey data from the eight cities, we adopt an exploratory approach. However, we expect citizens to mirror the frames – the selectively promoted ideas – in the wider policy discourse that media and actors with different goals use to define the FBE to the public (Hajer and Versteeg, 2005; Nelson et al., 1997). Further, we posit that public perceptions of the FBE resemble and interact with cultural worldviews – shared norms and beliefs that legitimate much of social life and serve as a heuristic for interpreting the world and evaluating its merits and deficiencies (Cohen, 2009; Wildavsky, 1987). Worldviews have previously been found to guide social mobilisation into factions over societal disputes and to enable the formation of perceptions of complex political matters from few cues (de Witt et al., 2017; Kahan, 2012). More specifically, we anticipate public perceptions of the FBE to comprise not only views of its political agenda and consequences, but also of the ways of constructing knowledge about it and of the role of humans in nature more generally. Public perceptions are thus bound to diverge along multiple dimensions. Like worldviews, perceptions of the FBE could interact with other sources of identity, including with age, gender, or residence in some particular city, each of which represents its own political world.

We take on the task of answering three questions: I) along which dimensions citizens align their perception of the FBE, II) what types of "communities" – here, simply referring to groups of like-minded individuals – form across those dimensions, and III) which individual traits are associated with membership in those communities? Original data and quantitative methods are used to address these questions; first, by grouping together variables based on pairwise correlations, second, by doing the same for respondents based on their pairwise distances, and, finally, by inferring relationships between membership and explanatory variables based on logistic regression.

The sections that follow describe our data, methods, and results. The paper concludes with a discussion on the implications of our findings for forest policy.

2. Methods

2.1. Data

To explore public perceptions, we developed a survey with 21 Likert-type items (i.e., statements) to collect comparable data from each city. The list of items was designed to operationalise the political agenda and our own understanding of the debate on forests and the BE in Europe (Table 1). However, some items toward the end of the list were created to reflect certain "aspects of worldviews", namely epistemology, anthropology, and social imaginary (de Witt et al., 2017).

As much of the debate focuses on climate science, four items dealt with carbon stocks and their link to current forest management practices and related support to forest owners. Four items measured prospects for the main political promises of the FBE, namely for reducing dependency on fossil fuels and for bringing well-being to rural areas. Two items focused on its risks and distributional aspects, and one on the need of taking all voices into account (cf. social imaginary). To operationalise the human-nature relationship and views of technology and the role of environmental regulation in the economy (cf. anthropology), we adopted six items from the New Environmental Paradigm scale by Dunlap et al. (2000). We also added an item to probe into the tension between forestry and agriculture that could compete over resources in the BE (Hertel et al., 2013). The last three items queried about trust in different institutional sources of information about the FBE (cf. epistemology), namely in experts, environmental organisations, and the government. The survey included questions about age, gender (female/male/else), area of residence (urban/suburban/rural), ownership of more than one hectare of land (no/yes), and perceived familiarity with the FBE (six-point measure) to gather information about individual traits.

All items included an ordinal-categorical six-point measure from (1) strongly disagree to (6) strongly agree. Neither did we offer a "do not know" option, the interpretation of which is notoriously challenging (for an overview, see Krosnick and Presser, 2010) nor did we explicitly define the term BE to the respondents. Our intention was not to measure respondents' knowledge about forests or the BE, but to capture the thought processes that influence the ways in which citizens attach meaning to controversial debates in society. When necessary, we instructed those collecting the data to mention a generic definition (without potentially leading normative elements) denoting a shift from our current economic system to one based on forest-based resources. The survey was tested with nine individuals before translating it from English to other languages and collecting data from Bordeaux (France), Bratislava (Slovakia), Freiburg (Germany), Helsinki (Finland), Padua (Italy), St. Petersburg (Russia), Uppsala (Sweden), and Vienna (Austria), each of which is an important university city. We collected the data face-to-face to allow for instructing the respondents in completing the survey. For practical reasons, we resorted to convenience sampling and collected the data from crowded public spaces (i.e., city squares, train stations, malls), prioritising local population and excluding tourists. This however meant that we chose not to ask more sensitive questions about social class, education, or political leaning. The data collection took place during 2019.

In total, we received 1534 completed surveys. As the intention was not to sample rural residents, we first excluded 183 respondents for identifying themselves as such. Next, we omitted 415 respondents, majority of which from Padua, who strongly disagreed with being familiar with the FBE to guarantee that our sample comprised people who were at least roughly familiar with the term. As only six respondents chose the option "else" for gender, we recoded their gender as a missing value. Thereafter, we had 0.3% of missing values – hence their case-specific imputation with the Random Forest algorithm by Xu et al. (2016). To correct for potential response biases, we cleaned the data from respondents with largest Mahalanobis distances as indications of highly unusual response patterns (Yuan and Zhong, 2008). This led to the exclusion of 19 respondents and to an aggregate sample of 917 respondents (Table 1). Concerning central tendencies, skewness and kurtosis of each item are less than 1.96 standard deviations away from the mean and thus fall within the approximate 95% confidence intervals. Emphases in the names of items were not in the survey. Hereafter, the words with emphasis serve as labels that we use to refer to the different items.

