Intended and unintended effects of statutory deposit return schemes for single-use plastic bottles

Lessons learned from the German experience

Several EU countries discuss introducing deposit systems for single-use bottles to mitigate pollution. However, as an analysis of the German experiences indicates, the introduction of a deposit on single-use beverage containers might unintendedly compromise the endeavor to implement a circular economy. Such unintended effects need to be considered to enable the implementation of a circular economy that prioritizes reduction and reuse compared to recycling.

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Abstract

High levels of environmental pollution and low recycling rates have triggered a debate on deposit return systems for single-use beverage containers (BCs) within the European Union. In 2003, Germany statutorily implemented a deposit for single-use BCs, which operates alongside a historically grown deposit system for multi-use bottles. The long-standing German practice can be used as a source of relevant experiences. These experiences show that the introduction of a single-use deposit is a double-edged sword: on the one hand, it caused an increase in return and recycling rates of single-use BCs. On the other hand, there were unintended effects on the long-standing multi-use system and, thus, on the endeavor to implement a circular economy where reduction and reuse are prioritized rather than recycling. It seems that the introduction of a single-use deposit system promotes a narrow mode of thinking and a focus on recycling, which hinders the revitalization of multi-use BC systems. The EU's debate on single-use deposit lacks critical consideration of such unintended effects. The discussion of the German experiences might help to avoid unintended effects that hinder the establishment of a circular economy.

Keywords

circular economy, deposit system, multi-use bottle, plastic bottle, single-use beverage container, waste hierarchy

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Mitigating the problem of plastic pollution is one of the greatest challenges of our time. A main reason of this pollution is the incorrect disposal of single-use plastic packaging caused, for example, by consumer misbehavior, a lack of waste infrastructure, waste mismanagement and/or vague political frameworks (e. g., Jia et al. 2019). Plastic packaging in the environment breaks up into microplastics (five millimeters or smaller in size), which leads to serious environmental problems (e. g., Bergmann et al. 2019). Plastic beverage bottles account for a significant share of this pollution. Approximately one million plastic bottles are sold per minute worldwide (Laville and Taylor 2017) – and a significant share of them ends up in the oceans (Orset et al. 2017) so that the proportion of bottles in marine waste continues to grow (BFFP 2020).

To mitigate the plastic problem, the European Commission adopted the *European Strategy for Plastics in a Circular Economy,* which is part of the *European Green Deal* (EC 2019). This strategy addresses the problem, among others, of single-use plastic bottles. Uncontrolled disposal should be minimized by introducing deposit return schemes for single-use plastic bottles (EC 2018).[1] It is beyond question that "achieving very high levels of recycling" (EC 2018, p. 12) is a valuable target as recycling is better than (incorrect) disposal. However, to implement a circular economy, means of reduction and reuse on the product level must be prioritized as opposed to recycling (e. g., Morseletto 2020). Thus, unintended effects of deposit return schemes for single-use plastic bottles, which might conflict with the fundamental pillars of a circular economy, must be considered carefully.

Germany implemented a deposit system both for multi- and single-use beverage containers (BCs) years ago and can be used to extract relevant experiences (Welle 2011, Zhou et al. 2020). This paper aims to contribute to the current debate on the introduction of a deposit for single-use BCs by discussing the German experiences and answering the question: what lessons relevant to the implementation of circular economic systems can be learned from the German experiences with single- and multi-use deposit systems?

The following paper provides first an overview of both the current state of research on deposit return schemes and the main pillars of Europe's framework for a circular economy. Then, the German deposit system is introduced, and finally the corresponding experiences are discussed.

State of research and the European Union's policy efforts

Robust production-, consumption- and waste-data regarding BCs in Europe is rare as it is not collected in a uniform way across the European Union (EU). Even for individual European countries, it is difficult to get reliable data. In the case of Germany, NGOs speak of around 16 billion single-use plastic bottles per year (DUH 2020), most manufacturers conceal the number of bottles produced, and official data regarding the sale of beverages refers to volumes – not bottles (e. g., UBA 2020 a). Consequently, even the European Parliament's briefing paper titled *A European Refunding Scheme for Drinks Containers* is more of a colorful compilation of different national contributions than an all-encompassing plan. The only thing agreed upon is that the introduction of EU-wide deposit return schemes is the preferred measure to prevent (the unknown number of) used BCs littering the environment and to ensure that the corresponding material is recycled (European Parliament 2011, EC 2018).

