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ARTICLES

Time to Say 'Good Buy' to the Passive Consumer? A Conceptual Review of the Consumer in the Bioeconomy

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Abstract

Successful transitions to a sustainable bioeconomy require novel technologies, processes, and practices as well as a general agreement about the overarching normative direction of innovation. Both requirements necessarily involve collective action by those individuals who purchase, use, and co-produce novelties: the consumers. Based on theoretical considerations borrowed from evolutionary innovation economics and consumer social responsibility, we explore to what extent consumers' scope of action is addressed in the scientific bioeconomy literature. We do so by systematically reviewing bioeconomy-related publications according to (i) the extent to which consumers are regarded as passive vs. active, and (ii) different domains of consumer responsibility (depending on their power to influence economic processes). We find all aspects of active consumption considered to varying degrees but observe little interconnection between domains. In sum, our paper contributes to the bioeconomy literature by developing a novel coding scheme that allows us to pinpoint different aspects of consumer activity, which have been considered in a rather isolated and undifferentiated manner. Combined with our theoretical considerations, the results of our review reveal a central research gap which should be taken up in future empirical and conceptual bioeconomy research. The system-spanning nature of a sustainable bioeconomy demands an equally holistic exploration of the consumers' prospective and shared responsibility for contributing to its coming of age, ranging from the procurement of information on bio-based products and services to their disposal.

Keywords Consumer · Innovation · Consumer responsibility · Shared responsibility · Sustainable bioeconomy · Transition

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Introduction

The bio-based economy or, in short, bioeconomy has been promoted by both researchers and policymakers as a viable response to various societal challenges such as health issues and food security. The bioeconomy is also associated with multiple positive impacts on sustainability such as green growth, job creation, rural regeneration, and climate change mitigation (Bugge et al., 2016; McCormick & Kautto, 2013; Meyer, 2017; Pyka, 2017).[1] Around 50 nation states and the European Union (EU) have adopted bioeconomy strategies or related policies (Bioökonomierat, 2018), and the number of academic papers on this topic is growing rapidly with contributions stemming from researchers around the globe and from different scientific disciplines.[2] Notably, there is still a great diversity in the notions of bioeconomy (Hausknost et al., 2017), which can be clustered into different ideal types ranging from the idea of increasing the use of *biotechnology for industrial purposes* to grounding *all economic activities* on the *use of renewable biogenic resources* (e.g., Bracco et al., 2018; Bugge et al., 2016; Hausknost et al., 2017; Meyer, 2017; Vivien et al., 2019). In addition to this conceptual diversity, one cannot expect that a bioeconomy will necessarily have a positive impact on sustainability. Quite to the contrary, unsustainable bioeconomies are easily conceivable, for example, resulting from the spread of high-risk technologies, excessive land and water use, deforestation, biodiversity loss, reduced food security, and unjust allocation of profits and burdens, to name just a few (Grefe, 2018; Lewandowski, 2015; O'Brien et al., 2017; Pfau et al., 2014; Smolker, 2008; Székács, 2017).[3] Consequently, to legitimize the political enforcement of a sustainable bioeconomy, it must always be measured against its contribution to meeting the grand societal challenges of our time (Vogt, 2018). If implemented accordingly, the sustainable bioeconomy can serve as an "innovation program" for sustainable development (Vogt, 2020). To achieve this, the bioeconomy transition must be regarded as a deeply normative endeavor that requires ethical

[1] We understand sustainability as a deeply normative concept/orientation with (at least) three dimensions (economic, social, and environmental), also comprising an intergenerational component. As with most normative concepts, there is an ongoing debate about the notion of sustainability, its scope, meaning, limitations, and implications, especially as there is ample potential for tension between the three dimensions of sustainability; and it may not be so clear what part of a system should be sustained or transformed, why, and by / for whom (see also Schlaile et al., 2017; Schlaile & Urmetzer 2021). Notably, the controversy around sustainability is not limited to academia. For example, Olde and Valentinov (2019) illustrate the ongoing debates about sustainability in Western agricultural systems, for which they do not see any consensus arising between the involved groups in the nearby future, due to the underlying moral complexity.

[2] The results of a search on *Scopus* with the query ("bio economy" OR "bioeconomy" OR "bio-based economy") in the field TITLE-ABSTRACT-KEYWORD showed one document in the year 2000, 43 documents in 2010 and 461 documents in 2019. The authors of these documents had affiliations to organizations from 94 different countries, with the five most frequent countries of origin being Germany (16.1% of results), the United States (13.5%), the United Kingdom (9.1%), Italy (8.3%), and the Netherlands (6.7%).

[3] Not to mention the general tension between using biomass for food versus using it as material and energy for industrial processes (OECD, 2018).

guardrails and public discourse (Kröber & Potthast, 2015; Vogt, 2020) instead of *purely* supply-oriented reverie. In contrast to inquiries into aspects regarding what is technologically possible, Sanz-Hernández et al. (2019) identify a gap in research into the social scientific aspects of a bioeconomy and others have argued that there is insufficient scholarly debate on what is normatively desirable for a bioeconomy (Urmetzer et al., 2018, 2020)—a trend which is also reflected in a public bioeconomy funding bias towards high-tech developments (Bogner, 2019; Ober & Huwe, 2020). When it comes to the question whether it is the supply of new technologies or the needs and desires of societies that drives socio-economic changes, we know (not only) from the literature on innovation economics that the story is much more complex than the simplifying dichotomy of "technology push" vs. "demand pull" may suggest (e.g., see Godin & Lane, 2013 for a detailed review). Yet, at a first glance, the contemporary bioeconomy literature appears to be somewhat biased in the sense of an implicit technology push focus.

Indeed, this perceived imbalance prompted us to scan the recent research landscape on bioeconomy more systematically. More concretely, we aim to explore the extent to which consumers are recognized as active agents in a bioeconomy context. It should be noted, however, that consumers (or, from an aggregated perspective, the "demand side") have been the subject of controversial debates especially regarding their contribution to social, ecological, and economic sustainability: For example, consumers have been argued to play an important role in various processes of economic change and novelty creation (e.g., Grabher & Ibert, 2018; Hoffmann, 2007; Müller, 2017; Schlaile et al., 2018b; von Hippel, 2005; von Hippel et al., 2011), and, more specifically, even in system-wide innovations such as *sustainability transitions* (e.g., Köhler et al., 2019, Sect. 7; Randelli & Rocchi, 2017), including transitions to a sustainable bioeconomy (Daniel & Reisch, 2014; Rösch & Scheer, 2020). On the other hand, there are good points against overestimating the transformative potential of ethical consumption and political consumerism (e.g., Devinney et al., 2010; Gjerris et al., 2016; Grunwald, 2012; Jacobsen & Dulsrud, 2007). Consequently, with our literature review we do not contend that consumers play a more important role in the bioeconomy transition than other economic agents; nor do we expect our review to be able to support any claim in favor or against this contention. Based on prominent debates in innovation economics and inspired by the recent literature on consumer responsibility, however, we deem it essential to explore the way consumers are considered in the recent bioeconomy literature. More concretely, our analysis addresses the following research question: *To what extent does the scientific bioeconomy literature capture the different roles and activities of consumers?*

The paper is organized as follows. The following section covers the theoretical background in detail, motivating this paper's focus on consumers in the bioeconomy—especially against the background of innovation economics and the literature on (prospective) shared responsibility. Subsequently, we present the systematic literature review by describing the method applied and by depicting the results. The fourth section discusses the results before we conclude our paper with a summary and avenues for future research.

Theoretical Background

Why the Bioeconomy is More than a Supply-side Endeavor

Scientists, politicians, and industrial actors around the world have acknowledged the potential contribution of a bioeconomy to climate protection while also recognizing its potential as a driver for employment, innovation, and increased resource productivity (Carus et al., 2011; European Commission, 2018a; Pyka, 2017; Staffas et al., 2013). However, visions of what exactly a bioeconomy entails—and expectations of its positive effects—vary widely (e.g., Bugge et al., 2016; D'Amato et al. 2017; Hausknost et al., 2017; Levidow et al., 2013; Möller et al., 2020; Oekom e.V., 2020; Pfau et al., 2014; Vivien et al., 2019; Zwier et al., 2015).

