Leveraging Participation in Apparel Global Supply Chains through Green Industrialization Strategies

Implications for Low-income Countries

Jensen, Federico ; Whitfield, Lindsay

Document Version
Final published version

Published in:
Ecological Economics

DOI:
10.1016/j.ecolecon.2021.107331

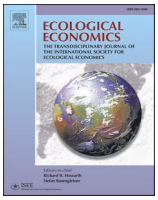
Publication date:
2022

Ecological Economics 194 (2022) 107331

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon



Leveraging participation in apparel global supply chains through green industrialization strategies: Implications for low-income countries

Federico Jensen, Lindsay Whitfield *

Copenhagen Business School, Frederiksberg, Denmark

ARTICLE INFO

Keywords:
Green Industrialization
Global Value Chains
Environmental Upgrading
Apparel
Green Industrial Policy
Ethiopia
Eco-Industrial Parks

ABSTRACT

The global apparel industry has been a gateway to industrialization, but changes in the global economy have eroded the benefits from participating in apparel global supply chains, leading to thin industrialization in low-income countries where suppliers firms are squeezed between low prices and high requirements. More recently, buyers added improved environmental performance as a new requirement for their suppliers, seeking to avoid brand risks in their supply chains due to consumer awareness. This environmental upgrading focused on eco-efficiency gains, which increased productivity among suppliers while using fewer resources, but buyers captured most of the benefits in terms of maintaining low prices due to market power imbalances. This article aims to shift the debate on the limits of participating in global supply chains by conceptualizing the opportunities available to late industrializing countries from embedding the environmental upgrading of individual supplier firms within a broader green industrialization process, which offers more opportunities for value capture and inter-industry linkages through circular industrial economies. We use this conceptual approach to examine the newest apparel sourcing location, Ethiopia, and the government's green industrial policy that aimed to spur industrialization through apparel specific eco-industrial parks.

1. Introduction

In low-income countries, the need for wealth creation, jobs and industrialization generally leads to a lesser prioritization of sustainability issues. Industrialization dynamics inherently continue to have negative consequences on the environment (Yoon and Nadvi, 2018). At the same time, the increased importance of sustainability for consumers, investors and country governments has started to motivate multinational corporations to address environmental issues within their global supply chains (Ponte, 2020). This has left low-income countries having to accommodate higher environmental requirements to foster industrialization through exporting to global markets. These added sustainability challenges to the question of economic development contribute to the increasing number of reasons for returning to targeted industrial policy by governments. However, managing and fostering industrialization is not an easy task, and requires good policy design, extensive market knowledge and institutional and political capabilities with which to facilitate knowledge transfer and value capture locally. Given the general challenges of industrializing through participation in global value chains (GVCs) and the added challenges of sustainability, this article asks whether and how governments can leverage GVC participation and the environmental upgrading of GVC suppliers for broader industrialization processes.

Historically, light manufacturing was perceived as the gateway to industrialization. Low-income country governments promoted new manufacturing export sectors such as apparel in order to access foreign knowledge and greater market demand than was available in the domestic economy. Although exporting apparel was never a high margin business, the initial financial requirements were low and the profits and learning opportunities were adequate for local firms to upgrade in the apparel industry and eventually move into other industries using accumulated knowledge and capital (Palpacuer et al., 2005). These benefits were eroded as more countries developed apparel export sectors and as the global economy evolved, particularly with the phasing out of the Multi-Fibre Agreement in 2005 that regulated international trade, which led to highly competitive apparel global supply chains. In the Global North, heightened competition among buyers, stagnating domestic demand and increased pressure to ensure profits due to financialization led to consolidation among buyers and new business models of capital accumulation including fast fashion and just in time delivery

* Corresponding author.
E-mail address: lwh.msc@cbs.dk (L. Whitfield).

https://doi.org/10.1016/j.ecolecon.2021.107331
Received 6 January 2021; Received in revised form 15 September 2021; Accepted 22 December 2021
Available online 21 January 2022

(Appelbaum, 2008; Palpacuer, 2008). Buyers then shifted more tasks and risks to supplier firms but with smaller profit margins, resulting in a supplier squeeze (Taplin, 2014; Anner, 2020). Low-income countries' apparel industries now often become stuck in the parts of global supply chains characterized by low value capture opportunities and limited linkages between the export industry and the wider domestic economy (Kaplinsky, 2005; Werner, 2019). More generally, the separation of innovation and market-facing activities from production and routine services lead to thin industrialization because supplier countries experience growth in industrial output and exports without developing the corresponding system of innovation needed to support self-sustaining economic development (Sturgeon and Whittaker, 2019).

In the 2010s, increased pressure from NGOs and consumers regarding the negative social and environmental impacts of the fast fashion business model led global brands and retailers to adopt social, safety and environmental standards (Lund-Thomsen and Lindgreen, 2014). This was part of a broader trend where lead firms in many GVCs aimed to mitigate reputational risks by adopting sustainability goals, initially through multi-stakeholder initiatives and then private standards that required suppliers to adopt certain labour and environmental management processes (Ponte, 2020; Havice and Campling, 2017). However, buyers' initiatives in the global fashion industry resulted in supplier firms bearing the costs of meeting environmental standards, with no price premium or other forms of financial support (Khattak et al., 2015, Khattak and Stringer, 2017; Goger, 2013; Khan et al., 2020). Suppliers perceived these investments as necessary to retain market access, while buyers captured the value in terms of reputational enhancement and products marketed as sustainable. In the context of market power imbalances, buyers across various GVCs use sustainability strategies to continue their business model of extracting value from greater efficiency in production processes and eco-branding but shifting costs and risks to suppliers (Ponte, 2019). However, these buyer initiatives did not address sustainability of the global value chain as a whole, including buyer business models, product usage and end of life.

In sum, scholars employing the Global Value Chain (GVC) approach have demonstrated the limitations to industrialization through participating in global supply chains due to limited linkages within the domestic economy and value capture by buyers due to market power asymmetries and intellectual property rights. These insights have been applied to sustainability issues to show how supplier firm investments in improving their environmental impact result in value capture by global buyers as part of their new green capital accumulation strategies (Ponte, 2019, 2020). As a result, the GVC literature tends to draw rather pessimistic conclusions about the opportunities for supplier countries in the global South, especially those still in the early stages of industrialization and particularly in terms of environmental upgrading.

One offshoot within the GVC literature has attempted to bring back the state as a key stakeholder in understanding development outcomes given a reassessment that value chains do not exist in an institutional vacuum. This literature seeks to understand how the state mediates the relationships between local and global firms, participates in GVCs in various roles and attempts to ameliorate the negative sides of upgrading within GVCs (Horner, 2017; Horner and Alford, 2019; Alford and Phillips, 2018; De Marchi and Alford, 2021). However, most of the focus has been on how the state in its various roles has facilitated economic upgrading, with environmental issues and the role of the state within them being less explored (De Marchi and Alford, 2021).

The contribution of this article is to move the debate forward on the role of the state in GVCs and environmental upgrading by presenting a different way of thinking about how governments can overcome the limitations of thin industrialization and limited value capture, while minimizing their environmental footprint. It does this by presenting a new conceptual approach that combines insights from the GVC literature with those from structural development economics and circular economy perspectives, to show that GVC oriented policies need to be embedded within broader green industrialization strategies. We then apply this conceptual approach in the case of Ethiopia's apparel export industry.

Ethiopia is a strategic case as it is one of the newest sourcing locations and one where the government has pursued green industrial policies that include renewable energy and eco-industrial parks. Despite the growing scholarship on Ethiopia's apparel export sector, its environmental features have not received much attention (Oqubay, 2019; Hardy and Hauge, 2019; Whitfield et al., 2020; Whitfield and Staritz, 2021). The case of Ethiopia illustrates the opportunities that green industrialization provides to low-income countries still in the early processes of industrialization, but also the challenges. The Ethiopian government is not 'greening' existing industrial production, but rather trying to create green industrial production from the beginning. This has an advantage of locking in sustainability early, but the disadvantage that implementing green industrial policy is more difficult because the competitiveness benefits of industrial clusters have not yet emerged. Government intervention is needed to coordinate collective investments and subsidize infrastructure, which has always been the rationale for industrial policy. But green industrial policy must also adopt a wider systems approach that goes beyond the apparel export industry to include creating markets in environmental services and waste management as well as supporting access to innovations and building the capabilities needed to make circular economy initiatives possible.

2. Combining Global Value Chain and Green Industrialization Approaches

GVC scholars introduced the concept of environmental upgrading to examine how supplier firms could capture more value in global supply chains from changes that reduce their environmental impact. At the same time, some GVC scholars emphasised the role of the state and the different roles that it can play within GVCs as facilitator, regulator, producer and buyer. However, to conceptualize the full range of opportunities and constraints not just for supplier firms but also for host governments to leverage GVC participation to drive broader industrialization processes, we need to supplement the environmental upgrading approach, which focuses on the firm level, and the state in GVCs approach which focuses on specific state roles within GVCs, with a green industrialization approach that encompasses the industry and domestic economy levels.