The entirety of the EU's sustainability-related efforts constitutes the *European Green Deal* (EC 2019). With, for example, the *Waste Framework Directive* (Directive 2008/98/EC) and the *Circular Economy Action Plan* (EC 2015), the *Deal* implies a strict focus on the development of a circular economy.

According to the waste hierarchy, which must be implemented in all member states' national legislation[2], the a priori reduction of waste (i. e., prevention through design or consumption practices), takes top priority followed by (preparation for) reuse in a second, and recycling attempts in a third step. Recovery, which means the incineration of waste to generate energy, and disposal occupy the two least preferable levels (Directive 2008/98/EC, Hultman and Corvellec 2012). Thus, even though the waste hierarchy primarily addresses waste management, it concretizes a common interpretation of circular economy (Zhang et al. 2021) by prioritizing

- measures of reduction compared to product reuse,
- and product reuse compared to recycling, that is, reuse of materials (not products) (e. g., Gharfalkar et al. 2015).

This hierarchical ordering of the so-called "3Rs" (reduce, reuse, recycle) is further supported by the Directive (EU) 2019/904 on the *Reduction of the Impact of Certain Plastic Products on the Environment,* which "promotes circular approaches that give priority to [...] re-usable products and reuse systems rather than to single-use products, aiming first and foremost to reduce the quantity of waste generated". In addition, even the *European Strategy for Plastics in a Circular Economy* encourages abandoning single-use items and overpacking and promotes the reduction and reuse of packaging (not the reuse of materials) (EC 2018).

The waste hierarchy can be challenged by results of life cycle assessments (LCAs) of different (packaging) alternatives. If the LCA of a lower-level alternative is evidentially better than that of a higher-level alternative, then this would justify a deviation from the waste hierarchy's requirements (Directive 2008/98/EC, Article 4 (2)). The LCA of different types of BCs as carried out by the German Federal Environmental Agency (Umweltbundesamt, UBA) (2016, 2000), however, corresponds to the waste hierarchy. According to this LCA, the most sustainable drink is tap water, which prevents packaging. However, consumers often prefer bottled water due to taste- or health-related aspects (Etale et al. 2018) – and tap water comes neither with fruit-flavor nor with alcohol so the use of BCs is mostly unavoidable.

Reusable BCs occupy the second (glass, reusable up to 50 times) and third (plastic, reusable up to 25 times) rank, given that their distance of transportation is less than 150 kilometers (UBA 2016, pp. 80 ff.). These help to prevent waste as well while they are in their refill-cycle. Considering the UBA's LCA, single-use Polyethylene Terephthalate-bottles (PET bottles) occupy a lower rank than multi-use glass and plastic ones. These bottles meet the third level of the waste hierarchy, assuming they are recycled – and even lower levels if they are energetically recovered or disposed. The UBA's LCA-based ranking is, among others, supported by Hamada et al. (2020) who state that even a one-time reused multi-use bottle has a better LCA than a single-use one.

Even though there is a lot of support for the idea that multi-use BCs are ecologically advantageous, the above given LCA-ranking is not entirely beyond dispute. Due to, for example, higher recycling rates and the increased use of recyclate in the production process, there are LCAs that rank single-use PET-BCs on par with or even slightly better than multi-use glass and/or PET ones. However, this only holds for very specific configurations of parameters (e. g., particular market segments, types of consumption) (e. g., Kauertz et al. 2010) or with regard to specific impact categories like acidification or eutrophication (e. g., Cottafava et al. 2021). As their outcomes partly depend on the "selection and relative weighting of environmental impacts" (Van Ewijk and Stegemann 2016, p. 124) and, thus, can differ with (the configuration of) the methods in use, LCAs are highly controversial. In their current form, they require further methodological development in order to take the idea of circular economy adequately into account (e. g., Peña et al. 2021). >

1 Within the EU, deposit systems' structures vary strongly. Most member states have no deposit on BCs, in other countries there are different amounts of deposits on plastic bottles or manufacturers sometimes charge a voluntary deposit on refillable glass bottles. For an overview see, for example, European Parliament (2011) and Zhou et al. (2020).

