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Article

# The impact of the external environment on transferring from linear to circular economy with the mediating role of knowledge assimilation

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**Abstract:** Knowledge transfer, assimilation, transformation and exploitation significantly impact performing business activities, developing innovations and moving forward to new business models such as transferring to a circular economy. However, organizations' decisions or willingness to transition to a circular economy are very often also influenced by the external environment. The study aims to determine the influence of the external environment on the transfer from a linear to a circular economy while mediating knowledge assimilation. The quantitative research involved 159 Nordic capital companies operating in Estonia and Lithuania. The survey has been performed by means of the CATI method. The analysis has been done also by applying structural equation modelling (SEM). In order to perform mediation analysis, IBM SPSS and a special PROCESS macro have been used. The study showed that knowledge assimilation partially mediates the relationship between the external environment and the transfer to the circular economy. Hence, the external environment's direct effect is much more significant than the indirect. The added value of the study also consists in extending the concept of circular economy by including some aspects of absorptive capacity and the external environment.

**Keywords:** circular economy; external environment; knowledge assimilation; Nordic countries; SEM

## 1. Introduction

The transition from a linear economy to a circular economy is essential in advancing sustainability and mitigating the environmental impacts of businesses. While this transition poses various challenges, technological advancements offer promising solutions and opportunities for companies to successfully implement circular economy strategies (Marino and Pariso, 2021; Bressanelli et al., 2022). The impact of the external environment on the transition from a linear to a circular economy can be mediated by various determinants (Nielsen and Hakala, 2023) such as technological innovation and knowledge (Aminoff and Pihlajamaa, 2020; Skordoulis et al., 2020; Vartanova et al., 2021). These determinants play an important role in facilitating the adoption and implementation of circular business models, which aim to minimize resource waste and environmental impact. Technological innovation is a key driver in transitioning to a circular economy (Vence and Pereira, 2019). It involves developing and applying new technologies, processes, and systems enabling the efficient use of resources, waste reduction, and the creation of sustainable products and services (Šimelytė et al., 2021). In addition to technological innovation, adopting new knowledge is crucial in facilitating the transition to a circular economy. New knowledge refers to the understanding and the awareness of circular economy principles and the best practices for implementing sustainable business models. Through education, training, and knowledge sharing, companies can enhance their capacity to adopt circular practices and overcome barriers to change (Šimelytė et al., 2021; Šimelyte and Tvaronavičienė, 2022; Holubčík et al., 2022). Moreover, the external environment plays a significant role in shaping the transition to a circular economy. Various researchers analyze interlinkages between the external environment and its role in the transition from linear to a circular economy involving different sectors such as agriculture and rural development (Corral et al., 2022), the automobile industry (James et al., 2023), the food industry (Kazancoglu et al., 2023), the food packaging industry (Nielsen and Hakala, 2023), the industry 4.0 (Ren et al., 2023; Ertz et al., 2022), textile and fashion (Muthu, 2017; Gazzola et al., 2020; Hanuláková et al., 2021), ceramic tiles manufacturing (Garcia-Muiña et al., 2018), the plastics production (Lisiecki et al., 2023), etc. Factors such as government regulations (Lisiecki et al., 2023), market demand, and societal expectations can influence the adoption of circular business models. For instance, supportive government policies and regulations can incentivize companies to embrace circular economy practices by providing financial incentives or setting targets for resource efficiency (Nielsen and Hakala, 2023; Kiškienė, 2009). Additionally, market demand for sustainable products and services can drive companies to adopt circular business models in order to meet consumer expectations and remain competitive. Overall, the impact of the external environment on transferring from a linear to a circular economy is significant (Razminienė et al., 2021; Rezk et al., 2023). It influences the availability of resources, sets the regulatory framework, shapes consumer preferences, and determines market dynamics. Determinants such as organizational culture, leadership support, and employee attitudes towards innovation can influence the adoption and implementation of new technologies and knowledge in a circular economy context. By understanding and addressing these determinants, companies can leverage the benefits of new technology or knowledge adoption to support their transition to a circular economy. Although the number of studies on transfer from linear to circular economy increases, there is still a lack of understanding of how international knowledge transfer, its assimilation, absorption and exploitation may stimulate willingness to transfer from linear to circular economy. Most of the studies focus on the impact of a circular economy in specific business sectors or regions. For example, Nordic countries are among the world's most producing and consuming renewable energy. Still, the transfer into the circular economy as an object of study of the scientific literature focuses more on business model innovation (Pieroni et al., 2021), processes of transfer from linear to circular economy or the impact on the economy. For example, Dukovska-Popovska et al. (2023) explore the supply and demand of recyclable textiles in the Nordic countries. Rönnlund et al. (2014) analyse the innovation-oriented challenges and areas with high growth potential within the Nordic bioeconomy. These studies investigate interlinkages between innovation, the circular economy and some external environmental factors.

Our study emphasizes the cooperation between Nordic-Baltic countries while examining the interlinkages among the external environment, the knowledge assimilation and the transfer from a linear to a circular economy. Furthermore, our research effectively investigates whether the external environment positively affects transferring from a linear to a circular economy in Nordic capital companies operating in Lithuania and Estonia arises. At the same time, knowledge assimilation is a mediating factor. A critical question is whether knowledge assimilation acts only as a direct factor affecting transfer from a linear to a circular economy or whether it also acts indirectly as a mediator.

The present study aims to determine the influence of the external environment on the transfer from a linear to a circular economy while mediating knowledge assimilation. This research can help identify the specific external factors facilitating (or hindering) the adoption of circular economy practices. This additional understanding will contribute to the successful implementation of circular economy practices and will provide insights into the economic impact at the firm level. Overall, the impact of the external environment on transferring from a linear to a circular economy with the mediating role of determinants of the benefits of new technology or knowledge adoption is a critical area of study urgently requiring further investigation.

