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**Article (Accepted version)
(Refereed)**

Original citation:

Alexander, Rachel (2018) *Sustainability in global production networks – introducing the notion of extended supplier networks*. [Competition and Change](#). ISSN 1024-5294 (In Press)
DOI: [10.1177/1024529418768606](https://doi.org/10.1177/1024529418768606)

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Sustainability in global production networks – Introducing the notion of extended supplier networks

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ACCEPTED MANUSCRIPT FOR COMPETITION AND CHANGE 03/2018

Abstract

Research considering globalized production as taking place within global production networks and global value chains has potential to provide insights into the challenges of sustainable production. However, studies employing these approaches to look at manufactured products have often concentrated on connections between lead buyers and upper tier suppliers and given insufficient attention to exploring interactions across all stages of production. In this article, the concept of extended supplier networks is introduced to address this gap by explicitly looking at how all stages of production are connected. The extended supplier network model that is presented provides an analytical framework that enables multiple scales of analysis in the study of sustainability challenges.

Keywords

Global value chains, global production networks, sustainability, governance, complex adaptive systems

Introduction

Producing goods sustainably is a pressing global issue. The concept of *sustainability* has been used with a wide variety of meanings in studies looking at global value chains (GVCs) and global production networks (GPNs) (Krauss and Krishnan, 2017). In this article, sustainable production is considered according to the definition associated with the United Nations' Sustainable Development Goal 12, which seeks to ensure sustainable consumption and production patterns. This definition describes

sustainable production as aiming ‘at “doing more and better with less,” increasing net welfare gains from economic activities by reducing resource use, degradation and pollution along the whole lifecycle, while increasing quality of life (United Nations, 2018)’.

Global manufacturing processes have been associated with numerous sustainability challenges that have tangible social, economic and environmental implications for individuals and communities (Lund-Thomsen and Lindgreen 2014). These challenges can be caused by activities at any stage from raw material production to final product assembly. For modern manufacturing practices, often involving separate facilities carrying out fragmented activities, production has been considered to be driven by brands and retailers (Gereffi, 1994). Empirical research looking at the role these lead firms play in addressing sustainable production challenges has focused on the practices of upper tier suppliers (Barnes et al., 2016; Lund-Thomsen and Nadvi, 2010; Mezzadri, 2012). Yet, expectations for many businesses’ sustainability engagement have expanded to include addressing a broad range of challenges across all stages of production (Schrempf-Stirling et al., 2013). Further research is needed to better understand the dynamics shaping practices involved in all stages of production. This article addresses this gap by asking how the complex systems of production connecting diverse sets of producers across multiple locations are organized.

The GVC and GPN frameworks have both been used to conduct research on aspects of relationships in globally fragmented production (Coe and Yeung, 2015; Gereffi et al., 2005). While relevant insights can be drawn from work using both frameworks, this article contends that the GPN approach is better suited for exploring challenges related to sustainable production. The model presented in this article can be used to operationalize a GPN approach to study this topic. This involves explicitly focusing on the network characteristics of the set of businesses directly responsible for creating a manufactured product by carrying out all processes starting with raw material production and ending with the final item. These businesses, which are a subset of a GPN that encompasses a varied set of actors, are considered here as an extended supplier network (ESN). ESNs often involve diverse businesses being connected through multiple and

intersecting vertical pathways made up of buyer–seller links. Identifying an ESN as a unit of analysis draws attention to the complex structures that facilitate production processes and other forms of flows, which connect the businesses involved.

Additionally, while GVC and GPN research has provided insight into how firms relate to other actors, most studies have not focused on exploring how production is organized within an individual producer organization. Within these frameworks, production has been described as taking place in a ‘black box’ (Coe et al., 2008: 277). In order to better understand how production is organized, it can be viewed as being made up of a set of activities that are embedded in a productive system. Wilkinson (1983: 417) explains that, ‘productive systems exist where the forces of production combine in the process of production’. Productive systems can be defined as, involving ‘labour, the means of production, the social system in which production is organized, the structure of ownership and control over the productive activity and the social, political and economic framework within which the processes of production operate (Wilkinson, 2003: 10)’. The way a productive system is organized determines the sustainability of production. To understand sustainability challenges in fragmented ESNs requires explicitly looking at producers as being part of productive systems.

This article makes a number of distinct conceptual contributions to the literature on sustainability in GPNs. The ESN model’s explicit identification of producers involved in all production activities addresses a limitation of past applications of the GPN and GVC approaches to examining buyer-driven manufactured goods. Namely, their concentration on upstream activities, with emphasis on how lead firms shape production processes of upper tier suppliers without sufficient consideration of the rest of the producers involved (Bair, 2008). Exploring manufacturing through the ESN model also provides a way to conduct research which can elucidate the dynamics involved in fragmented production processes which can connect distinct productive systems. In addition, another contribution of this model lies in providing an analytical framework that enables multiple scales of analysis in the study of sustainability challenges. These varied scales are important because the aspects of production that are problematic and the dynamics shaping relevant behaviours can be understood differently when viewed for

example, as being shaped by buyer–seller relationships versus being the consequence of local historical developments.

The article is structured as follows. The next section explains how the GVC and GPN approaches provide insight for answering questions about sustainable production. The third section outlines key considerations involved in understanding challenges related to sustainable production. The fourth section explains the ESN model and highlights the value of focusing on an ESN as a unit of analysis, particularly by identifying key features of the network structure, outlining benefits of viewing the structure at different scales and indicating how the structure can facilitate various forms of flows. The final section provides a conclusion suggesting ideas for applying the ESN model.

Understanding the organization of globalized production

The GVC and GPN frameworks (Coe and Yeung, 2015; Gereffi, 1994; Gereffi et al., 2005; Henderson et al., 2002) both provide insights for understanding how globalized production is organized. They have generated key findings which can be used to support explorations of sustainability challenges, which are incorporated into the ESN model presented in this article. Research based within the GVC framework has strengths in providing ways to examine vertical buyer–seller connections. The GPN framework draws attention to additional factors influencing production with businesses seen as being subject to path dependency (Henderson et al., 2002), shaped by their embedded locations (Henderson et al., 2002; Hess, 2004) and exposed to multiple governance forces (Coe and Yeung, 2015). These frameworks are reviewed below.

