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Getting Used to Reusing: Empirical Analyses of Consumer and User Engagement in the Circular Economy

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Acknowledgments

Having been familiar with the concept of the circular economy for a while, my interest in the topic was sparked by a talk by Peter Lacy at Saïd Business School in Oxford in early 2016. Peter Lacy had just published his book '*Waste to Wealth - The Circular Economy Advantage*' and presented a compelling pitch for a transformation from linearity to circularity. The aspect I found most exciting about the circular economy was its potential to align sustainability benefits – especially environmental protection – with economic incentives for businesses. At the same time, behavioral changes seemed inevitable to allow us to shift from a linear to a circular economy. After all, many circular offerings require individuals to fundamentally change their behaviors compared to engaging in conventional linear consumption. So, when I entertained the idea of returning to academia and completing a doctorate a few years later, I was both surprised and glad to see that research on consumption in the circular economy was only getting started. I had found a research field where I could put my experience and skills to use and contribute to advancing the circular economy in research and in practice.

Translating my curiosity for this topic into an actual thesis would not have been possible without my thesis supervisor, Prof. Dr. Alwine Mohnen. Had it not been for Alwine's openness to supervising me as a candidate without a history at TU Munich, with an interdisciplinary background, and with an interesting, but work-in-progress research idea, this thesis would not have left the ideation phase. In all our joint research projects, I was very lucky to be challenged by Alwine to develop thought-provoking research questions, apply advanced methods to collect and prepare comprehensive research data and make the most of the valuable datasets at hand, and broaden my horizon of theoretical frameworks to produce insightful research papers. I particularly appreciate the trust Alwine had in my ability to grow as a researcher and expand my methodological toolkit over the years. Furthermore, this thesis greatly benefitted from Alwine's

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To generate actionable insights with and for practitioners, this thesis relied on collaborations with a wide range of stakeholders. Papers 2 and 3 were only possible thanks to the invaluable field data provided by *Vytal* and the outstanding commitment of both co-founders, Dr. Fabian Barthel and Dr. Tim Breker, as well as Adrian Stein who was responsible for growth marketing and user analytics at *Vytal* at the time. Fabian's drive to develop a thorough understanding of network effects in *Vytal*'s system and his contributions as a co-author were key ingredients to the successful publication of paper 2 of this thesis. Furthermore, paper 4 was developed as part of the Electronics Club of the Consumer Insights Action Panel, a multi-stakeholder ini-

tiative that generated practical behavioral insights into circularity strategies for consumer electronics. The inspiration and feedback provided by all participating stakeholders and Mariana Nicolau and Dr. Imke Schmidt as working group leaders were crucial to design and conduct the study presented in paper 4. Finally, paper 5 was made possible by the generous support of Maximilian Schmierer and Felicia Svensson who provided field data on consumer-to-business smartphone sales and were invaluable sparring partners when it came to discussing and interpreting obtained results. I thank all practitioners for their curiosity and hope that our joint projects have showcased the mutual benefits of practice-oriented academic research.

Beyond collaborations with practitioners, I also greatly benefitted from co-authoring papers with inspiring researchers. Paper 1 was developed together with Stefanie Fella. I am very grateful for Stefanie's positive attitude, diligence, and her commitment to jointly move our paper forward through multiple rounds of data collection, feedback, and reviews. In addition, I am very happy to have found a sparring partner in Stefanie with whom I was able to discuss questions about my research well beyond our joint paper. Furthermore, paper 3 was co-authored with Prof. Wendy Wood and Prof. Thomas L. Webb. I truly appreciate Wendy's and Tom's guidance in exploring theoretical territories that were new to me, for challenging me to implement rigorous analyses that deliver robust results and speak to a relevant research question, and for their support in writing and reviewing our final paper.

Additionally, I would like to thank the entire team of administrative staff as well as internal and external researchers at the Chair of Corporate Management at TU Munich for their practical support, comments, and feedback. In our many brownbag seminars and doctoral colloquia, I particularly appreciated everyone's openness to engaging in topics beyond their own research field and the commitment to challenging each other to do their best. In addition, I am very grateful for all the feedback provided by journal editors, anonymous reviewers, and conference participants. A special thanks goes to Prof. Dr. Erik Hansen and Dr. Maryse Chappin

who headed the track ‘Innovation for Sustainability, Circularity and Green-tech’ at the Annual Conference of the European Academy of Management in Dublin in 2023. Erik and Maryse shared very valuable comments on paper 2 of this thesis and thanks to their nomination and support, paper 2 was later awarded the Best Paper Award of the Strategic Interest Group Innovation – undoubtedly one of the highlights of this thesis project. As a final group of reviewers, I would like to thank Prof. Dr. Magnus Fröhling for examining this thesis together with Prof. Dr. Alwine Mohnen, and Prof. Dr. Hanna Hottenrott for chairing the examination committee. I am grateful for submitting my work to an examination committee that perfectly fits the research domains and methodological approaches covered by this thesis.

Finally, I would like to thank my loved ones for their continued support over the past years. My family’s and friends’ genuine interest in my research was a great catalyst for my work, not least because I was challenged to distil digestible core messages and never lose track of the ‘so what?’ of my research. Perhaps even more importantly, I am thankful for the many people in my life who make it easy for me to switch off from work and recharge my batteries. Above all, I am incredibly grateful for my partner Maggie who is typically the first audience of a pitch for a new idea and the ultimate (firm but fair) editor of final drafts. Maggie, I admire your ability to structure your (and my) thoughts and your way of communicating with kindness while never sugarcoating the essence. Thank you for your encouragement, your patience, your heartfelt support, and for choosing to spend your time with me.

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Abstract

The circular economy is a promising concept for moving toward sustainable development by decoupling economic activities and well-being from resource extraction and use. To operationalize circularity strategies, implementation by businesses is needed. In turn, businesses require consumers' willingness to engage in circular offerings. Nevertheless, even though uncertainty on demand for circular offerings is frequently highlighted as a barrier to implementation, the understanding of consumption in the circular economy is a key gap in the literature. This thesis addresses this research need with five empirical research papers on reuse models in two research domains – Packaging-as-a-Service systems for reusable takeaway food containers and consumer-to-business smartphone selling.

Based on factorial survey experiments with restaurants and consumers, paper 1 highlights that providers of Packaging-as-a-Service systems for reusable takeaway food containers in access-based triadic systems face a novel set of challenges and opportunities. As simultaneous asset owners and operators of a triadic system, system providers need to attract sufficient demand from both restaurants and consumers, provide reusable containers that serve restaurants' and consumers' needs, and establish system mechanisms that protect their assets without introducing prohibitively high complexities for consumers. Paper 2 uses a large field dataset to examine the effects of increased geographic network density of restaurants in a system for reusable takeaway food containers on consumers' adoption and use of the system. Panel model results highlight positive effects of geographic network density on system adoption, with decreasing marginal effects as network density increases. These findings emphasize the importance of establishing sufficient levels of supply to attract consumer demand for systems for reusables, especially in nascent systems. Paper 3 leverages a field dataset with a regression discontinuity in time approach to investigate how the Christmas break, a quasi-exogenous temporal interruption, affects the behavior of different groups of consumers who engage in a Packaging-as-a-

Service system for reusable takeaway food containers. The paper finds that the interruption is associated with a drop in frequency of system use, but this drop is smaller among consumers who used the system in a more stable context before the break. As habits are established by repeating behaviors in stable contexts, this suggests that stronger habits increase the durability of reuse behaviors.

While papers 1–3 examine reuse systems with a focus on their initial adoption and continued use, papers 4 and 5 turn to disposition behavior, a third critical stage of consumption in the circular economy. Paper 4 explores motivators of consumer-to-business selling of secondhand smartphones with a factorial survey experiment among smartphone users. Results highlight the importance of sufficient (monetary) rewards, convenient return mechanisms, and consumers' environmental awareness and price consciousness. Finally, paper 5 presents a theoretical model that demonstrates how consumer-to-business selling could prolong product use phases by reducing transaction costs associated with secondhand selling compared to consumer-to-consumer secondhand markets. Based on a survey with smartphone users and large field datasets of *eBay* listings and a consumer-to-business selling platform, the paper demonstrates that consumer-to-business selling platforms have the potential to grow secondhand markets and extend product use phases, but their contribution remains limited at current price levels.

Overall, the papers' results highlight that circular offerings need to deliver sufficient functionality, convenience, and material benefits to attract demand. Accordingly, businesses are required to establish attractive circular solutions while supportive policy measures are needed to promote the competitiveness of circularity strategies by leveling the playing field with linear alternatives. At the same time, empirical findings highlight that – if attractive circular offerings are established – the circular economy can expand beyond niche markets of intrinsically motivated pro-environmental consumers and appeal to mainstream markets.

Zusammenfassung (German Abstract)

Die Kreislaufwirtschaft ist ein vielversprechendes Konzept zur Förderung einer nachhaltigen Entwicklung, indem wirtschaftliche Aktivitäten und Wohlstand von Ressourcengewinnung und -nutzung entkoppelt werden. Um kreislaufwirtschaftliche Strategien in die Praxis umzusetzen, wird deren Implementierung durch Unternehmen benötigt. Unternehmen sind wiederum auf die Bereitschaft der Konsumierenden angewiesen, zirkuläre Angebote anzunehmen. Obwohl Unsicherheiten bezogen auf die Nachfrage in der Kreislaufwirtschaft häufig als eine Hürde zur Implementierung hervorgehoben werden, ist das Verständnis des Konsums in der Kreislaufwirtschaft eine wichtige Lücke in der Literatur. Die vorliegende Arbeit adressiert diesen Forschungsbedarf mit fünf empirischen Forschungsaufsätzen über Modelle zur Wiederverwendung (‚reuse') in zwei Forschungsbereichen – Packaging-as-a-Service Systeme für wiederverwendbare Essensbehälter und Verkäufe gebrauchter Smartphones von Konsumierenden an Unternehmen.

Auf der Grundlage von Vignettenstudien mit Restaurants und Konsumierenden zeigt Aufsatz 1, dass Anbieter von Packaging-as-a-Service Systemen für wiederverwendbare Essensbehälter in ‚access-based triadic systems' vor einer neuen Kombination aus Herausforderungen und Möglichkeiten stehen. Als gleichzeitige Eigentümer der Behälter und Betreiber eines triadischen Systems müssen Systemanbieter ausreichend Nachfrage von Restaurants und Konsumierenden anziehen, Behälter bereitstellen, die Bedürfnisse von Restaurants und Konsumierenden erfüllen, und Systemmechanismen etablieren, die eigene Behälter schützen ohne Konsumierenden zu hohe Komplexitäten zuzumuten. Aufsatz 2 nutzt einen großen Felddatensatz, um den Effekt gesteigerter geographischer Netzwerkdichte von Restaurants in einem Mehrwegsystem für Essensbehälter auf die Annahme und Nutzung des Systems durch Konsumierende zu untersuchen. Die Ergebnisse von Panel Modellen weisen auf positive Effekte steigender geographischer Netzwerkdichte auf die Annahme des Systems durch Konsumierende hin, wobei

marginale Effekte mit steigender Netzwerkdichte abnehmen. Diese Erkenntnisse unterstreichen die Notwendigkeit, ein ausreichendes Angebot zu schaffen, um Nachfrage von Konsumierenden nach Mehrweglösungen zu generieren, insbesondere in neuen Mehrwegsystemen. Aufsatz 3 wertet einen Felddatensatz mit einer Regressions-Diskontinuitätsanalyse mit zeitlicher Diskontinuität aus, um zu analysieren, wie die Weihnachtspause, eine quasi-exogene temporäre Unterbrechung, das Verhalten unterschiedlicher Gruppen von Konsumierenden, die ein Packaging-as-a-Service System für wiederverwendbare Essensbehälter nutzen, beeinflusst. Der Aufsatz zeigt, dass die Unterbrechung mit einem Rückgang der Nutzung des Systems einhergeht, wobei dieser Rückgang unter Konsumierenden, die das System vor der Unterbrechung in einem stabileren Kontext genutzt haben, geringer ausfällt. Da Gewohnheiten entstehen, indem Verhalten in stabilen Kontexten wiederholt wird, weisen diese Erkenntnisse darauf hin, dass stärkere Gewohnheiten die Langlebigkeit von Mehrwegverhalten fördern.

Während Aufsätze 1–3 Mehrwegsysteme mit einem Fokus auf deren Annahme und Nutzung untersuchen, wenden sich Aufsätze 4 und 5 dem Entsorgungsverhalten zu, einer dritten kritischen Phase des Konsums in der Kreislaufwirtschaft. Aufsatz 4 untersucht Motivatoren für Verkäufe gebrauchter Smartphones von Konsumierenden an Unternehmen (‚consumer-to-business', C2B) mit Hilfe einer Vignettenstudie mit Nutzenden von Smartphones. Die Ergebnisse heben die zentrale Rolle ausreichend hoher (finanzieller) Anreize, bequemer Rückgabemechanismen und umweltfreundlicher sowie preisbewusster Einstellungen der Konsumierenden hervor. Schlussendlich präsentiert Aufsatz 5 ein theoretisches Modell, das darlegt, wie C2B Verkäufe Produktnutzungsphasen verlängern könnten, indem Transaktionskosten im Vergleich zu Verkäufen von Konsumierenden an Konsumierende (‚consumer-to-consumer', C2C) verringert werden. Auf Grundlage einer Umfrage mit Nutzenden von Smartphones und großen Felddatensätzen von *eBay*-Anzeigen und einer C2B Verkaufsplattform zeigt der Aufsatz, dass C2B

Verkaufsplattformen das Potenzial haben, Gebrauchtwarenmärkte zu vergrößern und Produktnutzungsphasen zu verlängern, wobei der Beitrag dieser Plattformen bei dem derzeitigen Preisniveau begrenzt bleibt.

Insgesamt weisen die Ergebnisse der Aufsätze darauf hin, dass zirkuläre Angebote ausreichend funktional und bequem zu gestalten sind und Konsumierenden materielle Vorteile bieten müssen, um Nachfrage zu stimulieren. Dementsprechend müssen Unternehmen attraktive kreislaufwirtschaftliche Lösungen etablieren während unterstützende Politikmaßnahmen benötigt werden, um die Wettbewerbsfähigkeit kreislaufwirtschaftlicher Strategien zu fördern, indem die Chancengleichheit im Vergleich zu linearen Alternativen unterstützt wird. Gleichzeitig zeigen die empirischen Ergebnisse, dass die Kreislaufwirtschaft – sofern attraktive kreislaufwirtschaftliche Angebote geschaffen werden – Nachfrage über Nischenmärkte intrinsisch motivierter, umweltfreundlicher Konsumierender hinaus anziehen und Mainstreammärkte ansprechen kann.

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List of Abbreviations

C2B	Consumer-to-business
C2C	Consumer-to-consumer
EU	European Union
LOESS	Locally estimated scatterplot smoothing
PaaS	Packaging-as-a-Service
PSS	Product-Service System
VAT	Value added tax

1. Introduction

1.1. Motivation

The linear take-make-use-dispose economy has led to growing levels of resource extraction and waste generation well beyond the limits of our finite planet. As illustrated by the *Earth Overshoot Day*, humanity's ecological footprint has drastically increased over the last 50 years. Whereas in the early 1970s, human demand for ecological resources and services was still roughly aligned with our planet's regenerative capacity, humanity's ecological footprint in 2023 already exceeded our planet's yearly capacity to regenerate on 2 August 2023 (Global Footprint Network, 2023b). Individual countries' overshoot days demonstrate that high-income countries are primarily responsible for excessive resource consumption (e.g., United States of America: 13 March; Australia: 23 March; Germany: 4 May; Global Footprint Network, 2023a). Yet, despite numerous regulatory efforts (e.g., in 2022, the European Union (EU) adopted its 8th Environment Action Programme), resource consumption and waste generation are on the rise in many domains. For instance, the amount of yearly plastic packaging waste per capita in the EU increased by more than a quarter from 2011 to 2021 to 35.9 kg (Eurostat, 2023) and a staggering 700 million unused and waste mobile phones – almost two per inhabitant – are estimated to be stored in people's homes in the EU alone (European Commission, 2023).