Green industrialization refers to the greening of the industrial growth process through renewable energy and circular economy principles.[1] Scholarship on circular economy has largely been written from the vantage point of advanced capitalist countries where the exported products are consumed. Thus, scholars have focused on how to create remanufacturing at the point of sale; services in local economies for extended use; and de-manufacture at end-of-life to create resources to be used in the production of new goods (Stahel, 2019). We are considering it from the perspective of low-income countries where the relevant dimension is circular economy initiatives in the production process such as recycling waste into raw material inputs for the same industry or other industries. We focus on industrial parks producing for GVCs and linking these industrial parks to waste management and recycling industries generating further benefits for the domestic economy.

The GVC approach highlights the ways in which lead firms coordinate (or govern) an international system of production among a network of suppliers and the implications for value distribution among firms in the chain, as well as on how supplier firms can change their position in the chain and thus their value captured. The global fashion industry is a buyer-driven value chain where retailers, brand marketers and branded

[1] We acknowledge that green industrialization constitutes only relative decoupling but argue that it is appropriate for low-income countries that still need growth to increase living standards while being more environmentally sustainable (Hickel, 2020).

manufacturers in the US, Europe and Japan control design, branding and marketing, and outsource most or all of the production process to suppliers in lower cost countries (Gereffi, 1999). The concept of upgrading refers to the process where firms improve their positions in the international hierarchy of low-value to high-value activities (Bair and Gereffi, 2003). Initially, upgrading was used to describe the development trajectories of export-oriented countries and regions, but the focus shifted towards the industry and firm level to analyse the opportunities for supplier firms in developing countries to gain market access, build capabilities through learning from lead firms, and increase their value capture, leading to better development outcomes. Humphrey and Schmitz (2002) proposed a four-fold classification of upgrading that is commonly used in the GVC literature: process, product, functional and inter-sectoral upgrading. Process upgrading refers to achieving a more efficient transformation of inputs into outputs through improving technology and/or production systems and procedures, while product upgrading means moving into more sophisticated, complex and higher quality products with increased unit value. Functional upgrading denotes firms increasing their range of activities in ways that increase the skill content and thus involve higher-value tasks. Inter-sector upgrading refers to firms using competences acquired in one chain to move into a different, more technologically advanced chain.

The GVC scholarship tended to perceive development outcomes in the context of globalized production as stemming from powerful global lead firms (multinational corporations) in terms of how they included or excluded local supplier firms and aided technology transfer. States were seen to play a small role, mainly facilitating connections between lead firms and local suppliers and building infrastructures (both material and knowledge infrastructures) that may indirectly assist local firms with economic upgrading within GVCs. However, recent extensions of GVC research have argued that the state has played roles other than just facilitator that helped to foster better gains from GVC participation, highlighting a regulatory role (trade policy, social and environmental standards), a producer role through state owned firms, and a role as buyer through public procurement (Horner, 2017; Horner and Alford, 2019). De Marchi and Alford (2021) point to aspects that should inform government policy in order to achieve not only better outcomes from GVC participation but also synergies between economic, social and environmental upgrading. Particularly important are the need for the state to mediate conflicting interests between country governments and lead firms and among contested interests within countries related to the given GVC, as well as coordinating policy implementation at national, regional and local levels. Additionally, there have to be local firms with the capabilities and willingness to invest in the given GVC.

These arguments about the role of the state are in line with approaches of structural development economists, who have long argued for state intervention beyond facilitation but do not always understand and integrate the functioning of global supply chains in their theories of industrialization. In bringing together these two literatures, we aim to contribute to the growing GVC scholarship emphasizing the role of state by showcasing the range of policies and actions the government of Ethiopia undertook and the need to politically manage the tensions between different forms of upgrading, as discussed by De Marchi and Alford (2021). But we also want to show that capturing benefits from environmental upgrading in the apparel global value chain requires a broader green industrialization strategy as structural economists suggest.

In terms of how environmental upgrading has been conceptualized in the GVC literature, definitions vary but all include the notion of economic upgrading with an intention to minimize a firm's environmental impact in terms of resource exploitation, waste generation and biodiversity loss. De Marchi et al. (2013a) delineate types of environmental upgrading that correspond to the four types of economic upgrading. For example, changes within the firm to achieve greater efficiency through reducing raw material, water and energy use in production are considered process upgrading; when these changes are intended to also reduce the firm's environmental impact by complying with environmental goals, they constitute environmental process upgrading, or eco-efficiency. The literature on environmental upgrading focuses on what drives supplier firms to pursue environmental goals and the kinds of competitive advantages that can be gained from them. It has examined a range of GVCs including ones characterized by high market power asymmetries where buyers are able to extract higher value such as apparel, furniture and fishing as well as GVCs with more balanced power relations between buyers and suppliers such as the shipping industry.[2] This literature makes important contributions regarding the drivers of environmental upgrading, but generally does not conceptualize how supplier firms' investments both minimize environmental impacts and result in higher value capture, particularly in GVCs with immense market power imbalances between buyers and suppliers. We build on this work to tease out causal mechanisms based on governance power structures of global supply chains to explain value capture opportunities (see Table 1), and then examine how the state can leverage these opportunities for broader industrialization objectives.

Table 1
Environmental upgrading, competitiveness and implications for value capture.

Economic upgrading	Environmental upgrading	Impacts on supplier firm competitiveness	Value capture implications
Process	*Eco-efficiency:* reduce raw material, water and energy use in production; use renewable energy, recycling waste for profit	Lower manufacturing costs	Efficiency gains shared by buyers and suppliers. In some instances, may lead to supplier squeeze.
Product	*Eco-branding:* same product but production process is green. Links to eco-efficiency	Differentiation from competitors based on environmental features: greater market access, and potential price premium	Depends on power relations in GVC whether supplier or buyer captures value
	Eco-product: new product due to design, recycled raw materials used, or product use	Typically developed in cooperation between buyer and supplier in relational GVC. Increases supplier switching cost for buyer.	More bargaining power with buyers over terms of production and price
Functional	*Vertical integration using virgin resources*: to ensure environmental standards in other steps in the supply chain	Lower transaction costs, lower costs of inputs, and/or greater market access.	Higher value but also higher risks
Inter-sectoral	*Vertical integration using recycled resources*: which involves a move into recycling industries. Links to eco-product.	Reduces competition: first mover advantages. Buyers can base new product lines on innovation. Recycling is a manufacturing process, so gains from increasing returns.	Oligopolistic rents (at least initially), High bargaining power with buyer, depending on whether buyer or supplier developed the innovation

Source: Created by the authors, but inspired by and adapting the work of De Marchi et al. (2013a).

[2] This literature includes De Marchi, Di Maria and Ponte (2013b); De Marchi, Di Maria, and Micelli (2013a); Havice and Campling (2017); Klooster and Mercado-Celis (2016); and Poulsen et al. (2016). For a review of this literature, see De Marchi et al. (2019).

The GVC literature critical of upgrading shows that buyers added more standards and shifted more tasks to suppliers, resulting in higher costs and risks born by suppliers, but did not always provide higher remuneration (Tokatli, 2013; Plank and Staritz, 2015). The extent to which suppliers captured the gains from their upgrading depended on whether they could be easily substituted with other suppliers (Schrank, 2004; Sako and Zylberberg, 2019). These dynamics of value capture apply equally to environmental upgrading, where the ability of suppliers to capture value from eco-efficiency and eco-branding (where eco-efficiency processes allow the same product to be marketed as more sustainable), depends on power relations within the GVC. Buyers gain reputational advantage and maintain low unit prices, which is particularly important for buyers in price-sensitive market segments, as they do not ask consumers to pay a premium price for reduced environmental impacts (De Marchi et al., 2013b: 314). Suppliers may marginally reduce costs, but increased orders are not certain in a hyper-competitive global industry like apparel, characterized by many suppliers and few buyers and where buyers can easily substitute one supplier for another. Where environmental certifications are increasingly the norm, eco-efficiency becomes a new market precondition rather than a lever of industrialization.

Eco-product upgrading refers to the production of a new product based on innovations in design that lead to greater sustainability during use and end-of-life disposal, and/or uses recycled raw materials based on new innovations in material production. The extent of value capture depends on how innovations emerge: whether from the buyer, the supplier, or collaborative arrangements between the buyer and supplier. The latter is more typical, especially in global value chains where buyers already depend on their suppliers for design capabilities, and this gives suppliers more bargaining power with buyers. This added bargaining power can then be leveraged for industrialization purposes if it means the build-up of local capabilities and further technology transfer locally.

We summarize the distinction made by De Marchi et al. (2013a) between functional and inter-sectoral environmental upgrading as one based on whether vertical integration of textile production and garment assembly involves the use of more sustainably produced virgin resources or the use of recycled resources. In vertical integration using virgin resources, suppliers' motivations are the same as in economic upgrading: they aim to lower transactions costs and the costs of inputs by internalizing a part of the supply chain, and to gain greater market access as some buyers increasingly require vertical integration as a way to ensure traceability and that quality and other standards are met. Functional upgrading usually entails higher remuneration but also higher risks.