2 In Germany's case, this means that § 6 of the "circular economy law" *(Kreislaufwirtschaftsgesetz, KrWG)* states that "prevention and waste management measures are ranked in the [...] order" of the waste hierarchy. However, this defining has no real impact: half of the households' plastic waste is recovered energetically (UBA 2020 b).

A confirmed, definite ecological advantage of single- compared to multi-use BCs in terms of LCA would justify a deviation from the waste hierarchy's prioritization. However, there are several reasons why the ranking of BCs according to the UBA's LCA (UBA 2016, 2000), which is generally in line with that of the waste hierarchy, is still relevant and, thus, builds the basis for further discussion:

1. There is no definite agreement on the LCA-based ranking of BCs.
2. There is criticism on the idea of LCAs and their compatibility with the circular economy concept.
3. The EU itself repeatedly highlights the importance of reduction and reuse.

In summary, the EU emphasizes the importance of pursuing a path towards a sustainable circular economy under strict consideration of the prioritization of reduction to reuse to recycling. At the same time, they discuss the introduction of a Europe-wide deposit system for single-use BCs. The respective briefing paper, however, primarily focuses on the (dis-)advantages of a mutual deposit system – and lacks a comprehensive discussion of intended and unintended effects of such systems in light of the endeavor to implement a circular economy (European Parliament 2011).

Research on (un-)intended effects of deposit systems is generally rare and mostly focuses on deposit systems for single-use packaging to mitigate uncontrolled disposal and the associated loss of materials (e. g., Kulshreshtha and Sarangi 2001, Moore and Scott 1983). This research indicates that deposit systems are suitable to prevent uncontrolled disposal and to increase recycling rates (Zhou et al. 2020) – a holistic consideration of the interrelation between deposit systems and fundamentals of a circular economy is still missing. The EU's willingness to push ahead with the transformation from a linear to a circular economy is substantial. However, as a look at Germany shows, interaction effects between respective means must be carefully analyzed and understood to avoid internal contradictions.

History, structure and legal foundation of the German deposit system

In Germany both multi- and single-use BCs made of different materials are in use. There are well-established deposit systems for both kinds of bottles, and these differentiate between single- and multi-use bottles, different materials, filling volumes, kinds of beverages, brands and much more.

Deposit on multi-use beverage bottles

Reusable BCs with a deposit have been in use for decades. Deposits were initially levied voluntarily by soft-drink companies and the brewing industry around the beginning of the 20th century (Elmore 2012). While, due to the invention of the plastic bottle by Coca-Cola in the 1970s (Elmore 2012), multi-use bottles gradually disappeared from markets worldwide (and with them the deposit), the traditional German system for multi-use bottles remains and has always worked without state regulation. Deposits on such bottles, to date, are not mandatory – the whole system is driven by the manufacturers' interest to get back empty bottles to refill them. The deposit is collected voluntarily by beverage manufacturers: retailers who sell the respective drinks are obliged to collect the deposit and to repay it to the customer when bottles are returned. The system is supported by hundreds of beverage manufacturers, retailers and NGOs.[3]

Even though – or perhaps precisely because – the reusable deposit system has a long tradition, it does have some special features that cause inconveniences for consumers. Today's multi-use bottles differ in many aspects other than simply being glass or plastic: some combinations of features define a pool bottle, which is used by a broad variety of producers (i. e., only the label indicates brand affiliation) and, thus, does not necessarily have to go back to where it was previously used. Other combinations of features make a bottle an individual, manufacturer-specific one that must be (eventually) returned to its place of origin. Deposits for bottles are usually between 0.08 and 0.15 Euro, depending on the bottle type.[4] Consequently, whereas buying a multi-use beverage bottle is easy, returning it correctly can be difficult. On the one hand, the multi-use system is mainly based on individual cooperation between manufacturers and retailers and is not regulated by law. On the other hand, the increasing share of highly individualized multi-use bottles encumbers the return system as retailers usually take back only those multi-use BCs that they themselves have in their range (UBA 2020a).