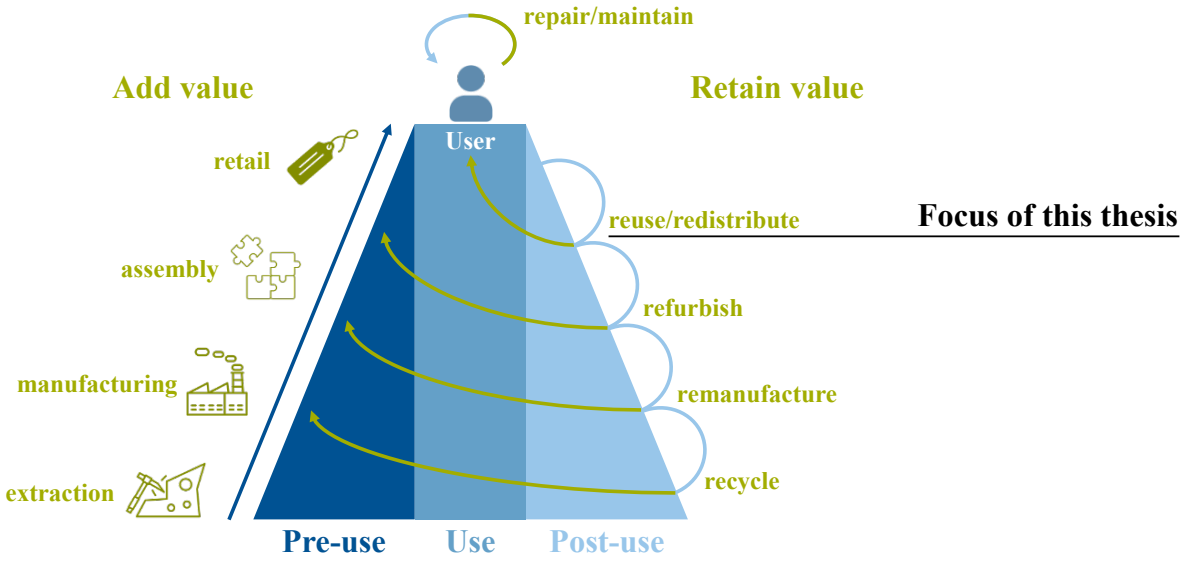
In response, the circular economy has been proposed as a strategy for decoupling economic growth and human well-being from resource consumption (Ghisellini, Cialani, & Ulgiati, 2016). The circular economy is an umbrella concept that comprises "a group of waste and resource management strategies to extend the productive life of resources" (Blomsma & Brennan, 2017, p. 603). Beyond conventional narrowing of resource flows (i.e., increasing resource efficiency by reducing the resources needed per product), product design and business model strategies for a circular economy aim to slow resource loops (e.g., product durability, reuse, and

repair aimed at extending or intensifying the utilization of existing products) or close resource loops (e.g., recycling post-use resources to make them available for production) (Bocken, de Pauw, Bakker, & van der Grinten, 2016). As such, the circular economy is typically not presented as a goal in and of itself but as a necessary condition, an intermediate step toward, or contributor to sustainable development (Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Ghisellini et al., 2016; Kirchherr, Reike, & Hekkert, 2017; Merli, Preziosi, & Acampora, 2018). For example, from an ecological perspective, the goal of promoting secondhand markets for electronics is not just to circulate devices, but to reduce the need for resource extraction and use by extending and intensifying the utilization of existing products. In addition to the circular economy's potential to contribute to sustainable development by reducing the need for resource extraction and use, it has also emerged as a promising strategy to increase economic resilience to supply chain disruptions. Especially in response to the COVID-19 pandemic (Alva Ferrari et al., 2023; Rejeb, Rejeb, Appolloni, Treiblmaier, & Iranmanesh, 2023) and the war in Ukraine (Hartley, Baldassarre, & Kirchherr, 2024; Quitzow, Renn, & Zabanova, 2022), the circular economy has been presented as a way to foster economic sustainability by keeping available resources and materials in use, thereby reducing the dependence on fragile global supply chains.

To translate more abstract, high-level conceptualizations of the circular economy into practice, various 'R frameworks' have been proposed over the years. The widely known circular 're'-strategies 'reduce', 'reuse', 'recycle', which even feature in pop culture like Jack Johnson's song '*The 3 R's*', are the starting point of most R frameworks. R frameworks typically comprise different combinations of up to 10 're'-strategies such as 'repair', 'refurbish', 'remanufacture', or 'recover' (Kirchherr et al., 2017; Reike, Vermeulen, & Witjes, 2018). While the environmental benefits of different 're'-strategies may vary case by case, most R frameworks present 're'-strategies in a hierarchy, providing a high-level heuristic to prioritize 're'-strategies according to their environmental benefits, similar to Stahel's 'inertia principle': "Do not repair

what is not broken, do not remanufacture something that can be repaired, do not recycle a product that can be remanufactured" (Stahel, 2010, p. 195). This hierarchical approach is nicely illustrated by the *value hill*, introduced by Achterberg, Hinfelaar, and Bocken (2016) as a practical guidance for businesses to position and develop circularity strategies. As shown in Figure 1, resource extraction, manufacturing, product assembly, and retail add value in the pre-use phase of a product. In the use and post-use phases, various 're'-strategies aim to retain as much of the value that has been generated in the pre-use phase as possible. As a practical guidance, the *value hill* posits that in many instances, strategies on top of the *value hill* retain more value and are therefore to be prioritized over strategies further down the *value hill*. For example, if it is possible to repair electronic devices, bicycles, or pieces of furniture or to redistribute them for reuse in other contexts, these 're'-strategies (higher up on the *value hill*) may be preferable to disassembling products and recycling their materials (at the bottom of the *value hill*).

Figure 1: *Value hill* by Achterberg, Hinfelaar, and Bocken (2016)



Especially in the early days of applying circular economy strategies, implementation largely focused on recycling (Ghisellini et al., 2016). Practitioners' focus on recycling is also reflected by research on the circular economy that often examines strategies to close resource

loops (i.e., recycling) rather than to slow resource loops by keeping products and materials in use longer (Merli et al., 2018). Among researchers in the circular economy, this has led to calls for a stronger emphasis on research on the 'inner loops' of the circular economy on top of the *value hill* (e.g., repair, reuse, refurbish) (Mugge, 2018; van den Berge, Magnier, & Mugge, 2023). After all, in doing so, researchers would adhere to hierarchical approaches to 're'-strategies, as proclaimed by R frameworks, the inertia principle, and the *value hill*.

Furthermore, research on the circular economy has paid much attention to physical flows of materials and energy or technical challenges of implementing circularity strategies while largely neglecting economic perspectives and incentives for businesses to participate in the circular economy (Lieder & Rashid, 2016) as well as consumer and user engagement (Haines-Gadd, Bakker, & Charnley, 2023; Korhonen, Nuur, Feldmann, & Birkie, 2018). This gap in knowledge is critical because the circular economy requires businesses to operationalize circularity strategies (Lieder & Rashid, 2016) and consumers to embrace a new consumption culture (Korhonen, Honkasalo, & Seppälä, 2018). Indeed, even the most effective reuse concepts, remanufacturing methods, or recycling technologies will not deliver on their environmental benefits if businesses are not incentivized to implement them, and if consumers are unwilling to adopt associated behaviors and return products to these circular processes.

As such, consumers are enablers of a circular economy (Kirchherr, Yang, Schulze-Spüntrup, Heerink, & Hartley, 2023) and their participation is required to promote the circular economy, especially in novel approaches that operationalize the inner loops on top of the *value hill* (e.g., reuse) (Mugge, 2018). Yet, a lack of demand is frequently highlighted as a barrier to the success of the circular economy (Camacho-Otero, Tunn, Chamberlin, & Boks, 2020; de Jesus & Mendonça, 2018; Hartley, Roosendaal, & Kirchherr, 2022), especially by policymakers and businesses (Kirchherr et al., 2018). Thus, considering high upfront investment costs and

capital commitments associated with implementing circular business model strategies (Kirchherr et al., 2018; Linder & Williander, 2017), understanding consumer and user needs and reducing risks associated with uncertain demand is crucial to promote the operationalization of the circular economy by businesses.

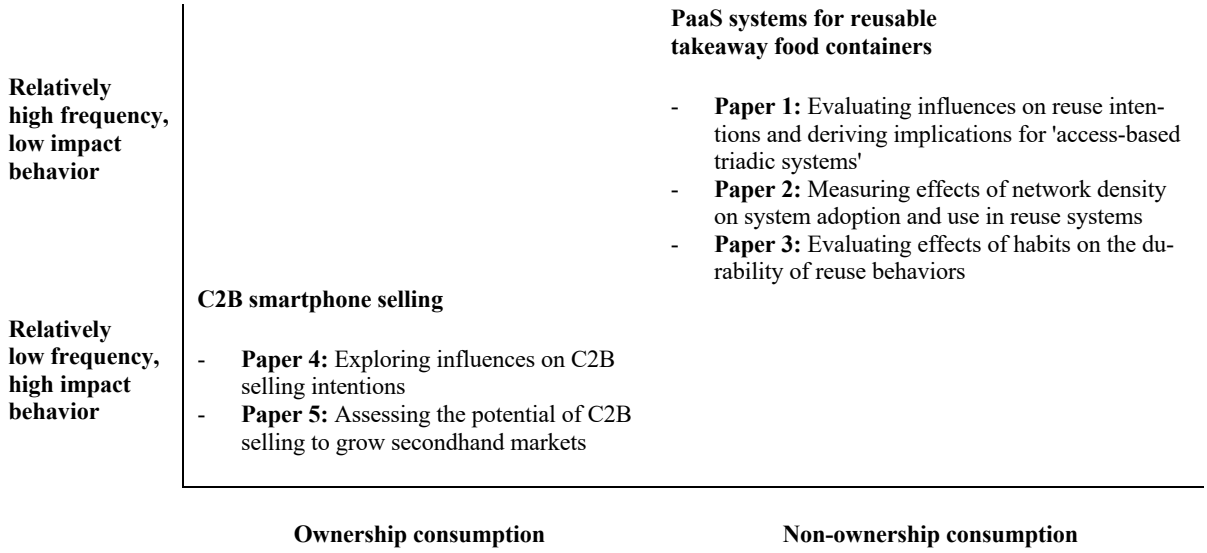
Against this background, this thesis examines consumption in the circular economy with a focus on reuse. In doing so, the presented research contributes to tackling two main research needs:

1) Expand research on circularity strategies higher up on the *value hill* (i.e., that often retain more value, see Figure 1) by investigating reuse.
2) Extend research on the demand side (i.e., consumption in the circular economy) by focusing on consumer and user engagement in reuse models.

To this end, this thesis comprises five empirical research papers on consumer and user engagement in two different reuse models: Packaging-as-a-Service (PaaS) systems for reusable takeaway food containers (papers 1-3) and consumer-to-business (C2B) smartphone selling (papers 4-5). These two research domains were chosen as a research focus because they (1) operationalize reuse with fundamentally different non-ownership and ownership models and (2) target consumer behaviors with diverging characteristics in terms of frequency and impact (see Figure 2). First, PaaS systems for reusable takeaway food containers operate Product-Service Systems (PSS) that enable non-ownership consumption by customers (i.e., restaurants and consumers) who use containers for a limited time period without owning them. In contrast, C2B smartphone selling operates within the realm of conventional ownership consumption as devices are sold from one owner to the next. Second, ordering takeaway food in reusable food containers is a behavior that can be performed relatively frequently, whereby each individual performance of the behavior has rather small environmental impacts. Indeed, life cycle assessments indicate that reusable food containers can deliver environmental benefits compared to

single-use alternatives if, and only if, they are used sufficiently frequently (Gallego-Schmid, Mendoza, & Azapagic, 2019; Greenwood et al., 2021). In comparison, considering smartphone replacement cycles of one and a half to three years (Wieser & Tröger, 2018), selling a secondhand smartphone is a rather infrequent behavior for most consumers. At the same time, as most environmental impacts in the life cycle of a smartphone occur in the production phase (Moberg et al., 2014), keeping devices in use (e.g., through reuse facilitated by secondhand selling) is a relatively impactful strategy to reduce the environmental burden of smartphone use.

Figure 2: Overview of papers



Taken together, the five papers included in this thesis address reuse models in two research domains that differ in terms of their application of non-ownership and ownership models to operationalize reuse as well as the frequency and impact of their respective target behavior. The following sections provide a background on conceptualizing and operationalizing reuse as well as consumption research in the circular economy. Afterward, the specific research questions of each research paper included in this thesis are developed, before the core methods applied in each paper are outlined. This introduction concludes by summarizing each paper's main results and contributions. The subsequent Chapters 2-6 present the five empirical research pa-

pers included in this thesis. Finally, Chapter 7 discusses overarching findings in relation to previous research and practical implications and provides an outlook with avenues for future research.

1.2. Conceptual background

This section first outlines how reuse has been characterized in the literature on the circular economy and how the two research domains of this thesis (PaaS for reusable takeaway food containers and C2B smartphone selling) fit into this paradigm. Afterward, the two different operationalizations of reuse that this thesis focuses on are introduced: Product-Service Systems that facilitate reuse through non-ownership consumption as well as secondhand markets, which enable reuse by redistributing goods with ownership transfer. Finally, this section addresses consumption research in the circular economy and characterizes three different stages of consumption in the circular economy, each of which are addressed by research papers in this thesis.

1.2.1. Conceptualizing reuse

According to the *Resource States Framework* introduced by Blomsma & Tennant (2020), resources in the industrial life cycle travel on a spectrum of resource states between individual particles (i.e., elements, molecules), parts (i.e., components or modules), and products (i.e., finished goods). Within this framework, reuse can take place by altering the resource state (i.e., inter-state reuse) or within the same resource state (i.e., intra-state reuse). Inter-state reuse describes reuse of disassembled parts for remaking and reassembling products in the same or alternative product systems. For example, if a car, electronic device, or piece of furniture is no longer functional, its parts may be used to repair, refurbish, or remanufacture other products. In

contrast, intra-state reuse involves as-is reuse of finished products, keeping their original function. For example, intact food containers, electronic devices, furniture, or books may be redistributed for reuse in different contexts.

The two research domains explored by this thesis – PaaS for reusable takeaway food containers and C2B smartphone selling – focus on the latter type of reuse, that is, intra-state reuse of reusable food containers and smartphones. Both cases are examples for product-level reuse, which typically refers to using previously used products that do not require substantial repair or refurbishment and are still functional to fulfil their original purpose (Reike et al., 2018). Within the *Waste and Resources Grid* described by Blomsma (2018), these reuse models fall into the category of 'intensifying loops' that tap into un- or underused capacity of finished products (Blomsma, Tennant, & Ozaki, 2023). For instance, PaaS for reusable takeaway food containers intensify the use of reusable food containers as they circulate between various restaurants and consumers, rather than relying on restaurants or consumers to acquire and use their own containers. Furthermore, secondhand smartphone selling enables the reuse of unused devices and thereby reduces the need for new products to serve consumer needs.

1.2.2. Operationalizing reuse: Product-Service Systems and secondhand markets

Even within the same category of reuse, the way product reuse is operationalized can take different shapes and forms. This thesis focuses on two different operationalizations of reuse without and with ownership transfer: Product-Service Systems (PSS) and secondhand markets. First, reuse may be facilitated through PSS, which provide a combination of products and services to customers, whereby the share of products and services varies depending on the type of PSS (Mont, 2002; Tukker, 2015). The literature typically distinguishes between product-oriented, use-oriented, and results-oriented PSS. Whereas product-oriented PSS remain within the conventional realm of ownership consumption and merely sell products with a broader set of services (e.g., product repair or maintenance offered for electronic devices), use-oriented and

results-oriented PSS shift toward non-ownership forms of consumption. In use-oriented PSS, products are temporarily provided to customers (e.g., short-term usage of a car). In results-oriented PSS, an outcome or functional result is delivered to customers, regardless of the product needed to provide said result (e.g., travelling from A to B) (Tukker, 2015). Although such non-ownership PSS could prompt less careful use of products by consumers (Tukker, 2015), use-oriented and results-oriented PSS are seen as a way to foster sustainable development because providers of such PSS are incentivized to promote the longevity and intensified use of their own physical assets and to reduce resource use (Bocken, Short, Rana, & Evans, 2014; Kjaer, Pigosso, Niero, Bech, & McAloone, 2019; Lüdeke-Freund, Gold, & Bocken, 2019; Tukker, 2015). For instance, a car sharing business benefits from running its service with fuel-efficient cars that are durable and easily maintained while being used intensively by customers. As such, use-oriented and results-oriented PSS apply circular business model strategies to slow resource use (Bocken et al., 2016) and – in the case of results-oriented PSS – are part of what Stahel coined the *Performance Economy*, which "sells results instead of objects" (Stahel, 2019, p. 66). The specific PSS examined in this thesis – PaaS for reusable takeaway food containers – typically operate use-oriented or results-oriented PSS or a combination thereof. Depending on the specific type of system, PaaS providers either charge restaurants a flat monthly rate for using their containers (use-oriented) or a fee for each meal that is served in one of their containers (results-oriented).

The second way to operationalize reuse examined in this thesis is through secondhand selling. Secondhand markets enable product reuse with ownership transfer, either through consumer-to-consumer (C2C) selling (e.g., on flea markets or online platforms like *eBay*), or through professional collectors and retailers who purchase used products from consumers and act as middlemen, that is, via C2B selling (e.g., *Back Market*, *Rebuy*, *Refurbed*, *BuyBack*)

(Blomsma & Tennant, 2020; Reike et al., 2018). By facilitating product reuse, secondhand markets deliver environmental benefits of longer product use phases and reduce the need for resources to produce new products. Although selling used products could invoke rebound effects (e.g., as sellers re-spend money they earn on additional products and services; Makov & Vivanco, 2018), secondhand selling is generally seen as environmentally beneficial (Makov, Fishman, Chertow, & Blass, 2019). In practice, secondhand selling may be combined with long life strategies like refurbishing and remanufacturing (e.g., applied by a C2B selling platform before selling to the next consumer) (Blomsma & Tennant, 2020) or may only require sellers to perform minimal product cleaning or repair activities before selling (Reike et al., 2018). In this thesis, secondhand markets are primarily examined regarding consumers' secondhand selling choices that do not involve additional repair or refurbishment activities performed by the consumer.

1.2.3. Consumption in the circular economy

The previous two sections provided a conceptual background of the domains of the circular economy this thesis focuses on – that is, the types and operationalizations of reuse. This section turns to the actors who are explored in this thesis: consumers and users in the circular economy.[1] Consumer behavior is typically split into three stages: Acquisition, consumption, and disposition (Jacoby, 1976). This tri-dimensional perspective is mirrored by research on consumption in the circular economy, which structures the customer journey (van der Laan & Aurisicchio, 2019) or consumer roles (Shevchenko et al., 2023) in a similar way (Camacho-Otero et al., 2020; Macklin & Kaufman, 2023). In the circular economy, customers first acquire

[1] This thesis uses the terms customer, consumer, and user to refer to demand-side actors in the circular economy. 'Customers' include both businesses and individuals that receive circular products or services (e.g., restaurants that obtain reusable containers from PaaS providers or end consumers who order food in reusable containers). In contrast, 'consumers' and 'users' refer to individuals, whereby the term 'users' is primarily used to describe individuals who engage in non-ownership consumption in which products are merely used but not owned.

a product, for example by buying a secondhand, repaired, or refurbished product, by renting a product as a service, or by receiving a product through an exchange. Afterward, customers enter the use phase, in which consumption activities depend on whether a product has been purchased (with ownership transfer) or obtained as part of a service (no ownership transfer). Activities in the use phase include product repair as well as efforts to retain product value by not retiring it prematurely. Finally, consumers typically deliberate between three disposition choices when a product is no longer used: To keep the product, to dispose of it temporarily, or to get rid of the product permanently (Jacoby, Berning, & Dietvorst, 1977). Circular disposition behaviors include product returns (e.g., if they were obtained as part of a service), product reselling, or non-monetary exchanges of products for other products or services (Camacho-Otero et al., 2020; Macklin & Kaufman, 2023).