Vertical integration using recycled resources is considered inter-sectoral upgrading because it involves a move into recycling industries, which requires the acquisition of new capabilities and establishing a recycling supply chain. We argue that this kind of environmental upgrading creates longer lasting first mover advantages that provide oligopolistic rents for suppliers, as there are few suppliers that can offer such products and buyers can build new product lines based on indigenous innovations. The benefits from vertical integration using locally recycled resources also extend beyond the supplier firm to the broader domestic economy of the supplier country. This is where we link the upgrading literature to the green industrialization literature. Recycling industries require firms that specialize in waste collection, sorting and distribution; in processing waste into inputs for other industries in the domestic economy; or in processing waste into recycled inputs for the same exporting firms.

The development of recycling industries creates additional manufacturing and innovation opportunities that are linked to, but separate from, GVC participation. Recycling waste is manufacturing, and manufacturing industries are characterized by three unique features, compared to natural resource and service sectors, which lead to wealth creation and self-sustaining growth: increasing returns, linkages, and a bias towards innovation (Mathews, 2017). Increasing returns result from large up-front investments in which mass production reduces the costs per unit produced as output increases, as well as from learning and improved organization within firms and the growth of correlated branches of industry that mutually assist one another, leading to productivity increases (Toner, 1999; Best, 2018).[3] Thus, increasing returns not only generate wealth, but they are also linked to competitive advantages and innovation. Innovation feeds into the growth process beyond the sector itself as other parts of the economy make use of the newly developed technologies. Manufacturing industries also have strong linkages to other parts of the economy, which are important because they imply that the growth of one industry creates additional demand or new supplies and opportunities for other industries (Hirschman, 1958). Growing domestic demand for intermediate goods has been an important driver of industrialization, and strategic government interventions were crucial in coordinating and subsidizing private investments across industries (Rodrik, 1995).

Green industrialization requires government action through industrial policies, with many of the requirements to make green industrial policies successful being the same as with traditional industrial policy. Industrial policy typically entails governments financing and managing large public infrastructure investments; creating and managing subsidies provided to local firms intended to spur technology transfer and learning; and managing relations between and among government agencies, investors and producers, as well as actors that feel they lose from the policy (Amsden, 2001; Whitfield et al., 2015). The role of the government is key in establishing infrastructures, but low-income country governments establishing green industrial zones from the outset face additional challenges. Trying to establish industrial parks and simultaneously create circular processes puts a lot of financial and technical pressures on low-income country governments. Because agglomeration and productivity gains have not yet kicked in, supplier firms in the industrial parks may be focused on becoming internationally competitive, with little interest in circularity, while collaborative institutions to facilitate joint action are still in their infancy. Furthermore, there are limited or no waste and environmental services in low-income countries, which means that industrial policies have to create a market for environmental management services (Peggels, 2014). Thus, the political context, infrastructural capacity and the economic complexity of a country can act as a constraint to green industrialization (Wang et al., 2017; Olayide, 2015). After describing the main environmental issues in the apparel value chain, we explain how the Ethiopian government tried to leverage the apparel GVC for green industrialization through eco-industrial parks.

3. Greening the Apparel Global Value Chain

The global fashion industry accounts for around 4% of greenhouse gas emissions globally, equivalent to the combined annual emissions of France, Germany and the United Kingdom (Fashion on Climate, 2020). Meeting the target of keeping the increase in global average temperature to 1.5 degree Celsius requires a rapid transition to renewable energy sources, increased circular material flows, a significant increase in manufacturing process efficiencies and smart design. Within the total emissions for 2018 from the global fashion industry of 2106 million tonnes CO2 equivalent, 71% of the emissions came from the production

[3] Increasing returns means that as a firm increases its inputs of labour and capital, the output increases more than proportionally.

process, with the remainder generated by transport, packaging, retail operations, usage (wash and drying), and end-of-use in landfill and incineration.[4] In the production process, the bulk of emissions came from the energy intensive cultivation and production of raw material, yarn and fabric production, and fabric wet processing. With global apparel production concentrated in Asia, emissions in these stages are driven by the reliance on hard coal and natural gas to generate electricity and heat (Quantis, 2018). Yarn production accounts for 8% of emissions, and fabric production for 6%. The wet processing of fabric (sizing, bleaching, printing, finishing) is more intensive, especially in its use of water, accounting for 15%. The assembly process accounted for only 4%. Raw material production of cotton and man-made fibres accounted for 38%; while synthetic fibres such as polyester comprised the majority, cotton production was the second largest due to extensive use of water, pesticides and fertilizers. Downstream, it is product use that accounted for the largest amount of emissions, with 20%, while transport, retail and end-of-use each accounted for 3%. Fig. 1 summarizes this breakdown in emission sources, and Table 2 indicates other environmental impacts such as water use, chemical use and wastewater discharge.

The major GHG impacts in the clothing life cycle are driven by power generated from fossil fuels, so achieving industry-wide science-based targets means that firms in producing and consuming countries need to switch to renewables and increase energy efficiency.[5] At the same time, water usage and river pollution due to wet processes in textile industries are considered a major biodiversity and freshwater pollution source, with the global fashion industry accounting for around 20% of global wastewater discharge to rivers and the sea.[6]

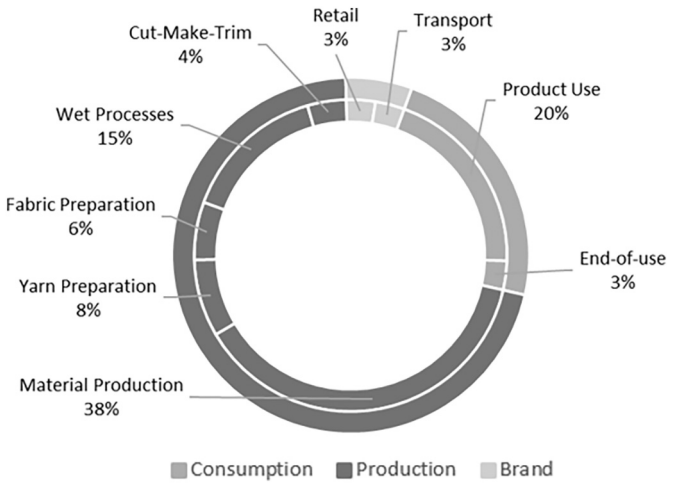


Fig. 1. Apparel and footwear GHG emissions in 2018.
Source: Created by authors, adapted from Fashion on Climate (2020). Emissions retrieved from: http://www2.globalfashionagenda.com/initiatives/fashion-on-climate/#/

Most of the potential for reducing emissions come in the production of inputs for garments. Preferred and recycled fibres are important for reducing the climate impact, including organic agricultural practices in cotton, emerging materials that use less energy intensive processes such as hemp, and recycled fibres made possible through new chemical recycling processes (Fashion on Climate, 2020). For example, rPET is around 40% less emissions intensive than regular polyester because of material recycling and closed-loop production methods. Sustainable manmade cellulose fibres like Modal and Lyocell produce around half the emissions of conventional fibres of this type due to closed-loop production methods.

In terms of fabric production, there are opportunities for efficiency gains in spinning, weaving and knitting stages, for example through modifications in machinery, a shift from wet to dry processing, and adoption of processing technologies that consume less energy (Fashion on Climate, 2020). There is also potential to reduce resource use in the production of other inputs, such as reduced polybag usage and recycled polybags, and increased recycled content in corrugated boxes with available technologies. It should also be possible to advance reuse and recycling further regarding inputs such as buttons and zippers. There are also possibilities for waste from fabric and garment production to serve as inputs into other industries in the domestic economy. For example, textile scraps can be cheap inputs for mattresses, and the sludge that is produced from treating wastewater can be sold to cement industries or mined for phosphate to create recycled inputs for fertilizer. Selling waste reduces the operating costs of firms, and when produced on a large scale, reduces the costs of inputs for other industries.

The textile and apparel sector presents opportunities for the 'greening' of vertical integration that goes beyond using renewable energy to include waste management, recycling within the sector and circular flows linked to other industries. Fibre recycling creates opportunities to shift from agricultural production to manufacturing raw materials for fabric production. Instead of growing cotton, low-income countries can produce synthetic fibres from plastic bottles, and mine textile waste for cellulosic and cotton fibres. They can also adopt fabric production processes that are less resource intensive and adopt wastewater recycling. In other basic inputs such as carton packaging and plastic packaging where local firms in low-income countries would have to buy new equipment to meet the quality and price (productivity) levels required by exporting firms' buyers, they could leap to green technologies that are most efficient and even use (partially) recycled materials from the domestic economy.

Apparel supplier firms generally have not leveraged these opportunities. The Sri Lankan apparel export industry was an earlier mover in seeking to gain competitiveness through differentiation based on ethical production. Sri Lankan local supplier firms also had long term relationships with buyers such as Marks & Spencer, Nike and Victoria's Secret, some of which encouraged their most capable suppliers to improve their environmental performance. Khattak et al. (2015) and Goger (2013) examined the supplier firms that engaged in environmental upgrading and come to similar conclusions. Buyers drove the initiative and focused on eco-efficiency, providing advice and access to technical support to their suppliers. On their part, suppliers agreed to the initiative and paid for the investments required because of potential cost-reductions and because they could see that such process environmental upgrading would become a buyer requirement in the medium term. Buyers did not increase unit prices paid to these firms, arguing that the investments would result in reduced operating costs and more orders. The findings of Khan et al. (2020) on the apparel export industry in Pakistan are similar, the only other country where studies of

[4] Emissions were calculated based on total volume of manufactured, used and disposed garments, accounting for fibres used to meet demand and the energy consumption and emissions intensity of raw materials and manufacturing processes involved. See https://www.mckinsey.com/industries/retail/our-insights/fashion-on-climate#. A CO2 equivalent is a measure to account for the emissions of various greenhouse gasses on the basis of their potential global warming effect by converting the amount of emission of such gases to the equivalent CO2 that would have to be emitted to reach that potential.