Although the deposit system for multi-use beverage bottles in Germany has never been anchored in law, it is politically supported. Aligning with increasing awareness of the negative environmental impact of packaging waste, a packaging regulation was adopted in 1991 *(Verpackungsverordnung)*. This regulation was intended to reduce the environmental impact of packaging waste and explicitly covered BCs: it states that the share of multi-use and environmentally advantageous single-use containers[5] must be increased so that they account for at least 80 % (§ 1 (2) Verpackungsverordnung). Even though the target level of 80 % was anchored in law, failure to reach this level remained without consequences so that the reusable quota dropped from year to year. In 2019, a somewhat lower quota was reconfirmed with the new *German Packaging Act (VerpackG)*[6], which states that the proportion of beverages put into multi-use packaging should be (re-)increased to at least 70 % (§ 1 (3) VerpackG). Again, failure

3 *www.mehrweg.org/mehrwegsystem*
4 *www.mehrweg.org/mehrwegsystem*
5 Ecologically advantageous single-use containers: composite packaging, poly-tube bags, and stand-up bags. Until 2018, this type of packaging was included in the calculation of the 80 %-quota (§ 1 (2) Verpackungsverordnung). Since 2019, ecologically advantageous single-use packaging is strictly treated as single-use packaging and is, therefore, not included in the calculation of the adapted 70 %- quota (§ 1 (3) VerpackG).
6 *Gesetz über das Inverkehrbringen, die Rücknahme und die hochwertige Verwertung von Verpackungen (Verpackungsgesetz, VerpackG): www.gesetze-im-internet.de/verpackg.*

to achieve this quota remains without sanctions – which is why it has never been achieved and has at best a signal effect.[7]

Deposit on single-use beverage bottles

In response to the decline of the share of multi-use bottles and the careless disposal of single-use plastic bottles and beverage cans, a deposit system for single-use BCs was introduced in Germany in 2003. The deposit was intended to protect the environment primarily by promoting multi-use packaging, as the following quotes of the Federal Minister for the Environment at that time, Jürgen Trittin, illustrate:

> *The deposit curbs the flood of single-use items, which is pushing the ecologically advantageous multi-use systems off the market with increasing force. It is an incentive for retailers and consumers to give preference to multi-use packaging.*
>
> BMU 2002, translated from German

As a monetary incentive, the comparably high single-use deposit was intended to encourage consumers to opt for the lower deposit multi-use bottle:

> *He (the consumer) can avoid the deposit by switching to multi-use bottles and, thus, by giving priority to ecologically advantageous beverage packaging again.*
>
> BMU 2001, translated from German

Besides, the deposit was intended to encourage the correct disposal of single-use bottles (BMU 2001). Since then, a deposit (0.25 Euro) has also been charged on selected single-use plastic bottles and cans – depending on which beverage is in the bottle.[8] According to § 31 (2) VerpackG, all retailers selling single-use BCs for which a deposit is charged, must take back all those single-use bottles, with refundable deposit, that are made of the same material as those they sell (§ 31 (2) VerpackG). As most of the single-use bottles are made from PET, all retailers must take back (nearly) all PET bottles, so that, from the consumers' point of view, returning single-use PET bottles is much easier than returning multi-use (individualized) bottles.

Although the deposit helped to increase return rates (UBA 2020 b), its introduction had unintended side effects that are discussed in the following.

The two sides of the coin

Keeping in mind the history of as well as the motivations behind the German deposit system and its legal foundations, we will now examine their effects on the market shares of multi-use and single-use BCs over time (figure 1).