The perception of the bioeconomy propagated, for instance, by the OECD and the US-American administration (OECD, 2018; The White House, 2012) displays a strong focus on technological innovation. It thus neglects resolution strategies for potential trade-offs, conflicting goals, and unintended consequences. Moreover, it ignores normative considerations such as visions of the type of society the bioeconomy intends to support (Hausknost et al., 2017; Ober & Huwe, 2020). For the European Commission, however, strengthening the bioeconomy has a clearly defined normative goal: the bioeconomy is seen as an important steppingstone to achieving many of the United Nations' *Sustainable Development Goals* (SDG).[4] Therefore, a central feature of the European understanding is a commitment to a bioeconomy that safeguards sustainability, modernization, and environmental protection (European Commission, 2018a).

This more holistic perception of the concept entails an understanding of the bioeconomy as a change process. The transition perspective from a fossil-based economy towards an economy that is fit for the future is also echoed in the strategy of the German Federal Government (BMBF and BMEL, 2020). Its focus on "a *structural transition* from an economy based on finite resources of fossil origin… to an economy more strongly based on renewable resources" (BMEL, 2014, p. 14, emphasis added) abandons the fixation on certain sectors and particular technologies. Instead, the search for solutions to unprecedented challenges requires the creation of new holistic knowledge for better understanding those global biological systems that provide the basis for sustainable economic development (BMBF and BMEL, 2020; de Vries et al., 2021; Urmetzer et al., 2018, 2020).

Against this backdrop and in the context of our paper, we premise that bioeconomy solutions must not be regarded as ends in themselves that are expected to automatically increase sustainability in one way or another (see also Székács,

[4] In this context, the SDGs as internationally agreed normative goals should be seen as a compromise covering a wide range of different themes. They also reflect multiple tensions between the three pillars of sustainable development, namely, the economic, the social, and the environmental one. Consequently, different aspects of the SDGs have been criticized, ranging from an underrepresentation of environmental issues to the broad range of SDGs and difficulties of measuring the underlying targets and indicators (e.g., Hák et al., 2016). A related critique revolves more generally around neglecting the normative complexity and process dimensions of transformations (e.g., Schlaile & Urmetzer 2021; Schlaile et al., 2017).

2017). Instead, we follow Vogt (2020) in interpreting the sustainable bioeconomy as an endeavor that operationalizes the innovative aspect(s) of sustainability (Vogt, 2020, p. 30). In other words, the bioeconomy can be an important driver of the required transformation that aligns the multiple innovative efforts of various actors in many areas to the ethical goals of a sustainable society (Vogt, 2018, 2020, see also Urmetzer, 2020). Yet, if we consider the bioeconomy to rely on (sustainable and responsible) innovations, we should be careful not to over-emphasize the role of the "supply side" and technologies as the main driver of economic change as promoted by the dominant "techno-economic paradigm" (Blok, 2020). To be clear, new technological solutions developed by firms and other "producers" are undoubtedly important. However, focusing solely on the production of new technologies may run the danger of neglecting, for example, the path dependence and resistance to change of technological regimes and socio-technical systems (e.g., Dosi, 1982; Geels, 2002) as well as the necessary non-technological (e.g., social and transformative) innovations and an adequate *societal* implementation (see also Blok, 2020; Loorbach et al., 2020). Indeed, without due consideration of the demand side impact of novelties *beyond* market uptake, technological advancements may even be voided or actually corrupted by unsustainable consumption habits (see also Daniel & Reisch, 2014, on a related note)—a ramification that has been dubbed *rebound effect* (e.g., Greening et al., 2000; Herring & Roy, 2007).[5] And finally, as also Randelli and Rocchi (2017, p. 95) highlight, there is an increasing number of studies that actually support "an active role of consumers in the innovation process and recognise that consumers cannot be conceived only as passive agents who select between different commercial options."

In the following two subsections, we outline some of the fundamental theoretical cornerstones that motivated our literature review, which aims to illuminate how the consumers' capacity for taking an active role is represented in the scientific bioeconomy literature. Here, we draw from two different (but interrelated) schools of thought: The contemporary literature in (evolutionary) *innovation economics* (e.g., Pyka, 2017, 2019, 2020) teaches us about the important function(s) and influence of various actors in innovation systems and innovation networks, including consumers (Schlaile et al., 2018b), while the recent literature on *consumer social responsibility* (e.g., Heidbrink & Müller, 2020; Schlaile et al., 2018a; Schmidt, 2016) helps to fathom the role(s) of consumers in co-defining the normative directionality of (bio-) economic systems against the backdrop of a prospective and shared responsibility.

[5] This effect has, for instance, been observed with recycled materials that are produced to substitute primary resources. In many cases and for various reasons, such recycled materials (e.g., aluminum, paper, or plastics) are not demanded to the expected extent, which is why they are likely to be produced in addition to—rather than instead of—primary ones, thus reducing the potential benefits of recycling (Zink and Geyer 2017).

The Consumer in Innovation Economics

From an innovation economics perspective, the role of the consumer in innovation processes has long been under great debate (for a more exhaustive recapitulation, see Godin & Lane, 2013). The origins of this debate can be traced back at least to the seminal work of Schmookler, who argued already in the 1960s for the importance of market demand by showing through a set of studies that patterns in patenting activities followed consumption patterns in certain industries (Schmookler, 1962). From these studies, he concluded that demand is key to explaining changes in an economy (cf. Müller, 2017, for a more detailed presentation of this argument).

Since then, several studies have attempted to support Schmookler's hypothesis that innovation follows demand while others viewed the activities and internal capabilities of firms as the primary drivers of innovation (e.g., Teece, 1986) and argued against Schmookler's interpretation. Notably, proponents against this "demand pull" perspective on innovation followed the ideas and arguments by Schumpeter (1943), who focused in his work more on the role of monopolists and entrepreneurs (see also Nelson & Consoli, 2010, on a related note). In fact, the paradigm of a passive consumer is lucidly summarized with the following quote by Schumpeter, which has also been highlighted by Korthals (2001):

> "It is ... the producer who as a rule initiates economic change, and consumers are educated by him if necessary; they are, as it were, taught to want new things, or things which differ in some respect or other from those which they have been in the habit of using" (Schumpeter, 1983, p. 65).

As a preliminary result of the debate between this demand-side vs. supply-side centered view on innovation, it was Mowery and Rosenberg (1979) who linked both contrasting views and argued that both sides appear to simultaneously play crucial roles:

> "Rather than viewing either the existence of a market demand or the existence of a technological opportunity as each representing a sufficient condition for innovation to occur, one should consider them each as necessary, but not sufficient, for innovation to result; both must exist simultaneously" (Mowery & Rosenberg, 1979, p. 143).

This seemingly appeasing verdict did not lead to a balanced consideration of both the demand side and the supply side in the literature (Godin & Lane, 2013). In fact, many authors have argued that despite the intense debate in the 1960s and 1970s the demand side and the consumer are still underrepresented in the innovation economics literature (e.g., Coombs, 2001; Müller, 2017; Nelson & Consoli, 2010; Schlaile et al., 2018b). However, at the same time, we also see that the debate has, in the meantime, branched out into a number of sub-debates and research fields, each of which highlighting different aspects of the consumers' role(s) in innovation processes. With this, we see a more comprehensive analysis of the multifaceted relation between demand and innovation as, for example,

Andersen (2007) points out. Possible examples cover the study of the diffusion of innovations (Rogers, 2003), including the more recent re-framing of diffusion in terms of a co-creative process (Vargo et al., 2020), and furthermore, the approaches of "democratizing" and "free" innovation (von Hippel, 2005, 2017), or the literature on evolutionary economics and economic geography arguing for a more prominent role of users and consumers in co-creating novelties (e.g., Chai & Baum, 2019; Grabher & Ibert, 2018; Grabher et al., 2008). In the context of the bioeconomy, examples of the centrality of users' knowledge for innovation have specifically been discovered for food technologies (Cappellesso & Thomé, 2019) or for the development of a forest-based bioeconomy (Grundel & Dahlström, 2016). The literature on innovation systems has long acknowledged the importance of user-producer interactions (e.g., Lundvall, 2016). Authors recently re-emphasized the importance of innovation system actors beyond the traditional "producers" of scientific and technological knowledge (e.g., Schlaile et al., 2017; Urmetzer & Pyka, 2021). That explicitly includes consumers (e.g., Randelli & Rocchi, 2017; Schlaile et al., 2018b).