## 2. Theoretical background

### 2.1. The concept of transfer from linear to circular economy

Current global issues of limited resources, environmental degradation, and economic strain have caused a shift in the general approach to production and consumption (Androniceanu, 2019; Marino and Pariso, 2021; Andryeyeva et al., 2021). The linear economy, which mainly consists in a “take-make-waste” model, has dominated the last decades (Saraiva et al., 2018). The linear model of an industrial economy, characterized by resource use and waste disposal, it generally led to contaminations, pollution, and conflicts for control of supply (Centobelli et al., 2020; Gazzola et al., 2020). In contrast, the circular economy aims to reduce waste and negative externalities on the environment by promoting reuse and recycling (Gazzola et al., 2020). This shift towards a circular economy is driven by the need to reduce the consumption of natural resources and to preserve the environment (Centobelli et al., 2020) since the negative impact on the utilization of natural resources, the behaviour of producers and consumers, waste management processes, the environment and society have become evident (Grigoryan and Borodavkina, 2017; Geissdoerfer et al., 2017; Somogyi and Nagy, 2022; Genys and Pažėraitė, 2022).

Consequently, a transition to a circular economy has emerged as a promising alternative. The circular economy seeks to disconnect economic growth from resource depletion by establishing a closed-loop system maximizing resource efficiency, reducing waste generation, and promoting sustainability (Tseng et al., 2018; De Almeida and Borsato, 2019). While the linear economy operates as an open-ended model, the circular economy represents a distinct approach prioritizing eco-efficiency through systematic optimization. In the linear economy, resources are extracted, processed into products, and disposed of as waste without considering the long-term consequences (Kopnina, 2017). This approach perpetuates resource depletion, waste accumulation, and environmental damage (Nassar and Tvaronavičienė, 2021; EIO, 2013; Naimoglu and Kavaz, 2023). In the circular economy, waste is derived from product consumption and is diligently converted into resources to be later on reintroduced into production to minimize (and ideally eliminate) waste generation by ensuring its transformation into reusable materials. By adopting this approach, the circular economy strives to create a sustainable system maximizing resource utilization and minimizing environmental impact. The concept of "cradle to cradle" (C2C), pertains to a regenerative circular economy that focuses on the continuous cycling of materials in a sustainable manner (Kopnina, 2017). This approach emphasizes the idea that products should be designed from the beginning with the intention of being fully recyclable and able to contribute to creating new products, thus eliminating the concept of waste. The "cradle to cradle" concept promotes a holistic and restorative approach to resource management within the circular economy framework. In this specific regard, the circular material use rate in the European Union increased from 2010 to 2021 by +0.9%, which might apparently appear to be only a "little" rise. This conclusion is only partially true, because there are numerous other countries having recorded a "jump" in their circular material use rate exceeding the average increase in the European Union. Interestingly enough, Estonia (i.e., one of the countries representing the object of our analysis) has according to Eurostat (2023) recorded an increase by +6.3% reaching a circular material use rate of 15.1%, a level surpassing by far that of the European Union (11.7%) in 2021 (**Table 1**).

The primary objective of transitioning to a circular economy is to mitigate the negative consequences associated with the production and consumption process (Gardiner and Hajek, 2020). Instead, the focus shifts towards amplifying the system's positive impact through innovative approaches that address existing issues and drive systemic change. In the realm of business, environment and resource efficiency concerned, innovations refer to the development, implementation, or utilization of anything new in terms of products or services, production processes, organizational structure, management, or other business practices bringing social or economic benefit (Esposito et al., 2015; Ferrante and Germani, 2020). This novelty is unique to organizations or users and, throughout its entire lifecycle, aims to reduce environmental risks, damages, pollution, and negative impacts on resource usage (Domenech and Bahn-Walkowiak, 2019). Due to different theoretical assumptions and contexts, it is important to note that the factors influencing innovation activities differ from those driving general innovation (Carrillo-Hermosilla et al., 2010). Recent studies on innovation, specifically eco-innovation, have identified external and internal barriers hindering its adoption in firms (Jakobsen and Clausen 2014; Levický et al., 2022). Additionally, a firm's motivation to embrace innovation practices is influenced by its knowledge and experience, which can be transferred from the external environment. Critical drivers of eco-innovation include technology, regulations, and the market.

**Table 1.** Circular material use rate in the European Union (2010–2021).

| | 2010 | 2015 | 2021 | In-/decrease |
|---|---|---|---|---|
| Austria | 6.6% | 10.7% | 12.3% | +5.7% |
| Belgium | 13% | 17.7% | 20.5% | +7.5% |
| Bulgaria | 2.1% | 3.1% | 4.9% | +2.8% |
| Croatia | 1.6% | 4.6% | 5.7% | +4.1% |
| Cyprus | 2% | 2.4% | 2.8% | +0.8% |
| Czechia | 5.3% | 6.9% | 11.4% | +6.1% |
| Denmark | 8% | 8.3% | 7.8% | −0.2% |
| Estonia | 8.8% | 11.3% | 15.1% | +6.3% |
| European Union—27 countries (from 2020) | 10.8% | 11.3% | 11.7% | +0.9% |
| Finland | 13.5% | 6.4% | 2% | −11.5% |
| France | 17.5% | 18.7% | 19.8% | +2.3% |
| Germany | 11.4% | 12% | 12.7% | +1.3% |
| Greece | 2.7% | 1.9% | 3.4% | +0.7% |
| Hungary | 5.3% | 5.8% | 6.8% | +1.5% |
| Ireland | 1.7% | 1.9% | 2% | +0.3% |
| Italy | 11.5% | 17.2% | 18.4% | +6.9% |
| Latvia | 1.2% | 5.3% | 6.2% | +5% |
| Lithuania | 3.9% | 4.1% | 4% | +0.1% |
| Luxembourg | 24.1% | 9.7% | 3.8% | −20.3% |
| Malta | 5.3% | 4.6% | 11.4% | +6.1% |
| Netherlands | 25.3% | 25.8% | 33.8% | +8.5% |
| Poland | 10.8% | 11.6% | 9.1% | +1.7% |
| Portugal | 1.8% | 2.1% | 2.5% | +0.7% |
| Romania | 3.5% | 1.7% | 1.4% | −2.1% |
| Slovenia | 5.9% | 8.6% | 11% | +5.1% |
| Slovakia | 5.1% | 5.1% | 8.3% | +3.2% |
| Spain | 10.4% | 7.5% | 8% | −2.4% |
| Sweden | 7.2% | 6.7% | 6.6% | −0.6% |