GVCs

The concept of a ‘global value chain’ was first described as a ‘global commodity chain’ (GCC). According to Bair (2008: 348), the GCC framework described the systems of production that developed since World War II, moving away from the World Systems tradition (Hopkins and Wallerstein, 1986) by focussing less on ‘the macro, holistic

structure of the world capitalist economy and more [on] the organisational field of contemporary global industries'. This new focus on business interactions provided a way to understand the dynamics and importance of transnational production in a world where companies can work across national borders and their activities have global impacts.

A major consideration that has been explored in research using a GVC approach is identifying drivers of production. Gereffi (1994) proposed that GCCs are governed by lead firms, which control access to major resources such as product design, new technologies, brand names or consumer demand and are the most profitable in an industry. These firms can be located upstream or downstream from manufacturing, with chains divided into those that are buyer-driven and those that are producer-driven. Buyer-driven industries are seen as those in which brands and retailers are lead firms and producer-driven industries are seen as those in which manufacturers are lead firms. While this work brought valuable insight for certain industries, it was shown not to be applicable in all cases (Gereffi et al., 2001; Henderson et al., 2002). It has since been argued that all production is moving towards the buyer-driven model (Gibbon et al., 2008). While some studies using GVC approaches have drawn attention to diversity of governance across chains by introducing the idea of bi-polar and multi-polar governance (Fold, 2002; Ponte and Sturgeon, 2014), these dynamics require further investigation. Explicitly considering how governance flows through ESN structures can facilitate a better understanding of these processes.

While in theory, the GVC concept, particularly research which has attempted to explore the role of chain drivers, can incorporate activities at all stages of production, much of the research on industries considered as buyer-driven has focused on interactions between lead firms and their upper tier suppliers (for example, Kadarusman and Nadvi, 2013; Schmitz, 2006). Two approaches to exploring governance in buyer–seller relationships have been commonly used in GVC research. One looks at power dynamics in these relationships, such as the prominent Gereffi et al. (2005) governance framework which classifies lead firms' interaction with first-tier suppliers based on their ability to control the suppliers. The other looks at normative expectations that shape interactions.

Such an approach can be seen in Ponte and Gibbon's (2005) presentation of conventions which shape activities and decisions in commercial transactions.

Distinguishing between scales which have been considered in GVC research, Ponte and Sturgeon (2014) describe coordination within direct buyer–seller relationships as micro governance and governance of an entire chain as macro governance and introduce the term meso governance which is the process through which governance flows across micro connections passing through multiple buyer–seller links. Meso governance is very important for exploring how the impact of governance pressures directly targeted at one part of production travels to other producers. Beginning to uncover the dynamics of meso governance, Nadvi and Raj-Reichert (2015) have studied experiences of second-tier suppliers in the electronics industry. However, further research is needed to better understand the dynamics of what buyer-driven governance means when looking at production processes fragmented between numerous suppliers. Conceptualizing the links between businesses as forming an ESN provides a way to study meso governance processes.

A major area of focus within GVC research has been upgrading. Governance by lead buyers has been found to shape suppliers' potential for upgrading. While much work on GVCs has focused on opportunities for economic upgrading (Schmitz, 2006), more recent approaches have expanded to include social and environmental components (Milberg and Winkler, 2011; De Marchi et al., 2013; Barrientos et al., 2011). These three forms of upgrading can contribute to addressing sustainability challenges.

With some key exceptions, which are discussed below, research using the GVC approach has concentrated on vertical commercial relationships. Although the model itself is relatively comprehensive, in practice, studies using this approach have not often incorporated how businesses interact with their surroundings. While the GVC's focus on vertical relationships may exclude important factors, its in-depth research into these relationships provides useful insights for exploring challenges related to sustainable production.

GPNs

The GPN framework moves beyond a vertical focus to incorporate actors external to production processes more centrally into the analysis. This is crucial when seeking to explain sustainability challenges. According to Coe et al. (2008), GPNs endeavour to cover all relevant sets of actors and relationships. The GPN framework has been defined as, ‘an organisational arrangement, comprising interconnected economic and non-economic actors, coordinated by a global lead firm and producing goods or services across multiple geographical locations for worldwide markets (Coe and Yeung, 2015: 1–2)’. GPNs have been considered economic, political, social and cultural phenomena (Coe et al., 2008; Levy, 2008). The GPN approach advances three dynamics that shape producers’ activities, which have often been underexplored through the GVC lens, namely: (i) evolutionary processes, (ii) embeddedness and (iii) pressures from diverse governance actors.

First, the evolutionary nature of networks is an important characteristic. Network structures, which can change over time, are seen to be shaped by processes of path dependency (Henderson et al., 2002). Yeung and Coe (2015) emphasize the importance of taking into account dynamic competitive drivers in shaping the emergence of these structures. When exploring challenges related to sustainable production, these forces which shape how production is organized cannot be overlooked.

Second, while the GVC approach has emphasized governance as taking place through vertical buyer–seller relationships, the GPN framework stresses the importance of embeddedness. Three types of embedded location are defined as territorial, network and societal (Henderson et al., 2002; Hess, 2004). Through experiencing multiple forms of embeddedness, production of the same product in different locations can involve very diverse processes.

Being embedded within a particular territory is a crucial factor shaping production practices. Important territorial considerations that have been highlighted in GPN literature include how places affect and are affected by flows of capital, labour, knowledge and power (Henderson et al., 2002); how diverse actors are bounded at different scales (Henderson et al., 2002); and the need to look at multiple scales

depending on the type of questions being considered (Coe and Yeung, 2015). All GPNs can be seen to be embedded in multi-scalar regulatory systems, which involve governance from various sources (Alford, 2016; Coe et al., 2008).

Producers in a GPN are also considered as being embedded within a network, which involves relationships between a set of actors. Hess (2004: 177) describes that network embeddedness involves

‘the structure of relationships among a set of individuals and organisations regardless of their country of origin or local anchoring in particular places. It is most notably the “architecture,” durability and stability of these relations, both formal and informal, which determines the actors’ individual network embeddedness (the relational aspect of network embeddedness) as well as the structure and evolution of the network as a whole (the structural aspect of network embeddedness).’

The third type of embeddedness that can be considered for actors within a GPN is societal embeddedness. This form of embeddedness is seen as the influence of an actor’s background including cultural and political aspects (Hess, 2004). Societal location can link producers working in different territorial and network locations. For example, producers can be part of the same ethnic group while working across multiple locations.