By taking the centrality of innovation for a sustainable bioeconomy transition seriously (e.g., Pyka, 2017; Vogt, 2020), this discussion implies that active consumers may also be important in and for this structural transition. Do we then simply need to enforce an increased consumption of bio-based products? This might be the alleged aim of the European Commission when calling—in their bioeconomy strategy—for policy instruments that help "to boost market uptake and consumer confidence" (European Commission, 2018a, p. 11) in order to promote bio-based innovations and products. Such policy instruments originate from the dominant bioeconomy narratives that have traditionally focused on research and innovation policies (Birch et al., 2010) and framed sustainability problems as efficiency problems that can be overcome by biotechnological progress and green growth (Hausknost et al., 2017; Székács, 2017; Vivien et al., 2019). However, the requirement of sustainability awards yet another role to the consumer: the negotiator of the ethical standards and the social desirability of this structural transition. The consumer helps define "the aims, contours, limits, moral standards and principles of that future economic model" (Hausknost et al., 2017, p. 19). In the same vein, the literature on *responsible innovation* argues that the directionality and desirability of novelties (technological and non-technological alike) cannot be determined by the "producers" alone and needs active engagement from stakeholders to innovate for and with society (e.g., Gianni et al., 2019; Sonck et al., 2020; von Schomberg & Hankins, 2019, for recent discussions). While the above quote from the European Commission's bioeconomy strategy already shows that consumers play an important role in the success of the transformation towards a bioeconomy, it also reveals a view of consumers that is rather passive. Yet, against the background of the long-standing debates in innovation economics mentioned above, we caution against a superficial promotion of the bioeconomy where consumers just need the right incentives for buying and using more bio-based products, thereby reducing their agency mostly to the purchase decision. Instead, the spheres and domains where consumers can become active should be made more explicit, which we will address in the subsequent section.

The Consumer as a Co-creator of a Sustainable Bioeconomy?

The literature on (dedicated) *innovation systems* (Pyka, 2017; Urmetzer & Pyka, 2021) acknowledges that (transformative) innovation processes involve multiple interconnected agents (Loorbach et al., 2020; Schlaile et al., 2017). Similarly, the *social connection model* of *shared responsibility* (Young, 2006) argues that corporations, consumers, and other actors within economic systems (e.g., investors, lobbyists, policymakers, media, and other actors in the public sphere; see also Srnka & Schweitzer, 2000) share the power to influence unjust and unsustainable structures (e.g., Barnett et al., 2011; Schmidt, 2016, 2017, 2020; Tempels et al., 2017, 2020; Young, 2006). It is important to stress that the social connection model is a *prospective* concept of shared responsibility, thus focusing on future-oriented capacities of actors for changing a system for the better (Schmidt, 2016; Young, 2006). In this respect, our article follows this future-oriented notion of responsibility, which does not focus on liability or blame but rather on the degree to which different agents can become more active participants in an economy and its structural transition (see also Sonck et al., 2020, for a lucid summary of different elements of responsibility, from backward-looking to forward-looking ones). As Barnett et al. (2011) clarify:

> "Young ... calls this alternative a model of shared responsibility, one in which responsibility is distributed across complex networks of causality and agency ... The advantage of the concept of shared responsibility is that it allows a more discriminating analysis of the partial ways in which actors might understand themselves to be responsible, where this in turn is not just a matter of liability or blame but is closely related to an analysis of the capacity to act" (Barnett et al., 2011, p. 8).

It should be evident by now that we do not want to create the impression that we expect consumers to always have the largest share in this *systemic* responsibility (see also Shove, 2010 for a related argument against an overemphasis of the roles of individuals' attitudes, behaviors, or choices). Quite to the contrary, we reject the position of a *narrow* variant of "consumer sovereignty" (Korthals, 2001; Persky, 1993). In fact, the responsibility of consumers must always be considered in relation to boundaries such as individual capabilities, institutional constraints, and resources (Jacobsen & Dulsrud, 2007; Kjærnes, 2012; Schlaile et al., 2018a, 2020; Schmidt, 2016, 2020). One cannot simply capture the agency of consumers in the bioeconomy transformation via binary categories such as "active" and "passive". While the idea that consumers can be active agents or passive participants in the (bio-) economy traditionally refers to the amount of effort that is put into each stage of the process of demanding, purchasing, and consuming, the notion of active consumers also relates to their attitudes towards novelty (Bianchi, 1998; Swann, 2009). In this context, Swann (2009) describes a continuum along different consumer types that follow various motives and interests, which can lead to a higher or lower degree of activity. From the discussion in the previous section, it should be remembered that the question whether consumers are active or passive, and to what extent, appears to be relevant when analyzing innovation processes, including systemic ones in the sense of social and economic transformations (e.g., Randelli & Rocchi, 2017; see

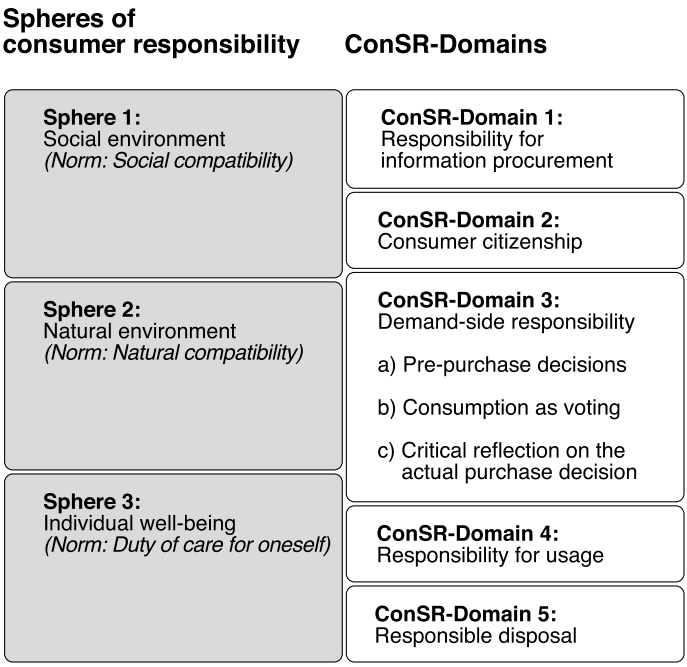

Fig. 1 The "consumer responsibility territory" reprinted from Schlaile et al. (2018a, p. 566, with permission from Springer© 2016)

also the contributions in Hübner & Schmon, 2019). Indeed, it has frequently been convincingly argued that consumers exhibit various types of power or influence on the structure of economic systems (e.g., Rommerskirchen, 2020; Schlaile et al., 2018a; Schmidt, 2016; Srnka & Schweitzer, 2000). We thus require a differentiated and more nuanced understanding of their potential range and scope (Schlaile et al., 2018a, 2018b, 2020).

To pay tribute to this requirement of a more fine-grained classification, we take up the literature on consumer social responsibility,[6] where consumers have been argued to be able to make a difference within three spheres and along five domains of what Schlaile et al. (2018a) have called the "consumer responsibility territory" (Fig. 1). This consumer responsibility territory may be understood as a *potential* or *possibility space* of consumers in the context of our article. While the three spheres are rather self-explanatory and all three of them are relevant in the context of a sustainable bioeconomy, the five domains require further elaboration:

(1) "Responsibility for information procurement". This domain includes both (a) looking for relevant information and (b) sharing this information with others.