## 2.2. External environment and enablers for the transition from the linear to the circular economy

Various external factors—Among others, the impact of the external environment—Influence the transition from a linear to a circular economy. One crucial enabler is using digital technologies, such as artificial intelligence, machine learning, the Internet of Things, Big Data, Blockchain, Robotics, and 3D technologies (Hoosain et al., 2020). These technologies have been implemented in different sectors and countries to support the transition towards a circular economy. They enable the flow of materials, components, and products while adding financial value and sustainability (Hoosain et al., 2020).

Additionally, digital tools and techniques such as life cycle costing, life cycle impact assessment, materials passports, and circularity measurements have facilitated the transition. Nature-based solutions (NBS) are also crucial in transitioning to a circular economy, especially in urban areas (Atanasova et al., 2021). Furthermore, regulatory frameworks and policies are essential enablers for the transition to a circular economy. The European Union, for example, has taken significant steps in shaping circularity as a driver measure across multiple sectors (Zarbà et al., 2021; Zecca et al., 2023). The Circular Economy Package of Directives is one of such initiatives promoting circularity and sustainability. These regulations provide a framework for businesses and industries to adopt circular practices and contribute to the transition from linear production systems to a more sustainable circular model (Zarbà et al., 2021). In addition to enablers, some barriers must be addressed in transitioning to a circular economy. These barriers include material properties and product characteristics, suitable processing technology availability, linear management's environmental impacts, organizational context, industry and supply chain issues, external drivers, public perception, regulatory framework, and economic viability (Dieckmann et al., 2020). Overcoming these barriers requires a clear positive business case, because economic viability is fundamental to any business' transition from linear to circular (Dieckmann et al., 2020). For example, Hassan et al. (2023) claim that—in order to stimulate companies' willingness to transfer into the circular economy—some policies that facilitate uniform usage and recycling of goods (or materials) are necessary. Another study of Bretschger and Valente (2023) substantially agrees with Hassan et al. (2023) and emphasizes the importance of external effects, which encourage companies to move to circular economy. Thus, an appropriate environmental policy mix and international environmental agreements may promote this transfer. Overall, various external factors and enablers influence the transition from a linear to a circular economy, including digital technologies, nature-based solutions, regulatory frameworks, and economic viability. By leveraging these enablers and addressing the existing barriers, businesses, industries, and cities can successfully transition towards a more sustainable and circular resource management model. The understanding of the impact of the external environment will contribute to the successful implementation of circular economy practices and provide insights into the economic impact at the firm level. Overall, the impact of the external environment on moving from a linear to a circular economy with the mediating role of determinants of knowledge assimilation is a critical area of study, which necessarily requires investigation.

It is also crucial to consider the external factors, which facilitate or hinder the adoption of circular economy practices. In fact, these factors can greatly influence the success of transitioning from a linear to a circular economy. Some external factors that impact the transition to a circular economy include technological advancements, government policies and regulations, socio-cultural norms and consumer behaviour, economic incentives and disincentives, and industry trends (Ntshangase et al., 2023).

## 2.3. Theory of absorptive capacity

In addition to external factors, the new technology or knowledge assimilation, absorption and transfer may mediate the transition to a circular economy. Knowledge transfer is significant in designing business models aligning with the principles of the circular economy (Centobelli et al., 2020). Companies must develop new value networks, establish relationships with supply chain partners, and offer value propositions promoting sustainable development and resource conservation (Mazzoni, 2020). However, adopting new technologies or knowledge practices and business models may be also influenced by factors such as the company size and the access to financing (Rodríguez-Rebés and Navıo-Marco, 2021). Larger companies may have a greater predisposition to adopt environmental objectives while smaller companies with limited access to funding may be less likely to adopt eco-innovation measures (Rodríguez-Rebés and Navıo-Marco, 2021). Research and innovation are essential in unravelling the links between sustainability, resilience, and a closed-loop system with zero negative environmental impact (Adelodun et al., 2021; Antonioli et al., 2022).

Overall, the transition from a linear to a circular economy is influenced by external factors such as the impact on the external environment, the integration of Industry 4.0 technologies, and the mediating role of the benefits of innovation. These factors shape the strategies and practices adopted by companies and industries as they strive to reduce waste, conserve resources, and promote sustainability in their operations. The successful implementation of circular economy practices requires exchanging and disseminating knowledge and innovation among different stakeholders in the value chain (Rizos et al., 2016). However, several barriers hinder the transfer of knowledge and the development of circular economy business models. One barrier is companies' confidential guarding of information, which prevents the broader dissemination of knowledge (Rizos et al., 2016). Additionally, people may find it difficult to communicate their expertise, which in turn further hinders the dissemination and development of circular economy business models. Furthermore, the limited application of new circular business models and the lack of successful paradigms contribute to the existing uncertainty in introducing circular practices.

