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Weaving sustainability: Asset modification and green path development in Norway's outdoor textile industry

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ABSTRACT

The article contributes to the literature on industrial path development through its focus on asset modification for green path development in the Norwegian outdoor textile industry. The authors drew on the concepts of green path development and asset modification to develop a theoretical framework that describes green industrial restructuring as a process by which firms build on various firm-level and system-level assets that are altered through different asset modification modes, which in turn leads to different green path development outcomes. The framework was applied in a study of the greening of the Norwegian outdoor textile industry. A case study was based on data from interviews with firm leaders and industry experts. The findings show that all modes of asset modification are at play in the ongoing greening process. However, asset upgrading and asset creation play a central role. Furthermore, firm-level assets in combination with system-level assets at national and supranational scales are particularly important inputs to the greening of the industry. The authors conclude that in contrast to findings from previous research on industrial path development, regional-level assets play a minor role, which can be explained by the lack of geographical clustering and local embeddedness of the industry.



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Introduction

An increasing need for more sustainable production and reduced environmental footprints has inspired academic researchers, business owners, policymakers, and decision makers worldwide to search for greener and more sustainable alternatives to existing economic structures and production processes. This need for more sustainable economic development has elevated green industrial restructuring to a core topic in economic geography (EG) and related fields (Trippel et al. 2020).

An overreaching argument in EG research is that the future development of industries is heavily influenced by historical and contextual settings ([Ronald] Martin & Sunley 2006; [Ron] Martin 2010; Henning 2019). The strong influence of history and context breeds industrial path dependency, and a change from existing historically embedded trajectories calls for a

modification of assets in firms and systems. Such modification is essential because existing resources are tailored to support present solutions but are less relevant for supporting economic diversification and new industry emergence (Isaksen et al. 2020; Rypestøl 2020; Trippel et al. 2020).

An industry consists of a critical mass of related firms founded upon a variety of knowledge, competences, resources, and technologies (Porter 1980). Research on regional industry development demonstrates that industries are heavily influenced and formed by regional settings (Asheim et al. 2019). Trippel et al. (2020) highlight that regional settings can offer both enabling and constraining conditions for the green restructuring of industries. The authors (Trippel et al.) identify regional industry structure, the regional organisational support structure, and the regional institutional setup as

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elements particularly relevant in enabling and hindering the green path development of industries.

While existing research on green industrial restructuring and path development typically focuses on the central role of regional context conditions, the degree to which industries cluster geographically can differ significantly. While many industries tend to cluster in certain regions, others are dispersed over wider geographical areas ([Roman] Martin & Moodysson 2013; Henning 2019; Nilsen & Njøs 2022). Due to a lack of a critical mass of related firms and support organisations at the regional level, some industries can only be identified at the national level. These varied geographies render the role of local context different for different industries. Nonetheless, even firms in geographically dispersed and nationally configured industries rely on assets accumulated at firm and system levels. How firms in nationally configured industries draw from firm-level and system-level assets for green restructuring remains unexplored in the literature.

This article aims at addressing the gap in the literature by studying asset modification for green industrial restructuring in the Norwegian outdoor textile industry. Empirically, we investigate how asset modification at the firm and system levels push green restructuring in this nationally configured industry. Our research relies on a case study design where information was collected from in-depth interviews with Norwegian textile firm leaders and experts with first-hand knowledge of the industry. The article raises three empirical research questions:

1. Which modes of asset modification at the firm level unfold in the greening of the Norwegian outdoor textile industry?
2. Which modes of asset modification at the system level unfold in the greening of the Norwegian outdoor textile industry?
3. Which future path development outcomes can be expected from the greening of the Norwegian outdoor textile industry?

The remaining part of this article proceeds as follows: The next section presents a short literature review on path development and types of assets and asset modification modes for green path development. Thereafter, we describe the research context and method used to explore green restructuring in the outdoor textile industry in Norway. In the section ‘Findings and discussion’ we present the empirical findings and discuss how the identified modes of asset modification can potentially modify and restructure the industry in a greener direction. The final section presents our conclusions and suggests topics for further research.

Theoretical underpinnings

In this section we review the literature on how asset modification influences and drives the processes of green industrial restructuring. The section starts by reviewing the literature on green industrial path development, and then explores the literature on assets and how asset modification processes can initiate and facilitate green industry restructuring in regional and national industries, respectively. The section is summarized with a suggestion for an analytical framework for researching green industry restructuring through asset modification.

Green industrial path development

Complementing the canonical version of path dependency introduced by David (1985) and Arthur (1989), Ron Martin (Martin 2010) proposed a ‘path as a process’ model. Focusing on the development of new industries, this model suggests that industrial paths can emerge and be renewed from the dynamic processes anchored in place-specific conditions and history. Following the understanding that industries follow dynamic trajectories and that new industries emerge from existing structures, several authors have added to Ron Martin’s work.

One of the early contributions in this line of research stems from a book chapter by Tödtling & Trippel (2013), who suggest three outcomes from evolutionary path development processes. The first outcome is path renewal, which describes the outcome following incremental innovation in existing industries. The second is path formation in established industries, which results from radical innovations and the combination of existing and new resources. The third outcome is path creation in new industries, which arises from branching processes or radical innovations that attract additional players and investors.

Boschma et al. (2017) and Boschma et al. (2017) focus on the importance of diversification processes for industrial restructuring. Their line of research suggests that industries can advance from processes where existing knowledge and capabilities are put to alternative use in related or unrelated sectors. Additional modes of path development have been suggested by, for example, Isaksen & Trippel (2016), who highlight that a pathway can also be upgraded through the implementation of new technologies or organisational innovations, and that new industries can emerge from the importation and commercialisation of scientific discoveries and radically new technologies or business models.

In this article, green industry restructuring is understood as green industrial path development. However, to make the different path development alternatives easier to describe and identify, we follow Trippel et al. (2020),

who distinguish between four main types of green path development: (1) the renewal of existing industries into a greener direction following the introduction of green technology or from an upgrade of business models or organisational structures that promote more eco-friendly solutions; (2) green path diversification, which refers to the birth of new green industries that follow from the implementation of green assets into emerging related or unrelated green industries; (3) green path importation, which covers a process in which a new green industry settles in a new region; and (4) green path creation, which implies the creation of a new industry based on scientific discoveries and radical green innovations.