Splitting consumer behavior into the three stages of acquisition, use, and disposition, helps to understand how the roles of consumers change as a result of transitioning from a linear to a circular economy. Crucially, engaging in the circular economy typically goes beyond a simple switch from choosing a conventional product to a 'green' or 'sustainable' product at the point of sale (Camacho-Otero et al., 2020). Instead, circular offerings often require consumers and users to perform new forms of 'consumption work'. For instance, car sharing schemes often require users to schedule use periods, refuel and return vehicles, or report damages (Hobson, Holmes, Welch, Wheeler, & Wieser, 2021). Especially in the use phase and regarding disposition, the circular economy introduces new activities (Camacho-Otero et al., 2020). For example, whereas product use or disposition is only a secondary concern of companies selling linear products (Wastling, Charnley, & Moreno, 2018), consumers play a key role in retrieving goods to close resource loops in PSS (van der Laan & Aurisicchio, 2019). This shifting role of consumers also manifests itself in the two research domains explored in this thesis. PaaS systems for reusable takeaway food containers depend on consumers' willingness to treat containers

with care and return them. In secondhand markets, individuals shift from a simple consumer toward a 'prosumer' role (Ritzer, Dean, & Jurgenson, 2012) as they switch between the role of sellers (i.e., producers) and buyers (i.e., consumers).

Traditionally, consumption research has largely focused on acquisition rather than the use phase or disposition (Jacoby, 1976; Ting, Thaichon, Chuah, & Tan, 2019). This reflects linear forms of production and consumption, in which little attention is given to what happens once a product has been sold to a consumer (Wastling et al., 2018). Even demand-side research on the circular economy largely focuses on questions around adoption and participation intentions for circular offerings that allow consumers to acquire products through circular rather than linear forms of consumption (Gülserliler, Blackburn, & Van Wassenhove, 2022; Hahn, Ostertag, Lehr, Büttgen, & Benoit, 2020; Lamberton & Rose, 2012). In contrast, the use phase and disposition have received less attention. Therefore, this thesis addresses the tri-dimensional role of consumers in the circular economy. To this end, the research papers included in this thesis investigate consumers' and users' (1) initial adoption and (2) continued use of reuse systems as well as (3) consumers' and users' engagement in disposition behavior to allow for product reuse. In doing so, the adoption and use stages are examined from the perspective of adopting and continuing to use a circular offering (i.e., a PaaS for reusable takeaway food containers), rather than the individual processes of acquiring or using a specific product (i.e., a particular reusable takeaway food container). Similarly, disposition is evaluated regarding intentions to engage in a novel solution to dispose of unused products as well as actual engagement in the novel disposition behavior (i.e., C2B smartphone selling).

1.3. Development of research questions

Regarding both research domains covered by this thesis – PaaS systems for reusable takeaway food containers and C2B smartphone selling –, research questions first address the influences of a wider range of factors on intentions to engage in the circular offering (papers 1 and 4). Taking these papers' findings as starting points, papers 2, 3, and 5 subsequently focus on more specific effects on actual consumer and user engagement.

Paper 1 investigates PaaS systems for reusable takeaway food containers, which allow restaurants and consumers to replace single-use packaging with reusable food containers through a PSS, without restaurants nor consumers having to purchase their own containers. As such, PaaS systems for reusable takeaway food containers facilitate reuse through a novel non-ownership business model at the intersection between dyadic access-based services and triadic frameworks (Andreassen et al., 2018; Benoit, Baker, Bolton, Gruber, & Kandampully, 2017). Crucially, PaaS systems for reusable takeaway food containers must appeal to two separate customer groups: Restaurants that serve food in the system's containers and consumers who order food in the system's containers. Yet, existing research on the diffusion of reusable food containers has primarily focused on consumers (Dorn & Stöckli, 2018; Ertz, Huang, Jo, Karakas, & Sarigöllü, 2017; Greenwood et al., 2021; Keller, Köhler, Eisen, Kleihauer, & Hanss, 2021; Loschelder, Siepelmeyer, Fischer, & Rubel, 2019; Novoradovskaya, Mullan, Hasking, & Uren, 2021), while the role of restaurants as important enablers has been largely neglected. To systematically assess the influences on restaurants' and consumers' adoption intentions and to investigate the implications of blending access-based services and triadic frameworks in a novel non-ownership business model for reuse, paper 1 addresses the following research question:

> ***Research question 1:*** *Which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers?*

Building on the positive effect of network density on consumers' self-reported adoption intentions identified in paper 1, paper 2 further investigates the effect of the network density of participating restaurants in a PaaS for reusable takeaway food containers on actual system adoption and use by consumers. Beyond the findings of paper 1, extant research on non-ownership consumption more broadly argues that assets need to be sufficiently accessible to attract demand (Wirtz, So, Mody, Liu, & Chun, 2019). If this is not the case, (perceived) product scarcity could discourage consumers from engaging in non-ownership consumption models (Hazée, Delcourt, & Van Vaerenbergh, 2017; Hazée et al., 2020; Lamberton & Rose, 2012). The literature on multisided markets refers to 'indirect network effects' when the utility of participating in a multisided market for one group (in PaaS systems for takeaway food: consumers) increases due to additional market actors from another group joining the system (in PaaS systems for takeaway food: restaurants) (Evans & Schmalensee, 2010; Gawer & Cusumano, 2014). Although indirect network effects on non-ownership consumption have been explored in conceptual research (Wirtz et al., 2019) as well as qualitative and stated preference studies (Habibi, Kim, & Laroche, 2016; Hazée et al., 2017, 2020; Lamberton & Rose, 2012), the magnitude of this effect on actual adoption and use of non-ownership consumption offerings has not yet been tested with field data. Therefore, paper 2 responds to the following research question:

Research question 2: *How does geographic network density affect consumers' adoption and use of Product-Service Systems?*

Paper 2 presents evidence for significant and meaningful effects of geographic network density on system adoption, but not on continued system use. Therefore, paper 3 examines system use in more detail and focuses on the durability of the behavior among existing users. In particular, paper 3 investigates the effect of a quasi-exogenous temporal interruption on system use and the moderating effect of stable behavioral contexts before the interruption. This way, paper 3 uses habit theory, which states that repeating behaviors in stable contexts (e.g., at the

same time of day, in the same location, with the same people) forges habit associations between contextual cues and behavioral responses (Mazar & Wood, 2018; Verplanken & Wood, 2006; Wood & Neal, 2016; Wood & Rünger, 2016). As a result, habitual behaviors are automatically cued by behavioral contexts, rather than triggered by deliberate behavioral intentions. As many pro-environmental behaviors such as commuting, household recycling, or food choices are habitual, research on pro-environmental behavior increasingly acknowledges that promoting more environmentally friendly lifestyles will require individuals to break and form new habits (Klöckner, 2013; Mazar, Tomaino, Carmon, & Wood, 2021; Russell, Young, Unsworth, & Robinson, 2017; Verplanken & Whitmarsh, 2021). Indeed, the widely cited *SHIFT framework* on sustainable consumer behavior change includes habits as one of five key psychological factors that need to be addressed to effectively engage consumers in pro-environmental behaviors (White, Habib, & Hardisty, 2019).

Many circular offerings (such as reuse systems for reusable takeaway food containers) address rather frequent everyday behaviors and require consumers and users to maintain their engagement over time to establish economically viable business models and deliver environmental benefits. Nevertheless, the role of habits is surprisingly underexplored in consumption research in the circular economy. While consumer habits are occasionally mentioned on an abstract level (de Jesus & Mendonça, 2018), research tends to focus on consumers' knowledge, awareness, and intentions or a lack thereof (Kirchherr et al., 2018), which underpin deliberate decision-making processes. However, habit theory suggests that these factors are unlikely to impact habitual behaviors that are triggered by automatic cue-response associations linked to behavioral contexts. Therefore, paper 3 considers context stability as an indicator of habit strength to investigate the durability of individuals' engagement in a reuse system as a pro-environmental, circular behavior. To this end, paper 3 addresses the following research question:

Research question 3: *Does a holiday break disrupt reuse behavior and is this effect moderated by context stability?*

Regarding the tri-dimensional role of consumers introduced in section 1.2.3, papers 1-3 examine non-ownership reuse systems for reusable takeaway food containers with a focus on adoption (papers 1 and 2) and use (papers 2 and 3). To complete this picture, papers 4 and 5 address the third key stage of consumption in the circular economy, disposition, by examining secondhand selling to facilitate reuse with ownership transfer. In doing so, papers 4 and 5 investigate consumers' selling intentions and actual behavior regarding unused personal smartphones.

Especially in high-income countries, low collection and reuse rates of smartphones (Gurita, Fröhling, & Bongaerts, 2018) lead to high levels of so-called product 'hibernation' (Glöser-Chahoud, Pfaff, & Schultmann, 2021). That is, many retired smartphones are stored at home and no longer in use. Secondhand selling of unused smartphones is relatively unpopular (Martinho, Magalhães, & Pires, 2017; Ylä-Mella, Keiski, & Pongrácz, 2015) even though many smartphones are replaced when only certain parts are broken or updated smartphone models enter the market (Martinho et al., 2017; Yin, Gao, & Xu, 2014; Ylä-Mella et al., 2015). With the objective to promote the reuse and redistribution of unused smartphones, C2B selling platforms emerged in recent years as a novel selling option for consumers (e.g., *Back Market*, *Rebuy*, *Refurbed*, *BuyBack*).[2] To sell their retired devices to a C2B selling platform, sellers need to enter information about their specific product (e.g., brand, model, condition) on a website or app. Afterward, the C2B selling platform offers a price for the product and arranges shipping if

[2] As research on C2B selling unfolded throughout the process of this thesis, so did the wording used for businesses that facilitate C2B selling by buying goods from consumers. Therefore, paper 4 refers to 'consumer-to-business buyback platforms' whereas paper 5 calls the same businesses 'consumer-to-business selling platforms'. The wording was updated in paper 5 to reflect that goods are not necessarily 'bought back' by the same entity they were originally bought from. Instead, the selling process is at the core of the phenomenon and is therefore featured more prominently in the term 'consumer-to-business selling platforms' used in paper 5 and this thesis more generally. Yet, the two terms 'consumer-to-business buyback platforms' and 'consumer-to-business selling platforms' are used interchangeably in this thesis.

consumers decide to sell to them. This way, C2B selling platforms aim to provide a low-effort option for sellers to facilitate the reuse of smartphones by redistributing devices from one consumer to the next. As C2B selling platforms present a novel selling channel and disposition is a generally underexplored aspect of consumer behavior (Phulwani, Kumar, & Goyal, 2021; Ting et al., 2019), paper 4 examined the following research question:

> ***Research question 4:*** *Which factors influence consumers' consumer-to-business selling intentions for personal smartphones that are no longer in use?*

Finally, based on findings of paper 4 that financial rewards and convenience play a key role in motivating consumers to sell secondhand goods to C2B selling platforms, paper 5 further investigates the costs and efforts as well as the financial benefits associated with secondhand selling. Conceptual (Thomas, 2003; Yokoo, 2010) and empirical research (Fremstad, 2017; Rapson & Schiraldi, 2013) on secondhand markets established the important effect of transaction costs on the size of secondhand markets. This body of literature highlights that lower transaction costs – that is, lower efforts associated with buying and selling secondhand goods, for example, finding a buyer or seller and negotiating a price – are associated with increased selling activity and, accordingly, a growing size of secondhand markets. As a result, C2B selling platforms potentially present a promising new selling channel as they aim to reduce the efforts associated with selling (i.e., transaction costs) even further compared to existing selling channels such as online C2C secondhand markets. However, C2B selling platforms tend to offer lower prices to sellers as they attempt to cover their own costs and resell devices at a profit after inspecting (and potentially repairing or refurbishing) them. As a result, C2B selling may not only reduce transaction costs, but also introduce new opportunity costs (i.e., the cost of foregone benefits; Polley, 2015), if prices are lower than on competing selling channels. However, the role of opportunity costs on secondhand markets and the effect of simultaneously reducing transaction costs while introducing opportunity costs is largely unexplored by extant literature.

Therefore, the effect of establishing C2B selling platforms on the size of secondhand markets and on product use phases remains unclear. To address this research gap, paper 5 investigates the following research question:

> ***Research question 5:*** *Do consumer-to-business selling platforms increase the size of secondhand markets and promote longer product use phases?*

1.4. Methods

To address the research questions introduced in section 1.3, this thesis primarily relied on quantitative empirical research and leveraged experimental methods and econometric analyses of large field datasets to investigate consumer and user behavior in the circular economy. This way, this thesis complements an emerging body of empirical research on consumption in the circular economy that largely relies on conventional surveys (Hamari, Sjöklint, & Ukkonen, 2016; Hazen, Mollenkopf, & Wang, 2017; Hwang & Griffiths, 2017; Möhlmann, 2015) and qualitative interviews and focus groups (Habibi et al., 2016; Hazée et al., 2017) or a combination thereof (Armstrong, Niinimäki, Kujala, Karell, & Lang, 2015; Moeller & Wittkowski, 2010). Indeed, a systematic review of 111 scientific contributions on consumer behavior in the circular economy illustrates this methodological focus, showing that 45% of publications were based on surveys and 20% used semi-structured interviews (Camacho-Otero, Boks, & Pettersen, 2018).

This body of research based on qualitative and quantitative self-reported data provides a solid foundation to evaluate consumption in the circular economy. At the same time, the literature on pro-environmental behavior often highlights the discrepancy between behavioral intentions and actual behavior, the so-called attitude-behavior gap (Carrington, Neville, & Whitwell, 2010; Claudy, Peterson, & O'Driscoll, 2013; Kollmuss & Agyeman, 2002; Park & Lin, 2018; Sheeran & Webb, 2016; Steg & Vlek, 2009; Young, Hwang, McDonald, & Oates, 2010). It has

been suggested that 'social desirability bias' contributes to this gap, as research subjects may overstate their attitudes, concerns, and intentions in self-reported responses on socially desirable behaviors (de Pelsmacker, Driesen, & Rayp, 2005; King & Bruner, 2000; Roxas & Lindsay, 2012). Accordingly, research applying qualitative methods and conventional surveys to study pro-environmental behaviors such as engaging in reuse systems for takeaway food containers or reselling smartphones could be prone to overstated preferences for pro-environmental choices. Therefore, this thesis leveraged experimental survey methods and analyses of large field datasets to investigate both research domains (PaaS systems for reusable takeaway food containers, C2B smartphone selling, see Table 1) and thereby contributes to a more robust understanding of consumers and users in the circular economy. The following sections outline the applied methods in more detail.

Table 1: Overview of papers' methods

Research domain	Paper	Factorial survey experiments and consumer surveys	Field data analyses
PaaS systems for reusable takeaway food containers	**Paper 1:** Blending Access-Based Services and Triadic Frameworks: An Empirical Evaluation of Packaging-as-a-Service	Factorial survey experiments with restaurants (N = 176) and consumers (N = 245)	
	Paper 2: Geographic Network Effects in a Circular Economy: A Field Data Analysis of Reusable Packaging Services		Fixed effects Poisson panel models with field data provided by *Vytal* (N = 1,442,972)
	Paper 3: Does a Holiday Break Disrupt Pro-Environmental Behaviors? Using Field Data to Test the Durability of Pro-Environmental Behaviors and the Moderating Effect of Habit		Regression discontinuity in time design with field data provided by *Vytal* (N = 17,284)
C2B smartphone selling	**Paper 4:** Motivating Consumer-to-Business Smartphone Returns: Evidence From a Factorial Survey Experiment	Factorial survey experiment with smartphone users (N = 1,192)	
	Paper 5: Do Consumer-to-Business Selling Platforms Increase the Size of Secondhand Markets and Extend Product Use Phases?	Willingness-to-accept survey with smartphone users (N_1 = 249, N_2 = 190)	Quantitative analyses of selling data from *eBay* and a C2B selling platform (N_3 = 27,307; N_4 = 78,096; N_5 = 2,330)

1.4.1. Factorial survey experiments and consumer surveys

Papers 1 and 4 leveraged factorial survey experiments to investigate intentions to engage in systems for reusable takeaway food containers and C2B smartphone selling. Factorial survey experiments apply experimental survey techniques and measure participants' preferences based on a holistic impression of so-called vignettes. Vignettes describe choices by systematically varying characteristics of previously defined dimensions (Aguinis & Bradley, 2014; Wallander, 2009). These vignette dimensions capture factors that are expected to influence preferences, for example, whether a reuse system is available at few or many restaurants or whether a smartphone can be sold at a low or a high price. As recommended by Atzmüller and Steiner (2010), vignette dimensions of studies included in this thesis were either derived from theory (paper 4) or from a qualitative pre-study (paper 1), if extant research was insufficient to determine relevant dimensions.