Finally, a third dynamic advanced by the GPN approach is the role of diverse governance actors. While the forms of governance described in GVC literature often focus on buyers’ ability to influence suppliers’ upgrading potential, sustainability, which is affected by this type of governance, is also affected by a much wider range of governance forces. Drawing attention to this issue, Coe and Yeung (2015: 15) present examples of members of GPNs as ‘supranational organisations, government agencies, trade unions, employer associations, NGOs, and consumer groups’.

An important contribution of the GPN concept is its explicit emphasis on the non-linear structure of relationships involved in globalized production. Coe et al. (2008: 273) describe that GPNs are not made up of merely top-down relationships but involve ‘dynamically inter-connected and simultaneous processes’ with asymmetrical power relationships. This understanding is crucial for exploring challenges involved in

sustainable production. The ESN model presented in this article is a tool to help with investigating these dynamics.

Vertical versus horizontal governance and the challenges of sustainable production

The strengths of the GVC and GPN frameworks can be brought together to conduct needed research on challenges related to sustainable production. Bolwig et al. (2010) highlight the potential for the GVC framework to assist in research related to sustainability. GPN analysis enhances this ability by providing a way to look at global production systems that takes into account the complexity of how the systems function. A comparison of key features of the GVC and GPN approaches is presented in Table 1. The GVC approach focuses on the roles of lead firms and provides in-depth exploration into vertical relationships. The GPN approach incorporates a broad set of actors interacting across a network structure. These interactions are shaped by evolutionary processes, embeddedness and pressure from multiple governance actors. However, these differences between the two frameworks are not always clearly distinguished. For example, some GVC studies have incorporated considerations of embeddedness. A notable example is found in Neilson and Pritchard’s (2009) research on tea production in India which used a self-described institutionally enhanced GVC approach.

Table 1. Understanding governance for sustainable production

	GVC Approach	GPN Approach
Key Actors	Producers, brands and retailers	Wide set of actors including commercial and non-commercial
Key Relationships	Buyer-Seller vertical relationships	Multiple actors interacting across a complex network

Source: Author’s Construction (drawing from Coe et al., 2008; Coe and Yeung, 2015; Gereffi and Fernandez-Stark, 2016; Gereffi et al., 2005; Henderson et al., 2002)

Bringing together concepts which have been prominent in the geographically based GPN approach with the linearly focused GVC approach leads to considering vertical governance relationships alongside a broader set of governance pressures, which

when territorially based can be considered as horizontal governance pressures. Following Humphrey and Schmitz' (2000) work which highlights the importance of paying attention to the intersection of horizontal governance in industrial clusters and vertical governance in GVCs, several GVC studies have explicitly explored this perspective. Notably, Bolwig et al. (2010) developed a framework for considering impacts of horizontal and vertical intersections for agricultural production and Gereffi and Lee (2016) present a framework for looking at these intersections for businesses in industrial clusters. Additionally, a number of studies have focused on production taking place in clusters that have direct connections to global buyers (Giuliani et al., 2005; Knorringa and Nadvi, 2016; Lund-Thomsen and Nadvi, 2010; Lund-Thomsen and Pillay, 2012; Mezzadri, 2014; Nadvi and Halder, 2005). These studies have emphasized the importance of cluster level institutions and collective action of cluster-based businesses. All of these approaches deal with the intersection of vertical and horizontal governance, which is an important consideration for understanding sustainability challenges.

When seeking to address challenges with sustainable production, it is important to also consider processes taking place across all tiers of fragmented business relationships. Expanding the conceptions of previous GVC and GPN research, which has analysed the intersection of vertical and horizontal governance, this article proposes a model that enables an exploration of a system involving a large and diverse set of production processes taking place in multiple locations connected through a network structure. Before moving on to discuss the details of the ESN model, the following section presents key considerations for addressing challenges related to sustainable production.

Sustainability in globally fragmented production

As described above, final manufactured products are often the outcome of work carried out by many specialized businesses responsible for different stages of production. Sustainability challenges across fragmented processes can vary dramatically. For example, the types of sustainability challenges faced during raw material production, such as toxic substances being used during mineral mining, may significantly differ from those faced during the assembly of intermediary components, such as lack of workers'

rights at a factory. When questioning how to achieve sustainable production for a final product, it is important to consider all stages.

The process of seeking to address sustainability challenges can be broken down into four key considerations. The first consideration is identifying the challenges. Technical tools for identifying sustainability challenges have been developed, such as life-cycle analysis and life-cycle sustainability analysis (LCSA) (Guinée et al., 2011). While this may seem like a straight forward task, it can involve several challenges.

One challenge lies in identifying the actors involved in a fragmented production system. Each business contributing to production can have various suppliers and subcontractors which results in many inter-firm relationships being included in making a final product. Additionally, manufactured items often involve networks that can have branches that touch down in multiple territories. For example, a manufacturer of a simple product, such as a hammer, may buy wood, steel, glue and varnish from multiple suppliers in different countries, in turn each of its suppliers may have multiple suppliers for their inputs. The set of actors could be much larger for a product with many component parts, such as a car. Another challenge is that the transactions taking place during the process of a product being manufactured might involve intermediary firms which do not share identifying information to either the buyer or the seller. As many industries do not have formal processes for trading inputs as they move across fragmented production networks, it is often difficult to identify all the businesses involved in the creation of one product.

In addition to being able to identify all businesses involved in production, another concern is that the identification of sustainability challenges can be contested and based on how an issue is framed (McAdam, 1996; Zald, 1996). While traditional life-cycle-analysis involved a limited definition of environmental outputs, LCSA includes social challenges which can be more difficult to understand and identify. Many challenges related to working conditions are difficult to observe and measure. Barrientos and Smith (2007) distinguish between measurable standards, which can be monitored through inspections, and enabling rights, such as freedom of association, which can be difficult

for external auditors to observe. Additionally, sustainability challenges can be viewed differently from the perspectives of diverse stakeholder groups (Krauss, 2017).

Another issue to consider is that multiple sustainability challenges can occur during the creation of one product. This can involve varying challenges across progressive stages of production or the same component facing distinct challenges at different production sites. For example, a company that makes shirts may use cotton from diverse sources. Comparing cotton production for some of the world's largest producers, the USA uses highly mechanized practices and India uses mostly manual processes, both of which have been associated with different sustainability challenges. Due to all of these factors, identifying the businesses involved in a specific network and classifying challenges are complex problems in themselves. The ESN concept described in the following section helps to visualize the multiple branches that need to be considered when trying to identify sustainability challenges during the production of a manufactured product.