To evaluate the representability of the sample, we compared the distribution of gender and age group in each city with available population benchmarks (Table 2). Likely due to our convenience sampling, there is a bias toward younger respondents in several cities, namely in Freiburg, Helsinki, St. Petersburg, and Vienna. In Uppsala, however, the data collection took place at a mall outside the busiest city centre – a likely explanation for higher participation by those between 35 and 54 years of age. In Bratislava, there is another bias toward females in our sample. These biases are weaknesses of the data, the implications of which are discussed in the final section of this paper.

Table 1
Central tendencies in the final aggregate sample with 917 respondents (MN = mean, SD = standard deviation, SK = skewness, KT = kurtosis). Items appear in the same order as in the survey. The trait *familiarity* has been recoded such that original response categories 2–4 and 5–6 constitute levels *lower* and *higher*, respectively. The values for gender were calculated without the seven respondents in the third category for "else".

	MN	SD	SK	KT
Managed forests have great **potential** to reduce carbon emissions	4.5	1.2	−0.4	−0.4
How forests are being managed can **threaten** carbon stocks in forests	4.2	1.2	−0.5	−0.2
Landowners need **support** to maintain and manage forests	4.5	1.2	−0.8	0.5
Landowners must be compensated **monetarily** for storing carbon in forests	3.9	1.3	−0.2	−0.5
FBE decreases our **dependency** on oil and fossil fuels	4.4	1.1	−0.4	−0.1
FBE increases our economic **self-sufficiency**	4.4	1.1	−0.6	0.2
FBE generates new **jobs** and well-being in rural areas	4.5	1.0	−0.4	0.0
FBE mainly benefits large **companies** and their shareholders	3.4	1.2	0.1	−0.4
Agriculture bioeconomy is more important for society than forest bioeconomy	3.6	1.1	0.3	−0.2
The risks of FBE are **greater** than its benefits	2.9	1.1	0.3	−0.1
The risks of FBE must be understood before we fully **embark** on it	4.6	1.2	−0.7	0.2
All different **views** must be seriously considered when forest-based bioeconomy develops	4.7	1.0	−0.7	0.3
Use of **fossil** fuels and non-renewable materials must be reduced as soon as possible	5.1	1.1	−1.4	1.6
Environmental **regulation** limits overall economic development and growth	3.3	1.3	0.1	−0.7
Humans will be able to resolve environmental problems when **technology** develops	4.1	1.3	−0.6	−0.2
Despite our special abilities, humans are still subject to **laws** of nature	5.2	1.0	−1.3	1.8
Humans have the right to **modify** the natural environment to suit their needs	2.8	1.3	0.4	−0.5
The balance of nature is very **delicate** and easily upset	5.2	1.0	−1.6	2.6
I trust information on FBE from **government** officials	3.3	1.3	0.0	−0.6
I trust information on FBE from scientists and **experts**	4.6	1.0	−0.6	0.2
I trust information on FBE from environmental and **civic** organisations	4.3	1.1	−0.5	0.4
Age	39.3	16.0	0.7	−0.6
Gender [1 = female, 2 = male]	1.5	0.5	0.1	−2.0
Landownership [1 = no, 2 = yes]	1.1	0.3	2.8	5.8
Area [1 = suburban, 2 = urban]	1.8	0.4	−1.6	0.6
Familiarity [1 = lower, 2 = higher]	1.2	0.4	1.5	0.1

Table 2
Deviation in the distribution of gender and age group between the true population and each subsample as percentage points. Positive and negative values indicate overrepresentation and underrepresentation, respectively. Population benchmarks from Eurostat (2021) and Safarova and Safarova (2019) are only available in binary. Actual percentages are reported in the supplementary file.

		Bordeaux		Bratislava		Freiburg		Helsinki		Padua		St. Petersburg		Uppsala		Vienna	
Completed surveys		155		106		171		202		270		100		155		192	
Valid observations		98		78		122		187		68		77		145		142	
Gender		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Deviation	15–34	4	−6	29	9	−10	17	13	8	5	13	15	2	−2	−8	14	21
	35–54	2	−2	−4	−5	3	10	−3	−8	2	9	0	3	9	3	−12	−8
	55-	−5	3	−16	−12	−16	−5	−7	−5	−18	−9	−12	−7	2	−3	−10	−6

2.2. Analysis

In the first stage of the analysis, using network methods (see further below), our aim was to group respondents with similar opinions together, regardless of their city of residence. Thus, the evident variation between our cities in terms of culture, politics and the debate on forest policy in the era of BE was not an issue in terms of analysing the data in aggregate. To make our analyses both feasible and meaningful, we began by exploring the data for possible latent dimensions, using (absolute) polychoric correlations between items to guide their grouping into meaningful dimensions (Olsson, 1979). Compared with alternative approaches to dimensional reduction, we were able to retain some degree of dimensionality within each latent dimension. By assigning each respondent a community membership instead of a coordinate along continuous scales, we nonetheless lost some variation in their responses. However, other approaches, including item-response-theoretic factor modelling (Reckase, 2009), were also tested, yielding poor results with our data.

In the second stage of the analysis, we divided our 917 respondents into groups. With information about the group membership of each respondent in each dimension, we further divided the sample into "communities" of like-minded citizens based on the similarity of respondents across those dimensions. In our view, each such community translates into an identifiable, multidimensional perception of the FBE. To achieve this, we used the Variable Entropy measure for categorical items. It has been shown to perform particularly well with less than seven items (Šulc and Řezanková, 2019). It defines variability as normalised entropy, treats the similarity between two categories based on the within-community variability, and assigns higher weights to rarer categories.