Factorial survey experiments provide several advantages compared to traditional survey methods that directly ask respondents to rate the importance of individual choice dimensions. Most importantly, factorial survey experiments increase external validity by exposing participants to a multidimensional description of vignettes, which invoke more holistic assessments of options (Aguinis & Bradley, 2014; Wallander, 2009). Furthermore, by measuring preferences more implicitly than conventional survey methods, factorial survey experiments reduce the risk that responses are affected by social desirability bias (Auspurg & Hinz, 2015). This advantage was particularly important as factorial survey experiments examined intentions to adopt socially desirable pro-environmental behaviors – adopting PaaS systems for reusable takeaway food containers (paper 1) and selling used electronics (paper 4). At the same time, factorial survey experiments can be used to test effects of vignette dimensions and participants' individual-level variables (Oll, Hahn, Reimsbach, & Kotzian, 2018). This allowed for tests of interaction effects between environmental value orientations and vignette dimensions (Cerri,

Testa, & Rizzi, 2018) and provided another reason to apply factorial survey experiments in papers 1 and 4.

Paper 5 surveyed smartphone owners to elicit price expectations for smartphone selling, which were later compared to actual prices (see section 1.4.2) to evaluate the potential of C2B selling platforms to increase the size of secondhand markets. Two separate survey tasks asked participants to quote their price expectations, thus resembling hypothetical direct open questions often used to study willingness-to-pay. This question format was chosen based on findings of a meta-analysis of studies on willingness-to-pay for private goods, which demonstrated that direct methods are less prone to hypothetical bias than indirect methods like conjoint analyses (Schmidt & Bijmolt, 2020). In addition, hypothetical bias was found to be stronger for more expensive goods and among specialty products (Schmidt & Bijmolt, 2020). As smartphones are moderately priced products all respondents were familiar with, hypothetical open-ended questions were used to assess price expectations for smartphone sales in paper 5.

1.4.2. Field data analyses

Papers 2 and 3 used field data of a PaaS for reusable takeaway food containers called *Vytal*. *Vytal* operates its system across an extensive and continuously growing network of partner restaurants and is the "world-leading provider of smart reusable food packaging" (Recker, Bockelmann, & Barthel, 2023). To order food in a reusable container provided by *Vytal*, users need to sign up through an app or purchase an offline card for €10. Afterward, reusable containers can be obtained from and returned to participating restaurants. Field data used by papers 2 and 3 captured transactions of reusable containers from restaurants to consumers with a unique user ID, restaurant ID, restaurant location, and time stamp.

For paper 2 on the effect of geographic network density on system adoption and use, a large dataset of *Vytal*'s transaction data over roughly two and a half years (N = 1,442,972 transactions) was aggregated to panel datasets capturing the number of new users and the number of

transactions at stores and cities per week. Geographic network density of *Vytal*'s network around stores or in cities, the main independent variable of interest, was measured using a 1km-buffer zone metric and the sum of inverse distances, in line with research on food environments (Currie, DellaVigna, Moretti, & Pathania, 2010; Harrison et al., 2011; Williams et al., 2014). To analyze the effect of geographic network density on system adoption and use by consumers, paper 2 relied on fixed effects panel models, a popular statistical method for causal inference using panel data (Cunningham, 2021a) that has also been applied by previous studies on food environments (Allcott et al., 2019; Currie et al., 2010).

For paper 3 on the effect of temporal interruptions on system use and the moderating effect of context stability, *Vytal*'s transaction data were aggregated to a panel dataset on the user level. That is, the final panel dataset captured 17,284 individuals' weekly frequency of system use six weeks before and after a Christmas break. This way, the Christmas break was used as a quasi-exogenous interruption that allowed for an investigation of the effect of a temporal interruption on system use by a large sample of individuals in a natural experiment. To this end, a regression discontinuity in time approach (Hausman & Rapson, 2018) was applied, an adaptation of the regression discontinuity design popular for identifying causal effects (Cunningham, 2021b). This methodological approach followed prior research on the effect of a quasi-exogenous temporal interruption (Easter) on gym attendance (Fredslund & Leppin, 2019). To examine the moderating effect of individuals' context stability before the interruption, context stability was measured by the standard deviation of times of day at which users engaged with the system (consistent time of day) as well as the number of restaurants at which individuals used the system (consistent location) before Christmas. Afterward, models were replicated for groups of users with more (vs. less) stable behavioral contexts before the interruption to test whether context stability moderated the effect of the interruption on system use.

Paper 5 examined whether C2B selling platforms increase the size of secondhand markets by complementing survey data on price expectations (see section 1.4.1) with large datasets of selling data from *eBay* and a C2B selling platform. To test the paper's theoretical model, *t*-tests were used to compare smartphone owners' price expectations for C2C and C2B selling, actual prices for C2C and C2B selling, and the age of smartphones sold on the two channels. Furthermore, locally estimated scatterplot smoothing (LOESS) was applied to estimate actual and expected prices as a function of device age.

1.5. Main results and contributions

With its five empirical papers on reuse (see summary in Table 2), this thesis contributes to consumption research in the circular economy. In doing so, it explores reuse in two research domains that differ in the way they facilitate reuse (non-ownership vs. ownership) and in the frequency and impact of the behavior (relatively high frequency, low impact vs. relatively low frequency, high impact). Furthermore, this thesis addresses the tri-dimensional role of consumers (Camacho-Otero et al., 2020; Macklin & Kaufman, 2023; Shevchenko et al., 2023; van der Laan & Aurisicchio, 2019) introduced in section 1.2.3, including adoption (papers 1 and 2), use (papers 2 and 3), and disposition (papers 4 and 5). The following section outlines the main results and contributions of each paper, before summarizing key findings in the final paragraph. An overarching conclusion with a general discussion of findings is presented in Chapter 7.

Paper 1 evaluated the effect of system attributes of PaaS systems for reusable takeaway food containers on restaurants' and consumers' adoption intentions based on factorial survey experiments with both target groups. From a methodological perspective, this presents a novel way to systematically measure and compare influences on adoption intentions of two market sides. Conceptually, paper 1 introduces 'access-based triadic systems' as a new hybrid form of

non-ownership consumption that combines aspects of access-based services and triadic frameworks. PaaS systems for reusable takeaway food containers are examined as a case of such access-based triadic systems to highlight the new set of challenges and opportunities these systems bring along: A preference for systems with a high number of participating restaurants and consumers highlights the challenge for system providers to simultaneously attract two market sides – restaurants and consumers. At the same time, both groups' demand for food containers that are customized to restaurants' food as well as consumers' preference for deposit systems (rather than digital, app-based systems) emphasize the importance of functionality and limited system complexity. System providers need to provide assets that fulfil functional demands while establishing system mechanisms that balance asset protection and system complexity. At the same time, as the asset owner, system providers enjoy high levels of asset and quality control, which provides opportunities for differentiation from competition.

Paper 2 used field data of *Vytal*, a system for reusable takeaway food containers, to analyze the effect of geographic network density of participating restaurants on system adoption and system use by consumers. This complements conceptual and stated preference research on (indirect) network effects in non-ownership consumption models and contributes to extant research by examining a large field dataset capturing revealed behavior over a long period of time. Furthermore, this paper applied measures of geographic network density primarily used in public health research on food-related behavior (buffer zone metrics, sum of inverse distances) to a new setting, PSS for reuse. Results demonstrate positive effects of increased geographic network density on system adoption by new users. Observed effects are both statistically significant and practically meaningful. Furthermore, marginal effects of network density on system adoption diminish as network density increases but remain positive across the entire relevant range of observed network density. This suggests that increasing network density is

particularly effective in the early stages of establishing reuse systems that allow the local sharing or redistribution of assets. Notably, the frequency of system use by existing users was not significantly affected by increasing network density. These divergent effects of network density on system adoption and use contribute to the wider literature on consumer behavior in non-ownership consumption as they highlight the need to analyze influences on these two stages of consumption (adoption, use) in a nuanced way.

Paper 3 also leveraged field data of the same system for reusable takeaway food containers to investigate the effect of a temporal interruption on system use and the moderating effect of context stability. With a regression discontinuity in time approach, the paper demonstrates that individuals' use of the system dropped by an average of 16.7% over a quasi-exogenous three-week Christmas break. Notably, this effect was smaller among system users whose engagement with the system was associated with a more stable behavioral context before the interruption, measured by the consistency of times of day and locations of system use. As habit theory states that repetition of behaviors in stable contexts forms habits, this suggests that pro-environmental circular behaviors are more durable and resilient to interruptions, if they are underpinned by habits. Thus, this paper contributes to habit research by presenting a novel way to measure indicators of habit strength (i.e., context stability) based on observational data. Furthermore, the paper complements research on habit discontinuity that typically focuses on the effects of changing behavioral contexts rather than temporal interruptions after which previous behavioral contexts reoccur. Finally, this paper contributes to research on pro-environmental behavior and consumption in the circular economy by acknowledging and highlighting the important role of habits in promoting and maintaining such target behaviors.

Table 2: Summary of papers

	Paper 1: Blending Access-Based Services and Triadic Frameworks: An Empirical Evaluation of Packaging-as-a-Service	**Paper 2:** Geographic Network Effects in a Circular Economy: A Field Data Analysis of Reusable Packaging Services	**Paper 3:** Does a Holiday Break Disrupt Pro-Environmental Behaviors? Using Field Data to Test the Durability of Pro-Environmental Behaviors and the Moderating Effect of Habit	**Paper 4:** Motivating Consumer-to-Business Smartphone Returns: Evidence From a Factorial Survey Experiment	**Paper 5:** Do Consumer-to-Business Selling Platforms Increase the Size of Secondhand Markets and Extend Product Use Phases?
Research question	Which attributes of access-based triadic systems for reusable food containers influence adoption intentions of restaurants and consumers?	How does geographic network density affect consumers' adoption and use of Product-Service Systems?	Does a holiday break disrupt reuse behavior and is this effect moderated by context stability?	Which factors influence consumers' consumer-to-business selling intentions for personal smartphones that are no longer in use?	Do consumer-to-business selling platforms increase the size of secondhand markets and promote longer product use phases?
Research domain	PaaS systems for reusable takeaway food containers (non-ownership reuse)			C2B smartphone selling (ownership reuse)	
Consumption stage	Adoption	Adoption, use	Use	Disposition	Disposition
Conceptual background	Non-ownership business models and consumption	Multisided markets, non-ownership consumption, network effects	Habit theory, habit discontinuity, pro-environmental behavior	Disposition behavior, pro-environmental behavior	Secondhand markets, transaction and opportunity costs
Empirical approach	Factorial survey experiments	Fixed effects Poisson panel models with field data	Regression discontinuity in time with field data	Factorial survey experiment	Survey of smartphone users and field data analyses
Key results and contributions	- Simultaneously handling product-related responsibilities and a two-sided system introduces new challenges and opportunities for PaaS system providers - 'Access-based triadic systems' as a new conceptual hybrid	- Significant and practically meaningful positive network effects on user adoption of a PSS for reuse - Novel approach to measuring and modeling network density with field data	- Context stability mitigates negative effect of interruptions, suggesting that habits make behaviors more durable - Novel observational measures of context stability and examination of a different type of habit discontinuity	- Key role of material incentives and convenience - Insights into disposition choices, a largely overlooked but increasingly important aspect of consumer behavior in the circular economy	- Consumer-to-business selling can expand secondhand markets, but low price offerings pose a limitation in practice - Key role of opportunity costs (in addition to transaction costs) in secondhand markets
Publication status	Published (*Journal of Service Management*)	Published (*Journal of Industrial Ecology*)	Published (*Resources, Conservation & Recycling*)	Published (*Journal of Cleaner Production*)	Under review

Paper 4 turned to secondhand selling as a way to facilitate reuse by transferring ownership of used products. By investigating C2B smartphone selling, the paper examined disposition behavior, which plays a crucial role in the operationalization of the circular economy but is generally under-researched in consumption research. Furthermore, the paper explored C2B selling platforms as a novel selling channel that only emerged in recent years. Based on conceptual accounts of disposition, paper 4 investigated three categories of influences on disposition choices: (1) the decision-making person (consumer characteristics), (2) the product (smartphone characteristics), and (3) the situation (return option characteristics). In terms of personal characteristics, both environmental awareness and price consciousness were linked to higher intentions to sell smartphones to C2B selling platforms. As expected, higher financial rewards (determined by smartphone characteristics) were associated with higher selling intentions and financial rewards were preferred over non-financial rewards (determined by return option characteristics). Yet, interaction effects indicated that non-financial rewards were more popular among environmentally aware consumers and for lower-value devices. Furthermore, more convenient return mechanisms were linked to higher selling intentions. This way, paper 4 presents new insights into disposition behavior as a crucial, but underexplored stage of consumption in the circular economy, and demonstrates effects of the decision-making person, product, and situation on selling intentions.

Paper 5 further investigated the costs and benefits of secondhand selling and examined whether complementing C2C secondhand markets with C2B selling platforms increases the size of secondhand markets and extends product use phases. To this end, the paper first developed a theoretical model of consumers' secondhand selling choices. According to the presented model, low transaction costs of C2B selling could lead to the redistribution of relatively old goods for which C2C selling is no longer an option because transaction costs are prohibitively high. Afterward, the model's underlying assumptions and key predicted outcome were tested

with the example of C2B smartphone selling. Using a survey with smartphone users and large field datasets of *eBay* listings (i.e., C2C) and a C2B selling platform, the paper demonstrates that C2B selling platforms have the potential to grow secondhand markets and extend product use phases, but their contribution remains limited at current price levels. That is, for most consumers, C2B selling platforms do not sufficiently reduce perceived transaction costs to offset additional opportunity costs at observed price levels. This way, paper 5 builds on extant research on transaction costs in secondhand markets and contributes to the literature on secondhand markets by providing new evidence for the important role of opportunity costs in secondhand selling decisions.

In sum, the key role of functionality, convenience, and material benefits emerges as an overarching theme from the results of all five empirical papers included in this thesis. Papers 1 and 2 highlight that network density, customized containers, and limited system complexity are key to motivate the adoption of PaaS for reusable takeaway food containers. Furthermore, paper 3 demonstrates that promoting reuse habits by fostering behavioral performance in stable contexts can increase the durability of the behavior. In terms of the dimensions of Figure 2, this suggests that just because non-ownership reuse models no longer sell products to consumers, they cannot compromise on product functionality. To the contrary, system providers in non-ownership reuse models need to supply customers with products that serve their needs while also fulfilling numerous other roles as a mediator between two market sides, not least establishing and maintaining a two-sided network of supply and demand. Furthermore, non-ownership models addressing relatively frequent behaviors benefit from engaging users in contexts that foster habit formation and thereby promote sustained, long-term consumer and user engagement.

With regard to reuse behavior that is less frequent and involves transfer of ownership between consumers and other consumers or businesses, papers 4 and 5 demonstrate the key role

of convenient, low-effort return mechanisms and sufficient monetary incentives to motivate consumers to sell their secondhand goods. In addition, although papers 1 and 4 reveal higher adoption and selling intentions among more environmentally conscious consumers, paper 4 also points toward price-conscious consumers as another promising target group. Overall, findings demonstrate that circular offerings can attract a broad range of consumers and users if they are sufficiently attractive in terms of their functionality, convenience, and material benefits.

2. Paper 1: Blending Access-Based Services and Triadic Frameworks: An Empirical Evaluation of Packaging-as-a-Service

Stefanie Fella and Christoph Ratay

Abstract

Recently emerged Packaging-as-a-Service (PaaS) systems adopt aspects of access-based services and triadic frameworks, which have typically been treated as conceptually separate. To investigate implications of blending the two in what we call "access-based triadic systems", this paper empirically evaluates intentions to adopt PaaS systems for takeaway food among restaurants and consumers. We derived relevant attributes of PaaS systems from a qualitative pre-study with restaurants and consumers. Next, we conducted two factorial survey experiments with restaurants (N = 176) and consumers (N = 245) in Germany to quantitatively test the effects of those system attributes on their adoption intentions. This paper highlights that the role of access-based triadic system providers as both the owners of shared assets and the operators of a triadic system is associated with a novel set of challenges and opportunities: System providers need to attract a critical mass of business and end customers while balancing asset protection and system complexity. At the same time, asset ownership introduces opportunities for improved quality control and differentiation from competition. Conceptually, this paper extends research on access-based services and triadic frameworks by describing an unexplored hybrid form of non-ownership consumption we call "access-based triadic systems". Empirically, this paper addresses the need to account for the demands of two distinct target groups in triadic systems and demonstrates how factorial survey experiments can be leveraged in this field.

Keywords

Packaging-as-a-Service, access-based services, triadic frameworks, reuse, factorial surveys

Note: As this paper has been published in the Journal of Service Management (see publication reference below), this publicly available version of the dissertation only includes the abstract to avoid self- plagiarism. This paper was written with Stefanie Fella. Therefore, the plural instead of the singular is used throughout this paper to refer to both authors. Both authors contributed equally and share lead authorship of this paper. The order of author names was determined alphabetically.

Contributions:

Conceptualization: Fella, S. and Ratay, C.; Methodology: Fella, S. and Ratay, C.; Data curation: Fella, S. and Ratay, C.; Formal analysis: Fella, S. and Ratay, C.; Writing - original draft: Fella, S. and Ratay, C.; Writing - review & editing: Fella, S. and Ratay, C.

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Conference Presentations:

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3. Paper 2: Geographic Network Effects in a Circular Economy: A Field Data Analysis of Reusable Packaging Services

Christoph Ratay, Fabian Barthel, and Alwine Mohnen

Abstract

Product-Service Systems have the potential to align businesses' financial incentives with environmental objectives. Conceptual and qualitative research on non-ownership consumption suggests that such offerings benefit from dense local networks, which motivate system adoption and use. However, geographic network effects and their magnitude have not been examined with field data capturing revealed behavior. This paper leverages a large field dataset from a system for reusable take-out food containers to evaluate the effect of increased geographic network density of participating restaurants on (a) the acquisition of new users and (b) the frequency of system use. Based on fixed effects Poisson panel models, this paper finds statistically significant and practically meaningful positive effects of increased geographic network density on acquiring new users. Notably, marginal effects of increased geographic network density on user acquisition diminish as networks get denser. In terms of frequency of use, no significant effects of geographic network density are identified. These results contribute to the literature on non-ownership consumption by presenting nuanced field evidence of indirect, cross-side network effects in Product-Service Systems. Furthermore, findings encourage businesses and policymakers to promote Product-Service Systems with dense local networks.