The second key consideration for addressing sustainability challenges once the nature of the challenge has been established is identifying potential solutions. For many products, multiple production methods are known and new processes are being developed that are more sustainable than processes that are currently being used. Alternate options for organizing production create possibilities for using processes that do not create sustainability challenges. However, with many options, making a good choice is not always clear cut. Sometimes a proposed solution to an existing sustainability challenge can create new challenges. For example, addressing an environmental concern may result in job losses. These factors make the identification of sustainable solutions a difficult process.

Additionally, the existence of alternative options does not mean that dominant practices will change. While the first two key considerations are important, improving the sustainability of production is not simply a technical issue that involves matching an identified sustainability challenge with a new process that addresses the challenge. Two additional key considerations for addressing sustainability challenges are identifying why

the problematic practice is being used and how to stimulate change. GVC- and GPN-based research which has explored how globalized production is organized can help with understanding the way that businesses are connected throughout the production of manufactured goods. Analysis rooted in these approaches is particularly useful for considering why current practices are being used. Better knowledge of the causes of sustainability challenges and the dynamics of the networks involved in production can help with identifying options for how change can be promoted.

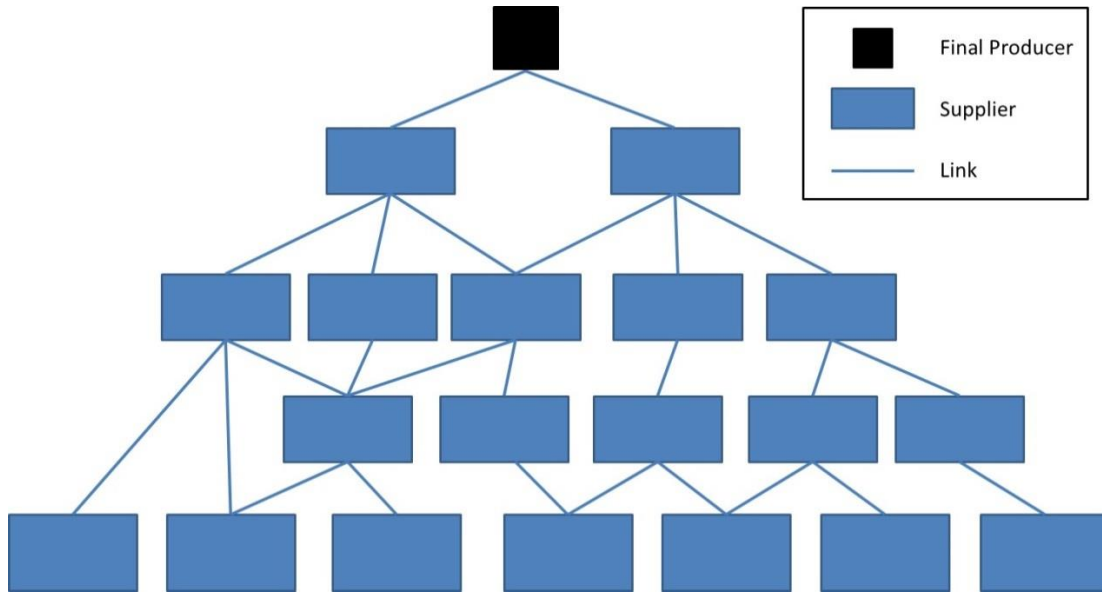
Understanding sustainability challenges through exploring ESNs

The ESN model proposed in this article can help with understanding all four key considerations of addressing sustainability challenges. The first part of this section provides a more detailed definition of an ESN. This is followed by a discussion of the structure of the network, the importance of scale when studying the network and how the model facilitates analysis of diverse types of flows that can shape sustainability challenges.

Defining an ESN

The ESN model considers production as taking place across a set of relationships structured as a complex network and thus relies on a GPN framework as its base. An ESN is defined as incorporating all businesses, including producers and intermediaries, directly involved in the creation of a final product (see Figure 1). This set of businesses is embedded within a GPN. Individual businesses are connected through buyer–seller links that form multiple and intersecting vertical pathways tying together a diverse set of producers to a final product. Each business can have numerous buyers and suppliers.

Figure 1. An extended supplier network



An important understanding derived from considering production as being organized in this way is it highlights diversity in vertical pathways. The creation of one product moving from the first stage of production at the bottom of the diagram up to the final producer at the top can involve multiple simultaneous pathways. These pathways can connect various businesses working in different productive systems.

The word ‘extended’ is used to draw attention to a wider group than is generally included within studies looking at governance of production in GVCs and GPNs, which have often focused on looking at connections between lead buyers and a set of first-tier suppliers responsible for the final stages of manufacturing. As discussed above, sustainability challenges can be connected to practices in earlier stages of production. The extended group includes those involved with the initial raw material production to those responsible for the final stages of product assembly.

The term ‘supplier’ is used instead of ‘supply’ to invoke the active nature of members of these networks. Additionally, the word ‘supplier’ indicates that, in this context, the producers are looked at as creating inputs for other businesses. Specifically, businesses are included in the ESN if they contribute to the production of an identified final product. Furthermore, this term solely refers to producers and not the wider set of actors that support production.

Finally, the word ‘network’ is used as it is seen to more adequately represent the structure of relationships than ‘chain’ which implies linearity. Specifically, when trying to analyse challenges with sustainable production, a network conception allows for research which takes into account the role of multiple and diverse connections. Coe and Yeung (2015: 15) describe the value of considering production as taking place in a network as seeking

‘to move beyond the analytical limitations of the chain notion. Production systems are seen as networked and recursive meshes of intersecting vertical and horizontal connections in order to avoid deterministic linear interpretations of how production systems operate and how value is generated and distributed... the term ‘network’ in GPN analysis is not mere semantics, therefore, but reflects a particular ontological understanding of how socio-economic systems are organised and function’.