Assets and asset modification for green restructuring

The literature has shown that green restructuring requires asset modification (Tripl et al. 2020; Isaksen et al. 2022). This argument follows from path dependency theory and the regional innovation systems literature, which argues that existing firm and regional assets have been formed throughout history through the principles of increasing returns and network externalities ([Ron] Martin 2010). Thus, existing assets and capabilities are tailored to support existing industrial structures (Asheim et al. 2019), but they are less relevant for supporting sizeable modifications and the creation of new pathways (Isaksen et al. 2019; Kyllingstad et al. 2021).

In this article, we follow the classification of assets suggested by Tripl et al. (2020) and distinguish between the following: (1) *natural assets*, such as land, climate, and coastlines, (2) *infrastructural and material assets*, including buildings, machines, knowledge infrastructure, and physical infrastructure, (3) *industrial assets*, embracing, for example, technology, financial leverage, and organisational methods, (4) *human assets*, such as knowledge and skills, and (5) *institutional assets*, such as formal laws and regulations, and informal ‘rules of the game’. According to Rypestøl (2020), these categories of assets can all be found at both the firm level and the system level, where firm-level assets are restricted by ownership and system-level assets are available for several actors, often without restrictions.

Tripl et al. (2020) maintain that asset modification can unfold through three modes, namely asset reuse, creation, and destruction. Kyllingstad et al. (2021) supplement this range of asset modification modes by suggesting asset upgrade as a fourth mode. In this context, asset reuse refers to processes in which existing assets are remixed and reused for new purposes. Asset upgrades include modifications in which existing assets are combined with new

ones for significant refinement and improvements. Asset creation covers the processes in which new assets emerge from importation or scientific discovery. Finally, asset destruction embraces techniques in which existing hampering assets are demolished or unlearned either intentionally or because they have become insignificant.

Green industrial path development in regional industries

Recent research on asset modification for the restructuring of industries has highlighted that a region can form both enabling and constraining conditions for green path development. When discussing how the regional level influences green restructuring, Tripl et al. (2020) suggest that the existing regional industry structure, both the organisational support structure and the regional institutional set-up influence the amount and quality of available assets, along with the actors’ ability to modify these assets for green restructuring. When referring to industry structure, a diverse portfolio of local firms can promote regional knowledge spillovers and close access to related and unrelated knowledge, technology, and material assets, while a cemented industry structure of a few strong industries may hamper green restructuring because of a lack of alternative assets. Furthermore, regions hosting a wide set of organisational supports, such as financial organisations, universities, and proactive policy actors, provide enabling conditions based on their rich support of system assets that are relevant for regional industries, while regions short on the same are less supportive of green industry restructuring. Lastly, regions that provide formal and informal institutional assets that are favourable to green restructuring, such as environment-friendly law, regulations, values, visions, and culture, offer enabling regional conditions, while regions that are more prone to support existing industries and existing solutions may hinder green path development in local industries.

Finally, because assets relevant to supporting or hampering industry development exist at both firm and system levels, the literature has highlighted the importance of aligning the two groups of assets. Such alignment occurs when regional firms can benefit from regional system-level assets and when actors at the system level can learn from regionally located firms (Isaksen et al. 2020).

Theoretical framework: green industrial path development through asset modification in national industries

From the preceding theory subsections, we have shown that industries tend to emerge and develop in an

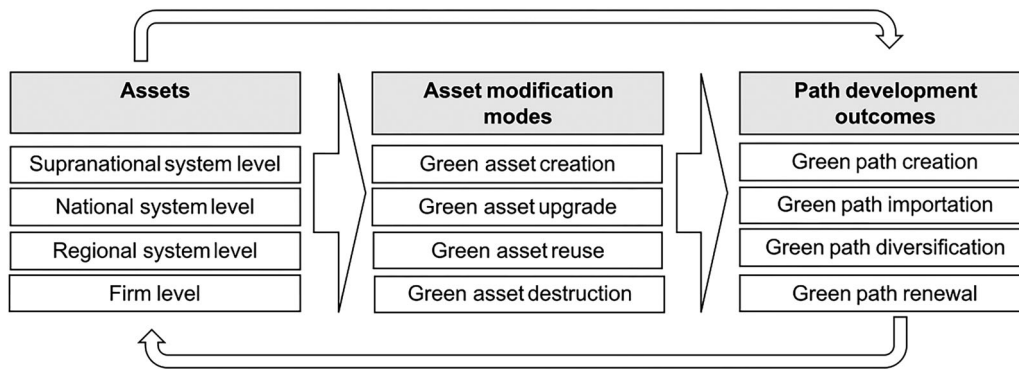


Fig. 1. A model of green industrial path development

evolutionary manner ([Ronald] Martin & Sunley 2006; [Ron] Martin 2010) from processes of asset modification (Isaksen et al. 2019; Rypestøl 2020; Trippl et al. 2020; Kyllingstad et al. 2021). The literature defines assets as a wide concept that embraces resources at both firm and system levels (Rypestøl 2020; Trippl et al. 2020). Furthermore, it highlights that existing assets need to be modified to support green restructuring. In this respect, Trippl et al. (2020) and Kyllingstad et al. (2021) distinguished reuse, upgrade, creation, and destruction as possible mechanisms that may promote green restructuring.