Knowledge assimilation involves acquiring, integrating, and applying new knowledge (Alkhazali et al., 2021). It enables organizations to effectively utilize external enablers such as total quality management (TQM) and knowledge management (KM) to enhance their organizational sustainability (OS) in the context of a circular economy. TQM and KM facilitate knowledge-related collaboration among stakeholders and continuous improvement in business processes, which are essential for a circular flow of manufacturing processes. KM, in particular, has a significant role in circular value creation and improving ecosystems (Rezk et al., 2022). In an environment made of small and medium-sized enterprises (SMEs), there are specific barriers and enablers to implementing circular economy business models. SMEs face challenges such as lack of financial resources and technical skills (Rizos et al., 2016). However, there are also enabling factors that help SMEs adopt circular economy practices. These include policy instruments supporting the incorporation of circular economy principles into SMEs' business models and the creation of dedicated marketplaces and communities of practice. Furthermore, transitioning to a circular economy requires changing consumers' lifestyles and behaviour. However, some consumers may perceive circular economy practices as costly and hard-to-implement alternatives without tangible benefits. The public response to circular economy practices largely depends on social norms and external conditions. In sum, knowledge assimilation is crucial as a mediator between external enablers and the transfer to a circular economy. It allows to overcome barriers to knowledge dissemination and the development of circular economy business models. SMEs face specific barriers and enablers in implementing circular economy practices, and consumer behaviour and social norms also influence the transition to a circular economy. Policy instruments, dedicated marketplaces, and communities of practice can support SMEs' adoption of circular economy principles. Moreover, Skordoulis et al. (2020) identify a relationship between environmental innovation, organizational sustainability, and circular economies. In the context of affordable housing projects, Adabre and Chan (2020) propose a sustainability assessment model that can objectively and comprehensively assess sustainability performance. This model can serve as a tool to mediate the transfer from a linear to a circular economy in the housing sector. Obeidat et al. (2022) explore the integration of green human resource management and the circular economy in the Qatari service sector finding that such integration can enhance sustainable performance. This suggests that the circular economy can mediate the relationship between green human resource management practices and sustainable performance in the service sector. Naveed et al. (2019) discuss the coupling of digitalization and the bioeconomy ultimately leading towards a digitalized bioeconomy able to satisfy people's eco-conscious preferences. This coupling can mediate the transition from a traditional fossil economy to a circular economy. Piccinetti et al. (2023) also tackle the current state of affairs and the challenges of developing a circular bioeconomy in Egypt. The authors recommend focusing on the bioeconomy as a societal value and regret that—despite numerous initiatives—there is currently no concrete strategy for developing a bioeconomy. In this specific regard, Yin et al. (2022) propose to construct and structurally analyse an inter-regional industrial circular network. They use indicators such as network, cycle, and inter-regional circulation effects to measure the structural characteristics of the network. This analysis can mediate the understanding of how economic circulation is hindered and development imbalances occur, which can contribute to strategies for transitioning to a circular economy. Centobelli et al. (2020) emphasize the need for a systemic perspective in designing business models in the circular economy. They argue that circular business models require companies to adopt a systemic perspective for managerial practices implementation. Precisely this systemic perspective can mediate the transfer from a linear to a circular economy by considering all value dimensions and establishing a higher number of relationships along the value chain. Morrow and Davies (2021) discuss the environmental injustice of the current linear waste economy and the potential benefits of shifting to a circular economy. They argue that the materialities of waste such as waste infrastructure and pollutants can be understood through the lens of materiality. This understanding of materiality can mediate the transition to a circular economy by addressing environmental injustices and promoting sustainable waste management practices. Ofori and Mensah (2021) highlight the waste management hierarchy as an integral circular economy paradigm. They argue that the circular economy decouples economic activities from negative environmental externalities. But precisely this decoupling can mediate the transfer from a linear to a circular economy by promoting sustainable electronic waste management practices. Furthermore, Xu et al. (2021) prove that investment in R&D and protection of intellectual property positively mediate regulation of governmental subsidy and enterprise performance. Thus, in the case analysed by them. investment in R&D creates knowledge assimilation, exploitation and adaption role.

In sum, the mediating role of knowledge assimilation between the external environment and the transfer from a linear to a circular economy can be explored in various sectors and contexts including agriculture, rural development, organizational sustainability, affordable housing, green human resource management, digitalization, inter-regional industrial networks, business models, waste management, and electronic waste management. These perspectives provide insights into how the circular economy can mediate the transition towards sustainability and can address environmental challenges. Despite the ongoing debate, there urgently needs to be more (and better) conceptualization on what indicators affect transfer from a linear to a circular economy and how many factors affect it. The present study aims precisely at determining the external environment's influence on the transfer from a linear to a circular economy work while mediating knowledge assimilation. In this specific regard, we formulate the following three different hypotheses (H1, H2 and H3):

- H1: The external environment has a positive, direct impact on knowledge assimilation.
- H2: Assimilation of new technologies or knowledge mediates the relationship between the external environment and the transfer from a linear to a circular economy.
- H3: The external environment directly affects the transfer from linear to circular economy.

## 3. Methodology, data and procedure

### 3.1. Research construct and factors definition

The structure of the questionnaire is based on previous studies of Flor et al. (2018), Agusti et al. (2022), Shakina and Barajas (2020), Cloodt et al. (2006), Holmström-Lind et al. (2022). The primary data for the empirical research has been collected by means of a quantitative survey in Lithuania and Estonia. The first part of the questionnaire was devoted to find out whether a networking or partnership between targeted companies and Northern European countries exists. This short part served to determine the type of collaboration (trade, FDI, R&D, training, product development, or outsourcing). A further question was devoted to indicate the origin of capital of the partnering company. The fourth question was asked to determine the partner's main activities (local private company, university, research centre, university, cluster, technology centre, laboratory, or other public institution). If the respondent answered the first question with NO, the interview was done. The second part of the questionnaire included 10 statements to evaluate the innovativeness of the company. The aim of this section was to observe whether company describes itself as innovator and what kind of innovations it has developed and implemented. Further, the first construct was to measure the impact of external factors in transferring technology and knowledge to partner companies and included 11 items. The statements representing the importance of the external environment were among others the following: "business investment in research", "foreign direct investments", "potential of intellectual capital", "number of young researchers", "high technology export and/or import”, “competences of a foreign partner in the development of innovations”, “state support for cluster development”, “state financial support for the transfer/assimilation of new technologies or knowledge”, “cooperation between research institutions and business”, “cultural and historical similarities between host and the transferring countries”, “geographical distance between technology and knowledge transfer and the host company”. For evaluating the usefulness of assimilation and new technologies or of knowledge that companies gain after managing to absorb and exploit it for own needs—Later on we will use the term “usefulness of knowledge assimilation”—We included the following statements corresponding to 11 items: “Increased efficiency and productivity”, “optimized processes”, “indirectly stimulated the supply of goods”, “indirectly stimulated the demand of goods”, “new knowledge drives further innovation”, “staff development”, “meeting the increased needs of consumers”, “improved organizational management (e.g., optimized structure, installed CRM, other software)”, “new products or patents developed”, “carrying out research in the company”. Further, we estimated the importance of factors affecting the transfer from a linear to a circular economy. In the questionnaire we included 9 items: “availability to use renewable energy sources, biological or potentially recyclable materials”, “extending the use of the product by repair, refurbishment and resale”, “participation in knowledge dissemination networks”, “technological innovation through digitization”, “advising on the application of new knowledge in digital technology management”, “exchange of knowledge and good practice”, “development of new production processes”, “use of secondary raw materials”, “application of reverse logistics”. The research used a five-point Likert’s scale where 1 meant “not important” and 5 meant “very important. The higher the score, the greatest importance of the factor is.