In both stages, we applied network methods, which have become increasingly popular across social sciences as a means of analysing relational phenomena, such as like-mindedness in our case (see e.g., Ward et al., 2011). All similarity (or correlation) matrices were converted into networks, with respondents (or items) as nodes and similarity (or correlation) as "weighted" ties between them. Ties with lowest weights were omitted to emphasise the network structure and to enhance the detectability of relatively dense communities. In network science, "community" detection is based on the idea of identifying groups of nodes that have relatively more (weight in) ties within them than between them (Girvan and Newman, 2002; Fortunato, 2010).

To partition the networks, the Leiden algorithm by Traag et al. (2019) was used to optimise modularity. Modularity is a simple, yet highly popular function to evaluate the quality of a network partition (Newman and Girvan, 2004). As optimising modularity is extremely difficult, Leiden algorithm is just one of the many algorithms that have been developed for the purpose of maximising modularity as the distance between the actual weight of ties in each community and the expected weight of such ties. Based on its already well-performing predecessor, the Louvain algorithm (Blondel et al., 2008; Yang et al., 2016), the Leiden algorithm, as shown by Traag et al. (2019), converges to stabler partitions with all subsets of all communities being locally optimally assigned. To explore the number and composition of communities, we took advantage of the resolution parameter of modularity to adjust for the size of communities (Reichardt and Bornholdt, 2006). As the algorithm determines the expected ties stochastically, we always chose the partition with the highest modularity after 100 runs (although we acknowledge that this neglects the possibility of there being competing ideas of the partition with almost the same modularity). By tuning the resolution parameter and visualising the results accordingly until an intuitively meaningful partition was detected, we were able to arrive at the final communities for each network (for an illustration of this approach, see supplementary file). Overall, this method was chosen for its flexibility and served as an alternative to hierarchical clustering.

In the third, final stage, we fitted binary logistic regression models to understand which traits of respondents predict membership in each community. We considered effects with p-values <0.05 as significant and evaluated model fit through Tjur's (2009) coefficient of discrimination (D) as an alternative pseudo-R-squared statistic. To ensure the validity of our findings, we inspected various model diagnostics, including Cook's (1979) distances to pin down potential outliers with excessive leverage over the results. All analyses were performed in R software (R Core Team, 2021).

3. Results

3.1. Latent dimensions

With our dimension reduction approach, we find six groups of items with relatively high within-group correlation (Fig. 1). Although these latent dimensions have meaningful interpretations, some of the correlations are relatively weak. However, turning our focus to the groups that emerge in each (Fig. 2), we note that much of the remaining dimensionality is captured in the composition of those groups. Below, we describe the dimensions and the relatively dense groups of respondents that were detected in each.

The first dimension has five items that correspond to an understanding of the human-nature relationship in combination with willingness to map risks and different perspectives before pursuing the FBE. This dimension thus represents both **biocentrism and precaution**. Variation in this dimension is small, though, and we detect only two meaningfully distinct groups. The first one covers those who mildly agree with the view that humans are not superior to nature – hence they are less biocentric and *conditional* in the sense that they are willing to balance between humans and nature, rather than putting nature above everything else. Analogically, being *unconditional* refers to those who deny the superiority of humans over nature and call for precaution and democratic decision-making before leaping into the FBE. Respondents belonging to both groups are found in all cities (Fig. 3).

The second dimension contains items that capture the main **political promises** around FBE in terms of its economic agenda, including the substitution of non-renewable resources and the delivery of well-being to rural areas. In public discourse, this has often been translated directly into sustainable development, possibly yielding additional legitimation – perception of rightfulness – among citizens. Such contentment also correlates with the idea of managed forests carrying potential to reduce emissions. In this dimension, one group contains those who are truly *enthusiastic* about this agenda. Such respondents are

Fig. 1. Polychoric correlations between items. Tie width indicates the strength of correlation ranging from 0.20 to 0.75. Colours refer to distinct groups of items with relatively high within-group correlation.

relatively common encounters in Helsinki. Perhaps against the notion of constrained supply of biomass in Europe, they believe in the potential of FBE to decouple the economy from non-renewable resources. By slowly storing carbon while growing (while in fact rapidly releasing carbon after harvest) and enabling the material basis of FBE, managed forests play an important role in the political BE discourse, along which this group aligns. There are also many who are less convinced, but *hopeful* in terms of such political promises. Most respondents, many Freiburgians, Paduans and St. Petersburgians in particular, are nonetheless *reserved* about this agenda. On average, they mildly agree with the potential of managed forests and the creation of jobs in rural areas, yet they have reservations about the potential of FBE to advance the transition to a post-fossil society.

The third one of the dimensions deals with **forest management** by tracking views of the threat that current practices pose to climate as well as willingness to support forest owners in changing those practices. The groups that are detected include *apathetic* and *empathetic* respondents. The former, those who are somewhat apathetic toward forest owners, contains the vast majority of respondents, who, unlike the latter group, are much less eager to subsidise forest owners in adopting alternative practices. Those who are apathetic, however, are not particularly worried about the climate impacts of current practices. The latter group, the empathetic ones, are much more divided in this regard, indicating, not surprisingly, that willingness to send subsidies to forest owners is not always associated with such worry. Our data however do not tell whether the empathetic citizens think that forest management becomes more climate-friendly through less, or perhaps more, intensive management. Those in this latter group are slightly more common sights in Bratislava, Helsinki and Uppsala, the latter two of which are cities in countries with widespread small to medium-scale forest ownership.