Literature focusing on the greening of regional industries stresses that the regional context can offer both enabling and constraining conditions for green restructuring (Tripp et al. 2020). Examples of parameters that may push or hamper sustainability in regional industries are the existing industry and organisational support structures, and the existing institutional set-up. The literature largely focuses on regionally configured industries. Examples include the article by Kyllingstad et al. (2021), who explore regional industry development in the culture and experience industry and the healthcare sector in the Agder region of southern Norway; the article by Gao et al. (2022), who explore industry development from asset modification in the Gengche township in Sucheng District, Jiangsu Province, China, and the article by Chen (2022), which exemplifies the suggested theoretical framework through Chen's research on how asset modification for green restructuring has unfolding in both Shenzhen in Guangdong Province and Suzhou in Jiangsu Province, China, and in the north-eastern part of the United States. However, not all industries can be identified at the regional level, as some industries are dispersed over a wider geographical area. In this article, we label such industries 'national industries'. We expect that regional system-level assets will be of less relevance to the green industrial restructuring of these national industries.

From the presented concepts and theories, we suggest the analytical framework presented in Fig. 1 is relevant to research on green asset modification for green industrial restructuring. We also suggest that green industry restructuring is a path-dependent process that starts from various assets at firm and system levels, including regional, national, and supranational ones. These assets are modified through different modes, including green asset creation, asset upgrade, asset reuse, and asset destruction. The asset modification process can lead to different outcomes when it comes to green path development, including green path creation, path importation, path diversification, and path renewal. As we examine green industry restructuring in a nationally configured industry, we expect that firm-level in combination with national system-level assets are particularly important inputs to the greening of the industry.

In the following sections, we refer to the framework provided in Fig. 1 when empirically exploring the ongoing process of greening in the Norwegian outdoor textile industry. In line with the research questions, we focus the analysis on (1) modes of asset modification at the firm level, (2) modes of asset modification on the system level, and (3) future path development outcomes.

Context and method

We start this section with a brief presentation of the Norwegian textile industry. Thereafter, we discuss the methodological considerations and methods used for our data collection and analysis.

The Norwegian textile industry

The textile industry has a long history in Norway, dating back to the Middle Ages when wool production and weaving were important economic activities.

The industrialisation of the textile industry began during the 19th century, when British engineers brought technology and know-how relating to large-scale textile manufacturing to Norway (Hebrok et al. 2016; Klepp & Laitala 2018). The industry grew rapidly, particularly in the cities of Oslo, Bergen, and Trondheim, and by the early 20th century, Norway was a major exporter of textiles. However, the industry faced challenges in the latter half of the 20th century, including competition from lower-cost producers in Asia and a shift towards more service-based industries in Norway's economy. Many textile factories closed, and the industry decreased in importance. Only few specialised textile manufacturers have remained, many of which are family-owned businesses (Klepp & Laitala 2018).

Today, the Norwegian textile industry is much smaller than formerly, but it still exists, primarily in the form of small businesses producing high-quality, innovative textiles. The industry is focused on niche markets, such as outdoor clothing, sportswear, and technical textiles. Norwegian textile firms are known for using sustainable materials and production methods, and for emphasising quality and design. The industry is still dependent on wool-based materials, mainly imported merino and alpaca, and either cultural or natural heritage is often emphasised in designs and marketing (Hebrok et al. 2016). Norwegian fashion is clearly influenced by country-specific attributes, such as the specific climate, wildlife, and nature. These influences have mainly centred on durable, warm, and weather-protective clothes. In addition, sustainability has been an important issue for the industry, a trend that has intensified in recent years. Furthermore, Norwegian brands benefit from their association with sociocultural values such as egalitarianism, gender equality, tolerance, and openness. These country-specific features are also reflected in the design and marketing of Norwegian fashion (Klepp & Laitala 2018).

Method for data collection and analysis

We draw on a qualitative case study (Yin 2013) of green restructuring in the Norwegian outdoor textile industry. To focus the study, we limit the textile industry to firms adhering to the sports and outdoor part of the industry. To identify the population of firms, we searched in local and national business registries and combined this with snowball sampling techniques. We identified 15 Norwegian outdoor textile producing firms. We approached all of them, and our request for an interview was rejected by four firms. Thus, we interviewed representatives of 11 firms (c.75% of the total number of Norwegian outdoor textile producing firms). Due to COVID-19

pandemic restrictions, all interviews were conducted digitally via Zoom. The interviews lasted an average of 60 minutes, and the conversations were recorded and transcribed according to recommendations for qualitative research practices provided by Gioia et al. (2013). The main themes discussed were green restructuring in general and whether or not and how firms activated and drew from various modes of asset modification to restructure in a greener direction. We conducted all interviews between March and June 2021 and complemented the interview data with extensive document studies, including firms' websites, sustainability reports, firms' mission and vision statements, and firms' annual reports. In addition to the 11 interviews with representatives from the top management teams, we interviewed two industry experts. One was the development manager of a textile, fashion, and sportswear branch organisation, and the other was an author, editor, journalist, and board member with significant industry knowledge. These additional interviews provided us with a broader perspective on the green restructuring of the industry. All 13 interviews were transcribed and analysed.

Due to the small size of the industry (identified 15 Norwegian outdoor textile producing firms) and to secure the promised level of anonymity, we provide little information about the firms' interviewees. However, some data of a broad nature are provided in Table 1.

Findings and discussion

As noted in the theory section ('Theoretical underpinnings'), green restructuring requires asset modification in firms and systems (Tripl et al. 2020; Kyllingstad et al. 2021; Chen 2022; Isaksen et al. 2022) because existing assets support mainly developments along existing trajectories (Asheim et al. 2019; Isaksen et al. 2019; Kyllingstad et al. 2021). In the following, three subsections we analyze how the interviewed firms modified assets for green restructuring and what outcome is most likely to follow from these modifications. We discuss the three research questions one by one.