The introduction of the deposit on selected single-use BCs in 2003 did not stop the decrease in use of multi-use bottles – the rate of decrease has levelled off (figure 1). The market share of multi-use BCs dropped from 66.3 % in 2004 to 41.2 % in 2018, while the share of single-use BCs has continuously increased. Based on the currently available data, it can only be said that the

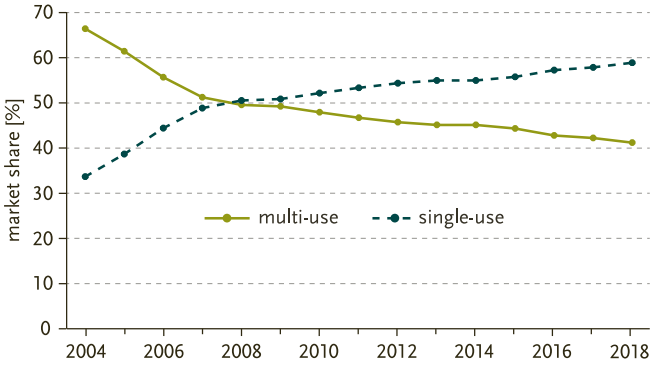

FIGURE 1: Development of market shares of single-use (including ecologically advantageous ones) and multi-use beverage containers. Data source: UBA (2020 a, 2015, 2013).

introduction of the mandatory deposit on single-use BCs has not led to the politically desired strengthening of reusable systems (BMU 2002, § 1 (3) VerpackG). Official and comprehensive studies on reasons why the introduction of the deposit on single-use bottles failed to promote the use of multi-use ones have not yet been carried out. Possible explanations for the ever-increasing market share of single-use bottles are discussed in the following paragraphs – whereby the discussion of each indication highlights a research gap that urgently needs further investigation.

One of the main reasons for the success of single-use BCs might be the conveniences and economic advantages of these bottles for all three, consumers, retailers and manufacturers.

Consumers' perspective

Consumers seem to appreciate the conveniences of both single-use bottles and the respective return systems. Due to the (legally anchored) special characteristics of the respective infrastructure in Germany, it is easier to return single-use (PET)bottles as most retailers have at least one kind of single-use PET bottles in their range and, thus, must take back this type of bottle (§ 31 (2) VerpackG). This does not hold for multi-use BCs – returning them is rather a challenge, as some retailers do not accept multi-use bottles at all, and others only accept the bottles they themselves sell. Besides, PET bottles are lightweight and easy to carry. Thus, even though consumers are generally aware that plastic waste is highly problematic (Rhein und Schmid 2020), they do not translate their awareness into action, as, among other reasons, they are not willing to put up with the inconveniences >

7 Environmental organizations have criticized this for years (DUH 2020). They see responsibility primarily with large manufacturers (e. g., Coca-Cola, Nestlé) and discounters (e. g., Aldi, Lidl), who are blamed for having successfully prevented such sanctions.

8 Up to June 2021, deposits were charged on single-use BCs containing beer, mineral water, soft drinks and alcohol-containing mixed drinks. Wine, spirituous beverages, fruit and vegetable juice and most dairy products, by contrast, were just as unaffected as bottles with a volume of more than three liters (UBA 2020 a). From July 2021 on, deposits were also charged on BCs that contain fruit and vegetable juices, among others (Deutscher Bundestag 2021).

of multi-use systems (Rhein and Schmid 2020). However, the reasons behind consumers' decisions against multi-use systems must be investigated in a lot more detail and both positive aspects as well as shortcomings of multi-use systems must be analyzed carefully.

The higher deposit charged on single-use PET bottles (0.25 Euro) as compared to multi-use ones (less than 0.15 Euro) also seems to have no effect in favor of the multi-use system. This might be due to the fact that returning single-use BCs is as easy as payment and reimbursement of the deposit. However, there is, again, a lack of systematic research that analyzes the consumers' perspective.