Furthermore, the research process includes survey conducting. Later the data has been checked whether it was acceptable for further calculations by applying Kaiser-Meyer-Olkin Measure of Sampling Adequacy test (KMO) and Bartlett’s Test of Sphericity. The construct has been validated by confirmatory factor analysis. In order to evaluate the model fit, we have performed several tests. Numerous indices of fit are provided in the literature (Alhija, 2020; Woods and Edwards, 2011) and researchers are advised to apply several of them when evaluating model fit. Among the most used are $\chi^2$ goodness-of-fit statistics. The normed fit index (NFI), comparative fit index (CFI), incremental fit index (IFI), Tucker-Lewis incremental fit index (TLI), and the root mean square error of approximation (RMSEA) are commonly used. Normed Fit Index, an NFI of 0.95, indicates the model of interest improves the fit by 95% (also called the Tucker Lewis index; TLI) and is preferable for smaller samples. The acceptable value is more than 0.90 while the Comparative Fit Index (CFI) is a revised form of NFI which is not very sensitive to sample size. It compares the fit of a target model to the fit of an independent, or null, model. Acceptable results should be more than 0.96 (Hu and Bentler, 1999) or 0.90. Further, IFI has been used to adjust the NFI for sample size and degrees of freedom (Bollen, 1989). The value of over than 0.90 is a good fit, but the index can exceed 1 as well. RMSEA is a parsimony-adjusted index. For the representing good fit, the result should be closer to 0. It should not reach 0.08. After evaluating the model fit, we performed a mediator analysis. In our case, the external environment (EE) is an independent variable which affects the transfer form from linear to circular economy (TC), because the external environment affects knowledge assimilation and knowledge assimilation in turn affects the transfer form linear to circular economy. The first stage of the mediator analysis is to indicate the interlinkages between the predictor and the mediator. Furthermore, we estimated the direct and indirect effect between EE and TC.

### 3.2. Sample and data collection

The survey was conducted in January 2022 by means of the CATI (computer assisted telephone interview) method, a survey conducted by a professional surveyor. He or she conducts a telephone conversation with the respondent based on prepared questions and records the answers in a questionnaire. Modern software allows to ensure the high quality of collected data and monitor surveys in real time. Meanwhile, the special software used works in such a way that the computer is programmed to automatically dial random phone numbers from a generated list. Depending on the application's specifications, the computer can determine if a real (live) person answered (not a recording or an answering machine) and connect/place the call to a free telephone pollster. The survey has been conducted by the survey company RAIT which has been using our developed questionnaire. The targeted respondents were CEO of Nordic capital companies operating in Estonia and Lithuania. The lists of targeted companies were received from Invest Lithuania and the Nordic Chamber of Commerce in Estonia and they included the company's title, address, contact phone number, origin of the capital, industry, number of employees, age and turnover. Despite the industry or size of the company, every company faces sustainable and socially responsible business challenges. Thus, companies switch their linear business models to that of the circular economy. However, these processes are often led by innovation influenced by the external environment. Thus, we included small, medium size and large corporations in our targeted list. After carefully filtering companies, the list contained 670 companies operating in Estonia and 446 in Lithuania. The responsiveness rate was 14% corresponding to 159 companies. Our research targets specific business companies and, thus, the results are statistically significant in relation to how the survey population has been composed based on the origin of the capital, the size and the sectors. The responsiveness rate is also in line with the previous studies of Lau and Lo (2015), Agusti et al. (2022) while most Nordic capital companies operating in the Baltics states are small and medium size (60%). Meanwhile, large companies hardly made 9%.

Depending on the business sector, almost half of the Nordic capital companies are operating in various manufacturing sectors, 9% are involved in commercial and trade activities, and business consultation companies make up for 6%. In contrast, three sectors (IT and telecommunication, logistics and transportation, and engineering design) accounted each of them for 8%. Although Scandinavian banks dominate the Baltic states, only 3% of all companies having participated in the survey were from the financial sector. The average turnover of the companies included in the sample is 12.5 mil. Euros, while the median is 2.5 mil. Euros and the mode of the turnover is 1.5 mil euros. The companies' age in the survey varied from 3 to 32 years. Moreover, 40% of all companies having participated in the survey originated from Finland, 27% from

Sweden and 19% from Norway. Iceland barely made up for 1%. 43% of the companies pointed out that they employ a high number of skilled employees. From 61% to 100% of employees hold at least a bachelor's degree, which allows us to assume that companies may hold a high level of potential absorptive capacity. In 9% of companies, 41% to 60% of all employees have at least a bachelor's degree, although only 32% of respondents stated that 20% (or even less) of their staff members hold at least a bachelor's degree.