Firm-level asset modification for green industrial restructuring

In general, the interviewed firms' representatives highlighted that the outdoor textile industry has been reorienting itself in a green direction. Although some firms have claimed to be at the forefront of this transformation by seeking to influence customers' preferences in a green direction, others have identified themselves as being followers who responded to

Table 1. Overview of studied firms

Firm No.	Size (*)	Age	Interviewee	Geographical context	Market focus
1	Medium	> 25 years	Textile engineer	Innland County	Home market only
2	Medium	> 25 years	Sustainability manager	Viken County	Home and export market
3	Medium	> 25 years	Head of sourcing	Innland County	Export dominant
4	Medium	> 25 years	Chief executive officer	Vestland County	Home and export market
5	Large	> 25 years	Sustainability manager	Oslo County	Home and export market (export dominant)
6	Medium	> 25 years	Chief sustainability officer & director of innovation	Viken County	Home and export market
7	Micro	5–10 years	Chief executive officer	Oslo County	Home market dominant
8	Micro	> 10 years	Chief executive officer & creative director	Vestland County	Home and export market
9	Medium	> 25 years	Managing director	Agder County	Home and export market
10	Small	> 25 years	Product development manager	Innland County	Home market dominant
11	Medium	> 25 years	Head of sustainability/Chief executive officer	Oslo County	Home and export market

*Firm size measured based on the European Commission's recommendation 203/361 (European Commission 2003) regarding number of employees, where 1–10 employees are categorized as in a 'micro firm', 11–50 employees as in 'small firm', 51–250 as in a 'medium firm', and more than 250 as in a 'large firm'

customers' changing demand preferences. Regardless of the firm's degree of proactivity in greening, all firms highlighted that the ongoing processes in the greening of the industry have required significant modification of their firm assets.

Previous research has shown that, in being the least radical form of modification, *asset reuse* is an important mode of modification, especially in the early phase of change (Rypestøl et al. 2022b). Our interviewees confirmed the importance of firm-level asset reuse for stimulating green restructuring. Examples include Firm 9, which developed a textile printing technology. The firm's representative highlighted that the firm would be using the technology in the future, and stated that the technology and the knowledge of textile printing can be a potential future resource for the firm once requirements for more environmentally friendly cloth printing is possible. Firm 2 stated that it was pursuing a new rental business model and had continued to reuse their existing machines to construct and make its clothing products more robust. Firm 8 highlighted that the textile industry possessed the technology needed to become more sustainable but that human assets, such knowledge and skills relating to sustainability, were scarce.

Even if human asset reuse is far more cost-effective than creating new knowledge, only a few firms' representatives highlighted knowledge and skill reuse as a well-enforced mechanism. However, Firm 2 was reusing its existing products, and how they were developed and made in a new way represented a reuse of knowledge. After the change to a service-oriented rental business model, the firm stated that it would reuse the products it already had in its portfolio.

If the existing internal assets of a firm are not sufficient to follow a greening strategy, theory suggests that new external assets can be combined with existing knowledge to upgrade the asset base (Kyllingstad et al. 2021). Our interviewees pointed to *asset upgrade* as the most important mode of asset modification for

greener solutions. In our case, suppliers were significant partners for asset upgrade, and examples included the fuelling of human assets such as knowledge of how to use machines effectively. Jensen et al. (2007) suggest that this type of synthetic knowledge is best shared in close interactions, and in the studied firms, both knowledge and skills were upgraded through courses and on-the-job training sessions facilitated by producers. It was mentioned by the representative of Firm 7 that this type of upgrade process can lead to an intended chain reaction of getting the 'right' people and with them, the 'right' knowledge, which will result in the 'right' vision. Another example was Firm 4, which cooperated with suppliers on how to produce alternatives to plastic bags, and to modify and extend existing knowledge of how to reuse yarn that had not been perfectly produced. This circular process of reusing yarn for new products, another example of producer-supplier initiatives to increase sustainability, focused on how to make Norwegian wool softer. Currently, imported merino wool is a key raw material, as garments made with it are more comfortable to wear than garments made with Norwegian wool. To address this challenge, Firm 4 had collaborated with machine suppliers on how to upgrade how they spin and knit the yarn so that the final product would be less rough. If this producer-supplier collaboration succeeded, locally produced Norwegian wool would be more appealing, thus decreasing the need for imported merino wool, which in turn would shorten transport times and reduce CO₂ emissions. Also, Firm 6 highlighted its strong effort in teaching and training suppliers in all tiers of the supply chain to implement a mindset of sustainability.

Other examples of asset upgrading for green restructuring in firms either went beyond human assets or combined human assets with other assets. Firm 11 evaluated the possibility of adding renting as an alternative business model. Firm 11 highlighted, however, that for such a change to be successful, the firm would need to pair existing knowledge with new knowledge from

software providers and retailers to overcome logistics and cleaning issues.

The empirical investigation revealed an important asset modification for greening the Norwegian textile industry that might occur unintentionally, which is the upgrade of mindsets, from supporting continuation of current practice to fostering an open, innovative business culture. Some firms argued that collaboration for innovation with other firms was vital in building and maintaining an innovative culture. For example Firm 11's representative said: 'you really find it hard to set aside time to innovate, and that's why you need inspiration and expertise from the outside'.

In the case where the greening strategy of a firm cannot be sufficiently followed by activating reuse or upgrades of assets alone, theory has pointed to *asset creation* as an alternative strategy. This approach is considered essential for radical changes in firms and systems. Sometimes, firms need radical changes to distance themselves from established practices. This need for radical change was highlighted by one of the firms that aimed to increase circular economy principles through recycling. The firm highlighted that it was entirely dependent on other industries when trying to integrate recycling. To gain more independence, it initiated research activities to develop its own technologies. That process was both cost-demanding and time-demanding because new assets needed to be created from scratch and, according to the firm's interviewee, no relation with existing ones could be established. An alternative way to gain new knowledge is by hiring new personnel who could implement new knowledge and introduce a change in existing skill sets. This mechanism was key to the greening process reported by many of the interviewed firms. An example was provided by one of the interviewed experts, who noted the need for the industry to import new knowledge about quality and innovative sustainable fibres. According to the expert, the outdoor textile industry currently uses synthetic material mainly derived from fossil fuels. This synthetic material is cheap, but it also has significant negative footprints in the environment. However, even if the need for knowledge and skills relating to sustainable materials was seen as urgent, textile engineers can be hard to find. Skilled personnel are found mainly in Asian countries because Asia represents the geographical centre of the textile industry. To compensate for this lack of possibilities for importing knowledge and skills, several firms highlighted collaboration as an alternative mechanism. Firm 3 was an example in this regard, as it was actively searching for collaborators who could fuel the firm with new knowledge and technology. An example of knowledge sourcing for asset creation was

the initiative taken towards a competitor to join an ongoing project for making synthetic silk that could be blended into wool for an entirely new yarn.