The fourth dimension looks into the perspectives on **risks and priorities** in FBE in terms of the accumulation of benefits and preference between agriculture and forestry, respectively. Views of the overall risk of FBE correlate the most with these two aspects. There are four distinct groups. The first two, *agriculturalists* and *distributists*, insist that the FBE mainly benefits large corporations and carries more risks than benefits. However, the former are more consistently prioritising agriculture over forestry, the latter exhibiting more division in this regard. The latter also feel particularly strongly about the distributive aspects of FBE, which are thought to be uneven. A large share of Paduans is found in this latter group. These two groups differ from the *fearless*, who see there to be more benefits than there are risks, benefits which also spread evenly. The fourth group in this dimension contains those who are somewhat *neutral* with regard to risks and priorities.

The fifth dimension describes leaning toward classical assumptions concerning the relationship between the economy and the environment. Such an extension to the **laissez-faire** paradigm covers views of the incompatibility of economic growth with environmental regulation (the former of which largely remains an overarching policy goal across the political spectrum), rights of humans to alter the environment, and optimism toward human ingenuity in solving environmental problems. In this dimension, there is little variation and thus only two distinct groups emerge: *anti-laissez* and *laissez-leaning*. The former describes the minority of respondents, those who do not associate deregulation with progress. Those in the anti-laissez group, however, are divided over the role of technology in solving environmental problems. The latter group, the majority, covers those who lean toward the paradigm with deep roots in Western societies.

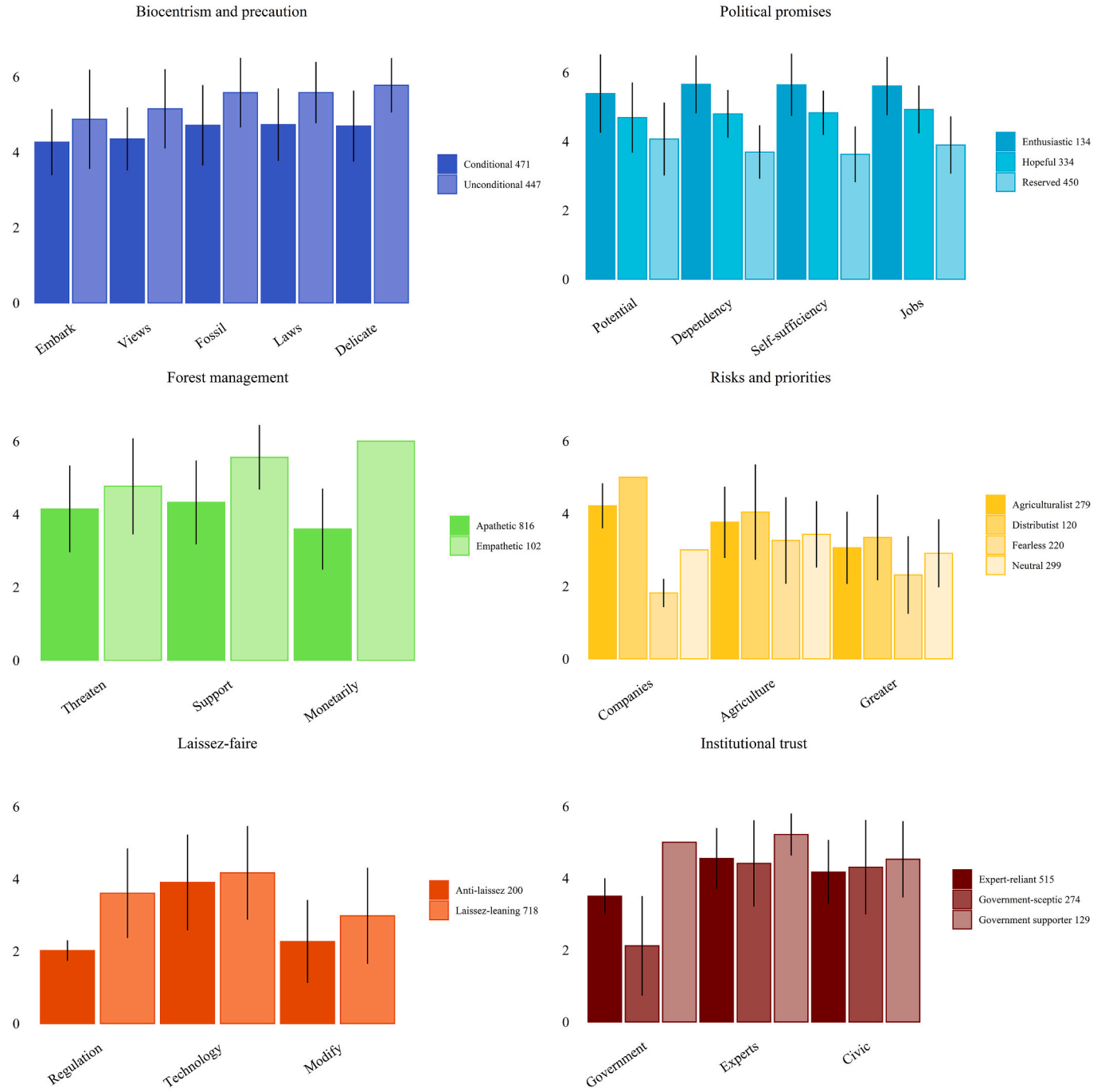

Fig. 2. Groups and within-group means with standard deviations in each latent dimension.