## 4. Research results

### 4.1. Validity of the construct

To check whether the data structure is acceptable for further calculations, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy test (KMO) and Bartlett's Test of Sphericity were applied. The KMO indicated the proportion of variance in variables potentially caused by underlying factors. High values, closer to 1, indicate that factor analysis might be used for this data. A value lower than 0.5 shows that factor analysis is not an appropriate tool (Kaiser, 1970). SPSS Amos was used to perform confirmatory factor analysis. For further research, we excluded NKA 9 with a standardized loading value 0.412 and EE2 with a loading of 0.390. All standardized loadings of the third construct items have satisfied the condition of greater value than 0.5. Thus, for further research, we use all 9 items. The value of KMO varied from 0.74 (knowledge assimilation) to 0.842 (external environment). Thus, it showed that available data are suitable for factor analysis. Meanwhile, Bartlett's Test of Sphericity has confirmed the results of KMO. The average variance extracted (AVE) varied from 0.502 to 0.696 with a threshold of 0.5. However, estimated composite reliability (CR) was in the range of 0.896 to 0.922, which showed a very good result as it was supposed to be not lower than 0.7 (Hair et al., 1998) (**Table 2**).

Statistical analysis shows that all three models fit well and confirm the usefulness of new technologies or knowledge assimilation (NFI = 6.05; IFI = 0.924; TLI = 0.905, CFI = 0.938; TLI = 0.88 and RMSEA = 0.044), external environment (NFI = 8.17; IFI = 0.968; TLI = 0.915, CFI = 0.902; TLI = 0.920 and RMSEA = 0.03) and transfer from linear to circular economy (NFI = 7.89; IFI = 0.942; TLI = 0.919, CFI = 0.947; TLI = 0.914 and RMSEA = 0.039) Incremental fit index (IFI) is >0.9, comparative fit index (CFI) >0.9, and root-mean-square error of approximation (RMSEA) <0.1 (Byrne, 2002). The results of the confirmatory analysis suggested that the constructs are suitable for further studies.

**Table 2.** Confirmatory factor analysis results.

| Constructs/items | Standardized loadings |
|---|---|
| The usefulness of new technologies or knowledge assimilation KMO 0.74, Barlett Chi-srq = 456.8, df = 55, sig. < 0.001, AVE = 0.502, CR = 0.910. | |
| NKA1 | 0.549 |
| NKA2 | 0.761 |
| NKA3 | 0.918 |

**Table 2.** (*Continued*).

| Constructs/items | Standardized loadings |
|---|---|
| NKA4 | 0.850 |
| NKA5 | 0.617 |
| NKA6 | 0.798 |
| NKA7 | 0.527 |
| NKA8 | 0.673 |
| NKA9 | 0.412 |
| NKA10 | 0.736 |
| NKA11 | 0.713 |
| External environment KMO 0.842, Barlett Chi-srq = 542.9, df = 55, sig. < 0.001<br>AVE = 0.544, CR = 0.922. | |
| EE1 | 0.804 |
| EE2 | **0.390** |
| EE3 | 0.771 |
| EE4 | 0.696 |
| EE5 | 0.658 |
| EE6 | 0.822 |
| EE7 | 0.693 |
| EE8 | 0.638 |
| EE9 | 0.714 |
| EE10 | 0.796 |
| EE11 | 0.758 |
| Transfer from linear to circular economy KMO = 0.808, Barlett Chi-srq = 404.5, df = 55, sig. < 0.001<br>AVE = 0.696, CR = 0.896 | |
| TC1 | 0.730 |
| TC2 | 0.778 |
| TC3 | 0.527 |
| TC4 | 0.817 |
| TC5 | 0.697 |
| TC6 | 0.698 |
| TC7 | 0.560 |
| TC8 | 0.772 |
| TC9 | 0.687 |

## 4.2. Scale reliability, descriptive statistics and correlations

Cronbach’s Alpha tested the scale reliability of all constructs used for data analysis. The test has proved that data were suitable for further research. The values fluctuated from 0.809 (transfer to the circular economy) to 0.881 (external environment). Thus, it satisfied the minimum requirement of Cronbach Alpha—0.7 (Kline, 1998). In our research, the value of Cronbach’s Alpha of the usefulness of knowledge assimilation (0.824). Thus, it indicated good reliability of data (**Table 3**).

**Table 3.** Reliabilities, means, standard deviations and correlations.

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| | Reliability | 0.809 | 0.881 | 0.824 |
| | Mean | 3.98 | 3.55 | 3.98 |
| | Std. deviation | 5.98 | 8.66 | 6.37 |
| | Min | 3.43 | 2.98 | 2.98 |
| | Max | 4.41 | 4.12 | 4.66 |
| 1 | Transfer to circular economy (9 items) | 1 | - | - |
| 2 | External environment (11 items) | 0.595 | 1 | - |
| 3 | Knowledge assimilation (11 items) | 0.437 | 0.594 | 1 |

After comparing the scale of transfer to the circular economy, external environment and usefulness of knowledge assimilation, it has been noticed that the mean is above the average. The results showed that the transfer to a circular economy ($r$ = 0.437) and the external environment ($r$ = 0.594) positively correlate with the mediator usefulness of knowledge assimilation. This implies some relationship between the mediator and that it transfers to the circular economy and to the external environment. Thus, aggregating them into a mediator model might be reasonable. All correlations are significant at the level 0.05.

## 4.3. Mediator analysis

Mediation or indirect effects occur if the causal effect of an independent variable ($X$) on a dependent variable ($Y$) is transmitted by a mediator ($M$). In other words, $X$ affects $Y$ because $X$ affects $M$, and $M$ in turn affects $Y$. The external environment is a predictor suitable for predicting the transfer from a linear to a circular economy and the assimilation of knowledge as a mediator. Our research expected that the external environment affects the transfer from a linear to a circular economy precisely because the external environment affects knowledge assimilation. The mediator analysis has been performed in a step-by-step order. The results of the linear regression are provided in **Table 4**.