[6] For example, German-speaking readers may refer to the contributions in Heidbrink and Müller (2020) for the current status of research on consumer social responsibility.

Especially in the context of new products and processes, consumers frequently act under uncertainty, first and foremost regarding the foreseeability of the consequences of their consumption decisions on all three spheres. However, particularly against the backdrop of a prospective and shared social responsibility, a decisive issue is no longer the question if actors know what they do but rather to what extent they are capable of influencing their nescience (Heidbrink, 2013). In order for consumers to be able to critically reflect on the impact of their decisions they require various types of information, ideally including background data on the value chain (e.g., Schmidt, 2016), which are provided by different sources ranging from firms, labels, or the consumers themselves.

(2) "Consumer citizenship". This domain refers to a variety of actions that fall into the political realm of consumer activism (e.g., de Tavernier, 2012; Müller, 2020; Schrader, 2007; see also Kallhoff, 2016 for a critical discussion). Examples of actions typically associated with political consumerism include boycotts, "buycotts" (i.e., deliberate purchase), various discursive actions, and lifestyle choices (e.g., Micheletti et al., 2012). Moreover, there is a broad literature on the potential of politicizing consumption revolving around consumers that actively seek to become agents for sustainable change through their actions (e.g., Lamla & Neckel, 2006; Røpke, 2013; WBGU, 2011, Sect. 6.3.3), which explicitly goes beyond boycotts or purchasing more climate-friendly products.

(3) "Demand-side responsibility". The third domain of demand-side responsibility can be further specified into (a) "pre-purchase decisions", (b) "consumption as voting", and (c) the "critical reflection on the actual purchase decision". Pre-purchase decisions (a) are an umbrella term for consumers' active participation in the value creation process especially prior to purchase, for example, by means of "co-production" and "co-creation of value" (e.g., Etgar, 2008; Hoffmann, 2007; Martínez-Cañas et al., 2016; Senge & Carstedt, 2003; Vargo et al., 2020) or "user/consumer innovation" (e.g., Grabher & Ibert, 2018; Grabher et al., 2008; Roberts et al., 2014; von Hippel et al., 2011). Consumption as voting (b) could be regarded as another particular domain of political consumerism: Not too different from a ballot, consumers can exert influence by being a force of selection (e.g., Dickinson & Carsky, 2005; Moraes et al., 2011; Shaw et al., 2006). Finally, the critical reflection on the actual purchase decision *(c)* includes assessing potential consequences, alternatives (in terms of quantity and characteristics of purchased goods and services), critically reflecting on one's needs, and eventually changing one's purchasing behavior (e.g., Heidbrink & Schmidt, 2011; Schmidt, 2016).

(4) "Responsibility for usage" and (5) "responsible disposal" are two rather self-explanatory domains but nonetheless highly relevant as much research on consumer responsibility tends to revolve around the purchasing decision. However, the subsequent processes of actually consuming, that is, using a product or service and disposing of what is left at the end of this process are often at least as important as the purchase decision (e.g., Lee et al., 2019, on the issue of responsible recycling)—especially in the context of a sustainable (and potentially even circular) bioeconomy. Using and disposing of goods and services in

a responsible way generally saves resources and avoids unnecessary waste (see also Heidbrink & Schmidt, 2011, on a related discussion).

In the following section, we use the above category of active vs. passive consumers in combination with the five domains as a template for coding the articles in our literature review. However, we caution against regarding the following analysis as an investigation of *moral responsibility* (as most articles do not explicitly address ethical issues) but rather as the degree to which a publication captures the different roles or activities of consumers in the bioeconomy (along the continuum of possibilities within their consumer responsibility territory).

Systematic Literature Review

Method and Data

To investigate how consumers are depicted in the bioeconomy literature, we present a systematic literature review in a manner informed by Okoli (2015), Tranfield et al. (2003), and Palmatier et al. (2018). The literature review was done following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework (Moher et al., 2009). The steps are depicted in Fig. 2. (Identification, Screening, Eligibility, Included). The relevant literature was analyzed by following the procedure of Krippendorff (2004) in unitizing, sampling, and coding.

Step 1 (identification) was a search on Scopus combining the search terms "consum*" OR "demand side" OR "demand driven" OR "procurement" AND "bio economy" OR "bioeconomy" OR "bio-based economy" in the title-abstract-keywords fields.[7] The first part of the search string covers different terms referring to consumers and, respectively, the demand side they represent. The second part covers bioeconomy and the synonymously used term bio-based economy in its variant forms of spelling. The search on Scopus resulted in 282 publications.

In step 2 (screening/eligibility), we analyzed those 282 publications regarding their relevance for the analysis at hand by reading the abstract. In several cases, additionally scanning through the full text of a publication was necessary to allow an informed decision whether to include a publication or not. The publication furthermore had to be available on 7 November 2019 to be included in the review. Step 2 lead to the exclusion of 188 publications, leaving an initial selection of 94 publications.

In the third step, documents were checked for inclusion in the final sample. The detailed analyses of the 94 publications lead to the exclusion of 20 papers due to a lack of relevance, leading to a final sample of 74 publications.

We furthermore scrutinized the reference lists to check for further relevant publications ("backward citation snowballing"), which did, however, not result in

[7] The exact search query was: *TITLE-ABS-KEY ((consum* OR ("demand side") OR ("demand driven") OR procurement) AND ("bio economy" OR "bioeconomy" OR "bio-based economy")).*

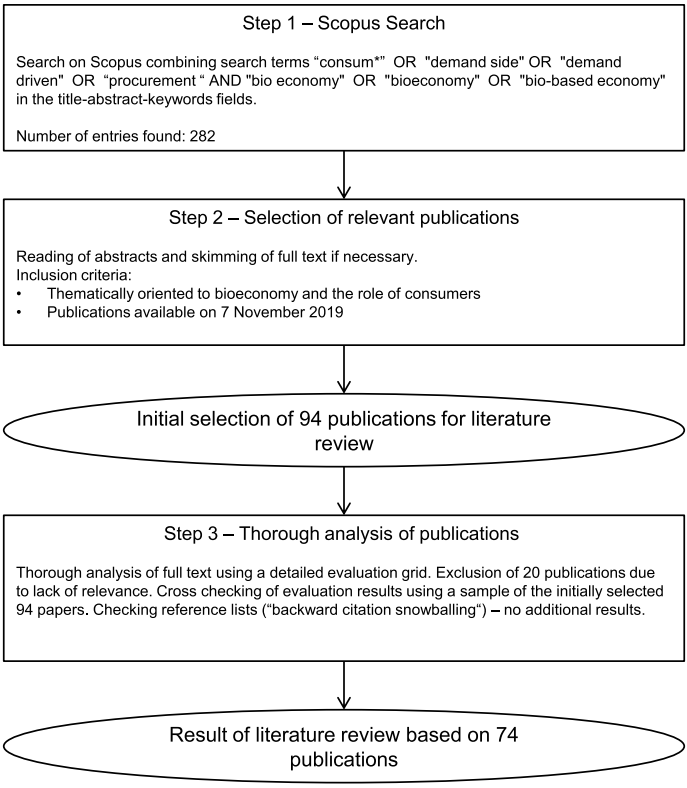

Fig. 2 Process of our literature review

the inclusion of additional publications. This final sample of 74 publications was thoroughly analyzed using qualitative content analysis (Mayring, 2014, 2015). We coded the content using deductive category assignment (Mayring, 2014), using a detailed coding scheme, grounded on the above theoretical considerations. The detailed coding scheme is shown in Table 1. It consists of two evaluation categories, namely category *A: Active or passive role of consumers*, and category *B: Domains of consumer responsibility*, which is divided in five sub-categories representing the different domains described above in the previous section. To assess the inter-rater reliability, a small number of additional data must be concurrently, but independently, coded by all coders. There is no general consensus on the optimal amount of data needed to credibly assess the inter-rater reliability (Campbell et al., 2013) but 10–25% are assumed to be sufficient (O'Connor & Joffe, 2020). We decide to take 8 randomly selected articles, which is equivalent to around 10% of the reduced sample. Based on this sample, we calculated Fleiss' Kappa with a statistically significant value of 0.467. According to Landis and Koch (1977), this can be considered as "moderate agreement". Taking into account the latent characteristic of the rated items, the relatively high number of