[5] Science based targets refers to commitments of emissions reductions by firms that are aligned with the latest climate science in relation to how many emissions reductions are needed so that average earth temperatures rise only between 1.5 and 2 degrees Celsius. See https://sciencebasedtargets.org/blog/how-fashion-companies-can-collaborate-to-tackle-their-biggest-source-of-carbon-pollution.

[6] See https://www.unenvironment.org/news-and-stories/story/putting-brakes-fast-fashion.

Table 2
Environmental concerns across the textile value chain.[a, b]

*Fibre Production**	CO2	Water use	Chemical Use	Wastewater discharge
Spinning, Weaving	CO2	N.A.	N.A.	N.A.
Wet Processes	CO2	Water use	Chemical Use	Wastewater discharge
Cut, Make, Trim (assembly)	CO2	N.A.	N.A.	N.A.
Transportation	CO2	N.A.	N.A.	N.A.
Retail	CO2	N.A.	N.A.	N.A.
*Consumer Care***	CO2	Water use	Chemical Use	Wastewater discharge

Notes: Lightest grey indicates low impact, light grey indicates medium impact, grey indicates high impact, dark grey indicates very high impact.
Source: Created by authors, adapted from Solidaridad Wet Processing Handbook, retrieved from: https://www.imvoconvenanten.nl/-/media/imvo/files/kleding/nieuws/2020/solidaridad-guidebook-wet-processing.pdf

[a] Water, Chemical and Wastewater impacts depend on fibre type.
[b] Emissions depend on whether consumers dry line or use machine dryers.

environmental upgrading have been examined.

These cases show that buyers generally have focused on eco-efficiency and thus when they drive environmental upgrading, suppliers generally do not capture capture additional value from their eco-efficiency investments, but rather may be further squeezed as buyers do not change their general sourcing and purchasing practices. Thus, in order for supplier countries to realize the opportunities for greening textile and apparel production discussed above, a wider systems perspective is required, which moves beyond a focus on the individual apparel firm within the apparel GVC, and acknowledges that the state must play a role in coordinating and incentivizing public and private investments.

The remaining sections examine how Ethiopia's apparel export industry emerged in the context of the supplier squeeze in apparel GVCs. The global fashion brand PVH and the global fashion retailer H&M played a key role in the creation of Ethiopia as the newest apparel sourcing location. We explain that PVH encouraged eco-efficiency environmental upgrading and vertical integration with virgin resources where the environmental impacts of textile production could be reduced, which led the Ethiopian government to adopt eco-industrial parks as part of its industrialization strategy. We examine the design of the eco-industrial park model and then challenges the government faced in implementing it.

4. Global Apparel Buyers, Environmental Upgrading and Eco-Industrial Parks in Ethiopia

The apparel export industry was central to the Ethiopian government's industrialization drive. It laid out targets for apparel export growth in the Plan for Accelerated and Sustained Development to End Poverty (2005/06–2009/10) and subsequently in the Growth and Transformation Plan I (2010/11-2014/15) and the Growth and Transformation Plan II (2014/15–2019/20). Manufacturing exports in Ethiopia were small in absolute terms, but the share of textile and apparel exports in total exports and total manufacturing exports increased from 2.4% and 6.2% respectively in 2001 to 9% and 37% respectively in 2018. The value of apparel exports rose from less than US $1 million in 2001 to 181 million in 2018.[7] Exports rose only modestly in the first decade of the industry, as the government's initial industrial policy approach to incentivize local investors in apparel exports was not very successful (Whitfield and Staritz, 2021). Given the growing balance of payment problems, the government shifted its industrial policy approach to strategic foreign direct investment, in which it sought to attract large global apparel buyers who in turn would encourage their suppliers to invest in Ethiopia (Whitfield et al., 2020). This new approach was successful because a handful of large apparel brands and retailers were looking for the next low-cost apparel sourcing location, particularly in Sub-Saharan African countries that benefited from preferential market access to the US under the Africa Growth and Opportunity Act, and showed interest in Ethiopia.

This section and the next draw on data collected in Ethiopia between 2017 and 2019. We interviewed government officials at the Ethiopian Investment Commission and the Industrial Park Development Corporation, the main government agencies responsible for creating and managing the industrial parks and had access to several government and consultancy documents relating to the parks. We also interviewed managers of the apparel supplier firms in the Hawassa, Mekelle, Kombolcha and Adama industrial parks; the company running the zero-liquid discharge treatment plant in Hawassa industrial park; and representatives of the main apparel buyers sourcing in Ethiopia: PVH, H&M, Decathlon, Calzedonia, and The Children's Place. We also had the opportunity to observe workshops convened in Hawassa to discuss issues related to the park in which investors, local and federal government representatives, buyer representatives, government park managers and NGOs participated.

The idea of using industrial parks emerged from interactions between PVH and government officials at the Ethiopia Investment Commission. In 2012, PVH began developing its Africa sourcing strategy and visited East Africa to find a country for its greenfield investment in a new business model that was part of its larger sustainability strategy 'forward fashion'. According to the Chief Supply Chain Officer, PVH wanted to pioneer the world's first fully vertically integrated, socially responsible supply chain and wanted to be an early mover in what it saw as an important new sourcing market, as wages were rising and labour markets tightening in Asia (Mihretu and Llobet, 2017). When PVH showed interest in Ethiopia, the government did what it took to keep them, including building an eco-industrial park that would meet their vision.[8] This not only showcases the integration of private actors in policy design and implementation from the part of the Ethiopian government, but also its willingness to use all its leverage and the different roles of the state to

[7] Statistics accessed from UN Comtrade database, 2020.

[8] PVH is a brand marketer and owns brands such as Calvin Klein and Tommy Hilfiger and is ranked 17th among top apparel buyers based on revenue. This ranking is based on data from 2017 and accessed from Forbes global 2000 for 2018. H&M, a retailer, is ranked 7th.

enter into the apparel GVC.

Hawassa eco-industrial park was designed by the government in collaboration with PVH and two of PVH's core suppliers: the Indian firm Arvind and the Chinese Wuxi group. PVH decided to focus on producing men's collared shirts in this park. The Wuxi group set up a woven textile mill in a specifically designed facility in the park. Arvind took several factory sheds for assembly of shirts and invested in a joint venture factory with PVH that was intended to be a state of the art factory with the latest technology in woven shirt production. PVH encouraged foreign suppliers of specialized inputs for men's shirts to locate in the park, and later supported one local investor to start producing specialized packaging in the park, to achieve its vertical integration goal.

To achieve its sustainability goal, the park was designed with PVH's environmental and safety standards in mind, so that suppliers located there could easily comply with these standards. PVH is a member of the Sustainable Apparel Coalition, which was started in 2009 by a group of apparel buyers to develop a common set of standards, verification and capacity building procedures for sustainability across the global fashion industry. Its primary focus has been to develop and support adoption of the Higg index, which became managed by a separate company, Higg Co, in 2019.[9] The Facility Environment Module (FEM) is the most developed of the six data tools that comprise the Higg Index and is an annual assessment of an apparel facility's environmental management capabilities, procedures and plans. This data is self-reported by a factory and then shared via the Higg Index platform with any contracted buyer that requests it. Lollo and O'Rourke (2020) argue that the proposition for supplier firms was to improve performance so as to gain more sales and better orders, or risk being dropped by buyers.

The environmental standards in PVH's code of conduct indicate that its suppliers must align their operations and practices with FEM; commit to reducing their facilities' use of natural resources; ensure that hazardous and non-hazardous waste is properly treated, stored, transported and disposed; and meet all standards for air emissions or discharge to the environment (PVH, 2019: 101).[10] Higg FEM has three levels.[11] Level 1 starts with requiring that supplier firms are aware of and track the environmental impacts of their facilities, while level 2 and 3 move to benchmarking and 'demonstrable' improvement on environmental impacts.[12] However, the incentives for suppliers to invest in structural changes to their factory are weak, with most changes driven by strong buyer engagement (Lollo and O'Rourke, 2020). In its supply chain guidelines, PVH states that apparel suppliers had to achieve Higg FEM level 1 by 2021, with textile suppliers required to reach level 2; presumably textile and apparel suppliers gradually will be required to reach level 3.

The infrastructure and systems put in place at Hawassa eco-industrial park make it possible for suppliers to meet Higg level 1 as well as several features of level 3 best practices. The park has a solid waste management system with fully sorted waste management practices. The park uses 100% renewable energy from hydroelectricity dams and LED lights to illuminate the park, and factories use electric boilers for producing steam. Thus, GHG emissions are very low in the park, mostly from circulating vehicles. Furthermore, the park has a zero-liquid discharge (ZLD) system for treating wastewater, largely needed to process waste water from the textile mill and some apparel production such as denim, to ensure no liquid waste discharge from the park into the surrounding areas, including Hawassa Lake. The ZLD system was a major investment by the government, accounting for approximately 60 million USD out of the total 260 million USD it cost to construct the park.