Keywords

Circular economy, industrial ecology, multisided markets, network effects, Product-Service Systems, reuse

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Previous versions of this paper were presented by Christoph Ratay at the *83rd Annual Meeting of the Academy of Management*, the *11th International Conference on Industrial Ecology*, the *SCORAI-ERSCP-WUR Conference 2023*, and the *23rd Annual Conference of the European Academy of Management*. At the latter, the paper was awarded the Best Paper Award by the *Strategic Interest Group (SIG) Innovation* of the *European Academy of Management*.

4. Paper 3: Does a Holiday Break Disrupt Pro-Environmental Behaviors? Using Field Data to Test the Durability of Pro-Environmental Behaviors and the Moderating Effect of Habit

Christoph Ratay, Thomas L. Webb, Wendy Wood, and Alwine Mohnen

Abstract

For pro-environmental behavior to have a meaningful impact, it needs to be maintained and resilient to temporary interruptions in daily life. Yet, the effects of temporal interruptions on pro-environmental behaviors are rarely explored. The present research applied a regression discontinuity in time approach to a large field dataset from a system for reusing food containers and examined the effect of the Christmas break on 17,284 individuals' use of the system. On average, the temporal interruption was associated with a 16.7% drop in individuals' use of reusable food containers. However, the interruption had a smaller effect on individuals who performed the behavior in more stable contexts before the interruption, as measured by the extent to which the individuals used the system in consistent times and places. Given that habits form through repetition in stable contexts, this finding suggests that stronger habits promoted the durability of pro-environmental behaviors.

Keywords

Pro-environmental behavior, durability of habits, reuse, field data

Note: As this paper has been published in Resources, Conservation & Recycling (see publication reference below), this publicly available version of the dissertation only includes the abstract to avoid self- plagiarism. This paper was co-authored by Thomas L. Webb, Wendy Wood, and Alwine Mohnen. Therefore, the plural instead of the singular is used throughout this paper to refer to all authors.

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Publication:

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5. Paper 4: Motivating Consumer-to-Business Smartphone Returns: Evidence From a Factorial Survey Experiment

Christoph Ratay and Alwine Mohnen

Abstract

In light of short replacement cycles and low recycling rates of smartphones, establishing effective return mechanisms for unused smartphones is crucial to prolong product use phases and thereby reduce the environmental impact of smartphones. Consumer-to-business return options provide a novel, accessible way to return unused devices but require consumer acceptance to fulfill their ecological potential. However, thus far, disposition is a largely understudied aspect of consumer behavior. We address the need for research on disposition behavior and smartphone returns by examining influences on consumers' intentions to use consumer-to-business return options for smartphones in a factorial survey experiment with 1,192 smartphone users in Germany. We find that environmental awareness and price consciousness are both associated with higher return intentions. Although financial rewards are generally preferred to non-financial rewards, non-financial rewards gain popularity among environmentally aware consumers and when lower financial rewards are offered. Neither marketing smartphone returns with different appeal types nor linking the smartphone return to purchasing a replacement device influence participants' return intentions. In contrast, return mechanisms and device condition do significantly affect return intentions in our experiment. We discuss our findings' implications for practitioners offering consumer-to-business return options and formulate practical recommendations, in particular regarding the use of non-financial rewards, the integration of return and refurbishing services, and potential benefits of physical drop-off stations.

Keywords

Circular economy, smartphone returns, consumer-to-business selling, disposition behavior, electronic waste

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6. Paper 5: Do Consumer-to-Business Selling Platforms Increase the Size of Secondhand Markets and Extend Product Use Phases?

Christoph Ratay and Alwine Mohnen

Abstract

Secondhand markets extend product use phases by redistributing unused goods. This paper evaluates whether complementing consumer-to-consumer (C2C) secondhand markets with novel consumer-to-business (C2B) selling platforms that reduce efforts of selling (i.e., transaction costs) while typically offering lower prices (i.e., introducing opportunity costs) increases the size of secondhand markets and extends product use phases. We first present a theoretical model proposing that C2B selling may enable the redistribution of goods for which transaction costs of C2C selling are prohibitively high. Subsequently, the theoretical model is tested empirically with the example of smartphone selling, using survey data and large field datasets of eBay listings (C2C) and a C2B selling platform. In support of the theoretical model, we find that (1) a substantial proportion of survey respondents associates C2B selling with lower transaction costs than C2C selling, (2) C2B selling introduces opportunity costs, and (3) C2B selling is more popular for older goods compared to C2C selling. However, to increase the size of secondhand markets at scale, we demonstrate that C2B selling prices need to increase to attract more sellers. We discuss implications for research on secondhand markets, practical lessons for operators of secondhand markets, and policy options to promote reuse.

Keywords

Circular economy, opportunity costs, reuse, secondhand markets, transaction costs

Note: The complete manuscript of the paper is included in the Appendix. This paper was co-authored by Alwine Mohnen. Therefore, the plural instead of the singular is used throughout this paper to refer to both authors.

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Previous versions of this paper were presented by Christoph Ratay at the *14th ISIE Socio-Economic Metabolism Section Conference* and the *2023 Fall Conference of the Sustainability Management Section ('WK NAMA')* of the *German Academic Association of Business Research (VHB)*.

7. Conclusion

"Don't hate the player, hate the game"

Popular proverb stating that "frustrations with a system or activity should be blamed on its weaknesses, rather than on individuals who operate within it" (Wiktionary, 2022).

The five empirical papers in this thesis explored consumption in two different reuse models. Section 1.5 summarized each paper's main results and individual contributions, highlighting the importance of functionality, convenience, and material benefits as overarching themes in all five papers. This chapter begins by discussing these general findings with regard to the prior literature and outlining practical implications. Afterward, this chapter provides an outlook with avenues for future research to advance the circular economy in research and in practice.

7.1. Discussion of main results and practical implications

An effective operationalization of the circular economy relies on businesses to implement respective strategies (Lieder & Rashid, 2016). For private sector actors to engage, circularity strategies need to deliver positive economic returns on investment in the long run (Ghisellini et al., 2016). Additionally, consumers have been highlighted as important enablers whose engagement is needed to effectively implement circularity strategies (Kirchherr et al., 2023). Yet, just like businesses that require circularity strategies to be economically viable in the long term, this thesis demonstrates that circular offerings also need to provide material benefits to consumers. In the words of Ladeja Godina Košir, Founder and Executive Director of *Circular Change*, circular solutions need to be "accessible and affordable, so I don't have to go an extra mile or pay more" (Alexander, 2023, p. 88).

This statement is supported by multiple findings across the five empirical papers included in this thesis. Paper 1 demonstrates that it is a key concern for restaurants and consumers that reusable food containers are customized to the food that is served in them. Neither suppliers nor consumers of takeaway food are willing to sacrifice food quality for the sake of using reusable packaging. In addition, papers 1 and 2 highlight the importance of indirect network effects to motivate participation by restaurants and consumers in PaaS for reusable takeaway food containers. Restaurants benefit from consumers who participate in the PaaS system and may discover the restaurant through the system. At the same time, additional restaurants present an advantage to consumers who enjoy more variety in the food they can order in reusable food containers and for whom it is easier to return containers if more restaurants are part of the system. Furthermore, paper 3 shows the importance of habit formation for maintaining relatively frequent circular behaviors. Finally, regarding smartphone selling, a less frequent behavior that involves ownership transfer, papers 4 and 5 highlight that convenience and financial benefits are key factors to motivate consumers to sell unused goods.

Although papers 1 and 4 provide some evidence that engaging in reuse behaviors is more popular among more pro-environmental consumers, key findings on the importance of functionality, convenience, and material benefits highlight that engagement in the circular economy is not necessarily subject to intentional decision-making based on pro-environmental attitudes, knowledge, or concerns. Within the realm of sustainable consumption more broadly, this links to the concept of ‘quiet sustainability’, which captures behaviors with sustainability benefits that are not guided by “explicit environmental or sustainability goals” (Smith, Kostelecký, & Jehlička, 2015, p. 227). In other words, circular behaviors do not necessarily have to be underpinned by the intention to behave pro-environmentally. Instead, they can be driven by functionality, convenience, or material benefits, while environmental benefits are merely a welcome side effect. Furthermore, paper 3 highlights habit formation as an important factor contributing

to the durability of potentially frequent, routine circular behaviors over time. Again, habitual behaviors are not triggered by intentions but cued by the behavioral contexts with which they are associated. This points toward the key role of breaking and forming habits to promote routine circular behaviors, rather than changing individuals' underlying environmental attitudes, knowledge, or concerns.

In sum, empirical findings suggest that intentions to behave pro-environmentally are not a necessary precondition for individuals to engage in the circular economy. While pro-environmental values may indeed contribute to some consumers' engagement in the circular economy, neither 'quiet sustainability' nor habits require individuals to be driven by pro-environmental attitudes, knowledge, or concerns that lead to pro-environmental intentions. Considering the difficult and time-intensive processes associated with changing attitudes, knowledge, and concerns about the environment, the notion that pro-environmental intentions are not a necessary precondition for engaging in circular behaviors is good news for the diffusion of the circular economy. As long as circular offerings are functional, convenient, and come with material benefits, they can appeal to mainstream markets rather than just a niche of intrinsically motivated pro-environmental consumers.

For businesses that offer circular solutions in practice, this implies that – beyond their environmental benefits – circular offerings need to focus on delivering functional and material benefits in a convenient manner to appeal to a broad range of customers and scale their solutions. For instance, by establishing dense networks of participating restaurants and providing customized food containers, PaaS systems provide a reuse alternative to single-use packaging that is convenient to use and increases food quality. Similarly, by facilitating secondhand selling through convenient return mechanisms (e.g., pick-up at the door or physical return stations) and rewarding sellers with sufficient financial benefits, operators of secondhand markets can motivate consumers to resell their unused goods.

Yet, the wider economic context often favors linear production systems that follow the conventional take-make-use-dispose paradigm. This poses challenges for businesses to offer circular alternatives with competitive material benefits. The (im-)balance of virgin material costs and labor costs has been highlighted as a key underlying systemic issue, especially in high-income settings. Low costs of virgin materials make it relatively cheap to manufacture new, linear products (Kirchherr et al., 2018) while comparatively high labor costs disincentivize labor-intensive circular activities like repair and reuse (Llorente-González & Vence, 2020; Roberts, Milios, Mont, & Dalhammar, 2023). In other words, linear and circular alternatives are not competing on a level playing field in many domains. This leads to the overarching conclusion captured by the proverb quoted at the beginning of this chapter:

'*Don't hate the player, hate the game*'

Both businesses and consumers (i.e., the relevant players) are often incentivized to engage in linear production and consumption rather than implementing circularity strategies. As a result, without changing the rules of the game (i.e., the wider economic incentives), it seems unfair to expect businesses and consumers to embrace the circular economy at scale.

Fiscal policies as potential regulatory measures to level the playing field have been highlighted by contributors from academia (Hartley, van Santen, & Kirchherr, 2020; Llorente-González & Vence, 2020; Milios, 2021; Roberts et al., 2023; Stahel, 2013) and practice (Ellen MacArthur Foundation, 2015; Wijkman & Skånberg, 2017). In particular, tax policies are seen as a suitable vehicle to disincentivize linear production and consumption and make circular offerings more appealing. On the one hand, a virgin material tax has been proposed to make it less attractive to produce new products instead of repairing, reusing, refurbishing or remanufacturing existing ones (Milios, 2021). On the other hand, it has been proposed to shift toward taxing non-renewable resources rather than renewable resources like labor (Ghisellini et al., 2016;

Stahel, 2013; Wijkman & Skånberg, 2017) and to consider a reduced value added tax (VAT) on circular products and services (Hartley et al., 2020; Milios, 2021; Roberts et al., 2023).

In relation to the two research domains examined in this thesis, a virgin material tax could be used to increase the cost of single-use packaging and new smartphones. In turn, a virgin material tax may incentivize the use of reusable food containers and the redistribution of unused devices. In addition, a reduced VAT on circular products and services could reduce the costs associated with running PaaS systems for reusable takeaway food containers or C2B selling platforms and thereby enable such businesses to offer consumers more financially attractive alternatives to linear consumption. While these fiscal policies primarily focus on promoting the material benefits of circular offerings compared to linear alternatives, such policies could also help to promote the functionality and convenience of engaging in circular alternatives. After all, if businesses are increasingly incentivized to implement circularity strategies, the value propositions of circular offerings likely improve due to competition with each other. Furthermore, economic incentives resulting from fiscal policies may increase the accessibility and availability of circular offerings. In turn, the functionality and convenience of circular offerings may also benefit from fiscal policies, as demonstrated by papers 1 and 2, which show positive effects of a dense network of restaurants (i.e., high accessibility) on the adoption of a PaaS systems for reusable takeaway food containers.

Crucially, the implementation of policies aiming to promote a shift from linearity to circularity benefits from an instrumental view of the circular economy. As highlighted in the introduction, the circular economy is a means to an end – sustainable development – rather than a goal in and of itself. Thus, fiscal policies that aim to internalize externalities by pricing in environmental costs (e.g., through a virgin material tax or a carbon tax) appear as particularly promising policy instruments, because they are agnostic about strategic responses by businesses. As a result, circularity strategies may emerge as effective solutions in some domains,

while other, non-circular sustainability strategies may be preferred in other areas. Policy options that aim to support specific circular activities such as a reduced VAT on circular products and services may also be effective but should be evaluated based on their sustainability benefits rather than their success in fostering the targeted circular activity.

In conclusion, the empirical results on the micro-level of individual consumers and users in the circular economy also speak to macro-level questions of how to promote the circular economy with enabling policies that shift incentives away from linear economic practices toward circularity (Leipold et al., 2023). Findings point toward the importance of the policy environment as a key contextual factor (Centobelli, Cerchione, Chiaroni, Del Vecchio, & Urbinati, 2020) that needs to give circularity strategies a fair chance to take root among businesses and consumers by leveling the playing field with linear production and consumption.

7.2. Outlook

In the introduction, this thesis started by presenting a two-by-two matrix differentiating between ownership vs. non-ownership reuse models and high frequency, low impact vs. low frequency, high impact reuse behaviors (see Figure 2). The five empirical papers included in this thesis addressed two of the four fields that emerge from this matrix: Papers 1-3 explored PaaS for reusable takeaway food containers as a non-ownership reuse model with a relatively frequent but low impact behavior. Papers 4-5 investigated C2B selling as a way to operationalize reuse with ownership transfer through a behavior that is relatively infrequent but has a higher environmental impact. Conversely, high-frequency, low-impact ownership models (e.g., packaging for fast moving consumer goods) and low-frequency, high impact non-ownership models (e.g., PSS for consumer electronics or clothing) were not addressed by this thesis and therefore present promising research fields for testing and validating the findings on consumption in the circular economy presented in this thesis.

In doing so, results highlight the merits of investigating consumption beyond questions of acquisition and adoption to acknowledge the tri-dimensional role of consumers in the circular economy by addressing the use phase and disposition. Furthermore, future research benefits from incorporating perspectives from different disciplines in research on the circular economy (Blomsma & Brennan, 2017), as demonstrated at various instances throughout this thesis. For example, paper 2 successfully transferred methods for measuring geographic network density from public health research to the context of PSS for reuse. Additionally, paper 3 drew valuable insights from psychological accounts of habit theory, which have not been considered in detail in circular economy research, even though many circular offerings require individuals to change their previously held linear routines to adopt and maintain new circular behaviors. Finally, from a methodological perspective, the extensive use of digital technologies by businesses that implement circularity strategies invites researchers to leverage large field datasets to explore consumption beyond stated preferences by studying revealed behavior with observations of large samples. Papers 2, 3, and 5 demonstrate that there is a myriad of opportunities to use field data for academic research on the circular economy.

Regarding the generalizability of presented findings, it should be noted that both research domains covered in this thesis were studied in a Western European, high-income context and with a focus on operationalizing the circular economy in formally organized markets. As a result, empirical findings and conclusions should not be expected to directly translate to low-income settings, in which the circular economy takes very different shapes and forms (Kirchherr & van Santen, 2019). In particular, the discrepancy between the cost of virgin materials and labor costs highlighted in section 7.1 is unlikely to be found to the same extent in low-income settings. In fact, as opposed to high-income contexts with high labor costs, time is typically a readily available resource in low-income settings, and individuals often retain the value of materials and goods through time-intensive circular activities (e.g., repair) out of economic

necessity (Korsunova, Halme, Kourula, Levänen, & Lima-Toivanen, 2022). This suggests that some of the issues addressed by reuse models studied in this thesis (e.g., unused, hibernating goods) are unlikely to emerge in low-income settings in the first place. Thus, the research presented in this thesis and the wider body of literature on the circular economy would benefit from a broadened geographical perspective and intensified research in low-income contexts in the future (Kirchherr & van Santen, 2019; Korsunova et al., 2022).