Table 1 Evaluation grid for the systematic literature review

Evaluation category	Explanation	Evaluation Scheme
(A) Active or passive role of consumers	Consumers as actors that are led and guided or as a driving force of market outcomes, reflected by the consumers' amount of effort put into market processes and the consumers' attitude towards novelty	0 = n. a.(exclusion)/1 = passive/2 = rather passive/3 = rather active/4 = active
(B) Domains of consumer responsibility		
(B1) Information procurement		
(B1.1) Get information	Responsibility for thinking independently and being attentive and observant of available information regarding products, services, and companies	0 = n.a./1 = weak/2 = strong
(B1.2) Share information	Responsibility for sharing reliable & relevant information with other consumers	0 = n.a./1 = weak/2 = strong
(B2) Consumer citizenship	Taking an active role via civic engagement (e.g., in non-governmental organizations), protesting, and exerting influence on market structures, corporations, policy, and other consumers, among various other options	0 = n.a./1 = weak/2 = strong
(B3) Demand-side responsibility		
(B3.1) Pre-purchase decision	Consumer involvement in the supply chain through (responsible) co-production and co-creation of value	0 = n.a./1 = weak/2 = strong
(B3.2) Voting	Selecting which products and suppliers remain in the market	0 = n.a./1 = weak/2 = strong
(B3.3) Critical reflection	Taking into account consequences, alternatives, quantity and type of goods or services, and eventually changing consumption patterns	0 = n.a./1 = weak/2 = strong
(B4) Responsibility for usage	Considering the social and natural environment and "taking care of oneself" during usage (whereas not taking care of oneself can also have negative consequences on others like family, co-workers, health system, etc.)	0 = n.a./1 = weak/2 = strong
(B5) Responsible disposal	Re-use, re-cycling, and avoiding unnecessary (food) waste and litter	0 = n.a./1 = weak/2 = strong

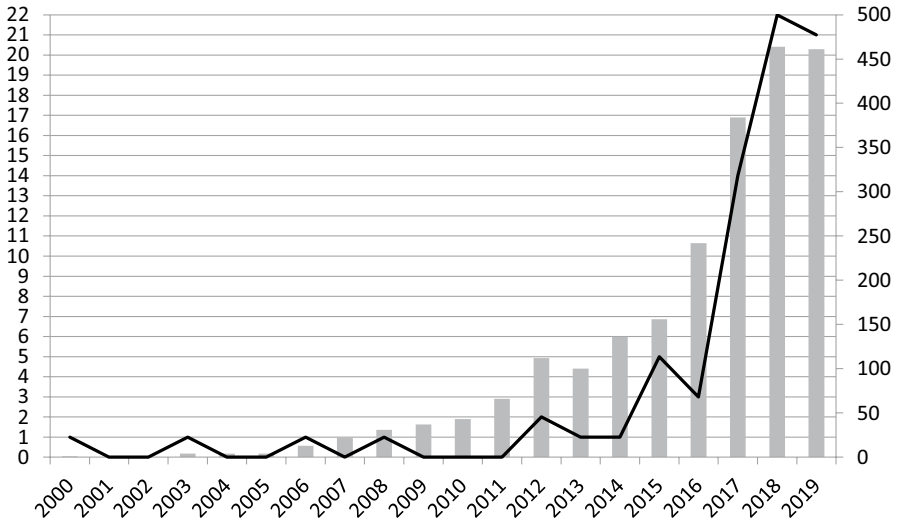

Fig. 3 Distribution of articles included in literature review according to year of publication. Left axis: number of publications considering both consumer and bioeconomy. Right axis: total number of publications in the field of bioeconomy

categories (in total 8 (sub-)domains) and the comparably large number of four coders, we consider this value to be sufficient to allow for an aggregation and comparison of the different ratings.[8]

The 74 publications are composed of 64 journal articles, 8 book chapters, and 2 conference papers. Figure 3 shows the spread of publications included in the literature review based on their year of publication. The figure illustrates that the role of consumers in the bioeconomy is receiving growing attention, in line with an overall increase of papers addressing bioeconomy. The oldest publication stems from the year 2000, while most of the others have been published since 2017.

The journal articles stem from 41 different journals, covering a broad thematic range including agriculture, economics, forestry research, technology transfer, environmental research, innovation policy, sustainability research, and others (see references marked with * in the reference list for a complete list of publications included in the final selection). Most of the journals are represented with only one article, showing the heterogeneity of interest in this topic.

Findings

In this section, we describe the results of the content analysis based on the abovementioned evaluation grid as shown in Table 1. Figure 4 displays the findings for

[8] Subjects = 80; Raters = 4; Kappa = 0.467; z = 12.7; p-value = 0.

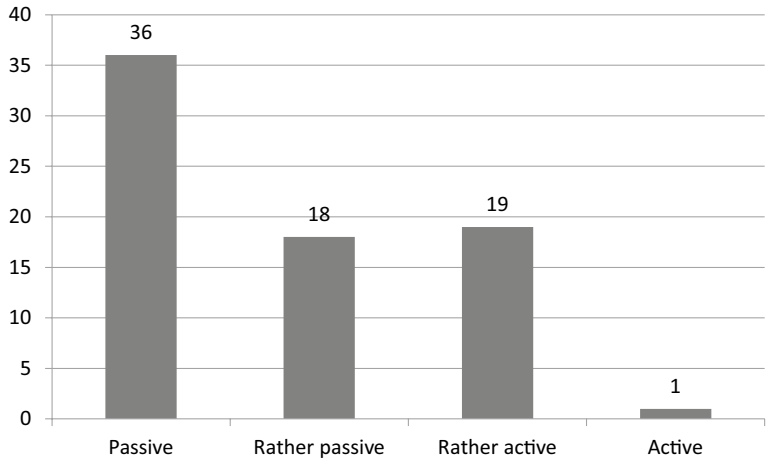

Fig. 4 Allocation of papers along evaluation category A: Active or passive role of consumers

evaluation category *A: Active or passive role of consumers.* For this category, the publications were classified according to their overall depiction of the role of consumers as *passive*, *rather passive*, *rather active,* or *active*. Publications that did not address any consumers partaking in the economic process (i.e., neither active nor passive) were excluded due to the centrality of this aspect for our analysis (hence the exclusion of 20 papers in step 3 of the literature review process).

In the remaining 74 publications, the consumers' role is mostly described as *passive* (49% of publications) or *rather passive* (24%). Roughly a fourth of the papers (27%) depict the consumers as *rather active* or *active*. An example of a *passive* role of consumers can be found in Jarre et al. (2020), where the consumers' role regarding the success of new biobased products is only relevant in the sense that the awareness of consumers of these new products has to be actively raised by the producers. Dobrowolski et al. (2017) is an example of a *rather passive* role of consumers as they illustrate at least some feedback from consumers, which has a (limited) influence on the development of new biobased products. An example of a *rather active* role of consumers can be found in Grundel and Dahlström (2016) who state that the involvement of consumers in innovation processes is necessary for the transformation towards a sustainable bioeconomy. The one publication in the sample depicting an *active* role of consumers (Winkler et al., 2019) describes how consumers actively change not only consumption but also production patterns in a bioeconomy.

Figure 5 shows the assessment of the 74 publications regarding the elements of evaluation category *B: Domains of consumer responsibility*. For each domain or sub-domain, the publications were categorized according to their account of the corresponding element. If an element was not addressed at all, the publication yielded *0* for *not addressed*. If consumers' roles were described in a way that a (sub-)domain was covered, the corresponding publication was coded *1* for *weak* coverage and *2* for *strong* coverage.