Diversity within production processes can be minimized when conceptualizing production as taking place through a linear GVC connecting a simple sequence of clearly differentiated stages of production. However, when looking at sustainability challenges, the way that businesses connect to lower tier production processes for manufactured products cannot be adequately represented as a one-dimensional linear process. The businesses that are defined to be members of a GVC are the same as those that are included in the description of an ESN. Nonetheless, focusing on this set of businesses as a network allows for an exploration of how producers are connected through multiple and interconnected vertical pathways. One GVC approach has drawn attention to different pathways as strands (see Bolwig et al., 2010). However, the discussion of strands focuses on agricultural production and considers them as distinct vertical pathways. A key component of understanding vertical pathways in an ESN is their interconnectedness.

Each vertical pathway that a product can flow through may involve diverse production technologies and related sustainability challenges based on where each stage of production takes place. If a company buys paint from two suppliers, one located in Costa Rica and the other located in India, the lower tiers of their supplier networks are likely to involve different actors using different practices. Understanding the set of connections involved in production as a network allows for an exploration of the

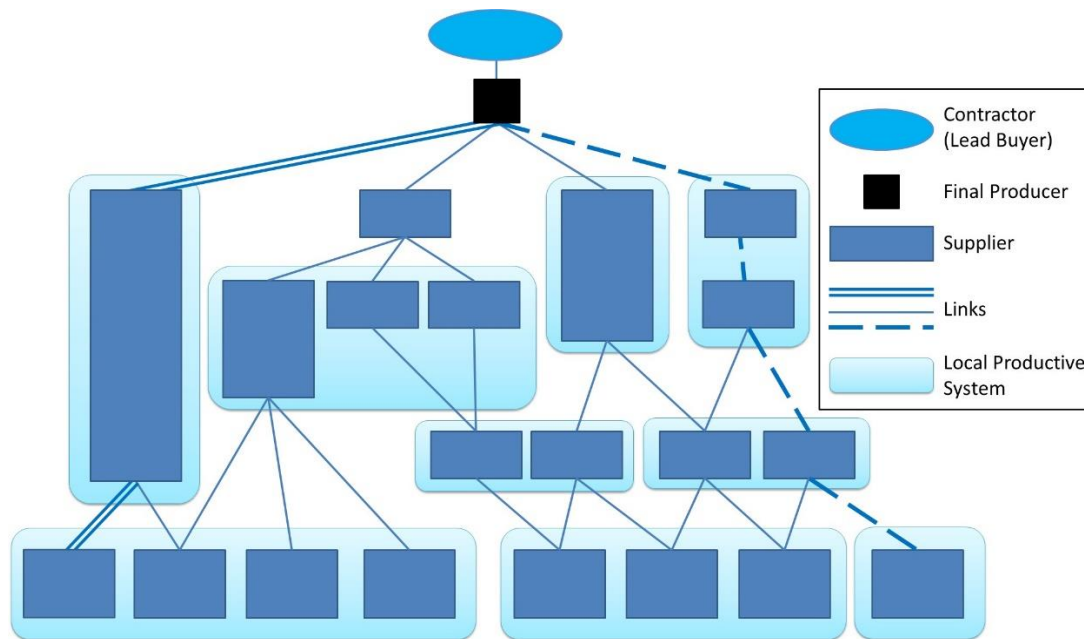
dynamics involved in shaping the sustainability of production for multiple producers involved in numerous vertical pathways contributing to making one product.

Additionally, conceptualizing the connections between producers as forming a network allows for a consideration of how the structure of the network can change. The dynamic nature of the network of suppliers involved in creating manufactured products has been described by Choi et al. (2001) as creating a complex adaptive system (CAS). They argue that supplier networks emerge rather than being designed by a lead buyer. Considering an ESN as a CAS involves an explicit understanding that multiple processes are simultaneously being used by a diverse group of producers that make active decisions based on interactions with their environments. As a whole, the system has the propensity to maintain existing patterns. However, it can adapt to changes, sometimes in unexpected ways as a feature of a CAS is non-linear behaviour, meaning a small stimulus can lead to a large change and vice versa. Evolution of CASs can follow general patterns, however, these do not allow for predictions of events occurring at a particular place or time.

Network structure

In research that has focused on relationships between lead buyers and upper tier suppliers, the structure of the networks connecting lower tier suppliers has often not been explored. Considering the whole network is crucial for understanding sustainability challenges. An ESN model enables this type of analysis. Four features of the structure of the ESN can be seen as supporting this type of analysis, which include the identity of the actor at the top of the ESN, the types of producers involved in the network as suppliers, the types of links that connect suppliers in the network and the locations of all members of the ESN. These four features can be seen in Figure 2 and are discussed below.

Figure 2. Highlighting four features of extended supplier networks



The actor at the top of an ESN may be a producer who sells its products to a consumer or an organization that is responsible for contracting out production. An important feature of many globally fragmented production processes, particularly in industries that have been considered as buyer-led, is a lead firm that contracts production and can have direct control over many factors critical to the sustainability of a product. The example ESN depicted in Figure 2 includes such an actor. The top actor in the ESN, whether a physical producer or a lead buyer, is an organization that can take multiple forms with differing priorities related to engaging with members of their ESNs. These can be branded firms with public images to protect, firms selling unbranded products or public organizations (Brammer and Walker, 2011; Horner, 2017).

Factors that a powerful actor at the top of an ESN may have influence over include design and cost. The design of a product shapes key sustainability related issues such as the material that is used or whether the product will be recyclable after its use. Cost can shape the production decisions carried out by lower tier suppliers. In some industries, lead buyers and/or final producers experience high levels of pressure to ensure the products sold in their name are made sustainably (Brown and Knudsen, 2015). Under this pressure, companies can change their practices and they can attempt to change practices used by lower tier members of their ESNs using various strategies (see Lund-

Thomsen and Lindgreen, 2014). When seeking to address sustainability concerns, types of changes that an actor at the top of an ESN may attempt to promote for suppliers in their networks include introducing new labour standards and modifying practices which have harmful environmental side effects. For similar products, diverse final producers and/or lead buyers may play different governance roles (Alexander et al., 2017; Hughes, 2005; Lane and Probert, 2009). Another consideration is that not all ESNs have powerful actors at the top. The actor at the top of the ESN may be buying inputs sold on an open market and have limited ability to shape practices of suppliers.

A second feature of an ESN is the types of suppliers that are involved. A major part of the identity of supplier businesses is the nature of the products they produce. Types of suppliers can include mines, farms or factories. Within an ESN, businesses can have different levels of vertical integration. Some suppliers are responsible for multiple stages of production and others concentrate on only one step. For example, an integrated factory can produce both yarn and fabric or these two activities can be carried out by two separate businesses. This variety is captured in the varied heights of producers depicted in Figure 2, which represent individual firms with different levels of vertical integration. Other features of supplier businesses that can be important include, but are not limited to, their sizes and business models.