German environmental organizations, in an attempt to influence consumer behavior, frequently call for taxes on single-use plastic items in addition to deposits to reduce their consumption and to promote multi-use systems while maintaining high return rates (DUH 2020). Information on consumers' willingness-to-pay for the conveniences of single-use BCs compared to multi-use BCs, however, remains absent. Addressing the willingness-to-pay issue, it would also be interesting to know if there is a threshold for deposits on single-use bottles that would cause a switch to multi-use items even though the deposit charged would be fully refunded. There is an obvious need for further research.

Retailers' perspective

For retailers, it seems easier to sell only single-use (PET) BCs as, then, they are required only to take back those bottles. Single-use bottles are usually compressed in reverse vending machines directly after return and, thus, do not take up as much space as multi-use ones. Considerably more plastic bottles can be transported (full and empty) in comparison to reusable, especially glass ones (Eichstädt et al. 1999). In addition, retailers who only take back single-use BCs do not need staff to manage the return, as the reverse vending machines operate largely autonomously.[9] All these cost savings might incentivize supermarkets, particularly discounters that aim to keep costs as low as possible, to sell exclusively single-use beverage bottles (DIW Econ 2017, Öko-Institut and IÖW 2009).

A further development that might have fueled the ascent of single-use bottles may result from a combination of 1. discounters' increasing market power, and 2. several discounters' decision to produce and bottle beverages primarily themselves rather than selling external brands. The company Mitteldeutsche Erfrischungsgetränke (MEG, a subsidiary of the Schwarz Group), for example, is the leading mineral water producer in Germany in terms of sales (Lebensmittelzeitung 2019 cited in Statista 2021) – and all their mineral water is filled in single-use PET bottles. In its dual role as retailer and manufacturer of PET-bottled beverages, the Schwarz Group benefits from twofold cost savings: production costs can be kept at a minimum as single-use PET bottles are still cheap, and costs of participating in the multi-use system can be avoided. It is, therefore, important to consider not only the cost advantages of single-use BCs but also the market power of those who predominantly use them at production and retail level. Leading discounters currently push solely single-use plastic bottles in the market – and leave consumers without any option (Rhein and Schmid 2020).

For these two reasons, and as discounters gain more and more importance all over the EU, it can be assumed that EU-wide deposits on single-use bottles will drive their exclusive use even further as long as there is no opposing, clear cut legal regulation like a multi-use quota that must be met. Germany actually has a legally implemented multi-use quota – but, without sanctions, it might be reasonable to expect that it will not be achieved.

Manufacturers' perspective

Single-use BCs, from the manufacturers' perspective, can also be said to have their advantages, which can be attributed to the inconveniences of the multi-use system, particularly the increasing trend to individualize multi-use bottles themselves (UBA 2020 a). Manufacturers frequently receive empty multi-use bottles that they themselves cannot refill. The resulting problems are twofold: on the one hand, this might be related to a lack of appropriate bottles to refill; on the other hand, manufacturers must either send these bottles to their correct destination or feed them into the recycling process (Stracke and Homann 2017). Furthermore, in peak periods with enormous demand for beverages (e. g., in the summer), empty containers are not always returned quickly enough to keep the process running without bottlenecks. As the production of multi-use bottles (both glass and PET) has high(er) costs (compared to single-use ones) (Grimes-Casey et al. 2007), multi-use bottle systems are only economically efficient if return rates are high. Otherwise, single-use bottles are economically advantageous and are able to provide beverage manufacturers with independence from return rates and security of supply. Particularly when crude oil prices are low, companies rely on single-use, virgin PET bottles to the disadvantage of both recycled material and multi-use systems for reasons of cost minimization (DIW Econ 2017), as the time-consuming, cost- and water-intensive cleaning process of multi-use bottles cannot match the low costs of virgin plastic (Grimes-Casey et al. 2007). In sum, and focusing on Germany, the increasing share of individualized bottles (UBA 2020 a) compared to pool bottles seems to be responsible for the lack of attractiveness of the currently operating multi-use system. In particular, the question of standards for reusable bottles and the central organization of bottle supply and cleaning must be investigated further.