**Table 4.** Mediation analysis.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model EE ≥ NKA** | | | | | | | | | |
| $R^2$ | F | Constant | | | | Coefficients | | | |
| | | value | | *t* | | Unstandardized B | stan | *t* | |
| 0.33 | 71.091 | 26.95 | | 13.065 | | 0.437 | 0.556 | 8.4413 | |
| **EE+NKA ≥ TC** | | | | | | | | | |
| $R^2$ | F | Constant | | EE coefficients | | | NKA coefficients | | |
| | | Value | *t* | unds | Stan | *t* | unds | Stan | *t* |
| 0.362 | 44.025 | 14.55 | 6.1566 | 0.326 | 0.501 | 6.5910 | 0.1172 | 0.1430 | 1.484 |
| **EE ≥ TC** | | | | | | | | | |
| $R^2$ | F | Constant | | | | Coefficients | | | |
| | | Value | | *t* | | Unstandardized B | stna | *t* | |
| 0.348 | 83.344 | 17.709 | | 10.7598 | | 0.377 | 0.591 | 9.123 | |

The first step consisted in indicating the interlinkages between the predictor and the mediator. A statistically significant ($p < 0.001$) positive relationship has been determined between the external environment and knowledge assimilation confirming our first hypothesis. The linear relationship is only $R^2 = 0.33$ which is above 0.2. Thus, in the next step, we ran multiple regression analyses where the predictor and mediator were taken as independent variables to predict the outcome. In this case, the external environment and the knowledge assimilation might explain the transfer from a linear to a circular economy. The analysis revealed that the external environment and the knowledge assimilation are sufficiently good predictors of dimension as linear relationships varied from $R^2 = 0.348$ to $R^2 = 0.362$. The greatest $R^2$ is obtained when the linear relationship between predictors and the full construct has been estimated. Further, standardized coefficients indicated a positive relationship between mediator knowledge assimilation and the transfer from a linear to a circular economy $\beta = 0.1430$ ($t = 1.484$, $p < 0.001$). The standardized coefficients of the second independent variable "external environment" and "transfer from linear to circular economy" were also positive with $\beta = 0.51$ ($t = 6.5910$, $p < 0.001$).

The next step consisted in estimating the direct effect between the predictor (i.e., the external environment) and the transfer from a linear to a circular economy. The analysis revealed that results were significant at $p < 0.001$ and confirmed that the external environment directly affects the transfer from a linear to a circular economy. The level of confidence for all confidence intervals corresponded to 95%. The number of bootstrap samples for percentile bootstrap confidence intervals is 5000. Further, the results indicated a significant indirect effect of the external environment on the transfer from a linear to a circular economy B = 0.08, BaCI [0.0182; 0.190] with the total effect of B = 0.3772 through knowledge assimilation. As both the direct and indirect impact of the external environment are significant, we can state that the partially mediating effect of the knowledge assimilation of the external environment on the transfer from a linear to a circular economy actually exists. However, the direct mediating effect (86.4%) of knowledge assimilation of the external environment on the transfer from a linear to a circular economy is greater when compared to the indirect effect (13.56%) (**Table 5**).

**Table 5.** Mediation effect.

| | **Effect** | **SE** | ***t*** | ***p*** | **Percentage** | **Hypothesis** |
|---|---|---|---|---|---|---|
| Total effect EE ≥ TC | 0.3772 | 0.0413 | 9.1293 | <0.001 | 100% | supported |
| A direct effect of EE on TC EE ≥ TC | 0.326 | 0.04 | 6.591 | <0.001 | 86.4% | supported |
| Indirect effect(s) of EE on TC (EE ≥ NKA ≥ TC) | | | | | | |
| - | Effect | BootSE | BootLLCI | BootULCI | - | - |
| TC | 0.08 | 0.0526 | 0.0182 | 0.190 | 13.56% | supported |

Based on the results of the mediator analysis, in Lithuania and Estonia the external environment makes a more significant impact on transferring from a linear to a circular economy than assimilating knowledge derived from Nordic capital companies. Anyway, knowledge assimilation still significantly impacts on whether moving to a circular economy.

## 5. Discussion and conclusion

Most studies focus on interlinkages between the external environment and the circular economy (Razminienė et al., 2021; Atanasova et al., 2021; Zarbà et al., 2021; Dieckmann et al., 2020) while others further develop the concepts of circular economy (Rodríguez-Rebés and Navıo-Marco, 2021), sustainability and impact on ecology (Skordoulis et al., 2020). Some researchers pay interest in eco-innovation or new business models while our study expanded the circular economy concept by emphasizing the impact of knowledge assimilation. Our study demonstrated that knowledge assimilation partially mediates the relationship between the external environment and transfer to the circular economy. The external environment's direct effect is much more significant than the indirect. These findings are coherent with the results of previous studies (Nielsen and Hakala, 2023) claiming that external factors such as political, technological, sociocultural and regulatory ones have a significant impact on the circular economy in the food packing industry. Hence, Xu et al. (2021) find that the external environment as government regulation had a less significant impact on innovations and willingness to transfer into the circular economy in less developed regions. However, barely a few studies concentrate on the absorptive capacity or knowledge transfer as the mediator. More studies have focused on the external environment and interlinkages with absorptive capacity, knowledge transfer and innovative performance in general (Laužikas et al., 2022). For example, Marrucci et al. (2022) investigated the relationship between the circular economy and the absorptive capacity. They confirmed that the absorptive capacity directly affects organizational performance while the circular economy and environment management systems mediate only partially the relationship between absorptive capacity and organizational performance. This study found that the absorptive capacity and acquisition activities play a significant role in identifying opportunities in the circular economy. However, in this study, absorptive capacity was chosen as a predictor. We might still claim that the results of Marrucci et al. (2022) are partially consistent with our study. However, the authors have chosen the absorptive capacity as a predictor rather than a mediator. This study generally focused on the absorptive capacity rather than on the ability to assimilate knowledge to develop the circular economy and its related business models. We can thus state that in a similar way to Marrucci et al. (2022). We synthesize the concepts of circular economy and absorptive capacity by focusing primarily on knowledge transfer and assimilation of knowledge. Another study by Lavrinenko et al. (2022) found that knowledge acquisition capability partially mediates the relationship between buyer-driven knowledge transfer activities and green product innovation. Thus, we can state that organizational abilities (including knowledge acquisition, assimilation, transformation and exploitation) are essential in changing company's business models and moving from a linear to a circular economy or developing new products (i.e., green innovation). Meanwhile, Heckova et al. (2022) confirm that assimilation of knowledge is not an internal process and that it might be more effective if small and medium size companies are involved in industry networks. In addition, Xu et al. (2021) find that the R&D investment in the resource recycling industry has not played an active intermediary role between government subsidies and corporate technological innovation performance. Thus, we can conclude that various external factors might have contradictory impacts on the transfer to the circular economy in different business areas. Furthermore, a dissimilar reaction to external environmental factors in less or more advanced regions might be absorbed. This might be explained by adding that less developed regions have a lower potential to recognize useful information, develop ideas, or are less experienced in terms of assimilating and absorbing knowledge to be turned into innovations.