A third feature to consider is the type of links that connect businesses across the network. Logistics and intermediary firms can be involved in facilitating these links. These links can be seen as commercial relationships that form multiple vertical pathways which represent different arrangements for production taking place within one ESN. Levels of integration and fragmentation shape the number of links that occur in the vertical paths. When looking at the producers connected with the double line in Figure 2, fewer individual businesses are involved in production when vertically integrated manufacturers are involved compared to the number of producers involved in highly fragmented production as depicted by the producers connected with the dashed line. Focusing on the links brings out the fragmented nature of production and the diversity of vertical connections involved in a product's life-cycle.

A key aspect of the links is the types of relationships they represent. These links can exhibit multiple features. The Gereffi et al. (2005) framework, which classifies forms of governance found in GVCs, is a prominent model which attempts to understand types of links by categorizing how much power a buyer would have over a supplier. Another feature of the links which can be considered is the proportion of a business' outputs or inputs that pass through a particular path. Looking at production as taking place within a network draws attention to the fact that each business can have many links simultaneously.

A fourth feature that can be considered is the location of businesses. The GPN framework draws attentions to how producers work within embedded locations (Coe and Yeung, 2015; Henderson et al., 2002). As described above, these locations can be defined as territorial, network and societal. These locations are all important when considering challenges with sustainable production.

First, businesses in different territories within an ESN are working in diverse contexts yet are all contributing to the production of a single final product. Knowledge of the territorial distribution of suppliers allows for an exploration of local factors that suppliers experience within a given territory. Territorial locations often house groups of producers creating similar products. As challenges related to sustainable production are often the result of actions within production sites, local context is a key factor. For instance, a certain region may rely of a manufacturing labour force from a marginalized community. Production processes within a local site can be considered as being part of a local productive system (LPS). In this article, LPSs are defined as encompassing a territorial area in which businesses take similar forms. Producers within the ESN are depicted as being located within distinct LPSs in Figure 2. These can be closely knit industrial clusters or broader regions with few inter-firm connections. The fact that the organization of activities involved in production can differ significantly between LPSs is an important consideration when looking at sustainability challenges. An example of how territorial location can shape the sustainability of a product is whether adequate waste processing facilities are available and how related practices are regulated.

Second, businesses in an ESN have a vertical location within the network. The location is determined by where a supplier is found within a vertical path. This is depicted through the vertical locations in Figure 2. Considering this location allows for an exploration of the types of buyer–seller governance, a firm receives and provides. Producers can simultaneously be located in different parts of multiple vertical paths. For example, a manufacturer can be a first-tier supplier to a powerful lead firm, while at the same time being a lead firm for its own branded products. Additionally, a vertically integrated supplier may sell a portion of its first stage product to external buyers while using the remainder as the input for its second stage product.

Third, how businesses are embedded within societal groups also influences their behaviour. The practices of producers within the same LPS may differ based on societal embeddedness of the owners, managers and workers involved. Considering societal location can be key for understanding how connections are formed and the types of business practices that are employed.

Across these three location types, businesses can be seen to be subject to multiple forms of institutional pressures. A useful way to explore these pressures is through Scott's (2013) classification of institutional pillars. His categories delineate institutions as being imposed through formal regulations, norms and socio-cognitive frameworks.

Scales of analysis

Considering the set of businesses involved in an ESN, various scales of network analysis are possible. The choice of scale when interrogating research problems can shape the results of analysis. Sayer (2010) describes the different results that can be obtained when looking at a phenomenon from multiple scales and highlights the example of explaining that water can put out fire. If the water were thought of as its component parts of hydrogen and oxygen, these are flammable substances. Considering water as a whole provides a unit of analysis that is more than the sum of its parts. The social world can be seen in the same way. For example, when exploring a sustainability challenge in an ESN, a researcher may have different findings if a study focuses on the relationship

between a producer and its main buyer, compared to a study that looks at a producer as a member of a LPS that houses many similar businesses using common practices.

Looking at buyer–seller links is one scale that has been popular in past empirical research using the GVC and GPN frameworks. This has involved looking at the process that Ponte and Sturgeon (2014) call micro governance. As discussed above, studies using this approach have often focused on the link between lead buyers and first-tier suppliers. In terms of sustainability challenges, this scale of research can be useful for understanding the leverage a buyer may have over a supplier’s production practices.

A second scale which can be used to explore sustainability challenges is to identify the multiple vertical pathways that can be involved within creating the same product. Looking at these vertical pathways allows for analysis of diverse processes simultaneously being used. Exploring governance flows along these pathways corresponds to Ponte and Sturgeon’s (2014) conception of meso governance. Researching vertical pathways can help to identify certain paths that pose less sustainability-related challenges.

A third scale that can be used to analyse ESNs is looking at groups of producers located within the same LPS. A benefit of focusing on LPSs is that the local context is an important scale for many of the sustainability challenges experienced in production processes. Local environments can be considered as involving organizational fields. Notably, DiMaggio and Powell (1991: 64–65) emphasize the tendency for homogeneity of organizational forms within organizational fields, with organizational fields defined as a set of organizations that ‘in aggregate constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organisations that produce similar services or products’. When seeking to understand sustainability challenges found within a GPN, focusing on a set of similar businesses with shared experiences can help with analysing why common practices are being used.

Another benefit of focusing on LPSs is that this scale allows for the creation of a streamlined conceptualization of how production is organized compared to the numerous and varied sets of vertical pathways found when focusing on individual buyer–seller

relationships. Concentrating on sets of producers within LPSs provides a larger scale unit of analysis and makes it possible to create a simplified map of an ESN. This scale can be helpful for mapping out patterns across types of ESN flows, as discussed below.

However, this level of simplification maintains an ability to consider diverse territorially based sustainability challenges that may be found in different parts of a GPN. As indicated by Coe and Yeung (2015), the choice of scale should be determined by the type of research question being asked.