Finally, the wide range of (fiscal) policies that have been proposed to promote the circular economy (see section 7.1) presents ample opportunities for future research. Crucially, such research should evaluate policies with regard to their ability to foster sustainable development rather than circularity itself. More generally, research in the circular economy should continue to critically evaluate the circular economy as an instrument to promote sustainable development rather than an ultimate objective in and of itself. Indeed, more skeptical accounts of the circular economy have questioned the extent to which the circular economy contributes to a sustainable transformation (Leipold et al., 2023), for instance arguing that environmental benefits tend to be based on assumptions and not sufficiently proven (Corvellec, Böhm, Stowell, & Valenzuela, 2020) or may be limited by rebound effects (Zink & Geyer, 2017). Thus, critically evaluating the sustainability benefits of the circular economy and its wider impacts continues to be an important research need (Geissdoerfer et al., 2017; Leipold et al., 2023). Life cycle assessments like the ones cited in this thesis exploring the benefits of reusable food containers (Gallego-Schmid et al., 2019; Greenwood et al., 2021) and the environmental impacts of smartphones in different phases of the life cycle (Moberg et al., 2014) provide much-needed evidence on the environmental implications of specific circularity strategies. At the same time, paper 5 of this thesis and prior empirical research on rebound effects (Makov & Vivanco, 2018) demonstrate the valuable contributions interdisciplinary research and the social sciences can make to examining the extent to which circular offerings deliver positive sustainability impacts. Importantly,

future research will benefit from multi-dimensional assessments of sustainability impacts that go beyond environmental and economic effects and consider social implications of the circular economy, which are largely overlooked in circular economy research (Geissdoerfer et al., 2017; Kirchherr, Urbinati, & Hartley, 2023; Merli et al., 2018; Oliveira et al., 2021).

Achieving sustainability benefits through the implementation of circularity strategies requires business implementation as well as consumer and user engagement. With five empirical papers that focus on two reuse models, this thesis demonstrated the crucial role of functionality, convenience, and material benefits in driving demand for circular offerings. To support businesses in establishing circular alternatives that effectively challenge linear production and consumption, this thesis highlights several regulatory measures that may level the playing field and give circularity strategies a fair chance to win over consumers and users beyond a niche of pro-environmental individuals. In doing so, the presented research advances both research and practice. By examining reuse, the five empirical papers complement circular economy research that often focuses on ways to close resource loops rather than strategies for slowing resource loops on top of the *value hill*. Furthermore, insights into consumer and user engagement with experimental methods and field data analyses address the need for a deeper understanding of the demand side in the circular economy. After all, as businesses are needed to operationalize circularity strategies, uncertain demand poses a major challenge to implementing the circular economy. Against this background, the practical insights on success factors for reuse models presented in this thesis address practitioners' need for empirical evidence on how to implement the circular economy "in real life" (Kirchherr & van Santen, 2019, p. 1). In light of excessive levels of resource extraction and waste generation as well as increasingly severe supply chain interruptions, this thesis hopes to help researchers and practitioners to establish impactful and scalable circular alternatives to linear production and consumption and thereby contribute to a shift toward sustainable development.

Appendix: Complete Manuscript of Paper 5

Title: Do Consumer-to-Business Selling Platforms Increase the Size of Secondhand Markets and Extend Product Use Phases?

Authors: Christoph Ratay and Alwine Mohnen

Do Consumer-to-Business Selling Platforms Increase the Size of Secondhand Markets and Extend Product Use Phases?

Christoph Ratay and Alwine Mohnen

Abstract

Secondhand markets extend product use phases by redistributing unused goods. This paper evaluates whether complementing consumer-to-consumer (C2C) secondhand markets with novel consumer-to-business (C2B) selling platforms that reduce efforts of selling (i.e., transaction costs) while typically offering lower prices (i.e., introducing opportunity costs) increases the size of secondhand markets and extends product use phases. We first present a theoretical model proposing that C2B selling may enable the redistribution of goods for which transaction costs of C2C selling are prohibitively high. Subsequently, the theoretical model is tested empirically with the example of smartphone selling, using survey data and large field datasets of eBay listings (C2C) and a C2B selling platform. In support of the theoretical model, we find that (1) a substantial proportion of survey respondents associates C2B selling with lower transaction costs than C2C selling, (2) C2B selling introduces opportunity costs, and (3) C2B selling is more popular for older goods compared to C2C selling. However, to increase the size of secondhand markets at scale, we demonstrate that C2B selling prices need to increase to attract more sellers. We discuss implications for research on secondhand markets, practical lessons for operators of secondhand markets, and policy options to promote reuse.

Keywords

Circular economy, opportunity costs, reuse, secondhand markets, transaction costs

1. Introduction

In industrialized countries, many private households are full of hoarded secondhand goods that are no longer in use. For instance, the average UK adult did not use about a quarter of their clothes in the past year (WRAP, 2022) and in Japanese, there is even a word – "*Tsundoku*" – for buying books without reading them (Mims, 2018). A consumer survey in six European countries in 2022 revealed that about 15% of consumer electronics and small electric household appliances were hoarded and no longer used (WEEE Forum, 2022). Reducing such unused storage times, so-called product "hibernation", of consumer electronics like smartphones could deliver environmental benefits by reducing the need for new carbon and resource-intensive products (Glöser-Chahoud, Pfaff, & Schultmann, 2021).

Secondhand markets address this issue by allowing consumers to pass on unused goods, thereby promoting longer product use phases (Makov, Fishman, Chertow, & Blass, 2019). This paper evaluates whether a novel selling channel – consumer-to-business (C2B) selling platforms – increases the size of secondhand markets and further extends product use phases. The size of secondhand markets depends on transaction costs (Thomas, 2003; Yokoo, 2010), such as search or bargaining costs. That is, the effort associated with buying and selling secondhand goods determines the volume of used goods that is resold. In the last few decades, internet-based consumer-to-consumer (C2C) secondhand markets substantially reduced transaction costs of secondhand selling (Einav, Farronato, & Levin, 2016; Fremstad, 2017; Thomas, 2003). Even more recently, C2B selling platforms emerged as an alternative selling channel, aiming to further reduce transaction costs. C2B selling platforms such as *Back Market* (consumer electronics) or *Momox* (books, clothes) offer consumers to sell their used goods to them or their affiliated partners. To do so, C2B selling platforms typically ask consumers to provide information about the product (e.g., brand, model, condition) through a website or app, before offering a guaranteed price for the product. Additionally, C2B selling platforms usually provide

shipping labels to consumers who sell products to them. Overall, C2B selling platforms aim to offer a low-effort alternative to C2C secondhand markets.

As a result, C2B selling platforms may enable the redistribution of unused goods that otherwise would not be resold because the efforts of C2C selling (i.e., transaction costs) are prohibitively high. At the same time, however, C2B selling platforms need to cover their own operating costs and usually aim to make a profit from trading secondhand goods. This suggests that C2B selling platforms offer lower prices than C2C secondhand markets, thereby introducing opportunity costs for sellers.

Thus far, the positive effect of reduced transaction costs on the size of secondhand markets has been established conceptually (Thomas, 2003; Yokoo, 2010) and tested empirically (Fremstad, 2017; Rapson & Schiraldi, 2013). However, the effect of simultaneously reducing transaction costs (through lower efforts associated with selling) and introducing opportunity costs (through lower price levels) on secondhand markets remains unexplored – both conceptually and empirically. Therefore, it is unclear whether C2B selling platforms facilitate the reuse of products that otherwise would not be redistributed on C2C secondhand markets. That is, the environmental benefits of C2B selling platforms are yet to be investigated. To address this research gap, this paper responds to the following research question about the effect of complementing C2C secondhand markets with C2B selling platforms: Do C2B selling platforms increase the size of secondhand markets and promote longer product use phases?

This paper proceeds as follows: To begin with, conceptual foundations on transaction and opportunity costs in secondhand markets are examined to derive a theoretical model on secondhand selling choices. To test the model empirically, section 2 proposes three hypotheses on the model's underlying assumptions and key predicted outcome. Afterward, section 3 introduces this paper's data sources and methods, followed by section 4 outlining the results of the

three hypothesis tests and a synthesis of key results. Section 5 discusses implications for theory as well as businesses and policymakers that aim to foster product reuse.

2. Theoretical background and hypotheses

2.1. *Transaction and opportunity costs in secondhand markets*

Following the neoclassical definition of transaction costs, this paper broadly conceptualizes transaction costs as "costs resulting from the transfer of property rights" (Allen, 2000, p.901). Regarding (secondhand) selling, these costs account for the time spent to realize the transaction (time costs), including efforts required for sellers and buyers to find each other (search costs) and negotiate a price (bargaining costs). Conceptually, it has been demonstrated that reducing transaction costs increases the size of secondhand markets. The lower the friction of selling used goods, the more used goods are sold (Thomas, 2003; Yokoo, 2010). Crucially, lowering transaction costs also reduces the amount of waste goods up to a certain point (Thomas, 2003).

In the last few decades, internet-based C2C secondhand markets matching sellers and buyers substantially reduced transaction costs of C2C selling (Einav et al., 2016; Fremstad, 2017; Thomas, 2003). For example, *eBay* or *Craigslist* make it easier for sellers and buyers to find each other (lower search costs) and to communicate (lower time costs). Accordingly, there is empirical evidence that the diffusion of internet access was associated with increased volumes of secondhand car sales (Rapson & Schiraldi, 2013) and *Craigslist* reduced solid waste generation (Fremstad, 2017). Taken together, both conceptual and empirical research highlights the importance of lowering transaction costs to promote secondhand selling.

In addition to transaction costs, opportunity costs also influence decisions to sell used goods. Opportunity costs are typically defined as "(the value of) what is given up in order to

get something else" (Polley, 2015, p.11).[1] With regard to selling used goods, no longer owning sold goods introduces opportunity costs for sellers. For instance, retired smartphones are sometimes used as storage (Martinho, Magalhães, & Pires, 2017) or kept as spare devices (Ylä-Mella, Keiski, & Pongrácz, 2015). After selling a secondhand smartphone, sellers no longer benefit from these purposes and therefore face opportunity costs. While these opportunity costs of forgone benefits of ownership are constant regardless of the chosen selling channel, some selling channels may introduce additional opportunity costs if they yield lower selling prices than others. For example, sellers may ask for a lower price when selling to friends and family rather than strangers. Similarly, C2B selling platforms may offer lower prices than buyers on C2C secondhand markets. In such cases, selling comes with additional opportunity costs of not maximizing the selling price.

2.2. *Theoretical model*

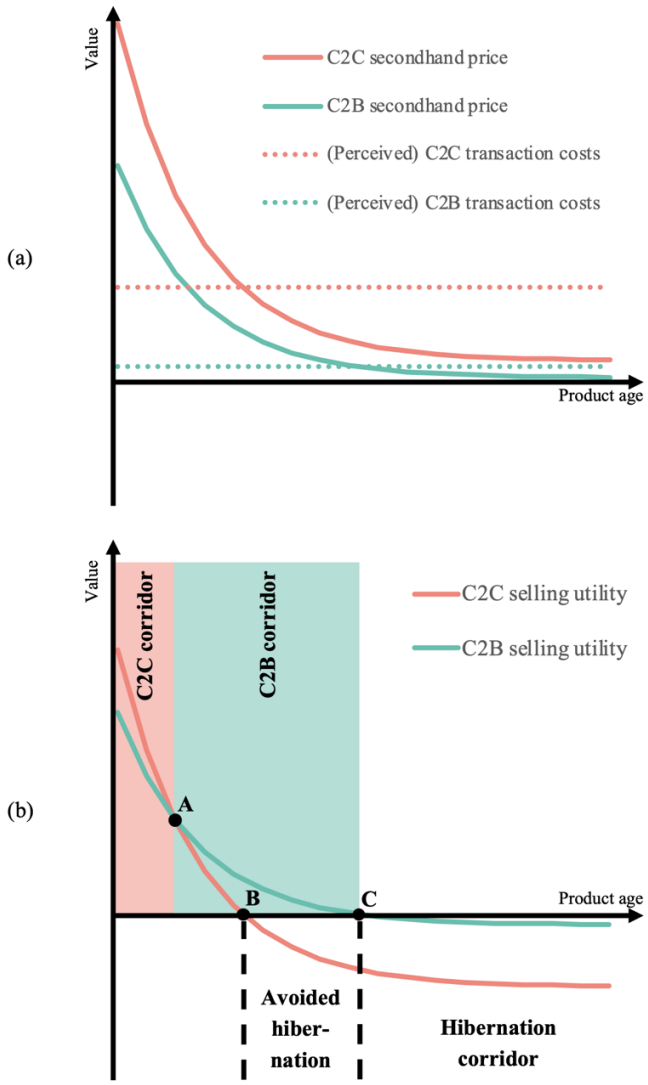
Transaction and opportunity costs of secondhand selling provide the conceptual foundations of this paper's theoretical model on C2C and C2B selling choices. Panel a of Figure 1 presents the model's starting point. The secondhand value of goods is plotted as a function of age. The two solid lines depict the price at which goods can be sold on C2C (red) and C2B (green) secondhand markets. C2B selling platforms aim to cover the costs of running their platform and typically resell repaired or refurbished products and thus face costs of inspecting, repairing, or refurbishing products (by the platform itself or by associated refurbishers). Finally, C2B selling platforms are usually run as commercial businesses that aim to resell goods at a

[1] In the wider economic literature, opportunity costs are sometimes seen as a subcategory of transaction costs. However, the literature on secondhand markets this paper contributes to primarily discusses transaction costs in terms of efforts associated with buying and selling (Fremstad, 2017; Rapson & Schiraldi, 2013; Thomas, 2003; Yokoo, 2010). We follow this logic and contrast transaction costs capturing efforts of selling (e.g., time costs, search costs, bargaining costs) with opportunity costs capturing foregone benefits of not selling or not maximizing the selling price.

profit. Thus, prices offered to sellers by C2B selling platforms are expected to be below C2C secondhand prices. Accordingly, C2B selling is associated with opportunity costs for sellers.

The dotted lines represent sellers' perceived transaction costs of C2C (red) and C2B (green) selling, which are assumed to be constant regardless of product age. A key difference between C2B and C2C selling is that C2B selling platforms usually guarantee to take back goods, offer fixed prices, and arrange shipping. Compared to C2C selling, C2B selling platforms thereby reduce the time and effort needed to find a buyer (search costs), negotiate a price (bargaining costs), and hand over the product (time costs). Thus, C2C transaction costs are expected to be perceived as higher than C2B transaction costs, as reflected by the different levels of the two dotted lines. Notably, we refer to "perceived" transaction costs to consider that the burden of selling is perceived differently by different sellers. For example, some sellers may view the time and effort spent to find buyers and negotiate a price on C2C secondhand markets as a larger burden than others who enjoy haggling and therefore perceive C2C transaction costs to be lower.

Figure 1: Theoretical model on C2C and C2B selling choices



Notes: Axes do not show units as this figure illustrates a theoretical model. This illustration of the theoretical model was compiled based on the assumptions that (1) initial C2C secondhand prices exceed initial C2B secondhand prices, (2) both C2C and C2B secondhand prices decrease by the same constant percentage from one period to the next, (3) C2C secondhand prices approach a residual value > 0 over time, (4) C2B secondhand prices approach 0 over time, and (5) perceived transaction costs associated with C2C selling exceed perceived transaction costs associated with C2B selling.

Panel b of Figure 1 depicts the utilities of C2C and C2B selling as a function of product age. Each selling channel's utility is calculated by subtracting perceived transaction costs from respective secondhand prices. The intersections of both utility curves with each other and with the x-axis define different corridors. We term the corridor between the y-axis and point A the

"*C2C corridor*" because the utility of C2C selling exceeds the utility of C2B selling (i.e., C2C sales are preferred to C2B sales). Points A and C define the "*C2B corridor*" in which the utility of C2B selling is consistently positive and exceeds C2C selling utility. B and C mark the points at which the utility of C2C and C2B selling drop below 0, respectively. The "*hibernation corridor*" starts at point C, after which both selling channels' utilities are negative and goods are no longer sold on secondhand markets. Importantly, without C2B secondhand selling platforms, used goods would only be sold on C2C secondhand markets up to point B. Thus, introducing C2B selling increases the product age up to which the utility of selling is positive from point B to point C, thereby creating the "*avoided hibernation*" section.

This model presents a conceptual response to this paper's research question whether C2B selling platforms increase the size of secondhand markets and promote longer product use phases. Introducing C2B selling platforms as an alternative to C2C selling could increase the size of secondhand markets by facilitating additional product sales in the *avoided hibernation* section as long as transaction costs are sufficiently low to offset opportunity costs. Crucially, this would increase the product age up to which the utility of selling is positive from point B to point C. This way, C2B selling could promote longer product use phases of older goods for which transaction costs of C2C selling are prohibitively high.

2.3. *Hypotheses*

To test this theoretical model empirically, we propose three hypotheses on the model's core assumptions (hypotheses 1 and 2) and its key prediction (hypothesis 3). To begin with, the model relies on the proposition that the choice between C2C and C2B selling is a trade-off between higher perceived transaction costs (of C2C selling) and higher opportunity costs (of C2B selling). Thus, the first two hypotheses state:

Hypothesis 1: *C2B selling is associated with lower perceived transaction costs than C2C selling.*

Hypothesis 2: *Prices offered for secondhand goods by C2B selling platforms are lower than prices offered on C2C secondhand markets.*

Furthermore, the theoretical model expects C2B selling platforms to increase the size of secondhand markets that are limited to C2C selling by facilitating additional sales of older goods in the *avoided hibernation* section, thereby extending product use phases. In particular, the model proposes that relatively new secondhand goods are sold on C2C secondhand markets whereas C2B selling is more popular for older goods. To test this key expected outcome of the model, hypothesis 3 states:

Hypothesis 3: *Secondhand goods sold to C2B selling platforms are older than goods sold on C2C secondhand markets.*

3. Methods

As smartphones are a consumer product with relatively high environmental impacts in the production phase compared to the use phase, reducing unused storage times by promoting recirculation is a key strategy to extend smartphone lifetimes and reduce environmental impacts (Bieser et al., 2022; Glöser-Chahoud et al., 2021). Therefore, this paper empirically examined secondhand smartphone selling to test hypotheses 1–3. In doing so, the following data sources were used: To test hypothesis 1 on perceived transaction costs of C2C and C2B selling, smartphone users were surveyed. By using self-reported data to measure perceived transaction costs, methods reflected that transaction costs associated with different selling channels are expected to vary from one person to the next, as explained in section 2.2. In contrast, actual prices and ages of secondhand smartphones sold on C2C and C2B secondhand markets can be measured more objectively based on observations of listings. Therefore, hypotheses 2 and 3 on prices and ages of secondhand smartphones were tested with data from *eBay* (C2C) and a C2B selling platform active in Germany and Austria. To ensure that survey and *eBay* data were

comparable to available C2B selling data, both datasets were compiled with German samples. This section outlines how datasets were collected and analyzed to test hypotheses.