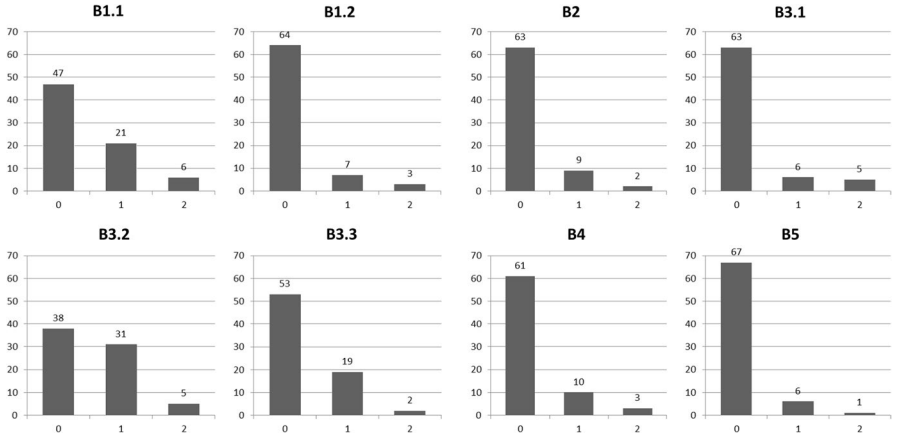

Fig. 5 Allocation of papers along the elements of evaluation category B: Domains of consumer responsibility. Legend: B1.1 = Information procurement—get information; B1.2 = Information procurement—share information; B2 = Consumer citizenship; B3.1 = Demand-side responsibility—pre-purchase decision; B3.2 = Demand-side responsibility—voting; B3.3 = Demand-side responsibility—critical reflection; B4 = Responsibility for usage; B5 = Responsible disposal; 0 = not addressed; 1 = weak; 2 = strong

The overall picture shows that the different (sub-)domains are addressed to a varying extent with most of the elements being addressed only by a minority of the publications. The aspect captured by far the most is *B3.2: consumption as voting*, which is addressed by 36 publications. In contrast to this, we see that *B5: responsible disposal* is considered by only seven publications.

To get a more in-depth understanding of how the bioeconomy literature perceives of consumers, we will now give examples from the literature and describe the appraisal regarding the eight elements. In sum, 27 of the 74 publications cover the issue of *responsibility for information procurement (B1)*, reflecting about aspects such as the growing information demand regarding biobased products in general (Brătucu et al., 2019; Soetaert & Vandamme, 2006), labeling as means for information procurement (Egenolf & Bringezu, 2019; García et al., 2018; Ladu & Blind, 2017), social learning (Grundel & Dahlström, 2016), and others. Among those publications, the aspect of *getting information (B1.1)* is addressed by all of these 27 publications (with six publications putting a strong weight on this aspect and 21 publications attributing less weight to it). In comparison, *sharing the information (B1.2)* is addressed by only ten publications.

The issue of *consumer citizenship (B2)* is raised by only 11 publications, two of which put a high weight on this aspect. Publications reflecting on this issue address, for example, the forming of consumer movements to influence bioeconomy policies (Marsden & Farioli, 2015; Zilberman et al., 2015), or the role of consumer networks in innovation processes of the bioeconomy (Pyka & Prettner, 2018).

The domain *B3: demand-side responsibility* is divided into three subdomains: *pre-purchase decisions (B3.1)*, *consumption as voting (B3.2)*, and *critical reflection on the actual purchase decision (B3.3)*. Of the 74 publications, 47 consider at least one of these subdomains with eleven publications addressing *B3.1*, 36 addressing

B3.2 and 21 publications addressing *B3.3*. Of those 47 publications, 32 focus on only one of these subdomains and six publications consider all three of them.

Regarding consumers' *pre-purchase decisions (B3.1)*, the literature covers aspects such as the involvement of consumers as co-creators in value chains and development processes of biobased products and services (Kristinsson & Jörundsdóttir, 2019; Toppinen et al., 2017), or the introduction of practices and norms for co-creation processes (Kurppa, 2016).

The aspect of *consumption as voting (B3.2)* is the domain most frequently represented in the publications. This is quite unsurprising, as selecting which products and suppliers remain in the market is the most straightforward channel of consumers' influence. Five publications make a strong case for *consumption as voting (B3.2)*, while another 31 publications ascribe at least some importance to this aspect of consumer activity, which means that almost half of the publications in our overall sample cover this topic. Those papers reflect on issues such as the consumers' attitudes in selecting products (Bennich et al., 2018; Duchesne & Wetzel, 2003), or the diverse interests of consumers (e.g., Hagemann et al., 2016), while several others address a growing demand of consumers for more sustainable (e.g., environmentally friendly or socially fair) bio-based products (Hertel et al., 2013; Jong et al., 2012; Korhonen et al., 2020; Toppinen et al., 2017).

The sub-domain *B3.3: critical reflection* is found in 21 publications, however, with only two publications giving it a strong weight. Regarding this element, the literature contemplates, for instance, consumers' consideration of the whole life cycle of biobased products (Egenolf & Bringezu, 2019), thorough reflection of environmental impacts (Vatamanescu et al., 2018), or the consideration of higher costs for biobased products as investment into the future (Hagemann et al., 2016).

A domain that only receives relatively little attention is *responsibility for usage (B4)* with in total 13 publications addressing the issue and only three putting a strong emphasis on this domain. The publications address issues such as the link between the usage of biobased products, physical health, and biodiversity (Schutter et al., 2019), or the shift in consumers' perception regarding usage and ownership (Barčić et al., 2019).

Finally, the domain of *responsible disposal (B5)* is the least addressed, with only one publication (Pätäri et al., 2017) giving this aspect a high weight, and six publications giving it some weight, which means that less than 10% of the publications address this domain at all. Issues addressed are, for example, new forms of consumption such as collaborative consumption, which can have positive effects on the amount of waste produced (Barčić et al., 2019; Imbert, 2017), or disposal as the least preferred end-of-life option consumers should choose, yet acknowledging technical and other barriers to re-use and re-cycle activities (Escobar et al., 2018; Korhonen et al., 2020).

In addition to the elaboration above, an even more detailed insight into the representation of consumers' scope of action in the bioeconomy literature can be gained by scrutinizing the links between the different (sub-)domains. Arguably, for capturing the consumers' scope of action in a specific domain it may be justified to do so in an isolated manner, that is, without considering the connections of that domain with others. However, at the same time, given our more systemic understanding of

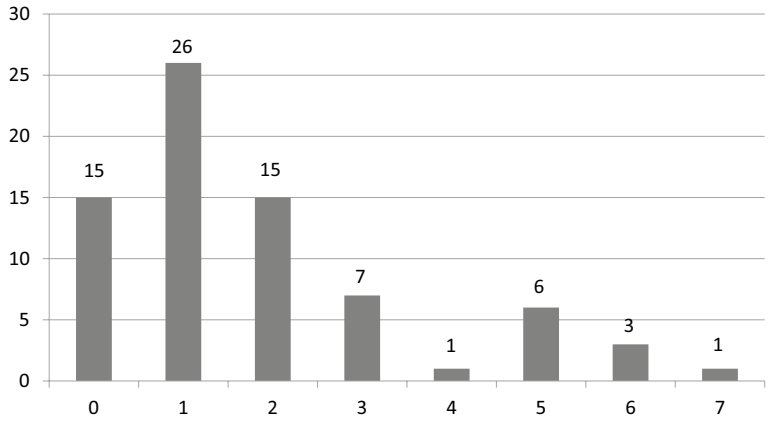

Fig. 6 Frequency distributions of domains mentioned per publication. The 15 papers not mentioning a domain still attributed at least a passive role to the consumer (category A) but did not allow for an unambiguous attribution to a specific domain (category B)

transitions and economic processes (including innovation), we would assume that an isolated or too focused discussion neglects potential interdependences between the domains and may present a myopic and reductionist perspective.