Another shortcoming mentioned by the firms was digital knowledge and skills (Firm 4). Despite modern technological adaptations in Industry 4.0, such as big data and robotisation, our interviewees highlighted that the Norwegian outdoor textile industry still lacked the technology for automated sewing. More critical, however, was the need for knowledge, skills, and technology in 3D printing, which stem from experiments involving new business models that prioritise tailored production on demand. If Norwegian outdoor textile firms were to become successful in this green shift to alternative business models, the firms would need access to new knowledge (Firm 8).

In some cases, green restructuring requires *asset destruction* (Trippel et al. 2020), and examples have often indicated that old technology and industry culture are possible hinderances to innovation (Trippel et al. 2020; Kyllingstad et al. 2021). We find that this is also the case for the Norwegian outdoor textile industry.

As demonstrated above, greening processes require updated and new tangible and intangible assets, and a forward-leaning mindset. As new technology was implemented and knowledge on effective use was updated, old, related tangible and intangible assets were destroyed. Most often, the destruction of assets followed from a lack of relevance of machinery, technology, or knowledge. The examples mentioned were the unlearning of irrelevant knowledge, the changing of existing routines, and the demolition of old machines and technologies. In some cases, changing intangible assets such as knowledge and routines may lead to the formation of a new firm and industry culture. In our case, some of the firms indicated that such a change in culture was emerging. They indicated that young people are more committed to sustainability than members of the older generations. Some firms highlighted that this push from young people influenced the culture of the firm because the young, new employees pushed for sustainability, thereby contributing to changing the mindsets of senior employees gradually.

In sum, green restructuring through firm-level asset modification in the outdoor textile industry has followed a combination of pressures from all modes of modification. However, the upgrade and creation modes were highlighted as the most influential. This indicates that the fuelling of new assets has been essential for green restructuring in the industry. Geographically, our interviewees pointed to the national and, to some extent, the supranational level as the most relevant sources for asset importation and collaboration. This was

the case because there were few relevant assets available regionally.

System-level asset modification for green industrial restructuring

System-level assets include assets for which distribution is not restricted by private ownership. Instead, system-level assets are available for large groups of firms. In general, the interviewees did not consider system-level *asset reuse* as a significant mechanism within the ongoing greening process of the outdoor textile industry. However, one firm stated that, to an extent, the principles behind standard-setting procedures were a reuse of what had been experienced as being useful in other relevant industries. Thus, institutional settings, such as procedures and structures, were to some degree reused at the system level. The source of this reuse of procedures and structures was mainly found at the national and supranational levels because regional standards and procedures did not exist.

Another aspect highlighted as system-level asset reuse was the general access to financial support from private investors and the support of public organisations such as Innovation Norway and the Research Council of Norway. If public investment budgets remain constant, increasing public support for green restructuring projects will result in less support for other investments. Firm 2 highlighted the importance of having access to funding for green innovations as very important. To Firm 2, actors such as Innovation Norway were particularly important, while Firm 6 noted private investor funds as being one of the most significant change agents within the outdoor textile industry. By financing some innovations and ignoring others, such investor funds can have a significant impact on the future development of the industry.

Apart from the reuse mechanism, the firms highlighted system-level *asset upgrade* as a significant mechanism to support the green restructuring of the industry. The firms highlighted that both firm-level and system-level actors pushed upgrade mechanisms at the system level. This need to develop the system level is mentioned by Isaksen et al. (2019), who claim that entrepreneurs and firms could provide system-level assets. In our case, one example of a system-level initiative was mentioned by Firm 4, who described an initiative suggested by firms in order to create a discussion group among competitors. Firm 4 highlighted that, because of the lack of regionally located competitors, the participants in this discussion group were geographically dispersed throughout Norway. The main purpose was to exchange ideas and experiences of sustainability issues because

‘this is something we should share, right?’ (Firm 4 representative).

Like Firm 4, Firm 7 also focused on an open access approach to sustainability. It practised an open access strategy because they believed it was important to grant access to important information and knowledge to other firms in order to change the industry both on a large scale and from within. Because transparency may provide new insights into sustainability issues to competitors and other industry-related actors, Firm 7 can be seen as contributing to the system-level asset base. An open-source strategy was considered the only alternative because the firm had a vision of changing the world and expected the same transparency from other serious outdoor textile producers: ‘Changing the industry is part of our vision, so if we really mean it, we should hope that others are willing to change as well’ (Firm 7 representative).

When analysing how *asset creation* played out at the system level, we found that the interviewees placed a strong focus on institutional assets at the national level. The implementation of new laws and regulations was mentioned as a significant factor behind green restructuring in the industry. As was highlighted by our stud participants, such initiatives can, however, be both enabling and constraining in green restructuring. One example of a negative impact on green restructuring through the implementation of a new law was mentioned by Firm 2, which referred to a national law, *Brukhandellova* (Nærings- og fiskeridepartementet 2015), stating that the selling of used products must be registered with the police to prevent an active market of stolen goods. The firm added that in a setting where firms want to repurpose worn garments, this law becomes a burden that hinders sustainable development through the reuse of garments.

However, even if some laws may hinder green restructuring, such as the one mentioned above, most new legislation succeeds in supporting sustainability in the outdoor textile industry. When addressing this issue, several of the interviewees drew parallels to the success of electric cars in Norway, which has been backed by significant tax reductions and other policy instruments: ‘You saw electric cars as well, ‘no market penetration’. We change the legislation, and we change the incentives, and ... boom!’ (Firm 11 representative).

Laws and regulations are set at the national level, and none of the firms’ interviewees referred to local regulations as important for their firm’s ongoing green transitions. Instead, they pointed to the national level and, even more importantly, the supranational level when reflecting on system-level asset creation that was important to support green industrial restructuring in textiles.