Finally, the sixth dimension represents **institutional trust** in different sources of information about the FBE. The largest group in this dimension includes those who express high levels of trust in experts, slightly less in environmental organisations and the government. They are *expert-reliant*. However, there are also those who express trust in experts and the civil society, but not in their government. A relatively high number of such *government-sceptics* are found in Bratislava, St. Petersburg, and Vienna. We also find another group with people who trust all three sources of information about the FBE, yet they differ from the other two groups by counting on their government. They are best described as *government supporters*, who are slightly more prominent in Helsinki and Uppsala. It also makes sense to attach such institutional trust not only to FBE per se, but to wider societal structures and to past forest governance at the local level.

3.2. *Multidimensional perceptions*

When analysing the network with information about the similarity of respondents across the six dimensions, we detect five distinct communities (Fig. 3), each of which translates into a public perception of the FBE. The communities are clearly identifiable from the network visualisation in Fig. 4. The visualisation further highlights the "cohesion" in each community.

Although comparing the size of the communities in our imbalanced sample does not make much sense, the largest and thus first community that is detected gathers those who score high on biocentrism and

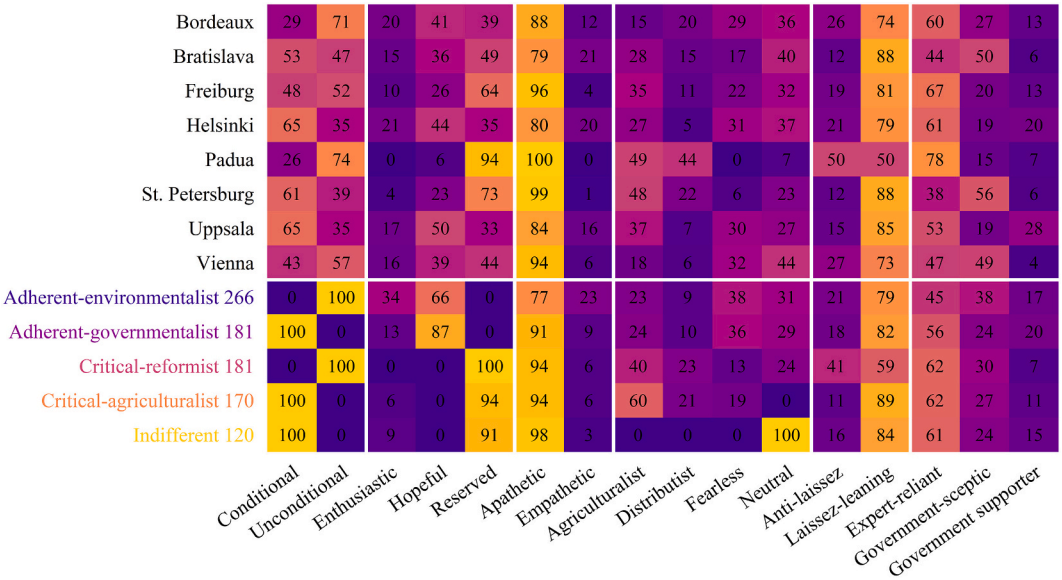

Fig. 3. Share of respondents in each dimension-specific group by city and community. Colours in the names along the vertical axis match each community to the network visualisation in Fig. 4.

precaution, yet largely adhere to the political agenda of FBE. On average, respondents in this community are also willing to subsidise forest owners to adopt climate-friendly management practices. They are also convinced that the FBE is bound to benefit the society at large.

Looking at the predictors of being an *adherent-environmentalist*, we find that age has an effect that is not observed by coincidence (Table 3). An odds ratio of 1.01 means that when age increases by one year, the odds of carrying this perception increase by 1%. Those from Bordeaux are