Six other core suppliers of PVH invested in sheds between 2016 and 2017, when the construction was finished. PVH promised to give these suppliers new orders for their factories in Ethiopia, but did not offer higher prices in relation to the environmental aspects of the park. Hawassa was the largest industrial park in Sub-Saharan Africa at the time, encompassing 300 ha with 52 sheds, and it attracted other suppliers whose buyers such as JCPenny and H&M had urged them to open factories in Sub-Saharan Africa as well as local suppliers in Asian countries such as Sri Lanka and Indonesia seeking a lower cost production location.

Table 3 summarizes the Hawassa model in terms of the features associated with the eco-industrial park concept. Eco-industrial parks range from those focusing on sharing utilities such as renewable energy, waste management, water and wastewater with the purpose of achieving environmental standards, to those establishing industrial symbiosis, where the waste of one producer becomes an input in other production processes, a term coined industrial symbiosis (Chertow and Ashton, 2009: 129; Altenburg and Vrolijk, 2020). We then assessed these features in terms of the type of environmental upgrading that they represent. We find that the park focuses primarily on eco-efficiency. The provision of infrastructure such as green energy, solid waste management and water and wastewater management are all infrastructure provisions that provide eco-efficiency to suppliers. The few other infrastructure provisions in the park such as greeneries and LED lights provide some eco-efficiency but are driven more from a position of eco-branding for attracting suppliers to the park and are used actively in promotional park material. The ZLD wastewater treatment facility is an example of vertical integration with recycled resources, as it requires capabilities in a different industry, water recycling. The inter-sectoral upgrading is undertaken by a partnership between a foreign supplier firm and the government-run park agency, as discussed below.

5. Green Industrial Policy: Implementing the Eco-Industrial Park Model

The Ethiopian government adopted the Hawassa model for subsequent apparel-specific industrial parks that it constructed in Mekele, Kombolcha and Adama, although on a smaller scale. The government financed the construction of these parks using proceeds of a Eurobond issue, and argued that they would spur green industrialization as they provide investors with sustainable factories, logistics and infrastructure to start production in the country quickly and gain from co-location

Table 3
Features of the Hawassa Eco-Industrial Park Model.

Eco-industrial park concept	Hawassa eco-industrial park model	Types of environmental upgrading
Sustainable infrastructure	Greening of park and led street lighting.	*Eco-efficiency and eco-branding*
Green energy	All energy comes from hydroelectric sources; all boilers are electric.	*Eco-efficiency*
Solid waste management	Waste management according to buyers' standards.	*Eco-efficiency*
Water and wastewater management	Water utilized in the factories is 90% recycled through the ZLD system.	*Vertical integration with recycled resources*
Industrial symbiosis	Solid waste from wastewater (sludge) as input into other industries.	*Eco-efficiency*

Source: Created by the authors.

[9] See https://www.prnewswire.com/news-releases/sustainable-apparel-coalition-launches-technology-venture-higg-co-300848584.html.

[10] Many environmental standards and certifications exist in the textile and apparel industries: OekoTex, WRAP and ISO14001 etc. we focus on the Higg FEM given its prominent role in PVH's supply chain code of conduct. See Khan et al. (2020) for an overview of the most often used third-party standards in the apparel industry.

[11] Higg FEM measures environmental impacts in seven areas: Environmental Management Systems, Energy Use and Greenhouse Gas Emissions, Water Use, Wastewater, Emissions to Air, Waste Management and Chemical Management. https://apparelcoalition.org/higg-facility-tools/

[12] https://howtohigg.org/fem-landing/fem-getting-started/#section4

(Oqubay, 2019, Oqubay and Kefale, 2020). The Ethiopian Investment Commission is the federal government agency that liaised with global buyers and sought to attract their core suppliers to invest in the industrial parks. As such, it was at the top of the political hierarchy, with the Industrial Parks Development Corporation (IPDC) responsible for managing the parks and answerable to the Commission. The strategy was that IPDC staff would build capabilities in park management and operating the ZLD system through agreements with China Civil Engineering Construction Corporation, which built the park, and Arvind Envisol, a sister company of Arvind, which built the ZLD plant.[13] In this function the state is the regulator, producer and facilitator of environmental upgrading, as regulation has been created that implicitly binds the Ethiopian state in achieving green economic development, and it does so by creating state-owned enterprises to build sustainable infrastructures that also facilitate coupling to the apparel GVC. In essence, the main requirement of a green industrialization strategy is to combine all roles of the state towards industrialization, constantly managing conflicting political interests within the state and contradictions between forms of upgrading.

In implementing the eco-industrial parks, the government faced challenges that are typical to traditional industrial policy. Construction of the large-scale infrastructure for the parks in five different regions faced delays and financing problems, as well as political struggles over who benefits from the parks and who does not, at least in the immediate term. Government support for accessing and learning to use foreign technology entailed creating and managing learning rents, but in this case the government was managing rents related to technology transfer from Arvind Envisol to local park staff.[14] Furthermore, the government's green industrial policy focused largely on firms and systems within the parks and neglected in the planning stage how these systems link up to local and regional economies, which caused challenges that had to be solved along the way.

5.1. Creating the Eco-Industrial Park Infrastructure

The government's Climate Resilient Green Economy strategy adopted in 2011 aimed, among other high-level ambitions, to produce all electricity from renewable resources. While most of the electricity available from the national grid already came from hydropower, the government made significant investments to expand energy from wind, water and geothermal sources.[15] In 2018, hydropower accounted for 92% of the 4300 MW per day available in the country, but the government's industrialization strategy, including the apparel and other industrial parks, required doubling of this amount of energy at the minimum. The government was constructing three major dams (Grand Ethiopian Renaissance Dam at 6350 MW; Koysha at 2160 MW; Genale Dawa III at 254 MW), which when completed will triple the electricity supply, although delays, corruption and geopolitical tensions surround the Grand Ethiopian Renaissance Dam.[16] In addition to hydropower, wind projects increased, with the Adama I, Adama II and Ashegoda projects providing 354 MW, with good prospects for further wind expansion. A geothermal power project was started with a 75 MW facility in Aluto-Langano, and more projects were being planned. When these projects are completed, electricity generation capacity plans to stand at over 17GW (Medhin and Mekonnen, 2019). These investments in renewable energy were also to power a new electric railway system linking all industrial parks to the international port in Djibouti, which landlocked Ethiopia uses. Construction of the railway began in 2013, with the Addis Ababa to Djibouti line completed in 2018. However, construction on other parts of the railway system were delayed or not started due to lack of funds.

In general, the government's large-scale public investments in utilities for the eco-industrial parks did not match its financial and implementation capabilities. The eco-industrial parks were supposed to have a dedicated power sub-station that was prioritized, shielding them from the recurrent power outrages affecting the rest of the country. Nevertheless, the provision of sufficient electricity to the parks was an issue. The Ethiopian Electric Power state agency entered a public-private partnership agreement in mid-2019 with the State Grid Corporation of China to improve the power distribution systems to the industrial parks and electric railway. It involved a 1.8 billion USD investment, with the State Grid Corporation holding a majority share of 80%.[17]

Due to the government's effective marketing of Ethiopia as a new low cost sourcing location, many investors took sheds in Mekele, Kombolcha and Adama eco-industrial parks before these parks were completed, with some suppliers starting operations without access to the dedicated electricity sub-station and the water supply and treatment plants. The provision of these utilities faced delays, some of which emerged from financial issues and others that related to unforeseen challenges.[18] As these suppliers lost money every day that they did not operate, they often chose to invest in their own water provision and treatment and had to use generators. It is likely that these private systems will converge with park provided systems in a longer-term solution, but the different speed at which private firms were able to implement solutions show the challenges that the Ethiopia Investment Commission faced in implementation as it had to work with and depended on the government agencies for water and electricity.

For solid waste management, IPDC could not collaborate with local governments and had to find new solutions because the Hawassa municipal government only allocated dumpsites and did not have any type of solid waste management system. Supplier firms generally sold their textile scraps to local firms, after paying the 15% value added tax to enter the local market, often for filling in mattresses and other furniture. For disposal of non-sellable scraps and other organic recycling, Hawassa IPDC park managers eventually found a local firm that could provide the segregated waste disposal and recycling services required by PVH standards, which was possible because the local firm owner had previous experience running waste disposal in Australia. However, there was no government strategy to support local firms in gaining knowledge in waste management systems.

For liquid waste management, the ZLD system recycled water within the park but also produced its own waste: salts and toxic sludge. In their plants in India, Arvind Envisol sold the sludge to firms in other industries such as for furnace burning, for use in making bricks or as a component in cement mixes, for 42 to 55 USD per metric ton. Sustainably managing this kind of waste through reuse requires collaboration and exchanges with other industries, which were normally located close to Arvind's plant, reducing the price of managing and moving the sludge. In the

[13] The Arvind Group based in India started in textile and later moved into other businesses; it developed a zero-liquid discharge system to cater to its need and then became a global supplier of such systems.