At the national level, International Organization for Standardization (ISO) certification was mentioned as important, and at the supranational level the European Union (EU) was raised as one of the important actors of change. Other international actors that perform asset creation at the system level are international coalitions holding key positions in the industry, such as the Sustainable Apparel Coalition (SAC), which has developed the Higg Index (a suite of tools for the standardized measurement of value chain sustainability). The Higg Index enables owners of brands, retailers, and other facilities to measure their environmental and social impacts across the life cycle of their product. Despite the importance of such international coalitions, Firm 6 had found that only a few Norwegian outdoor textile firms were members. The firm's representative argued that even fewer firms aimed for board positions in such supranational coalitions. Thus, Norway has limited influence in setting the standards for the industry.

The fourth and final mode of asset modification that actors could activate at the system level is *asset destruction*. Asset destruction includes the demolition of tangible assets, and unlearning and relearning of intangible ones. The asset destruction mechanism most often referred to by our study participants was the ongoing change in mindsets concerning increased sustainability by all humankind. The notion of the increased importance of sustainable production and consumption has placed increased pressure on the outdoor textile industry. However, most of the firms' interviewees highlighted that the industry itself was the main player in this ongoing green restructuring process. Thus, neither the Norwegian government nor customers were taking the lead. Instead, several firms highlighted that the government lagged behind and that customers did not possess knowledge relevant to guiding sustainable choices. Firm 6's representative reflected on the role of the customers and stated: 'Consumers do not catch up, because they do not know what is sustainable and what is not.'

Finally, some of the interviewees mentioned that also the Internet had been a game changer, as online stores made it possible for producers to sell directly to customers. In this way, digitalisation has changed the distribution model and network structure of all firms to a systemic extent.

In an article on regional industrial path development, Trippel et al. (2020) highlight the regional industry structure, regional organisational support structure, and regional institutional settings as elements that have a significant influence on green restructuring processes. In our case, these regional system-level assets were not highlighted as important by the study participants. Instead, the firms' representatives referred mainly to

national levels and partly to supranational levels when reflecting on which system-level assets had influenced greening of the restructuring processes in the outdoor textile industry.

Green path development outcomes and the greening of the Norwegian outdoor textile industry

Our analysis of asset modification in the Norwegian outdoor textile industry has revealed asset upgrade and creation as the main modes that have pushed green restructuring in this industry. Rypestøl (2020) argues that there is a link between various modes of asset modification and various forms of path development outcome. He claims that the most radical forms of path outcome require the most radical forms of asset modification. Furthermore, according to Rypestøl (2020) asset reuse supports mainly the extension of existing pathways, whereas asset upgrade supports significant upgrades of an existing industry in new directions. Finally, more radical changes in terms of the birth of new industries typically require asset creation (Rypestøl 2020).

In this article, we understand industrial restructuring as industrial path development and have identified four future path development outcomes: green path renewal, green path diversification, green path importation, and green path creation. Before elaborating on the possible path development outcomes, we note, however, that industrial path development is considered a meso-level and macro-level dynamic. We follow the procedure suggested by Rypestøl et al. (2022a) and analyse industrial path development as the aggregated result of firm-level dynamics. Thus, we rely on asset modification processes reported by firms' representatives when discussing the green path development outcomes in the industry.

The interviewees did not highlight firm-level asset reuse as a main mechanism to become more sustainable. Instead, they highlighted asset upgrade and asset creation as the most evident modes of modification at both the firm level and system level. We researched asset upgrade as a process whereby existing assets are modified by new assets from outside, and asset creation as a process whereby new assets are developed from importation or radical new innovations.

Following argumentation in the literature (Rypestøl 2020), we would expect that future development will manifest primarily as path renewal, with some possibilities for related path diversification. Although green path renewal in the outdoor textile industry in Norway may follow from the aggregated level of asset upgrades evidenced at the firm and system levels, diversification may follow from the implementation of new business

Table 2. Summary of key findings from the analysis of asset modification in the Norwegian outdoor textile industry

Level	Asset	Key findings, summarized
Firm	Creation	Asset creation is a pivotal mode of assets modification. Some firms import knowledge and skills to implement new sustainable practices, while others hire new personnel with expertise in sustainability.
	Upgrade	Asset upgrade is essential for green restructuring. Firms collaborate with suppliers to upgrade their knowledge and skills, focusing on sustainability.
	Reuse	Asset reuse is done especially in the early phase of change. Firms reuse existing technologies and products to make their processes more environmentally friendly.
	Destruction	Asset destruction occurs when existing assets such as machines, technology, or knowledge become obsolete. Firms ‘unlearn’ knowledge, alter established routines, and sell obsolete machinery to become more sustainable.
Regional	Modification	Regional-level assets are less relevant in the context of green industrial restructuring in the Norwegian outdoor textile industry. The emphasis is mainly on national and supranational assets, as relevant assets are not readily available regionally.
National	Modification	National-level asset modification includes the implementation of new national laws and regulations that support green restructuring. While some laws may prove hindering, most new laws contribute to sustainability within the textile industry. National-level assets also include financial support from organizations such as Innovation Norway and the Research Council of Norway, which are important for financing green innovations.
Supranational	Alignment	Alignment between firm-level and national-level asset modification processes is critical for effective restructuring.
	Modification	The supranational level, particularly the EU and international coalitions such as the Sustainable Apparel Coalition, plays a significant role. The EU and the coalitions develop standards, regulations, and initiatives that influence green restructuring in the textile industry.
	Alignment	Similar to the national level, alignment between firm-level and supranational-level asset modification processes is important.

models that hold the potential to change the industry’s future structure radically. One example of such a radical change may follow if renting textiles, instead of buying them, becomes successful.

Finally, the literature has shown the importance of alignment between firm-level and system-level asset modification processes when it comes to green restructuring (Isaksen et al. 2020). The most effective restructuring unfolds when firms can draw from system-level assets and when system-level actors can benefit from firm-level assets. For such an alignment to emerge, assets at the firm and system levels must be related and relevant. In our case, the interviewees indicated that regional system-level assets were less relevant, while national and supranational assets were more relevant. The extraregional level was significant in providing new assets to ongoing modification processes and in guiding further development from formal and informal institutional settings. Thus, extraregional assets were used to support green path renewal, and possibly green path diversification. The key findings from the analysis are summarised in Table 2.