3.1. *Data collection*

3.1.1. Survey with smartphone users

To elicit perceived transaction costs of C2C and C2B smartphone selling, smartphone users in Germany were surveyed in May and June 2022. Participants were recruited through a market research agency and received a small financial reward for their successful completion of the survey. The recruited sample was representative of smartphone users in Germany in terms of age and gender, based on public data on demographics (Destatis, 2022b) and smartphone ownership (Destatis, 2022a). At the beginning of the survey, respondents were informed about key characteristics of C2C and C2B selling options. Afterward, participants responded to two hypothetical open-ended contingent valuation questions about selling price expectations, similar to hypothetical direct open questions used to study willingness-to-pay (Schmidt & Bijmolt, 2020). The overview of C2C and C2B selling options shown to respondents as well as the two contingent valuation questions are reported in Appendix A.

The first set of questions asked participants for the minimum selling price at which they considered it worthwhile to sell a smartphone through C2C and C2B channels, respectively. Second, participants were asked to imagine a scenario in which a device was expected to yield a certain price on C2C secondhand markets. The presented price was randomly chosen from a numerical sequence between €5 and €500 in intervals of €5. Participants were asked for the minimum price a C2B selling platform needed to offer to be more attractive than the C2C sale at the randomly chosen C2C reference price. Both sets of contingent valuation questions were followed by open-ended questions asking for a brief explanation of reported figures. This survey design allowed us to test hypothesis 1 (C2B selling is associated with lower perceived

transaction costs than C2C selling) by examining whether respondents (1) accepted lower minimum C2B selling prices, (2) quoted lower C2B price demands compared to C2C reference prices, and (3) reported lower transaction costs to explain differences.

3.1.2. C2C and C2B selling data

To compile a dataset of secondhand smartphone prices on C2C secondhand markets, the category "Smartphones" (*eBay* category ID: 9355) of the German *eBay* website was searched for the keywords "iPhone", "Samsung", "Huawei", and "Xiaomi" at least once every other day from July 1, 2022, to December 31, 2022.[2] The four keywords were selected to reflect that more than 80% of smartphone users in Germany used these smartphone brands in 2022 (Statista, 2022). Every time *eBay* listings were searched, the 9,900 most recent listings for each of the four keywords were saved. If fewer than 9,900 listings were found, all listings were recorded.

For each individual listing, the title, condition, listing type (e.g., auction or fixed price), current price, location, and information on whether the listing offered different variations of the same smartphone model were recorded. As the dataset was intended to capture sales of secondhand smartphones by consumers rather than commercial resellers, several data cleaning steps were performed. Multi-variation listings of the same smartphone model were removed from the dataset to exclude commercial resellers who create one listing for multiple devices. In addition, listings with similarly structured titles that were simultaneously sold from the same location were excluded, assuming that these were posted by commercial resellers. Another step to exclude commercial offers was to filter out top-rated listings, which are also typically associated with commercial sellers. Additionally, listings whose titles indicated that the device was broken were removed (e.g., if titles included keywords such as "error", "broken", or "defect") and listings were filtered for used smartphones (rather than refurbished or new devices, using

[2] By searching the category "Smartphones", results were restricted to listings marked as offering smartphone devices rather than other related products (e.g., accessories, replacement parts).

the *eBay* condition display name category "used") and for fixed price offers (rather than auctions, using the *eBay* listing type "fixed price"). Finally, only the last observation of each listing was used as this was most likely to capture the price at which the smartphone was eventually sold. This resulted in 40,110 individual listings capturing C2C secondhand prices of used smartphones.

To determine the age of each listed device, the specific smartphone model was identified by matching the title with a dataset of 38 iPhone, 366 Samsung, 158 Huawei, and 222 Xiaomi device types and their release dates (month and year). Device identification returned a specific device type for 96.5% of all 40,110 listings in the dataset, leaving a final dataset of 38,720 C2C listings that were used to test hypotheses 2 and 3 on price and age differences on C2C and C2B markets.

C2B selling data were extracted from two datasets provided by a C2B selling platform active in Germany and Austria. The first dataset captured daily selling prices the platform offered to sellers from July 1, 2022, to December 31, 2022. As this dataset reflected the prices at which consumers could sell their smartphones to the selling platform, this dataset was used to test hypothesis 2 (price differences on C2C and C2B markets). To reflect that the C2B selling platform's price offers depend on the device condition, the median price was chosen as the relevant reference price for each daily observation.[3] To ensure consistency with C2C data, C2B selling offers were filtered for iPhone, Samsung, Huawei, and Xiaomi devices. Smartphone models and release dates were identified with the same matching method applied to the C2C dataset. All device types could be identified, yielding a final dataset of 78,648 observations from July 1, 2022, to December 31, 2022.

[3] As a robustness check, results were also reproduced using the highest price offers rather than median price offers (see section 4.2).

A second C2B selling dataset recorded each completed resale process of the C2B selling platform from July 1, 2022, to December 31, 2022. In contrast to the first C2B dataset, which captured prices offered to sellers but did not provide any information on the number of devices sold, this second dataset reflected the actual volume of C2B sales by device type. Therefore, this dataset was used to estimate the average age of devices sold to the C2B selling platform and was leveraged to test hypothesis 3 (age differences on C2C and C2B secondhand markets). Once more, the dataset was filtered for iPhone, Samsung, Huawei, and Xiaomi devices and name matching was applied to determine device models and release dates. All devices were successfully identified, yielding records of 2,330 completed resale processes.

3.2. *Statistical analyses*

The hypotheses presented in section 2.3 expected differences between distributions' means (i.e., transaction costs associated with C2C and C2B selling, price and age of devices sold on C2C and C2B markets). Therefore, this paper used *t*-tests to formally test hypotheses 1–3. Furthermore, additional descriptive statistics about subgroups in the surveyed sample of smartphone users are reported as applicable. Finally, the synthesis of results used locally estimated scatterplot smoothing to plot C2C and C2B secondhand prices and C2B price expectations as a function of device age. For each of the three hypotheses outlined in section 2.3, Table 1 lists respective data sources and statistical tests, and sections that report results.

Table 1: Overview of hypotheses, data sources, statistical tests, and results sections

Hypothesis	Data source(s) used	Statistical test	Results
Hypothesis 1: *C2B selling is associated with lower perceived transaction costs than C2C selling.*	• Survey with smartphone users (N_1 = 249, N_2 = 190) (see section 3.1.1)	• Two-sided paired *t*-test • One-sided one-sample *t*-test	Section 4.1
Hypothesis 2: *Prices offered for secondhand goods by C2B selling platforms are lower than prices offered on C2C secondhand markets.*	• Selling prices on C2C market (N = 27,307) • Selling prices offered by C2B selling platform (N = 78,096) (see section 3.1.2)	• One-sided two-sample *t*-test	Section 4.2
Hypothesis 3: *Secondhand goods sold to C2B selling platforms are older than goods sold on C2C secondhand markets.*	• Ages of devices sold on C2C market (N = 27,307) • Ages of devices sold to C2B selling platform (N = 2,330) (see section 3.1.2)	• One-sided two-sample *t*-test	Section 4.3

4. Results

4.1. *Perceived transaction costs of C2C and C2B selling*

Hypothesis 1 proposed that C2B selling is associated with lower perceived transaction costs than C2C selling. To test this hypothesis, we first analyzed the 249 valid survey responses (see Appendix B for sample characteristics) on minimum acceptable C2C and C2B selling prices (first contingent valuation task).[4] The mean minimum acceptable C2B price of €112.1 (*SD*: €151.4) was not significantly different from the mean minimum acceptable C2C price of

[4] Responses were only considered if participants completed the full survey and passed two attention checks included in scales measured after the contingent valuation tasks. Additionally, responses of participants who completed the introduction and contingent valuation tasks in less than two minutes were excluded due to concerns that information was not read properly. Finally, respondents were excluded if they entered random text in the open text fields or if text responses indicated that numbers could not be meaningfully interpreted.

€106.3 (*SD*: €100.7) according to a two-sided paired *t*-test ($p = .42$).[5] Second, C2B price expectations and associated C2C reference prices were compared (second contingent valuation task). A one-sided one-sample *t*-test of the 190 valid responses (see Appendix B for sample characteristics) on differences between C2B price demands and C2C reference prices revealed that expected C2B prices were on average €39.6 (*SD*: €76.3) below offered C2C reference prices at a significance level of $p < .001$.

Table 2 demonstrates that both tasks split the sample into three distinct subgroups, whereby a sizeable proportion of respondents favored C2B selling: 38.2% (task 1) and 72.1% (task 2) indicated a preference for C2B selling by reporting a lower minimum acceptable C2B price (task 1) or because C2B price demands were lower than C2C reference prices (task 2). In contrast, stated minimum prices and price expectations of 21.3% (task 1) and 13.2% (task 2) of respondents signaled a preference for C2C selling. The remaining 40.6% (task 1) and 14.7% (task 2) of respondents indicated that they were indifferent by reporting the same minimum acceptable prices (task 1) and price expectations (task 2). Notably, 54.7% and 27.7% of respondents who indicated a preference for C2B selling in tasks 1 and 2, respectively, explicitly mentioned lower selling efforts (i.e., lower perceived transaction costs) in their written explanations.

Overall, these findings provided partial support of hypothesis 1 that C2B selling is associated with lower perceived transaction costs than C2C selling. Although we did not find that sellers generally accept lower C2B selling prices than C2C selling prices, a sizeable proportion of participants would sell to C2B selling platforms at lower prices than on C2C secondhand markets and associated C2B selling with lower perceived transaction costs than C2C selling.

[5] Contrary to hypothesis 1, the mean minimum acceptable C2B price exceeded the mean minimum acceptable C2C price, thus rendering a one-sided *t*-test obsolete. Instead, a two-sided *t*-test was used to examine whether the difference in means was significant.

Table 2: Preferred selling channels according to reported minimum acceptable selling prices (task 1) and C2B price expectations (task 2)

	Task 1		Task 2	
Preferred selling channel	***n***[a]	**Proportion of sample**	***n***[b]	**Proportion of sample**
C2B selling	95	38.2%	137	72.1%
C2C selling	53	21.3%	25	13.2%
Indifferent	101	40.6%	28	14.7%

Notes. [a] Before analyzing minimum price expectations, respondents' reported reasons for the prices they entered were examined to ensure that all considered responses were valid. Responses of 10 participants (out of the full sample of 259 participants) could not be used because the task was unclear to participants, or they stated that one or both selling options were out of the question for them so figures could not be meaningfully interpreted. Thus, accepted minimum prices were compared based on 249 remaining responses.
[b] To ensure that the second task was independent of the first task, the randomly selected price was not contingent on the minimum acceptable C2C and C2B prices previously stated by respondents in task 1. Thus, it was possible that participants were presented with C2C prices that were below their minimum acceptable C2C prices (e.g., a participant first indicated that C2C smartphone sales for less than €100 would not be pursued in task 1 and was later asked about a situation in which a smartphone could only be sold for €50 on C2C secondhand markets in task 2). As these responses could not be expected to yield plausible assessments of the scenario by participants, these observations (n = 46) were removed. In addition, open text responses of 23 participants indicated that the task was not fully understood. In most cases, comments signaled that entered price expectations related to participants' own smartphones rather than smartphones in the described hypothetical scenario. These observations were also removed, resulting in a final dataset of 190 responses.

4.2. *Opportunity costs of C2B selling*

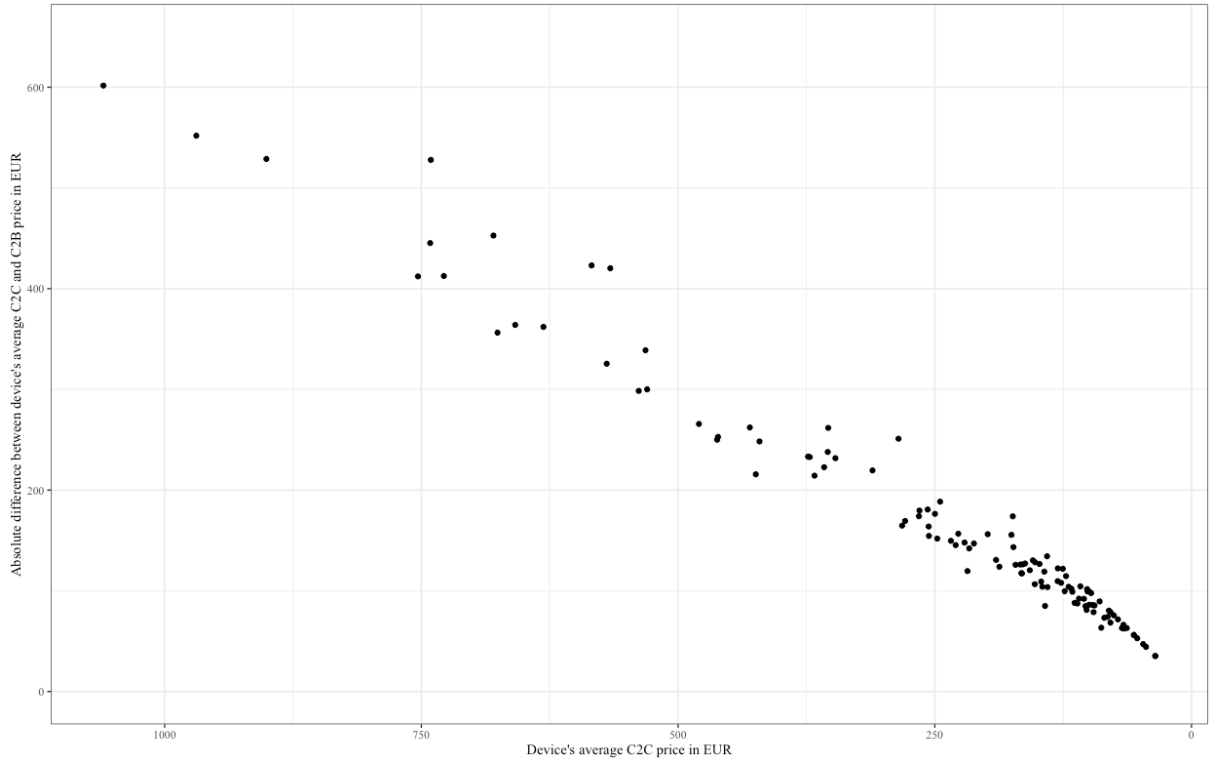
Hypothesis 2 stated that C2B selling is associated with opportunity costs because C2B selling platforms offer lower prices than C2C secondhand markets. To test this hypothesis, C2B prices were compared to C2C prices based on the 116 smartphone types that were observed in both the C2C and the C2B dataset (27,307 observations of C2C listings; 78,096 observations of C2B price offers). With this granular, device-level approach, it was ensured that price comparisons were not skewed by potential differences in the types of devices that were sold on C2C

or C2B secondhand markets. Separate one-sided two-sample *t*-tests for each of the 116 device types demonstrated that C2B prices of all 116 smartphones were significantly below C2C prices at a significance level of $p < .01$ or lower. In relative terms, C2B prices of the 116 smartphone types were at least 50.8% below respective C2C prices (*M*: -76.9%, *SD*: 15.3%).[6] To illustrate this finding, Figure 2 plots absolute price differences of all 116 smartphone types, revealing a homogenous relationship between the absolute price difference of C2B and C2C prices and the average C2C price across the observed price spectrum.[7] Overall, the comparison of C2B and C2C prices confirmed hypothesis 2. Prices offered by the C2B selling platform were consistently lower than prices on C2C secondhand markets.

[6] The main analysis used the median price offered by the C2B selling platform for each smartphone type on each day in the dataset as the relevant C2B price offer. The robustness of the finding that C2B price offers were consistently below C2C prices was tested by using the maximum price offered by the C2B selling platform for each smartphone type on each day (i.e., assuming the best possible product condition). One-sided two-sample *t*-tests confirmed that for all 116 smartphone types, C2B price offers were significantly lower than C2C prices ($p < 0.01$). Even assuming the maximum C2B price, offered C2B prices were at least 35.9% lower than C2C prices (*M*: -68.4%, *SD*: 19.4%).

[7] It should be noted that 7,778 (28.5%) of all 27,307 C2C listings considered in device-level comparisons offered free shipping. In these cases, shipping costs need to be deducted from C2C selling prices to calculate the price sellers receive. However, average C2C prices exceeded average C2B prices by at least €35 (see Figure 2) and observed shipping costs mostly ranged between €4.95 and €6.99. Thus, the finding that C2C prices are significantly higher than C2B prices is not compromised by the fact that some C2C sellers offer free shipping and bear shipping costs themselves.

Figure 2: Comparison of average C2C and C2B secondhand prices in EUR



Notes: For each of the 116 smartphone types considered to test hypothesis 2, this figure plots the average C2C price in Euros (x-axis) and the absolute difference between the device's average C2C and C2B prices in Euros (y-axis). To increase the comparability of this figure with figures 1 and 3 (both plotting age on the x-axis), this figure's x-axis was reverse-scaled, reflecting that prices generally decrease as devices get older.