Even though the deposit charged on single-use bottles was insufficient to promote the use of multi-use bottles in Germany, it has had one (and a half) positive outcome(s): according to the Gesellschaft für Verpackungsmarktforschung (GVM)[10] (UBA 2020 b),

9 *www.tomra.com/en/collection/reverse-vending/about-reverse-vending*. Tomra (leading producers for reverse vending machines in Europe) emphasizes the enormous cost-saving effects. Retailers do not address these cost savings in public.

10 The return rate is estimated by GVM on the basis of statements made by individual market participants. UBA (2020 b) refers to this study.

the return rate of single-use PET bottles has increased up to around 96 % in 2018. Thus, it seems likely that the introduction of deposit systems for single-use BCs within the EU can prevent the uncontrolled disposal of bottles and mitigate plastic pollution. The high return rates for empty beverage bottles in Germany (and other countries) show that, in this regard, deposit systems have proven successful and help increase recycling rates (Zhou et al. 2020). In addition, the separate collection of bottles eliminates the need for a costly, a posteriori separation process that is associated with a loss of material (Welle 2011). Assuming a reasonably well-functioning market, this might lower the corresponding recyclate price and might promote the use of recycled instead of virgin plastic.

Without doubt, the introduction of deposit systems would be necessary and helpful to mitigate the environmental damage caused by carelessly discarded plastic bottles. But at least in Germany's case, the mentioned positive effects of deposit systems seem to provide a justification to rely mainly (in some cases, exclusively) on single-use bottles. High recycling rates seem to silence the conscience and belie negative externalities. This not only counteracts the initial intention of deposits on single-use BCs to promote the multi-use system but also the endeavor to implement a circular economy in which the prioritization of reduction and reuse is taken seriously (Rhein and Sträter 2021).

Conclusion

Several lessons can be learned from both the German experiences and the attempt to provide a holistic view of the problem.

First, it must be concluded that the discussion on single- and multi-use BCs (at the EU-level and below) lacks an unambiguous political road map. On the one hand, there is the overarching goal in the EU to implement a circular economy, with a clear focus on reduction and reuse – and most member states agree that "we cannot recycle our way out of the plastics issues we currently face" (European Plastics Pact 2020, p. 8). On the other hand, LCAs in some cases justify deviations from the prioritization of reduction and reuse to recycling and, thus, from the fundamental ideas of a circular economy. Besides, the discussion of the introduction of Europe-wide deposits on single-use BCs, which is intended to reduce respective littering, might sharpen the focus on recycling of single-use BCs instead of strengthening multi-use systems as discussed previously. Individually, all these ideas are both reasonable and valuable. However, taken together, they are a disjointed system, in which individual measures are not necessarily mutually beneficial but may even negate each other. Thus, there is an urgent need for a clear political statement on what kind of BC is to be used in order to achieve the target of a circular economy in Europe? This, however, presupposes an agreement not only on the political level but also in science.

Second, for the specific case of Germany, it must be concluded that neither the perspective of consumers, retailers, nor manufacturers on single- and multi-use deposit systems is sufficiently investigated. There is a crucial need for further research, not only in Germany but also in other EU countries. Our discussion of possible adjusting screws (see section *Two sides ...* above), however, points to the following: if multi-use systems are to be preferred to single-use ones (see section *State of research ...*) and, thus, are to be promoted, then it seems to be necessary to transform the multi-use system in such a way that it no longer takes a back seat to single-use systems in terms of economical and convenience-related benefits. In this light, a focus on, for example, multi-use pool bottles, which manufacturers individualize by a label only[11], could help to reduce transportation costs and the inconveniences of return that consumers currently face.

In summary, even though the introduction of a deposit on single-use BCs can be expected to help mitigate environmental pollution caused by plastics, a clear commitment to as well as the further development and promotion of multi-use systems seems to be better suited for achieving the EU's goal for a circular economy, in which reduction and reuse are taken seriously (EC 2018).

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