Conclusions

While previous research on asset modification has typically focused on path development in regions (Trippel et al. 2020; Kyllingstad et al. 2021; Gao et al. 2022), in this article we focus on asset modification and path development in a nationally configured industry. We define a nationally configured industry as an industry where firms are not clustered in a region but geographically dispersed. As industry representatives do not cluster in one region, path dependency theory indicates that they have a lower influence on the development of

structural and institutional settings in the region. Thus, over time, the region will not prioritise building strong system assets to support nationally configured industries. Hence, we expect that asset modification for green restructuring will mainly rely on the modification of assets at the firm, national, and supranational levels, while assets at the regional level will be less relevant.

Empirically, we have investigated the ongoing process of asset modification for green restructuring in the Norwegian outdoor textile industry. From the interviews with firm leaders and industry experts, we found that a further greening of the industry is high on the agenda at firm and system levels.

The empirical analysis has shown that asset upgrade and asset creation are important modification modes that fuel the greening process in the outdoor textile industry. The assets most exposed to modification are human assets such as knowledge and skills, industry assets such as technology, and institutional assets such as laws and regulations, habits, and ways of thinking. Both asset upgrading and creation require fuelling by new assets not previously available to the firms. When researching the geographical origin of these new assets, the national and supranational levels were found prevailing. These findings differ from previous research findings relating to asset modification and regional industrial restructuring (e.g. Trippel et al. 2020). The explanation for this is that firms in regionally configured industries are, to a larger extent, locally embedded than are firms in nationally configured industries. The latter have related firms, knowledge creators, and support organisations in close geographical proximity, which creates a critical mass of actors that can create deeper footprints in the region. Path dependency theory

suggests that some industrial growth paths are discriminated against and that more significant groups of actors are favoured over less significant ones. Therefore, in our case, firms adhering to a national industry are only weakly represented in each region and will have less ability to form and influence beneficial regional settings. Instead, firms in national industries will search for new assets outside their region. One consequence of this focus on the extraregional could be that firms in national industries become more prone to transplanting new assets, and hence more prepared for radical change.

The analytical framework in Fig. 1 shows that green path development can be understood as the result of asset modification processes, which can be situated at firm, regional, national, and supranational levels. The framework also presents alternative modes of asset modification, as well as alternative path development outcomes, which have been investigated empirically. Regarding the relationship between asset modification and path development, we found that the most likely path development outcomes in the Norwegian outdoor textile industry are green path renewal and green path diversification. Following the logic that national industries are less locally embedded and therefore more open to new assets, it can be argued that national industries hold more potential than regional industries to renew through asset upgrade and asset creation.

These findings have relevance for theory development. First, the study offers insights into the dynamics of asset modification and path development in nationally configured industries, contrasting with previous research that has primarily focused on regionally configured industries. This emphasises the significance of considering multiple spatial levels when analysing industrial path development. Second, the findings highlight that national industries, due to their limited regional embedding, tend to rely more on extraregional assets and relations. This underscores the importance of broadening the scope of theoretical frameworks to accommodate the varying influences of regional and extraregional factors. Third, the identification of green path renewal and diversification as the likely outcomes in the Norwegian outdoor textile industry also contributes to enriching theoretical discussions on industrial transitions. The findings suggest that national industries and their distinct characteristics require tailored approaches in industrial path development theories. In sum, the study challenges conventional assumptions about the role of regional context conditions and underscores the need for more comprehensive theoretical frameworks that account for the diverse pathways to industrial sustainability in both nationally and regionally configured industries.

With regard to its practical implications, the study shows that some industries are less influenced by regional context conditions and rely more on extraregional relations, structures, and institutions compared with other industries. Consequently, policies intended to support sustainable transitions, and the greening of industries should focus not only on building system-level assent at the regional level but also on aligning and bridging firm-level assets with extraregional assets. This recommendation is in line with recent research on regional industrial path development stressing how factors exogenous to a region (e.g. national regulations, global commodity markets) can stimulate innovation and alter industrial path development in regions (Trippel et al. 2018).

Finally, this study provides some avenues for future research. First, the empirical analysis is grounded within the Norwegian outdoor textile industry, which is associated with specific national characteristics. However, the textile industry is embedded in global value chains and global production networks. Because textile businesses operate worldwide, more research is needed in other geographical areas, including the Global South. Second, we investigated outdoor textiles as a subsector of the textile industry. Hence, future research should focus on other areas of the textile and apparel industry, which might undergo different path development processes. Third, to date, asset modification and path development have been discussed with a focus on structures but without a deeper consideration of agency, which is another important avenue for research on green path development (Fløysand et al. 2022; Mjørner 2022; Blažek & Květoň 2023). Future research should be conducted on antecedent factors and agency to understand their interaction or applicability.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

- Arthur, W.B. 1989. Competing technologies, increasing returns, and lock-in by historical events. *The Economic Journal* 99(394), 116–131.
- Asheim, B., Isaksen, A. & Trippel, M. 2019. *Advanced Introduction to Regional Innovation Systems*. Cheltenham: Elgar.
- Blažek, J. & Květoň, V. 2023. Towards an integrated framework of agency in regional development: The case of old industrial regions. *Regional Studies* 57(8), 1482–1497.
- Boschma, R. 2017. Relatedness as driver of regional diversification: A research agenda. *Regional Studies* 51(3), 351–364.
- Boschma, R., Coenen, L., Frenken, K. & Truffer, B. 2017. Towards a theory of regional diversification: Combining insights from evolutionary economic geography and transition studies. *Regional Studies* 51(1), 31–45.