Our analysis reveals major differences in terms of interconnectedness among the different (sub-)domains (see Fig. 6 and Tables 2 and 3), that is, how many domains are treated by a publication at the same time and which domains are dealt with jointly. Figure 6 shows that the majority of publications tackle only a small number of elements while a few consider the role of the consumer alongside different (sub-)domains, thereby taking a more comprehensive perspective, such as Pätäri et al. (2017), who explicitly see consumption as a process with many phases also including post-use behavior. Only one publication (Grundel & Dahlström, 2016) covers seven (sub-)domains and none of the publications addresses all of the eight (sub-)domains. Table 2 gives an overview on how many papers that address a specific domain also consider other domains and shows the average number of other domains mentioned. An even more granular picture of the domains' co-occurrence within the reviewed publications is provided in Table 3.

To derive the results presented in Table 3, we first count the total number of publications that address a particular domain (black diagonal cells). We then counted for any pair of domains (i,j with $i \neq j$) the number of publications that address both domains $X_{i,j}$ (absolute numbers in brackets). Based on this, we computed the relative occurrence of a domain j (columns) for domain i (rows) by dividing the number of publications that address these domains ($X_{i,j}$) with the total number of publications that address domain i (percentages in Table 3). So, for example, by dividing the total number of publications that address both domains *B1.1* and *B1.2* with the total number of publications that address *B1.1*, we see that approx. 37% of all publications that address *B1.1* also consider *B1.2*. In contrast, the total number of publications that address both domains *B1.1* and *B1.2* divided by the total number of publications that address *B1.2* shows us that

Table 2 Relative interconnectedness of domains (category B)

Domain	B1.1	B1.2	B2	B3.1	B3.2	B3.3	B4	B5
Share of papers addressing this domain that also address at least one of the other domains (in % and absolute numbers)	~81% 22/27	~100% 10/10	~64% 7/11	~100% 11/11	~64% 23/36	~86% 18/21	~100% 13/13	~86% 6/7
Average number of other domains addressed	2.4	4.1	2.8	3.6	1.6	2.6	2.6	1.7

Table 3 Directed and weighted co-occurrence matrix of domains in publications

	B1.1	B1.2	B2	B3.1	B3.2	B3.3	B4	B5
B1.1	27	37% (10)	26% (7)	33% (9)	59% (16)	56% (15)	22% (6)	4% (1)
B1.2	100% (10)	10	60% (6)	60% (6)	70% (7)	90% (9)	30% (3)	0% (0)
B2	64% (7)	55% (6)	11	45% (5)	45% (5)	45% (5)	27% (3)	0% (0)
B3.1	82% (9)	55% (6)	45% (5)	11	73% (8)	64% (7)	36% (4)	9% (1)
B3.2	44% (16)	19% (7)	14% (5)	22% (8)	36	33% (12)	22% (8)	8% (3)
B3.3	71% (15)	43% (9)	24% (5)	33% (7)	57% (12)	21	24% (5)	10% (2)
B4	46% (6)	23% (3)	23% (3)	31% (4)	62% (8)	38% (5)	13	38% (5)
B5	14% (1)	0% (0)	0% (0)	14% (1)	43% (3)	29% (2)	71% (6)	7

all publications (100%) that address *B1.2* also consider *B1.1*. This reveals some major discrepancies and a structural asymmetry in the mutual consideration of the domains.

Regarding the issue of *responsibility for information procurement (B1),* 81% of the papers addressing *getting information (B1.1)* also address one or more of the other domains, with an average of 2.4 other domains being addressed. As shown in the first row of Table 3, the other domain most frequently covered by those papers addressing *B1.1* is *consumption as voting (B3.2)* (i.e., 59% of the papers addressing *B1.1* are also concerned with *B3.2*), closely followed by *B3.3* (with 56%). All those papers speaking about *sharing information (B1.2)* also address one or more of the other domains, with on average 4.1 other domains being discussed, which is the highest value among all domains. Rather unsurprisingly, all papers dealing with *B1.2* also approach *B1.1*. Interestingly, 90% of the papers addressing *B1.2* also treat the topic of c*ritical reflection (B3.3).*

Only 64% of the papers addressing *consumer citizenship (B2)* also look at one or more other domain, with on average 2.8 other domains being addressed. Most frequently, *B1.1* is also addressed (64%), followed by *B1.2* (55%).

Looking more closely at domain *B3: demand-side responsibility*, we see that all papers addressing *B3.1 (pre-purchasing decision)* also pay attention to one or more of the other domains (on average 3.6 others). Of all domains covered together with *B3.1*, *getting information (B1.1)* is the most common one (82%), followed by *B3.2* and *B3.3*. Only 64% of the papers addressing *consumption as voting (B3.2)* also touch upon other domains, with on average only 1.6 other domains being covered. Again, *B1.1* is the domain most frequently addressed (44%), followed by *B3.3*. Interestingly, there is no strong connection to *B3.1* in this direction. From the papers covering *critical reflection (B3.3),* 86% also attend to one or more of the other domains (on average 2.6 other domains). The strongest link is again to *B1.1* (71%) followed by *B3.2* (57%). Yet again, there is no particularly strong connection to *B3.1* in this direction.

All papers covering the domain of r*esponsibility for usage (B4)* also address one or more other domain, with on average 2.6 other domains being treated by these publications as well. The strongest link exists to *B3.2* (62%) followed by *B1.1* (46%).

Finally, six of the seven publications speaking about *responsible disposal (B5)* also deal with one or more other domain (on average 1.7 other domains). Here, the most prominent link exists to *B4* (71%), followed by *B3.2* (43%).

To summarize, our results present a detailed picture of the different weight and interdependence of the domains as addressed in the contemporary bioeconomy literature. In the following section, we will discuss selected findings against the background of the overarching theoretical debate.

Discussion

Starting from the previously undocumented and thus merely anecdotal suspicion that the scientific bioeconomy literature could be biased towards what Blok (2020) calls the *techno-economic paradigm* of innovation (which regards novelty creation as mainly driven by new technologies that are introduced into the market by the "supply side"), we have taken up the task of looking more closely and systematically into the way consumers have been treated in the contemporary bioeconomy literature. Our analysis has followed established procedures for systematic reviews and qualitative text analysis, and we proposed and applied a novel coding scheme to move beyond dichotomous representations of merely active vs. passive consumers. By doing so, our results contribute to the literature not only by presenting the current state of the art of research on consumers in the context of the bioeconomy in a detailed manner but also by developing a more nuanced and theoretically well-founded analytical approach to depicting consumer activity in economic systems.

So, what have we gained? First and foremost, our results clearly indicate that most bioeconomy-related publications indeed focus on other issues than consumers.[9] Interestingly, in the subset of the bioeconomy literature that made up our final sample (i.e., the 74 publications marked with * in the references), consumers tend to be considered in a mostly passive way. Moreover, our analysis reveals that the scientific bioeconomy literature, thus far, focuses mainly on the more "traditional" domains through which consumers have been argued to contribute to economic change, that is, through consumption as voting (B3.2; occurring in 36 papers) and thanks to information procurement—especially getting information (B1.1; occurring in 27 papers). In this regard, our review already supports the aforementioned bias towards reducing the consumer's sphere of influence mostly to the adoption (or refusal) of new bio-based products and processes.

In the context of the transition towards a sustainable bioeconomy, however, this focus should be questioned. Yet, it is likely that some bioeconomy scholars will argue that the current focus of the literature is fully justified—especially if they were to view the bioeconomy from the lenses of industrial biotechnology or efficient biomass utilization (which only represent a "weak sustainability"

[9] For the timeframe considered in our analysis, this means that only roughly 3.3% of the bioeconomy publications found with the Scopus search string *TITLE-ABS-KEY ("bio economy" OR "bioeconomy" OR "bio-based economy")* address consumers.

approach, though; cf. Vivien et al., 2019). Indeed, if one adheres to a techno-economic innovation paradigm (Blok, 2020) that focuses solely on the necessary technological advances that facilitate the transformation towards a bioeconomy, then the consumers' scope of action may—at most—be viewed as the collective "voting" for more or less "responsible" technological innovations. However, as argued above in our "Why the bioeconomy is more than a supply-side endeavor" section, the transition towards a *sustainable* bioeconomy goes way beyond market acceptance and diffusion of novel and "more efficient" biotechnological innovations.