[14] Rents are created through government policies that change existing market conditions. Learning rents occur when government policies reduce the costs that firms bear when investing in learning and building capabilities.

[15] Revised National Energy Policy, Ethiopian Electricity Authority, Ministry of Water Irrigation and Electricity, The Federal Democratic Republic of Ethiopia, October 2018, p. 3. Retrieved from [25.09.2020]: http://www.eea.gov.et/index.php?option=com_content&view=article&id=72:revised-national-energy-policy-englishoctober-2018&catid=33&Itemid=182&lang=en.

[16] On geopolitical tensions, see https://foreignpolicy.com/2020/09/22/the-ethiopian-egyptian-water-war-has-begun/; on corruption, see https://www.hydroreview.com/2020/01/02/ethiopian-attorney-general-files-charges-related-to-the-6450-mw-grand-ethiopian-renaissance-dam-project/#gref.

[17] https://allafrica.com/stories/201905020321.html.

[18] For example, water for Hawassa eco-industrial park comes from boreholes and this method was planned for the other parks, but there were problems accessing ground water in Adama and a new strategy was devised, while the ground water in Mekele and Adama had to be treated before it could be used in electric boilers.

contract that Arvind signed with IPDC in Hawassa eco-industrial park, IPDC was responsible for the sustainable disposal of the waste. As of 2019, the sludge was being stored in the park until solutions were found, with 20 tons of sludge created a day. Hawassa is a resort town located on Lake Hawassa, in an otherwise rural area, so there were no industries located close to the park that could take the sludge as an input. In contrast, IPDC managers at Bole Lemi industrial park, located on the outskirts of the capital city Addis Ababa, sold their sludge to a local cement plant (Mathews, 2020). Without any other material exchanges to rely on for further usage, the waste would have to be transported to a facility far away, but there were no local firms interested in providing this service due to the high costs of transport and poor transport logistics available in Hawassa town. It became a question of how far and at what price the IPDC was willing to move what was essentially trash for further treatment given the financial constraints of the agency, an issue to which we return below.

IPDC staff discussed creating a sanitary landfill in Hawassa town or acquiring an industrial incinerator to derive energy for the ZLD plant itself and ash for brick production, but both options were too costly, particularly the sanitary landfill at an estimated cost of 12 million USD. Other options also existed such as the extraction of phosphates from the sludge to create a fertilizer, a needed product in Ethiopia to improve productivity in agriculture and thus an industry with good potential for inter-firm partnerships, but again financial pressures and government prioritization of resolving other challenges in the parks (see below) impeded IPDC from experimenting with any of these options.

5.2. Creating and Managing Learning Rents for Environmental Upgrading

IPDC was to take over managing the whole park infrastructure after a period of three years of knowledge transfer, and to take over the ZLD system after two years. Hawassa industrial park would then serve as the training ground for IPDC managers that would be sent to run the other parks. Twenty-nine operation managers from IPDC went to China in 2017 for training on how to manage an industrial park. After the first year of operations, the returning IPDC managers felt that they could manage general park issues and thus terminated the agreement with the China Corporation. The challenge came with learning to operate the ZLD system, which did not happen within two years.

The first management contract with Arvind Envisol established a learning partnership where expats from Arvind were to provide guidance and direction to the employees from IPDC for a technology transfer service fee of 1.2 million USD annually. However, the fee was not linked to performance criteria in terms of knowledge transfer to local managers, nor was the contract structured in such a way to incentivize Arvind to make sure that knowledge transfer occurred. At the same time, Arvind complained about the low quality of the engineers being placed for training and the high labor turnover among local workers.

The Ethiopia Investment Commission mediated a new agreement between IPDC and Arvind that included a clearer process for technology transfer. It had a phase-out plan, where three expats would be replaced every three months with local managers; established a senior management position within the ZLD plant to be filled by IPDC in order to manage local workers; and included the creation of a specific learning guide and structured learning process for IPDC workers. However, it still did not set strict performance criteria, and implementation lagged behind objectives: after six months into the new agreement, the senior management position from IPDC had not been filled, nor had any expats from Arvind been replaced.

Finally, the Commission turned to the possibility of a joint venture between IPDC and Arvind in order to share risks and eventually expand regionally in East Africa, positioning Ethiopia as a leader in this industry, but such negotiations were still underway in 2019. A joint venture agreement would provide more incentives for Arvind to ensure the profitable running of the ZLD system, and thus cost recovery in relation with tenants, but it would not necessarily lead to incentives for Arvind to ensure knowledge transfer to local workers and managers.

5.3. Governing Green Industrialization

The Ethiopian Investment Commission was created by the Prime Minister to improve relations with private investors, with support from foreign consultants to establish routines that reflected international best practices and to recruit a professional staff (Sutton, 2019). The resulting high level of capabilities within the Commission led to the relative success of the parks, especially within the Sub-Saharan Africa context. However, the Commission's priorities were investment attraction and retention in the parks and not its environmental features, as the country needed to increase exports and reduce pressure on the balance of payments. Thus, the Commission intentionally kept fees low during the planning of Hawassa eco-industrial park, as it was focused on attracting foreign supplier firms by marketing Ethiopia as a low-cost production country. This decision to charge investors low fees for park services created budgetary constraints and reduced the role that IPDC could play in driving broader circular economy initiatives.

IPDC receives fees for shed rental, park management and utility services, which are described in Table 4. However, the shed rental fees are too low, and the costs of running the ZLD system were underestimated. The feasibility study of Hawassa park estimated the costs of running the park at 20,116,000 USD annually. Even when the shed rent increases to 3 USD per square meter in the eleventh year of rental, IPDC total revenue will still be only 15 million USD. Part of the issue is that the water services provided by the ZLD system are three times cheaper for tenants (at 0.80 USD per cubic meter of water irrespective of the method being used to calculate the volume of water) than what the estimated costs to treat the water are (2 USD per cubic meter). Based on these calculations, the suppliers are not paying the full costs of the services and infrastructure provided in the park.[19]

PVH spearheaded the creation of a tenant's association in Hawassa eco-industrial park to facilitate joint action among supplier firms in the park and to solve collective problems. The director and deputy director

Table 4
IPDC expected revenues in Hawassa industrial park.

Price of rent per month per square meter (USD)*	2.00	2.50	2.75	3.00
	For the first 4 years of tenancy	For years 5–7	For years 8–10	For year 11 and onwards
Per month, total shed space: 402,680 square meters in 52 sheds	805.360	1.006.700	1.107.370	1.208.040
Total annual rent	9.664.320	12.080.400	13.288.440	14.496.480
Annual management fee (1.50 USD per square meter)	604.020	604.020	604.020	604.020
Total revenue: annual rent+ annual management fee	10.268.340	12.684.420	13.892.460	15.100.500

Note: Shed rental fees were raised in the third wave of parks in Adama and Dire Dawa, starting at 2.75 USD per month per square meter the first four years and going up to 4 USD by year 11.
Source: Created by the authors based on interviews and documents from IPDC.

[19] At the time of our research, none of the other eco-industrial parks were fully operational, so we could not yet assess their operational costs compared to revenue. Notably, the shed rental costs in the other parks were slightly higher than those for Hawassa.

of the Commission held frequent meetings with the association to discuss issues affecting firms' profitability such as inadequate transport logistics to the port, inefficient customs services, and low labor productivity due to high turnover and recruitment challenges arising from insufficient housing and transportation. At some point, though, the tenant's association stopped functioning well, and PVH served as the main voice in liaising with the Commission to solve these problems.

On park related issues, IPDC liaised bilaterally with firms to solve issues. In general, there was a lack of collaboration among investors and with IPDC, and IPDC had limited political authority without the Commission's support. For example, IPDC could not get investors to adhere to changes in the method for calculating use of services. Tenant contracts specified that they must pay according to water discharged to the ZLD, but the sheds only had meters to measure water flowing into the factories, and so tenants were charged for water used instead. IPDC wanted to add a water treatment fee based on the amount of wastewater discharged, to represent better the costs of treating the water, and came up with a new pricing method, but tenants refused to pay for discharged water. The conflict over paying for discharged water arose because tenants did not want to see their operational costs increase, especially when they were not yet profitable given the issues mentioned above, and cleaner production objectives were not reasons they invested in Ethiopia. Their investments were driven by buyer encouragement linked to the prospect of new orders, combined with the labor cost differential compared to Asian countries based on government estimates of starting wages as well as preferential access to the US market under the African Growth and Opportunity Act. However, it was taking longer than expected for the potential of Ethiopia as a new low-cost sourcing location to be realized.

Tense relations between the park and Hawassa municipal government authorities compounded the lack of joint actions at the park level. The municipal government was not involved in designing and running the park, but the Commission and IPDC park managers engaged municipal political leaders to help find solutions to issues undermining labor productivity in the park such as adequate housing, transport and food for migrant workers. The high costs of these amenities relative to workers' wages reduced the purchasing power of workers and put pressure on wage increases, while the municipal government wanted to check the rising informal settlements. Solutions were hard to achieve, as the municipal government saw the park as only bringing problems and no benefits for Hawassa town. The short-term benefits of the park included increasing export revenues, management fees for IPDC and jobs, and a better environmental profile, most of which did not directly benefit town residents as workers came from surrounding rural areas and the environmentally friendly technologies of the park did not reach the town. As De Marchi and Alford (2021) discuss, managing interests is key for GVC policies to succeed, and that is also the case in Ethiopia.