Network flows

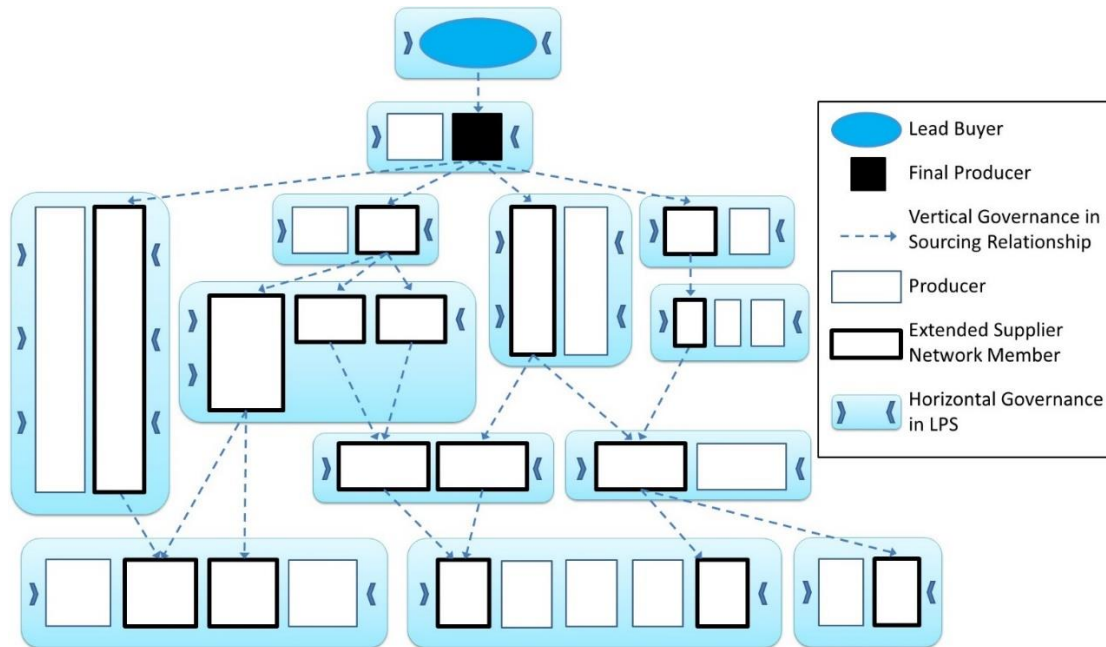
A focus on sustainable production requires viewing products as items with histories. This is in contrast to literature looking at economic systems, which generally looks at separate industries and their interactions. A key process that can be explored when looking at an ESN is how the structure of the network facilitates different types of flows, which can include product, financial, knowledge and power. These flows can be explored through considering the four ESN features at any of the scales discussed above.

One way to look at flows would be to map all buyer–seller links. As discussed above, it can be difficult to gain access to information that identifies all suppliers. However, in some industries, the use of electronic tracking of transactions is increasing. Additionally, in some industries, information is becoming publicly available as a response to calls for traceability (Norton et al., 2014). When looking at vertical flows between businesses in an ESN, millions of connections can be involved. Computer software can help with processing and analysing this type of data.

Focusing on LPSs can be a useful scale for looking at multiple types of flows. For example, identifying patterns in trade flows across particular locations or routes can address some of the difficulties posed by the challenges inherent in attempting to map out the numerous pathways created by all of the individual transactions found within an ESN. A specific type of analysis that can be supported by focusing on LPSs is looking at flows of governance, which can be considered as a form of power flow. Location-related governance pressures are depicted in Figure 3. This figure continues the example of an ESN with a lead buyer and indicates flows of both vertical and horizontal governance.

The fact that producers across the ESN have different vertical and horizontal positions draws attention to the potentially dissimilar governance experiences felt by producers within the same ESN. Understanding sustainability challenges caused by production practices in GPNs requires considering how multiple types of flows pass through an ESN.

Figure 3. Diverse experiences of vertical and horizontal governance across an extended supplier network



Conclusion

Addressing sustainability challenges in fragmented production processes is an important global imperative. Currently, there is a lack of understanding of how decisions affecting sustainability are shaped across production processes for manufactured products that involve producers situated in diverse locations and responsible for different sets of production activities. The bodies of literature considering globalized production as taking place within GPNs and GVCs have potential to provide insight into these issues.

However, past research using these approaches has often concentrated on governance between lead buyers and upper tier suppliers and placed insufficient focus on exploring interactions experienced by producers at all stages of production, which is a critical issue for improving the sustainability of production.

The ESN model provides a way to address this gap by looking at how all stages of production are connected, guided by the GPN and GVC frameworks. The GVC literature provides a valuable perspective through its concentration on exploring dynamics of the linear relationships that connect businesses involved in outsourced production. The GPN framework expands this approach and emphasizes the importance of historical developments, embedded location and the role of multiple governance actors. Using an ESN model to map out production processes provides a method for applying learnings from GVC and GPN research to ask questions related to sustainability challenges.

By presenting the ESN model, this article proposes an understanding of the production stages of products' life-cycles organized within a GPN. The group of businesses within an ESN constitutes the productive core of a manufacturing GPN. The article demonstrated four features of the ESN model which are important to shed light on the organization of production. These include the identities of the actor at the top of the ESN, the identities of all suppliers, the way businesses are linked together and where businesses are located. These features can be explored at multiple scales. Considering the structure of the network draws attention to the complexity of flows that pass through it. The model provides a targeted way to trace product, money, knowledge and power flows across the diverse links that connect the businesses.

This new perspective can contribute to finding solutions to address sustainability challenges across GPNs responsible for creating manufactured goods. Choi et al. (2001) argue that by thinking of supplier networks as CASs, managers and researchers can develop more effective interventions. Incorporating this perspective, the ESN model can help to draw attention to how diverse actors can stimulate change.

The approach developed in this article emphasizes the complexity of relationships involved in globally fragmented production. While identifying this complexity can help to better understand sustainability challenges, it can also create difficulties for analysis processes. When examining large complex ESNs, computer technology can be used to assist in mapping out structures and to understand flows. Additionally, multiple scales

can be used as lenses which can facilitate simplifications that enable different forms of analysis.

Future studies applying this model could involve research on governance experiences of LPSs connected to ESNs defined by the identity of a lead buyer or product type. As discussed above, past research has looked at experiences of territorial groups of producers directly supplying global markets. However, more research is needed to understand vertical and horizontal governance experienced by lower tier ESN suppliers that do not sell directly to global lead buyers. The existence of multiple types of businesses simultaneously being responsible for different stages of production requires an exploration of relationships in diverse vertical pathways within the same ESN. This approach could help to advance explorations of processes of buyer-driven governance.