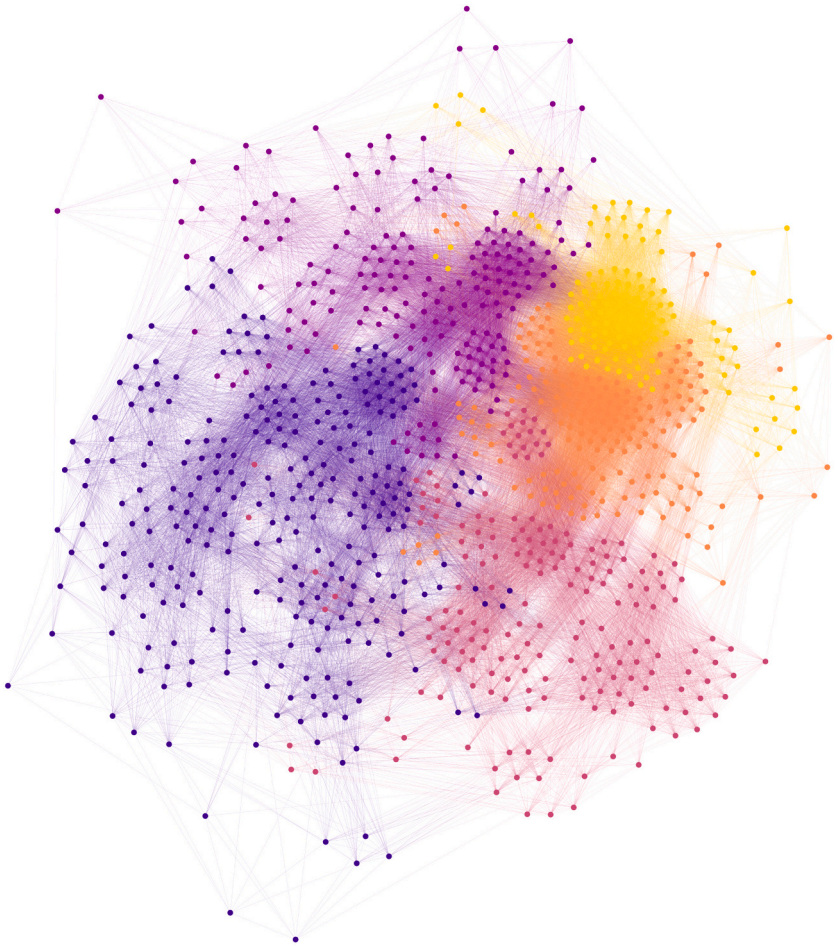

Fig. 4. Visualisation of the five communities. Layout is based on the force-directed spring-block algorithm by Hu (2005).

most prominent in this community – the odds of those from Helsinki or Uppsala are 58% and 54% lower, respectively. People expressing higher familiarity with the FBE are also much more likely to be found in this community. The second community, *adherent-governmentalists*, share many characteristics with the first community, yet they take a more conditional approach to environmentalism and place more trust in their government. This is the public perception that is widespread in Helsinki and Uppsala. Higher familiarity increases the odds of having this perception.

Like the first two communities, the third and the fourth community also share certain characteristics. The former, *critical-reformists*, are unconditional about precaution and the fragility of nature, have reservations about the consequences of FBE, and exhibit relatively strong anti-laissez sentiment. Those worried about the distribution of benefits are also relatively common in this community, just as they are in the community of *critical-agriculturalists*. This perception differs from the former by leaning toward the laissez-faire paradigm and by prioritising agriculture over forestry. Thus, people with this perception express worry about the distributive aspects of FBE, but likely due to an interest in developing the agricultural BE instead. Of these two communities, we find that Paduans are very likely to be found in the former, while the odds of finding those from Freiburg, St. Petersburg and Uppsala in the latter are high. The last community connects respondents who score high on biocentrism and have reservations about the political promises of the FBE yet remain neutral about the distribution of benefits. Such *indifferents* are more likely to be found from Bratislava or Helsinki. The odds of finding those with higher familiarity in this community are however 63% lower than those with lower familiarity. People with this perception also tend to be younger.

More generally, neither gender, area of residence, nor landownership plays any significant role in explaining membership in any of the five communities. Importantly, however, we find respondents from each city in each community (Fig. 5), indicating that the range of perceptions in each city is wide. A closer look at the D statistics reveals that there remains much unexplained variation in each model. Model diagnostics did not flag any respondents with such leverage over the models that would distort the estimates.

4. Discussion

Increasing the use of forests as the material basis for the European BE has been contested at multiple fronts, including in terms of global justice and sustainability. In political discourse, actors articulate its contradictions differently and compete for traction for their viewpoints among the public. In this paper, we contribute to the understanding of the ways in which the citizens of urban areas interpret this discourse and evaluate its merits, deficiencies, and rightfulness (Mustalahti, 2018; Ranacher et al., 2020). Conceptualising perception as a multidimensional construct resembling a cultural worldview (de Witt et al., 2017), we pooled empirical data from eight European university cities to explore its dimensions (question I), communities of like-minded individuals across those dimensions (question II), and predictors of membership in such communities (question III).

We identify six dimensions (question I): i) conditionality toward biocentrism and precaution, ii) adherence to the main political promises around FBE, iii) willingness to subsidise forest owners to align forest management along climate commitments, iv) understanding of risks and priorities in terms of distributional aspects, v) leaning toward laissez-faire paradigm in environmental management, and vi) trust in different institutions as sources of information about the FBE. The analysis reveals five communities of like-minded citizens (question II): A) adherent-environmentalist, B) adherent-governmentalist, C) critical-reformist, D) critical-agriculturalist, and E) indifferent, each of which translates into a perception of the FBE.

Among those in the first community (A), we are most likely to find slightly older people from Bordeaux. Those from Helsinki and Uppsala are more prominent in the second community (B) that places more trust in their government and is less cautious about the FBE than the former. People in these communities are similar in approving much of the political enthusiasm around FBE and in claiming to know more about it. The other three perceptions are more reserved about the FBE, even if shared more often by people with lower familiarity. The third (C) is concerned with corporations reaping the benefits from FBE and in opposition to free-market approaches to environmental management. Paduans with this perception stand out. Among critical-agriculturalists (D), citizens of Freiburg, St. Petersburg and Uppsala are common. They tend to worry about the distribution of benefits and prefer agriculture over forestry. The fifth perception (E) is more prominent in Bratislava and Helsinki as well as among younger citizens. It describes those who are not convinced about the promises of FBE but remain neutral about risks and distributional aspects. For the last two communities, precaution is not utterly important either.

Contrary to some previous findings as reviewed by Ranacher et al. (2020), in our sample, gender does not play any significant role in public perception of the FBE. Perhaps surprisingly, landownership is not predicting any specific perception either, nor are there any significant differences between suburban and urban populations. The share of landowners in our sample is also quite low. Perceived familiarity with the FBE, however, predicts membership in each community – the higher, the more hopeful and the other way round. However, our limited set of predictors is unable to catch much of the variation in each community (question III).