The lack of collaboration among stakeholders made it difficult to find joint solutions to the issues within and outside the park that led to low profitability and long lead times, resulting in Ethiopia not yet being a competitive sourcing location, especially compared to Bangladesh. Such collaboration was even more absent in relation to the 'eco' aspect of the parks, especially among tenants. As Mathews et al. (2018) argue, eco-industrial parks require supra-firm institutions that facilitate joint action among tenants and modes of exchange in a form of network governance. They explain the supra-firm network governance structures in Chinese industrial parks through which firms took joint actions to solve problems and close industrial loops, and in which municipal or provincial governments played key roles. The difference in Ethiopia is that industrial parks were new and the country was in the early phase of industrializing, with many collective action problems to solve; whereas, in the industrial parks in China, they had been operating for a long time but were now being 'greened', meaning that collaborative relations had been in place and firms' profitability was not in question.

6. Conclusion

Applying a conceptual approach that combines GVC, structural development economics and circular economy perspectives to the case of Ethiopia highlights that without more ambitious green industrial policy to create recycling industries, new host countries to apparel GVCs will be left with an eco-efficient thin industrialization. This is a better outcome than the current more polluting option, but brings few opportunities for embracing circular economy principles and the creation of new industries through vertical integration using recycled resources. Although the constraints to overcome in Ethiopia are high, the potential of eco-industrial development for newly industrializing countries exist if a broader systems approach to industrialization is taken.

Ethiopia's experience shows that buyers drove environmental upgrading but focused on eco-efficiency. In this case, it is the Ethiopian government that paid for eco-efficiency, while buyers, especially PVH, were largely the beneficiaries and to some extent foreign suppliers as they did not have to bear the full costs of these investments. The Commission did this to attract investors as well as to create a more sustainable textile and apparel export industry from the beginning. Creating eco-efficiency systems at the level of an industrial park ensures that more supplier firms meet environmental standards. Ethiopia benefited from the better environmental performance, job creation, and potential technology transfer regarding waste management systems. However, the resulting financial constraints on IPDC meant that it could not pursue further circular economy and waste management opportunities in Hawassa eco-industrial park without additional resources from the federal government, which itself faced budgetary and foreign exchange pressures and struggled to complete and staff the other parks, at least in the short term. GVC coupling and the interactions of the state and GVCs may only lead to thin outcomes unless states can truly foster domestic industries.

The value captured in Ethiopia from assembly factories is limited, and given foreign exchange controls in Ethiopia, foreign suppliers prefer to charge only assembly prices to their factories there, which means just the labour cost per garment sewn. The Commission recognized this limitation, combined with the pressures on foreign exchange, and encouraged foreign textile and other input firms to invest in and around the industrial parks, increasing the inputs available in the country. Vertical integration would reduce the lead time and make Ethiopia a more competitive sourcing location, but it would not significantly increase the value captured in the country. In this context, government subsidizing eco-efficiency environmental upgrading with some recycled resources (the ZLD system) is a limited return green industrial policy.

More ambitious green industrial policy by the government is required to achieve further economic gains from environmental upgrading. There is an opportunity for countries like Ethiopia to use apparel exports and the industrial parks to drive wider industrialization and value capture processes by shifting from linear production system to a more circular economy system characterized by apparel inputs produced from recycled resources; closed loop textile and apparel production systems; further development of park management capabilities, especially linked to environmental capabilities; and the development of inter-sectoral linkages through waste management services and industrial symbiosis. There are already private firms in Ethiopia engaged in producing inputs and apparel products from recycled resources. For example, a foreign firm buys cotton fabric remnants for demanufacturing into fibres and then remanufacturing into cotton blended yarns, knitted fabric and clothing. It also has closed loop production systems and does not use chemicals or dyes.[20] There is also a local firm that recycles water bottles into flex and exports it to firms that use it to make polyester fibre. The owner applied for a shed in the

[20] The firm is Etur, established in 2010 as a subsidiary of the Turkish textile firm Yuksel Tekstil. See http://www.eturtextile.com.

expanded Bole Lemi industrial park and a loan from the Development Bank of Ethiopia in order to invest in making fibre out of the flex and then yarn, for sell to apparel firms in Ethiopia.[21]

The experience of Ethiopia shows that low-income governments may have to pursue green industrialization in two phases, where the first phase is establishing successful industrial clusters with sustainable waste management practices, and the second phase focuses on adding circular economy initiatives. In phase two, government industrial policy can be used to encourage investments in recycling industries and incentivize apparel and textile firms to buy recycled raw material locally, where value capture opportunities are higher. Furthermore, industrial policy can also be used to build IPDC capabilities to coordinate and incentivize linkages to other industries such as local production of chemicals for the ZLD process and mining of the ZLD waste to recycle chemicals. Government industrial policy could focus on creating new industries linked to the apparel sector, and leave it to global buyers to pressure and support increased eco-efficiency and circular economy initiatives through investments in new equipment and processes within supplier firms.

The economic rationale for green industrialization is largely at the country level and not the level of the supplier firm. The benefits accrue to individual firms only with coordinated collective action and investments at the industry level and in related industries in recycling and waste management as well as industries receiving waste as inputs. That is why government industrial policy is necessary.

Creating circular industrial economies requires accessing and learning how to use equipment at the technological frontier as well as indigenous innovations in alternative and recycled raw materials, but this is not impossible. Structural development economists have long argued that the diffusion of foreign technologies and the building of local firms' technological capabilities are at the heart of economic development (Amsden, 2001; Lee and Malerba, 2018). It is the same with green industrialization. Mathews (2017) argues that given the Schumpeterian creative destruction of these technologies, green industrialization eventually will become just 'industrialization', setting the competitive norm. Green industrialization requires industrial policies that are not significantly different from traditional industrial policies that emphasized the diffusion of foreign technology (emulation) and capability building among local firms, industrial clusters and government agencies. But they do require a systems approach rather than just an industry one, and thus are more challenging for low-income country governments still building government capabilities and institutions to implement industrial policy.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was financed by the Danish Council for Independent Research in the Social Sciences, grant number DFF 4182-00099. Federico Jensen also acknowledges a travel grant by the Institute of Social Science and Business at Roskilde University to conduct fieldwork in Ethiopia.

References

Alford, M., Phillips, N., 2018. The political economy of state governance in global production networks: change, crisis and contestation in the South African fruit sector. Rev. Int. Polit. Econ. 25, 98–121. https://doi.org/10.1080/09692290.2017.1423367.

Altenburg, T., Vrolijk, K., 2020. Greening structural transformation: what role for industrial hubs? In: Oqubay, A., Lin, J.Y. (Eds.), The Oxford Handbook of Industrial Hubs and Economic Development. Oxford University Press, Oxford.

Amsden, A., 2001. The Rise of "The Rest": Challenges to the West from Late-Industrializing Economies. Oxford University Press, New York, NY.

Anner, M., 2020. Squeezing workers' rights in global supply chains: purchasing practices in the Bangladesh garment export sector in comparative perspective. Rev. Int. Polit. Econ. 27, 320–347.

Appelbaum, R., 2008. Giant transnational contractors in EastAsia: emergent trends in global supply chains. Compet. Chang. 12, 69–87.

Bair, J., Gereffi, G., 2003. Upgrading, uneven development, and jobs in the North American apparel industry. Global Networks 3, 143–169.

Best, M., 2018. How Growth Really Happens: The Making of Economic Miracles through Production, Governance, and Skills. Princeton University Press, Princeton, NJ.

Chertow, M., Ashton, W., 2009. The social embeddedness of industrial symbiosis linkages in Puerto Rican industrial regions. In: Boons, F., Howard-Grenville, J. (Eds.), The Social Embeddedness of Industrial Ecology. Edward Elgar, Cheltenham.

De Marchi, V., Alford, M., 2021. State policies and upgrading in global value chains: a systematic literature review. J. Int. Bus. Policy. https://doi.org/10.1057/s42214-021-00107-8.

De Marchi, V., Di Maria, E., Micelli, S., 2013a. Environmental strategies, upgrading and competitive advantage in global value chains. Bus. Strateg. Environ. 22, 62–72.

De Marchi, V., Di Maria, E., Ponte, S., 2013b. The greening of global value chains: insights from the furniture industry. Compet. Chang. 17, 299–318.

De Marchi, V., Di Maria, E., Krishnan, A., Ponte, S., Barrientos, S., 2019. Environmental upgrading in global value chains. In: Ponte, S., Gereffi, G., Raj-Reichert, G. (Eds.), Handbook on Global Value Chains. Edward Elgar Publishing, Cheltenham, pp. 310–323.

Fashion on Climate, 2020. Fashion on Climate: How the Fashion Industry Can Urgently Act to Reduce its Greenhouse Gas Emissions. McKinsey & Company. Retrieved from: http://www2.globalfashionagenda.com/initiatives/fashion-on-climate/.