In this context, it is also worthwhile to have a closer look at our findings regarding the treatment of the actual consumption (i.e., usage of goods, services, energy, resources, etc., and the disposal of what is left at the end of this process) after the purchase decision. We observe in the literature a relatively low consideration of the domains of usage (*B4*; occurring in 13 papers, of which it is highlighted in 3) and disposal (*B5*; occurring in 7 papers, of which it is highlighted in 1). Especially in the context of a sustainable bioeconomy, it is noteworthy that responsible disposal (B5) is only rarely addressed (in less than 10% of the publications of our final sample) and that this domain has not been covered in connection to B1.2 and B2 at all. Apparently, in the current bioeconomy discourse, this domain is treated as a rather individual one with no obvious collective dimension. It is quite surprising that the topic of responsible use and disposal by consumers has not received much attention compared to the other domains, especially since circular economy approaches and waste or residuals at the end of the product life cycle are of central importance in a bioeconomy. The potential superiority of the environmental performance of bioplastics as compared to their conventional fossil-based counterparts, for instance, has been found to be strongly dependent on their 'end of life'. Studies have shown that the ways plastics are used and disposed of are critical for the evaluation of the sustainability of plastics (European Commission, 2018b). Waste separation, deposit schemes, the avoidance of littering, or reuse and repair (Bertling et al., 2018) are not only matters of design and effective waste management, but also depend on the individual decisions of the person taking possession of the product (Minelgaitė & Liobikienė, 2019).

More generally, it should be remembered that consumers' motivations, behaviors, lifestyles, and daily routines have frequently been argued to be relevant especially for the success (or failure) of sustainable development (Heidbrink & Schmidt, 2011; Jaeger-Erben et al., 2015; López Davis et al., 2017; McCormick et al., 2016), also in the context of a sustainable bioeconomy (Otto et al., 2020, 2021). At the same time, however, there have been important arguments against over-emphasizing the roles of *individual* consumers without sufficient acknowledgment of their embeddedness within the greater innovation or socio-technical systems (Shove, 2010), different institutional or cultural background, budget and other constraints, access to knowledge and information, and many other capabilities (Gjerris et al., 2016; Grunwald, 2010, 2012; Jacobsen & Dulsrud, 2007; Kjærnes, 2012; Schlaile et al., 2018a). Our findings suggest that the bioeconomy literature still has much to gain from taking up these relevant debates, especially to avoid falling for the lure of a rather one-sided techno-economic paradigm.

Another insight from our systematic review is that getting information seems to be acknowledged as relevant in the bioeconomy literature also in the context of the other domains (since publications discussing other domains also frequently address *B1.1*). For example, sharing information *(B1.2)* only appears together with *B1.1* (getting information). Indeed, getting information has often been argued to be a prerequisite for any kind of consumer activity, especially responsible consumption (Schmidt, 2016; Srnka & Schweitzer, 2000).[10] Moreover, the different interconnections we revealed between the domains in the literature can be used as a starting point for further inquiries into necessary and sufficient conditions for consumers to contribute to the transition towards a sustainable bioeconomy. For example, the sharing of information *(B1.2)* appears to be the most salient aspect also in the context of many of the other domains. Notably, both consumer citizenship *(B2)* and all the sub-domains of demand-side responsibility *(B3)* are strongly interconnected with both sub-domains of information procurement *(B1)*. The example of bioplastics introduced before illustrates how conducive a holistic consideration of the various domains of consumer responsibility is especially in the context of a transition to a sustainable bioeconomy: It is not sufficient for the responsible "bio consumer" to just choose the bio-based plastic product. The way we consume is of considerable importance for the success or the failure of the establishment of a truly sustainable bioeconomy. A first step can be the inquiry into the type of bio-based material and the sharing of this information with peers (*B1: Information procurement*) (e.g., regarding the origin and related carbon footprint of the raw material; cf. European Commission 2018b). A second step can be active engagement for the communal waste management (*B2: Consumer citizenship*) or the critical reflection of the own demand by also taking into consideration alternatives (*B3: Demand-side responsibility*). Another step involves critical reflection of the decisions regarding use (*B4: Responsibility of usage*) and disposal (*B5: Responsibility of disposal*) (see above).

Considering these insights, a few limitations must be acknowledged. First, it is important to note that although we build upon the domains identified in the consumer responsibility literature, our review cannot reveal the exact roles and responsibilities consumers may or may not have in the structural transition towards a sustainable bioeconomy. Nonetheless, our results and the theoretical discussion presented above have pointed towards several aspects that may be under-researched and should be taken up in further conceptual and empirical bioeconomy research. Second, our qualitative review has the methodological limitation that it relies heavily on subjective components that are prone to different interpretations by the individual authors, especially against the backdrop of the complexity of the consumer responsibility domains. Regarding the review process, we thus acknowledge that the inter-rater reliability has to be considered as representing "moderate agreement" (Landis & Koch, 1977) between the four coders. Third, having coded a paper as strongly

[10] Notably, of the 27 publications addressing *B1.1*, only 10 address *B1.2*. Yet, 16 address *consumption as voting (B3.2)* and 15 cover *critical reflection (B3.3)*. Hence, one could get the impression that a central aspect of consumer action in a bioeconomy is seen in getting information about which products to buy, purchasing them, and reflecting upon this decision.

addressing a particular aspect does not necessarily reflect the paper's overall focus (e.g., consumers may have been positioned in an active way but do not play a major role for the research focus of the respective paper). Fourth, we acknowledge that we have not focused on the bioeconomy paradigm predominant in the papers (e.g., if the papers explicitly or implicitly represent a focus on biomass utilization, industrial biotechnology, or an ecological economy more broadly as described by Vivien et al., 2019). It may thus be interesting for future studies to take up the question in which ways the representation of the consumers differs in the various perspectives on the bioeconomy.

Conclusion

The bioeconomy in its various facets has been promoted both by policymakers and scientists especially due to its various promises of positive impacts on society, economy, and the environment. We share the widely held view that the bioeconomy has the potential to contribute to sustainability transitions but that it will not automatically lead to more sustainable processes of production and consumption (e.g., Székács, 2017). We build upon the view that the bioeconomy involves (responsible) innovation processes on various scales beyond (but including) new technologies. The literature on innovation economics and consumer responsibility provides foundational arguments for regarding consumers as potentially active agents. This means that they are not merely passive participants within the structural transition towards a sustainable bioeconomy but share responsibility with other actors in the system. This argument provides the theoretical starting point for our systematic literature review that fathoms how the consumers' scope of action is represented in the scientific bioeconomy literature. With the findings of our review, we contribute to the literature on multiple ways: First, our paper provides a starting point for further inquiry as this is the first systematic review of the consumers' scope of action in the context of a (sustainable) bioeconomy. Second, we propose and apply a novel coding scheme to evaluate whether consumers are treated as active or passive and specify the consumers' sphere of influence along five domains (or, eight sub-domains) known from the literature on consumer social responsibility (e.g., Schlaile et al., 2018a). Third, our results have shown that the consumer has been treated as a mostly passive entity within the bioeconomy literature, which is at least questionable against the backdrop of our theoretical considerations and should thus be taken up in future empirical and conceptual research (e.g., especially considering the increasingly blurred boundaries between consumers, producers, and citizens). Fourth, we have revealed various interesting interconnections but also several missing links between the different domains that can also serve as a basis for future studies. Finally, and quite generally, we conclude that our article has shown that there is a promising field of scientific inquiry into the complexity and interdependence of roles, shared responsibilities, and distributed agency of consumers in the context of a sustainable bioeconomy. At the same time, this article should also be read as an appeal to bioeconomy policymakers to resist the lure of the dominant techno-economic paradigm of innovation.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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Note: References marked with * indicate studies included in the (final sample of the) literature review.

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