Table 3
Results for binary logistic regression models. Estimates converted into odds ratios and values with emphasis indicate significant effects. The intercept, *p*-values and 95% confidence intervals for the effects are reported in the supplementary file.

	Adherent-environmentalist	Adherent-governmentalist	Critical-reformist	Critical-agriculturalist	Indifferent
Membership	265	184	182	165	121
Age	1.02 **	1.00	0.99	0.99	0.98 *
Gender [male] [ref. female]	0.84	1.04	1.09	1.27	0.84
Gender [else]	1.98	1.37	0.00	1.90	0.00
Landownership [yes] [ref. no]	0.68	1.45	0.85	1.46	0.72
Area [urban] [ref. suburban]	1.29	0.96	1.00	1.07	0.65
Familiarity [higher] [ref. lower]	2.46 ***	1.77 **	0.46 **	0.32 ***	0.37 **
City [Bratislava] [ref. Bordeaux]	0.59	1.15	0.53	1.69	4.52 **
City [Freiburg]	0.57	0.53	0.80	3.04 **	2.49
City [Helsinki]	0.43 **	2.97 **	0.25 ***	2.11	2.97 *
City [Padua]	0.06 ***	0.11 *	5.42 ***	1.99	0.92
City [St. Petersburg]	0.20 ***	0.97	0.88	4.82 ***	2.72
City [Uppsala]	0.46 **	3.25 ***	0.15 ***	2.70 *	2.11
City [Vienna]	0.83	1.25	0.62	1.44	2.18
D	0.10	0.10	0.17	0.05	0.04

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

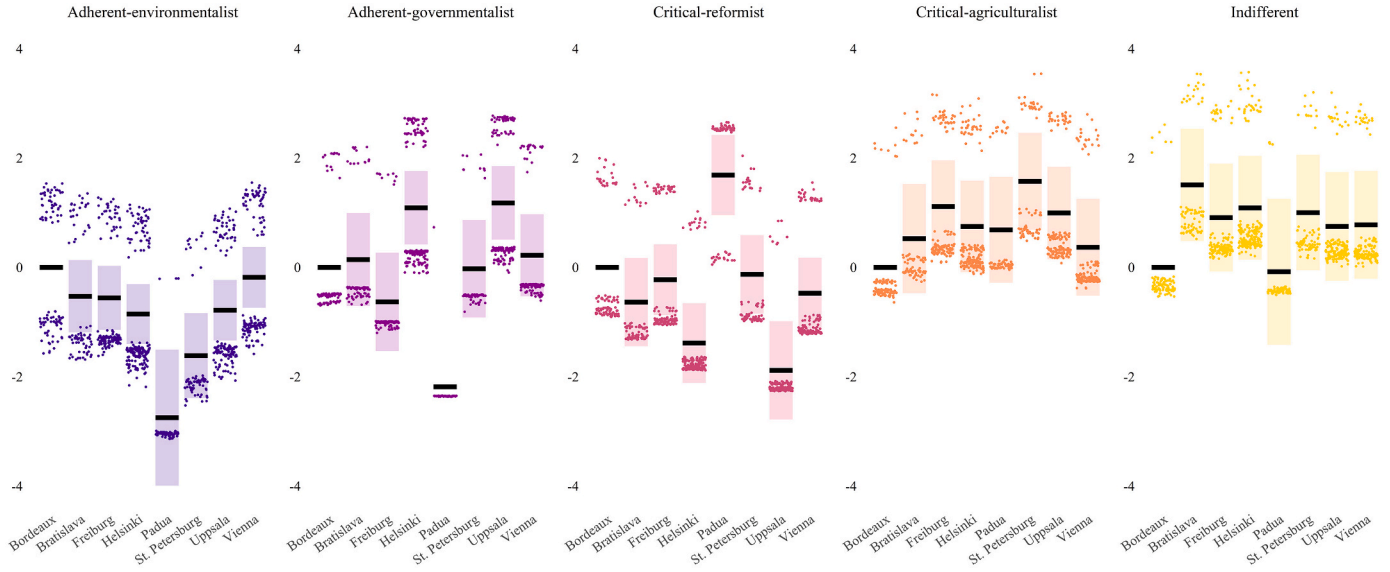

Fig. 5. Main effects for the predictor *city*. The means along the vertical axis differ from odds ratios in Table 3 by the mean of Bordeaux having been fixed at zero (there is certainty about this, hence lack of 95% confidence interval), while the slopes and differences between the cities are the same.

Based on these results, we raise three points for discussion. Below, we look at the variation within and between the cities, discuss the role of perceived familiarity with the FBE, and argue how public perceptions of the contested political project on European BE matter for forest policy.