4.3. *Age of secondhand goods on C2C and C2B markets*

Hypothesis 3 expected devices sold to C2B selling platforms to be older than devices sold on C2C markets. Thus, the device age of C2C listings and the age of devices sold to the C2B selling platform were compared based on the 116 smartphone types that were observed in both datasets (27,307 observations of C2C listings; 2,330 observations of completed C2B sales). A one-sided two-sample *t*-test showed that the mean age of smartphones sold to the C2B selling platform of 55.7 months (*SD*: 21.5 months) was significantly ($p < 0.001$) higher than the mean age of devices sold on C2C markets of 44.7 months (*SD*: 25.3 months). Thus, hypothesis 3

expecting devices sold to C2B selling platforms to be older than devices sold on C2C secondhand markets was confirmed.

4.4. *Synthesis: C2B selling in theory and practice*

Overall, the three hypothesis tests support the theoretical model proposed in section 2.2. However, to evaluate whether C2B selling platforms increase the size of secondhand markets and extend product use phases in practice, a synthesis of results is required. After all, the positive effect of complementing C2C secondhand markets with C2B selling platforms only materializes if the reduction of perceived transaction costs of C2B selling (as demonstrated by partially confirming hypothesis 1) outweighs the opportunity costs introduced by C2B selling (as demonstrated by confirming hypothesis 2).

To examine whether this is the case, actual price levels of C2C and C2B selling and C2B price expectations were compared in Figure 3. First, secondhand smartphone prices on C2C markets and C2B selling platforms were plotted as a function of device age. To ensure that C2C and C2B prices were comparable, observations of C2C smartphone listings were only considered if there was at least one observation of a C2B price offer for the same smartphone type in the same month and vice versa. This resulted in 27,269 observations of C2C listings and 76,656 observations of C2B price offers. Afterward, a stratified sample of C2B price offers was drawn so each device-month combination was represented equally frequently in both datasets.[8] Second, locally estimated scatterplot smoothing (LOESS; span parameter: 0.75) was used to estimate smoothed lines of both selling channels' price levels as a function of device age in months. Finally, individual survey respondents' C2B price expectations were added as individual dots

[8] As some device-month combinations were observed more frequently in the C2C dataset than in the C2B dataset, C2B observations were sampled with replacement.

(blue) and a smoothed line of all C2B price expectations by device age with a 95% confidence interval were included using LOESS (span parameter: 0.75).[9]

Figure 3: C2C prices, C2B prices, and C2B price expectations

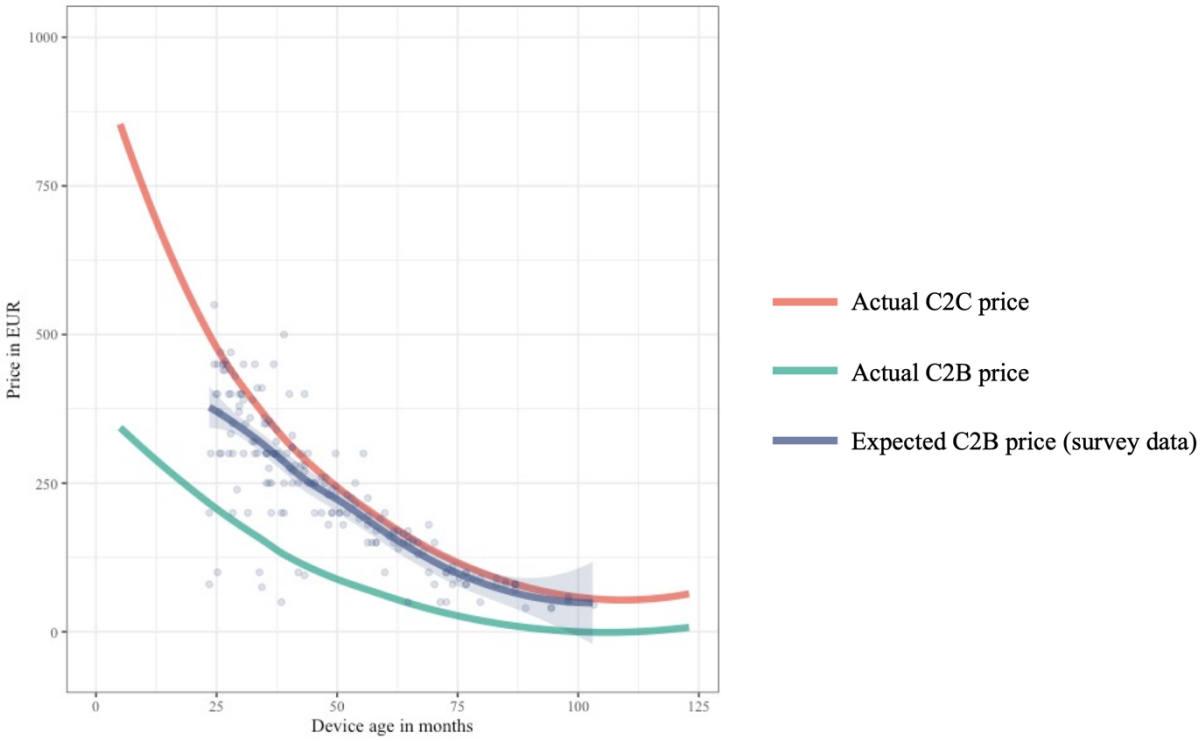


Figure 3 addresses the question whether C2B selling facilitates the redistribution of smartphones that otherwise would not have been resold, and thereby increases the size of secondhand markets. While the line of average C2B price expectations (blue) is consistently below C2C prices (red), C2B price expectations are also consistently above actual C2B prices (green). In fact, as is evident from Figure 3, only a few respondents reported price expectations (blue dots) below the green line of actual C2B prices. Thus, although smartphone users do

[9] Since the survey asked participants for expected C2B price levels based on a C2C reference price, data points were added as a function of the smoothed curve of C2C secondhand prices. For example, if a respondent reported a C2B price expectation in response to a C2C reference price of €250, the x-axis value was determined by the point at which the smoothed curve of C2C prices reaches €250 (about 49 months). Of the 190 valid responses indicating C2B price expectations, six participants were shown a C2C reference price that was below the minimum actual C2C price level plotted in Figure 3. Thus, 184 data points were plotted.

accept lower prices for C2B smartphone sales, most respondents' C2B price expectations exceed actual C2B price offers. In other words, at current price levels, the reduction of perceived transaction costs is not sufficient to make up for the additional opportunity costs of C2B selling for most sellers.[10]

5. Discussion

Taken together, these empirical findings support the theoretical model outlined in section 2.2 in principle but highlight its limitations in practice. On the one hand, a sizeable proportion of consumers accepts receiving lower prices from C2B selling platforms compared to C2C secondhand markets and acknowledges reduced transaction costs as the underlying reason. Furthermore, we demonstrate that goods sold to C2B selling platforms are substantially older than those sold on C2C secondhand markets. This finding is crucial as it demonstrates the potential of C2B selling platforms to prolong product use phases. Especially for older products for which transaction costs of C2C selling are prohibitively high, C2B selling is a promising way to facilitate the recirculation of unused goods and thereby enable the reuse of goods or their parts. However, as shown in relation to hypothesis 2, C2B selling currently requires sellers to accept a substantially lower price compared to C2C selling. Figure 3 demonstrates that only a small minority of the surveyed sample of smartphone users in Germany was ready to accept C2B offerings under these conditions. This highlights that – despite some promising evidence that C2B selling platforms have the potential to facilitate sales of used goods that otherwise would not be sold on C2C secondhand markets – low price levels currently limit the contribution of C2B selling platforms to increasing the size of secondhand markets and extending product use

[10] The robustness of this finding was tested by plotting C2B prices based on the highest rather than the median price offered for each smartphone type on each day. Furthermore, the plot was reproduced using all 78,096 observations rather than a stratified sample of C2B price offerings. Both robustness checks confirmed the result that most survey respondents' C2B price expectations exceed actual C2B prices.

phases at scale. This section discusses these findings' implications for theory and practice and outlines limitations and avenues for future research.

This paper highlights opportunity costs as an additional key influence on selling choices that has not been considered by existing research on secondhand markets, which has primarily focused on the key role of transaction costs in secondhand markets (Fremstad, 2017; Gavazza, Lizzeri, & Roketskiy, 2014; Rapson & Schiraldi, 2013; Thomas, 2003; Yokoo, 2010). Both the decision to sell at all (i.e., foregoing the benefits of product ownership) and the choice of selling channels that yield lower selling prices than others can introduce opportunity costs for sellers. We demonstrate that establishing an additional selling channel that reduces transaction costs while offering lower prices only increases the total size of secondhand markets if the reduction of transaction costs is not offset by opportunity costs arising from lower price levels.

In principle, the theoretical model presented in section 2.2 supports previous research on circular business models highlighting the potential of redistributors to extend product value and slow resource use (Lüdeke-Freund, Gold, & Bocken, 2019; Whalen, 2019) and the sustainability benefits of usage-extending distributors and refurbishing and repair gap-exploiters (Zufall, Norris, Schaltegger, Revellio, & Hansen, 2020). At the same time, empirical evidence of price expectations and actual prices highlights potential limitations, too. Product life extension is only achieved at scale if the benefit of reduced efforts associated with selling is not outweighed by low price offers. This was not the case for most sellers in the context studied by this paper – smartphones in Germany.

The magnitude of differences between C2B and C2C prices and the robustness of findings, even when the highest C2B price offers were assumed (see footnotes 6 and 10), suggests that conclusions extend to C2B selling platforms more broadly. Nevertheless, it should be noted as a limitation of this study that empirical data focused on Germany, and price levels were derived from data of just one C2B selling platform and one internet-based C2C secondhand

market. Therefore, we encourage future research to investigate price levels in different countries and across different C2B selling platforms and C2C secondhand markets.

In addition, future research on secondhand markets could examine whether expected and actual C2B selling prices are more aligned regarding other products, allowing C2B selling platforms to increase the size of secondhand markets and extend product use phases in other domains. From an environmental perspective, C2B selling could be a particularly promising addition to C2C secondhand markets for goods that are easily hoarded and come with high embedded environmental impacts compared to their use phase impacts. In addition to consumer electronics, this also applies to unpowered products like clothes and books. Compared to smartphones, which are relatively standardized products with well-established C2C secondhand markets, it is conceivable that transaction costs for C2C selling of secondhand clothes or books are rather high. In turn, C2B selling platforms could be a particularly promising addition to secondhand markets in these product categories. Thus, exploring whether the findings of this paper extend to these product categories appears as a promising avenue for future research.

In doing so, future research on secondhand markets would benefit from assessments of the environmental impacts of introducing C2B selling options. Beyond this paper's focus on whether C2B selling platforms may increase the size of secondhand markets in principle, the total volume of resold goods, the actual reuse of resold products (or their parts), and the displacement of new products are key issues to consider when assessing whether C2B selling platforms are environmentally beneficial. In this context, C2B selling platforms appear as a particularly intriguing research subject because they typically act as a buyer of secondhand goods, a refurbisher (or facilitator of refurbishment), and a seller of refurbished goods.

For operators of C2B selling platforms, this paper highlights two key strategies to attract sellers: (1) Reducing transaction costs even further compared to C2C selling and (2) limiting opportunity costs by offering higher prices. Transaction costs could be reduced by improving

and streamlining the user experience of selling, which is typically initiated online or in an app. For instance, by allowing users to scan barcodes or enter product serial numbers (e.g., ISBN to sell books to *Momox*), product characteristics can be retrieved automatically without requiring users to enter information manually. Additionally, C2B selling platforms that simultaneously sell repaired and refurbished products could integrate C2B selling into their selling process. Furthermore, offering alternative return mechanisms such as physical return stations or pick-up services could reduce the efforts associated with facilitating the sale even further (Ratay & Mohnen, 2022).

Reducing opportunity costs, that is, increasing prices offered to consumers, may sound like an easier task in theory than in practice. Depending on the magnitude of profit margins, there may be room to decrease profit margins per product, thereby increasing the overall volume of C2B sales and total profit. This could benefit both the business (if absolute profits from operating the C2B selling platform increase) and the environment (by facilitating the additional redistribution of products). In addition, C2B selling platforms could address the costs of inspecting, repairing, and refurbishing products before reselling them, which are largely driven by the time it takes to handle used products and the cost of labor. Although large businesses may be able to benefit from economies of scale, reducing these costs may often be beyond individual businesses' control.

Instead, product-related regulations and tax policies could help to address these issues. For instance, increasing the standardization of products could help to reduce the time required for upskilling and to inspect, repair, and refurbish products – by consumers themselves, by non-profit organizations, or by commercial businesses. As such, product standardization could benefit C2B selling platforms and promote longer product use phases in general. Additionally, tax policies could be used to increase the competitiveness of product life extension activities compared to product replacement. Especially in high-income countries, activities like repairing and

refurbishing are often not economically viable because of the high ratio of labor costs to the cost of virgin materials and resources. Both reduced taxation of circular business activities (e.g., inspecting, repairing, refurbishing) or circular products (e.g., secondhand or repaired goods) as well as increased taxation of virgin materials could help to level this playing field (Hartley, van Santen, & Kirchherr, 2020; Kirchherr et al., 2018; Llorente-González & Vence, 2020; Milios, 2021; Roberts, Milios, Mont, & Dalhammar, 2023; Stahel, 2013). Again, such policies increasing the value of secondhand goods compared to new products would not only support commercial C2B selling platforms but secondhand markets and product life extension more generally, and thereby contribute to the overarching goal to reduce environmental impacts by keeping products in use.

6. Conclusion

Secondhand markets promote product reuse by enabling consumers to sell secondhand goods. As shown by prior research, the size of secondhand markets depends on transaction costs associated with selling, that is, the effort it takes for buyers and sellers to connect and complete a sale (Fremstad, 2017; Gavazza, Lizzeri, & Roketskiy, 2014; Rapson & Schiraldi, 2013; Thomas, 2003; Yokoo, 2010). C2B selling platforms that aim to provide a low-effort option for selling secondhand goods further reduce transaction costs compared to C2C secondhand markets. At the same time, however, C2B selling introduces opportunity costs for sellers because professional C2B selling platforms typically offer lower prices than C2C selling options. This paper presents a theoretical model that demonstrates how the introduction of C2B selling platforms could increase the size of secondhand markets and extend product use phases as long as opportunity costs are offset by sufficiently low transaction costs. Based on survey data and field data of C2C and C2B secondhand markets, this paper examines the example of secondhand smartphone sales and demonstrates the potential as well as current limitations of C2B selling.

On the one hand, a sizeable proportion of consumers is willing to accept lower prices from C2B selling platforms compared to C2C selling, quoting lower efforts (i.e., transaction costs) of C2B selling as a reason. Furthermore, a comparison of C2C smartphone listings and C2B smartphone sales highlights that C2B selling is primarily attractive for older goods. This points toward the potential of C2B selling platforms to increase product use phases by recovering relatively old goods that otherwise would not be redistributed on C2C secondhand markets. On the other hand, a comparison of actual and expected C2B selling prices highlights that comparatively low price levels currently pose a barrier to expanding C2B selling at scale. We demonstrate how these findings support prior research on policy measures to promote the circular economy and encourage future research to investigate the environmental potential of C2B selling with regard to different product categories such as secondhand clothes or books.

Appendices

Appendix A. Introduction of C2C (Option A) and C2B (Option B) selling options and contingent valuation tasks included in the survey.

	Option A: **Private selling online**	**Option B:** **Selling to a professional selling platform online**
Buyer	You advertise your smartphone **on an online marketplace** and **search and determine a buyer** for the smartphone.	You enter information about the model and condition of your smartphone on a **professional selling platform online** and receive an offer for **selling the smartphone to the professional selling platform**.
Price	**You negotiate** the price with the buyer.	You receive a **fixed price** suggestion, which depends on the model and condition of the smartphone.
Hand-over and shipping	**You arrange** the hand-over and delivery of the smartphone with the buyer.	You receive a shipping label and **send in the smartphone by mail**.
Data handling	**You delete your data** before you hand over the smartphone.	**You delete your data** before you send in the smartphone. If any personal data are still stored on the smartphone, the **professional selling platform deletes them**.

Note: The two options were displayed in random order to avoid order effects.

Questions in first contingent valuation task:

- What is the lowest selling price (in Euros) for which the effort of selling a smartphone privately on the internet (option A) is still worthwhile for you?
- What is the lowest selling price (in Euros) for which the effort of selling a smartphone to a professional selling platform online (option B) is still worthwhile for you?

Question in second contingent valuation task: (displayed on a new page)

- A quick search of comparable offers shows that your smartphone in its current condition usually sells for around [*randomly chosen number from 5 to 500*] Euros in private sales online (option A).
  Please indicate the minimum price (in Euros) that a professional selling platform would have to offer you in order for you to accept the selling platform's offer (option B).

Contingent valuation questions listed above asked respondents to enter a number in a text field and were followed by an open text field asking respondents to explain their reported numbers.

Appendix B. Demographic characteristics of surveyed smartphone users

		Respondents who completed task 1	**Respondents who completed task 2**
Gender	Female	125 (50.2%)	96 (50.5%)
	Male	122 (49.0%)	91 (47.9%)
	Non-binary	2 (0.8%)	3 (1.6%)
Age	*M*: *SD*:	46.7 15.7	46.7 15.2
Area of residence	Rural community	52 (20.9%)	35 (18.4%)
	Small city	44 (17.7%)	35 (18.4%)
	Mid-sized city	59 (23.7%)	52 (27.4%)
	Large city	41 (16.5%)	33 (17.4%)
	Major city	53 (21.3%)	35 (18.4%)
Net income	Less than €500	13 (5.2%)	12 (6.3%)
	€501-€1.000	27 (10.8%)	18 (9.5%)
	€1.001-€1.500	21 (8.4%)	15 (7.9%)
	€1.501-€2.000	48 (19.3%)	33 (17.4%)
	€2.001-€3.000	64 (25.7%)	51 (26.8%)
	€3.001-€4.000	39 (15.7%)	33 (17.4%)
	€4.001 or more	22 (8.8%)	15 (7.9%)
	Prefer not to say	15 (6.0%)	13 (6.8%)

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