- Chen, Y. 2022. Rethinking asset modification in regional industrial path development: Toward a conceptual framework. *Regional Studies* 56(2), 338–350.
- David, P.A. 1985. Clio and the economics of QWERTY. *American Economic Review* 75(2), 332–337.
- European Commission. 2003. Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (Text with EEA relevance) (notified under document number C(2003) 1422). *Official Journal of the European Union* L124, 0036-0041. <http://data.europa.eu/eli/reco/2003/361/oj> (accessed 12 October 2023).
- Fløysand, A., Sjøtun, S.G., Jakobsen, S.-E., Njøs, R., Tvedt, H.L., Gjelsvik, M. & Aarstad, J. 2022. Institutional work, regional key actors, and green industrial restructuring. *Norsk Geografisk Tidsskrift–Norwegian Journal of Geography* 76(1), 14–28.
- Gao, J., Hu, X., Li, Y., Zhuo, R. & Chen, C. 2022. Entrepreneurial agents, asset modification and new path development in rural China: The study of Gengche model, Jiangsu Province. *Journal of Rural Studies* 95, 482–494.
- Gioia, D.A., Corley, K.G. & Hamilton, A.L. 2013. Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods* 16(1), 15–31.
- Hebrok, M., Klepp, I.G. & Turney, J. 2016. Wool you wear it? – Woollen garments in Norway and the United Kingdom. *Clothing Cultures* 3(1), 67–84.
- Henning, M. 2019. Time should tell (more): Evolutionary economic geography and the challenge of history. *Regional Studies* 53(4), 602–613.
- Isaksen, A. & Trippel, M. 2016. Path development in different regional innovation systems. Parrilli, M. Fitjar, R. & Rodríguez-Pose, A. (eds.) *Innovation Drivers and Regional Innovation Strategies*, 66–84. Abingdon: Routledge.
- Isaksen, A., Kyllingstad, N., Rypestøl, J.O. & Schulze-Krogh, A.C. 2019. Entrepreneurial discovery processes in different regional contexts: A conceptual discussion. Mariussen, Å., Virkkala, S., Finne, H. & Aasen, T.M. (eds.) *The Entrepreneurial Discovery Process and Regional Development*, 35–53. New York: Routledge.
- Isaksen, A., Langemyr Eriksen, E. & Rypestøl, J.O. 2020. Regional industrial restructuring: Asset modification and alignment for digitalisation. *Growth and Change* 51(4), 1454–1470.
- Isaksen, A., Trippel, M. & Mayer, H. 2022. Regional innovation systems in an era of grand societal challenges: Reorientation versus transformation. *European Planning Studies* 30(11), 2125–2138.
- Jensen, M. B., Johnson, B., Lorenz, E., Lundvall, B.Å. 2007. Forms of knowledge and modes of innovation. *Research Policy*, 36, 680–693.
- Klepp, I.G. & Laitala, K. 2018. Nisseluelandet—The impact of local clothes for the survival of a textile industry in Norway. *Fashion Practice* 10(2), 171–195.
- Kyllingstad, N., Rypestøl, J.O., Schulze-Krogh, A.C. & Tonnessen, M. 2021. Asset modification for regional industrial restructuring: Digitalisation of the culture and experience industry and the healthcare sector. *Regional Studies* 55(10-11), 1764–1774.
- Martin, R. 2010. Roepke lecture in economic geography—Rethinking regional path dependence: Beyond lock-in to evolution. *Economic Geography* 86(1), 1–27.
- Martin, R. & Sunley, P. 2006. Path dependence and regional economic evolution. *Journal of Economic Geography* 6(4), 395–437.
- Martin, R. & Moodysson, J. 2013. Comparing knowledge bases: On the geography and organization of knowledge sourcing in the regional innovation system of Scania, Sweden. *European Urban and Regional Studies* 20(2), 170–187.
- Miørner, J. 2022. Contextualizing agency in new path development: How system selectivity shapes regional reconfiguration capacity. *Regional Studies* 56(4), 592–604.
- Nærings- og fiskeridepartementet. 2015. *Lov om handelsverksmed brukte og kasserte ting (brukthandelova)*. <https://lovdata.no/dokument/NL/lov/1999-12-22-105> (accessed 12 October 2023).
- Nilsen, T. & Njøs, R. 2022. Greening of regional industrial paths and the role of sectoral characteristics: A study of the maritime and petroleum sectors in an Arctic region. *European Urban and Regional Studies* 29(2), 204–221.
- Porter, M.E. 1980. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.
- Rypestøl, J.O. 2020. Regional industrial restructuring. Farinha, L., Santos, D., Ferreira, J.J. & Ranga, M. (eds.) *Regional Helix Ecosystems and Sustainable Growth*, 125–146. Cham: Springer.
- Rypestøl, J.O., Martin, R. & Kyllingstad, N. 2022a. New regional industrial path development and innovation networks in times of economic crisis. *Industry and Innovation* 29(7), 879–898.
- Rypestøl, J.O., Kyllingstad, N. & Martin R. 2022b. Asset modification for regional industrial restructuring in times of economic crisis. *European Planning Studies* 31(8), 1715–1733.
- Segran, E. 2017. Environmental degradation could literally threaten the clothes on your back by 2030. <https://www.fastcompany.com/4036909/environmental-degradation-could-literally-threaten-the-clothes-on-your-back-by-2030> (accessed 2 October 2023).
- Tödtling, F. & Trippel, M. 2013. Transformation of regional innovation systems. Cooke, P. (ed.) *Reframing Regional Development: Evolution, Innovation, and Transition*, 297–317. Abingdon: Routledge.
- Trippel, M., Grillitsch, M. & Isaksen, A. 2018. Exogenous sources of regional industrial change: Attraction and absorption of non-local knowledge for new path development. *Progress in Human Geography* 42(5), 687–705.
- Trippel, M., Baumgartinger-Seiringer, S., Frangenheim, A., Isaksen, A. & Rypestøl, J.O. 2020. Unravelling green regional industrial path development: Regional preconditions, asset modification and agency. *Geoforum* 111, 189–197.
- Yin, R.K. 2013. Validity and generalisation in future case study evaluations. *Evaluation* 19(3), 321–332.