First, it is not by chance that there are respondents from Helsinki and Uppsala among both the hopeful and the reserved communities. This suggests that large forest sectors come with large disputes over forests that are mirrored by the urban public (Beland Lindahl et al., 2017; Kröger and Raitio, 2017). This also applies to the Viennese, who are relatively evenly spread across the five perceptions. According to Getzner et al. (2018), while the Austrian forest sector is significant, most Austrians (58%) ought to reject public policy that increases logging. Bordeaux being keen on the FBE could link to a recent frame emphasising the "low economic weight" of French forests, 60% of which are unmanaged – and thus diverse (Martinez de Arano et al., 2018). Private forest ownership also concentrates in Western France. In Italy, participatory forest governance remains very limited, perhaps explaining the lower familiarity in Padua (Secco et al., 2018). However, due to recent storms and wildfires with negative impacts on the local forest sector, forests have drawn more attention in this region (Udali et al., 2021). In our sample, Paduans also engage with quite different political ideas. Freiburg, renowned for its green city status, not only places agriculture above forestry, but leans toward the laissez-faire paradigm. The German discourse on BE has also emphasised biotechnology and the chemical sector over the forest sector (Giurca and Metz, 2018; Schütte, 2018). Analysing nationally representative data, Eversberg and Fritz (2022) recently showed how the German population is in fact strongly divided over the prospect of BE not only in terms of mentality, but also in terms of practice. In Slovakia, the contribution of forests to the economy is marginal (Navrátilová et al., 2020), and Bratislava receives the FBE cautiously. However, the country is currently preparing its BE strategy that could have brought forest policy to the fore, particularly since recent deforestation along the Carpathian mountain chain has contributed to muddy floods and water shortages (Danáčová et al., 2020). Russians in turn likely associate forests with state-run "wood mining", unclear land use rights, and limited value addition (Dobrynin et al., 2021; Naumov et al., 2016). This offers cues to contextualise our notion of St. Petersburg being best represented among critical-agriculturalists.

Second, of the eight cities, perceived familiarity with the FBE is relatively low everywhere except in cities in the most forest-dependent economies, i.e., Helsinki and Uppsala (unsurprisingly, though, see Dallendörfer et al., 2022). Such familiarity is certainly relevant in countries with large forest sectors, yet low familiarity with political plans that impact the economy and the environment with undeniable implications for justice within and beyond national borders undermines the democratic right of citizens to review policies that make strong claims about sustainability. Obviously, with intricacies ranging from technological innovation through spatial governance to climate impacts, grasping the FBE is not an easy task, not even for experts (Hurmekoski et al., 2019). Our results indicate that perceived familiarity interacts with the perception of FBE. With the FBE being contested at multiple fronts, interpreting this finding is difficult. It is possible that familiarity reflects politically motivated reasoning or perceived social consensus than actual understanding (Lewandowsky et al., 2019; Taber et al., 2009). As this was not controlled for, the result cannot be taken as evidence of a "knowledge deficit" to be filled with information (Sturgis and Allum, 2004). Rather, the selective use of information is more like currency in the politics of FBE (Daviter, 2015).

Third, there is nothing new in the clash between commercial forestry and forest conservation (Sotirov et al., 2021). Since the current BE policies with their selectively articulated contradictions have been crafted largely by powerful economic interests, finding concerns among the public is less surprising. However, perceptions of the FBE are not only about concern, but also about more fundamental ideas about the world and societal organisation, over which the respondents in our sample are divided. This implies potential for social conflict that is largely absent from current BE policies and much of the public discourse (see also Eversberg and Fritz, 2022). Correcting for this leads to questions about participatory governance, the true potential of which in forest policy remains unclear (Kleinschmit et al., 2018). How such an ideal of participation unfolds depends on motives to participate, ways of constructing and validating knowledge, and power dynamics (Reed et al., 2018), the latter of which in forest policy clearly remain uneven. In the era of social media, our findings raise another question about whether the vertical power struggle (and the perceived ambiguity around forest policy) is turning into a horizontal social conflict, with different public perceptions moving further away from one another, and making effective and just forest governance for sustainability even harder (Bail, 2021; Mason, 2015).

This study contributes to the literature by offering insights into the dimensions and the diversity of public perceptions of contested political discourses in general and the FBE in particular. As an important

limitation to our results, our convenience sampling of respondents lacks representability and, thus, our findings lack generalisability. The data are imbalanced and biased toward younger generations. Respondents were also classified as urban citizens based on their self-identification, without information about the duration of being an urban resident. However, without considerable resources, it is debatable whether some alternative survey technique, such as an online survey, would have yielded significantly better results in terms of representativeness. We recommend that quantitative studies on public perceptions adopt robust research designs and strive to collect larger samples.

In this same vein, it is important to note that our survey was not necessarily coherent and comprehensive enough in terms of the content and number of items, respectively, to elicit the full range of perceptions about a phenomenon as complex as the FBE. Anchoring the items more consistently in local contexts and theories of the formation of perceptions of politically charged matters is an obvious next step (Brandt and Sleegers, 2021; Johnson et al., 2020). It is also necessary to further expand the analysis of the role of "socioeconomic geographies", partisan sorting, and social life more generally for perceptions of the BE and other mainstream sustainability paradigms (Baldassarri and Gelman, 2008; Scherer and Cho, 2003; Weckroth and Ala-Mantila, 2022). Comparing the underlying political claims with actual developments on the ground could also serve as a more meaningful basis for analysing their legitimacy among citizens.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Consortium reports financial support was provided by European Forest Institute. Arttu Malkamäki reports a relationship with Kone Foundation that includes: funding. Anne Toppinen reports a relationship with European Forest Institute that includes: board membership. Helga Pulzl reports a relationship with European Forest Institute that includes: research network and employment. Lea Ranacher reports a relationship with Wood K plus that includes: employment. Lea Ranacher also reports a relationship with Austrian Research Promotion Agency (FFG) that includes: funding under the COMET program Grant Number 865905.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2022.102749.

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