## 5.1. Theoretical implications

From a theoretical point of view, we confirmed a positive moderate correlation between knowledge assimilation and the organization's willingness (or ability) to transfer to the circular economy. In addition, this research proved that knowledge assimilation directly and significantly impacts the organization's transfer to a circular economy. Thus, in this way, our study extended the background of the absorptive capacity theory (Zahra and George, 2002), which states that a firm's prior knowledge is important for developing absorptive capacity (especially knowledge assimilation) transfer and knowledge exploitation being critical for contributing to innovation. Specifically, we shed light on knowledge assimilation while other studies emphasize knowledge transfer as the process from one partner to another. However, it is highly important to understand what factors influence the ability to assimilate knowledge and turn into innovation, especially new models such as the circular economy.

Thus, we advance the circular economy concept by including the external environment (i.e., external enablers) which may have (or not) an influence on an organization's willingness or ability to transfer to a circular economy. The interaction of knowledge assimilation with the organization's transfer to a circular economy is essential, because the circular economy generally implies a new business model. Thus, for organizations with a low ability to assimilate knowledge, it is challenging to move and reshape their activities from traditional (linear) to new (circular) business models. Or, even more significantly, organizations with a low ability to assimilate knowledge might be less motivated for any changes. Further, our study proposed three instruments to evaluate the importance of the external environment, the knowledge assimilation and the transfer from a linear to a circular economy. We validated and confirmed all three instruments to be used in studies.

## 5.2. Managerial and macroeconomic implications

In the long-term, the circular economy will continue to grow and include new business models, innovative processes, products and other activities. Consequently, each company should improve its ability to recognize and assimilate information (knowledge) from external sources or participation in networks. In addition, circularity involves not only business companies, but it also should be sustainable for the economy, society, and for environment in general. Thus, based on our results of the empirical research, we can draw several recommendations. First, Lithuanian and Estonian officials should consider complexity of transferring business to circular economy as this transfer involves more than business companies. For that reason, new strategies and tactics should be considered and implemented so that these two countries in collaboration with Nordic partners would be able to implement international obligations affecting greener and cleaner environment and climate change. Thus, by promoting sustainable activities, governments should stimulate the willingness to move from a linear to a circular economy while providing financial support for installing new processes, developing innovations, and funding training of employees of the companies. Training employees is especially important for the companies located in these regions, as they very often face the problem to find new and younger professionals. In addition, the transfer from a linear to a circular economy and new possibilities to find better remunerated job at the regional level would bring back young specialist to smaller towns. Furthermore, the present study's results should be significant for those Nordic capital companies operating in Estonia and Lithuania as this research has been performed in these countries. Furthermore, our study shows the importance of the external environment (i.e., external enablers) for changes in organizing business and as in the present case for improving the own business model or for introducing innovation and joining substantially new business sectors or activities. In addition, managers should consider and evaluate the ability to assimilate the knowledge usually acquired by organizations from external sources. In case of low ability, managers should consider measures or systems to improve the situation. Moreover, the results might be important and interesting for policymakers because our study oriented towards Nordic capitals contributes to a (quite large) part of foreign direct investments in Estonia and Lithuania. Furthermore, these results might contribute to the development of certain improvements in developing promotion packages for newly attracted Nordic capital companies or in funding training to improve the absorptive capacity in the companies.

While this aspect has not been explicitly treated in the present study, it is hereby also worth mentioning that the shift from a linear to a circular economy is expected to have a macroeconomic impact in the medium term too. More specifically, as reminded by the United Nations Economist Network (2023), "its gradual adoption will produce structural change in investment, employment, capital depreciation and sectoral growth as attention shifts towards end-of-life resource management, design-for-durability and services playing a larger role in the economy. The circular economy is also likely to bring production and consumption sites closer to each other, as material loops are more easily managed on a national and regional basis". Not only business and managerial aspects are concerned by the successful implementation of a business model reflecting an approach typical of the circular economy, but also the economy as a whole. In fact, it should not be forgotten that Estonia's and Lithuania's private consumption rate to their nominal gross domestic product (GDP) corresponded respectively to 52.6% as of March 2023 and to 60.7% as of December 2022 (CEIC Data, 2023a, 2023b). While this does not significantly differ from the rest of the world, its intrinsic message is relevant and powerful at the same time: it's through production first and consumption then that businesses and policymakers as well as individuals can truly "make the difference" in terms of sustainability. Hence, also in terms of new growth opportunities and better wealth.

### 5.3. Limitations and further research

The research focused only on Nordic capital companies in Estonia and Lithuania with a total Nordic capital population of 2000 subjects. In addition, the survey has not prioritized any specific business sector. Thus, one among the further directions for research might consist in focusing on the business sectors with the most promising future in a circular economy. In addition, the study might include more external factors influencing the organizations' transfer to a circular economy. Furthermore, some moderators (such as the size of the company/organization, the age, the turnover and number as well as qualification of employees) might be included into the model as well.

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