Gereffi, G., 1999. International trade and industrial upgrading in the apparel commodity chain. J. Int. Econ. 48, 37–70.

Goger, A., 2013. The making of a 'business case' for environmental upgrading: Sri Lanka's eco-factories. Geoforum 47, 73–83.

Hardy, V., Hauge, J., 2019. Labour challenges in Ethiopia's textile and leather industries: no voice, no loyalty, no exit? Afr. Aff. 118, 712–736.

Havice, E., Campling, L., 2017. Where chain governance and environmental governance meet: Interfirm strategies in the canned tuna global value chain. Econ. Geogr. 93, 292–313. https://doi.org/10.1080/00130095.2017.1292848.

Hickel, J., 2020. What does degrowth mean? A few points of clarification. Globalizations. https://doi.org/10.1080/14747731.2020.1812222.

Hirschman, A., 1958. The Strategy of Economic Development. Yale University Press, New Haven.

Horner, R., 2017. Beyond facilitator? State roles in global value chains and global production networks. Geogr. Compass 11, e12307. https://doi.org/10.1111/gec3.12307.

Horner, R., Alford, M., 2019. The roles of the state in global value chains. In: Ponte, S., Gereffi, G., Raj-Reichert, G. (Eds.), Handbook on Global Value Chains. Edward Elgar Publishing, Cheltenham, pp. 555–569.

Humphrey, J., Schmitz, H., 2002. How does insertion in global value chains affect upgrading in industrial clusters? Reg. Stud. 36, 1017–1027.

Kaplinsky, R., 2005. Globalization, Poverty and Inequality: Between a Rock and a Hard Place. Polity Press, Cambridge, MA.

Khan, M., Ponte, S., Lund-Thomsen, P., 2020. The 'factory manager dilemma': purchasing practices and environmental upgrading in apparel global value chains. Environ Plan A 52, 766–789.

Khattak, A., Stringer, C., Benson-Rea, M., Haworth, N., 2015. Environmental upgrading of apparel firms in global value chains: evidence from Sri Lanka. Compet. Chang. 19, 317–335.

Khattak, Amira, Stringer, Christina, 2017. Environmental Upgrading in Pakistan's Sporting Goods Industry in Global Value Chains: A Question of Progress? Bus. Econ. Rev. 9 (1), 43–64.

Klooster, D., Mercado-Celis, A., 2016. Sustainable production networks: capturing value for labour and nature in a furniture production network in Oaxaca, Mexico. Regional Studies 50, 1889–1902. https://doi.org/10.1080/00343404.2015.1071915.

Lee, Keun, Malerba, Franco, 2018. Economic Catch-Up by Latercomers as an Evolutionary Process. In: Modern Evolutionary Economics: An Overview. Edited by Richard Nelson et al. Cambridge University Press, Cambridge, pp. 172–207.

Lollo, N., O'Rourke, D., 2020. Measurement without clear incentives to improve: the impacts of the Higg facility environmental module (FEM) on apparel factory practices and performance. Pre-print - SocArXiv. https://doi.org/10.31235/osf.io/g67d8. August 3.

Lund-Thomsen, P., Lindgreen, A., 2014. Corporate social responsibility in global value chains: where are we now and where are we going? J. Bus. Ethics 123, 11–22.

Mathews, J., 2017. Global Green Shift: When Ceres Meets Gaia. Anthem Press, London.

Mathews, J., 2020. Greening industrial policy. In: Oqubay, A., Cramer, C., Chang, H.-J., Kozul-Wright, R. (Eds.), The Oxford Handbook of Industrial Policy. Oxford University Press, Oxford.

Mathews, J., Tan, H., Hu, M.-C., 2018. Moving to a circular economy in China: transforming industrial parks into eco-industrial parks. Calif. Manag. Rev. 60, 157–181.

[21] The firm was established in 2017. Interview with the firm owner, Addis Ababa, August 2018.

Medhin, H., Mekonnen, A., 2019. Green and climate-resilient transformation in Ethiopia. In: Cheru, F., Cramer, C., Oqubay, A. (Eds.), The Oxford Handbook of the Ethiopian Economy. Oxford University Press, Oxford.
Mihretu, M., Llobet, G., 2017. Looking Beyond the Horizon: A Case Study of PVH's Commitment in Ethiopia's Hawassa Industrial Park. World Bank, Washington, DC.
Olayide, O.E., 2015. Industrial ecology, industrial symbiosis and eco-industrial parks in Africa: issues for sustainable development. Int. Perspect. Indus. Ecol. 30–45 https://doi.org/10.4337/9781781003572.00011.
Oqubay, A., 2019. Industrial policy and late industrialization in Ethiopia. In: Cheru, F., Cramer, C., Oqubay, A. (Eds.), The Oxford Handbook of the Ethiopian Economy. Oxford University Press, Oxford.
Oqubay, A., Kefale, D., 2020. a strategic approach to industrial hubs: learnings in Ethiopia. In: Oqubay, A., Lin, J.Y. (Eds.), The Oxford Handbook of Industrial Hubs and Economic Development. Oxford University Press, Oxford.
Palpacuer, F., 2008. Bringing the social context Back in: governance and wealth distribution in global commodity chains. Econ. Soc. 37, 393–419.
Palpacuer, F., Gibbon, P., Thomsen, L., 2005. New challenges for developing country suppliers in global clothing chains: a comparative European perspective. World Dev. 33, 409–430.
Peggels, Anna, 2014. Why We Need a Green Industrial Policy. In: Peggels, Anna (Ed.), Green industrial policy in emerging countries. Routledge, London, pp. 1–8.
Plank, L., Staritz, C., 2015. Global competition, institutional context, and regional production networks: up- and downgrading experiences in Romania's apparel industry. Camb. J. Reg. Econ. Soc. 8, 421–438.
Ponte, S., 2019. Business Power & Sustainability in a World of Global Value Chains. Zed Books, London.
Ponte, S., 2020. Green capital accumulation: business and sustainability management in a world of global value chains. New Polit. Econ. 25, 72–84.
Poulsen, R.T., Ponte, S., Lister, J., 2016. Buyer-driven greening? Cargo-owners and environmental upgrading in maritime shipping. Geoforum 68, 57–68.
PVH, 2019. Corporate Responsibility Supply Chain Standards and Guidelines For Meeting PVH's Shared Commitment. Retrieved from [25.09.2020]: https://responsibility.pvh.com/resources/.
Quantis, 2018. Measuring Fashion: Insights from the Environmental Impact of the Global Apparel and Footwear Industries Study. http://www.quantis-intl.com/measuring-fashion-report-2018/.
Rodrik, D., 1995. Getting interventions right: how South Korea and Taiwan grew rich. Econ. Policy 10, 53–107.
Sako, M., Zylberberg, E., 2019. Supplier strategy in global value chains: shaping governance and profiting from upgrading. Soc. Econ. Rev. 17, 687–707.
Schrank, A., 2004. Ready-to-wear development? Foreign investment, technology transfer and learning by watching in the apparel trade. Social Forces 83, 123–156.
Stahel, W., 2019. The Circular Economy: A User's Guide. Routledge, London.
Sturgeon, T., Whittaker, H., 2019. Compressed development. In: Ponte, S., Gereffi, G., Raj-Reichert, G. (Eds.), Handbook on Global Value Chains. Edward Elgar, Cheltenham, pp. 452–465.
Sutton, J., 2019. Institution building for industrialization: the case of the Ethiopian investment commission. In: Cheru, F., Cramer, C., Oqubay, A. (Eds.), The Oxford Handbook of the Ethiopian Economy. Oxford University Press, Oxford.
Taplin, I., 2014. Global commodity chains and fast fashion: how the apparel industry continues to re-invent itself. Compet. Chang. 18, 246–264.
Tokatli, N., 2013. Toward a better understanding of the apparel industry: a critique of the upgrading literature. J. Econ. Geogr. 13, 993–1011.
Toner, P., 1999. Main Currents in Cumulative Causation: The Dynamics of Growth and Development. Macmillan Press, Basingstoke.
Wang, Q., Deutz, P., Chen, Y., 2017. Building institutional capacity for industrial symbiosis development: a case study of an industrial symbiosis coordination network in China. J. Clean. Prod. 142, 1571–1582. https://doi.org/10.1016/j.jclepro.2016.11.146.
Werner, M., 2019. Geographies of production I: global production and uneven development. Prog. Hum. Geogr. 43, 948–958.
Whitfield, L., Staritz, C., 2021. The learning trap in late industrialization: local firms and capability building in Ethiopia's apparel export industry. J. Dev. Stud. 57, 980–1000.
Whitfield, L., Therkildsen, O., Buur, L., Kjær, A., 2015. The Politics of African Industrial Policy: A Comparative Perspective. Cambridge University Press, Cambridge, UK.
Whitfield, L., Staritz, C., Morris, M., 2020. Global value chains, industrial policy and economic upgrading in Ethiopia's apparel sector. Dev. Chang. 51, 1018–1043.
Yoon, S., Nadvi, K., 2018. Industrial clusters and industrial ecology: building 'eco-collective efficiency' in a South Korean cluster. Geoforum 90, 159–173. https://doi.org/10.1016/j.geoforum.2018.01.013.