Another area for future research includes investigating the dynamics shaping the structures of vertical pathways linking suppliers across the creation of manufactured products. This could involve examining why different business forms have developed and prospered. Additionally, changes within the membership of vertical pathways and changes to the nature of long-term vertical links could also be explored.

References

- Alexander R, Ashwin S, Lohmeyer N, et al. (2017) Analysing the Evolving Texture of Transnational Industrial Relations: Opening the Black Box of Interfirm and Firm-Union Relationships in the Global Garment Industry. Garment Supply Chain Governance Discussion Paper Series No. 1/2017. Berlin: Garment Supply Chain Governance Project.
- Alford M (2016) Trans-scalar embeddedness and governance deficits in global production networks: Crisis in South African fruit. *Geoforum* 75: 52-63.
- Bair J (2008) Analysing global economic organization: Embedded networks and global chains compared. *Economy and Society* 37(3): 339-364.
- Barnes T, Das KSL and Pratap S (2016) Incorporating labour research into studies of global value chains: Lessons from India's auto industry. *Global Labour Journal* 7(3): 240-256.
- Barrientos S, Gereffi G and Rossi A (2011) Economic and social upgrading in global production networks: A new paradigm for a changing world. *International Labour Review* 150(3-4): 319-340.
- Barrientos S and Smith S (2007) Do workers benefit from ethical trade? Assessing codes of labour practice in global production systems. *Third World Quarterly* 28(4): 713-729.
- Bolwig S, Ponte S and Du Toit A, et al. (2010) Integrating poverty and environmental concerns into value-chain analysis: A conceptual framework. *Development Policy Review* 28(2): 173-194.
- Brammer S and Walker H (2011) Sustainable procurement in the public sector: An international comparative study. *International Journal of Operations & Production Management* 31(4): 452-476.

- Brown D and Knudsen J (2015) Domestic institutions and market pressures as drivers of corporate social responsibility: Company initiatives in Denmark and the UK. *Political Studies* 63(1): 181-201.
- Choi TY, Dooley KJ and Rungtusanatham M (2001) Supply networks and complex adaptive systems: Control versus emergence. *Journal of Operations Management* 19(3): 351-366.
- Coe NM, Dicken P and Hess M (2008) Global production networks: Realizing the potential. *Journal of Economic Geography* 8(3): 271-295.
- Coe NM and Yeung HW-C (2015) *Global Production Networks: Theorizing Economic Development in an Interconnected World*. Oxford: Oxford University Press.
- De Marchi V, Di Maria E and Micelli S (2013) Environmental strategies, upgrading and competitive advantage in global value chains. *Business Strategy and the Environment* 22(1): 62-72.
- DiMaggio PJ and Powell WW (1991) The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. In: Powell WW and DiMaggio PJ (eds) *The New Institutionalism in Organizational Analysis*. Chicago, IL: The University of Chicago Press, pp.63-82.
- Fold N (2002) Lead firms and competition in 'bi-polar' commodity chains: Grinders and branders in the global cocoa-chocolate industry. *Journal of Agrarian Change* 2(2): 228-247.
- Gereffi G (1994) The organization of buyer-driven global commodity chains: How US retailers shape overseas production networks. *Commodity Chains and Global Capitalism*. Westport, CT: Praeger Publishers, pp.95-122.
- Gereffi G and Fernandez-Stark K (2016) *Global Value Chain Analysis: A Primer*. Durham, NC: Center on Globalization, Governance & Competitiveness, Duke University.

- Gereffi G, Humphrey J and Kaplinsky R (2001) Introduction: Globalisation, value chains and development. *IDS Bulletin* 32(3): 1-8.
- Gereffi G, Humphrey J and Sturgeon T (2005) The governance of global value chains. *Review of International Political Economy* 12(1): 78-104.
- Gereffi G and Lee J (2016) Economic and social upgrading in global value chains and industrial clusters: Why governance matters. *Journal of Business Ethics* 133(1): 25-38.
- Gibbon P, Bair J and Ponte S (2008) Governing global value chains: An introduction. *Economy and Society* 37(3): 315-338.
- Giuliani E, Pietrobelli C and Rabellotti R (2005) Upgrading in global value chains: lessons from Latin American clusters. *World Development* 33(4): 549-573.
- Guinée JB, Heijungs R and Huppes G, et al. (2011) Life cycle assessment: past, present, and future. *Environmental Science & Technology* 45(1): 90-96.
- Henderson J, Dicken P and Hess M, et al. (2002) Global production networks and the analysis of economic development. *Review of International Political Economy* 9(3): 436-464.
- Hess M (2004) 'Spatial' relationships? Towards a reconceptualization of embeddedness. *Progress in Human Geography* 28(2): 165-186.
- Hopkins TK and Wallerstein I (1986) Commodity chains in the world-economy prior to 1800. *Review (Fernand Braudel Center)* 10(1): 157-170.
- Horner R (2017) Beyond facilitator? State roles in global value chains and global production networks. *Geography Compass* 11(2): DOI: 10.1111/gec3.12307.
- Hughes A (2005) Corporate strategy and the management of ethical trade: The case of the UK food and clothing retailers. *Environment and Planning A* 37(7): 1145-1163.

- Humphrey J and Schmitz H (2000) *Governance and Upgrading: Linking Industrial Cluster and Global Value Chain Research*. Brighton: Institute of Development Studies.
- Kadarusman Y and Nadvi K (2013) Competitiveness and technological upgrading in global value chains: Evidence from the Indonesian electronics and garment sectors. *European Planning Studies* 21(7): 1007-1028.
- Knorranga P and Nadvi K (2016) Rising power clusters and the challenges of local and global standards. *Journal of Business Ethics* 133(1): 55-72.
- Krauss J (2017) What is cocoa sustainability? Mapping stakeholders' socio-economic, environmental, and commercial constellations of priorities. *Enterprise Development and Microfinance* 28(3): 228-250.
- Krauss J and Krishnan A (2017) Interrogating 'sustainability' in value chains and production networks. In: *DSA2017: Sustainability interrogated: societies, growth, and social justice*, Bradford, UK, 6-8 September, 2017.
- Lane C and Probert J (2009) *National Capitalisms, Global Production Networks: Fashioning the Value Chain in the UK, US, and Germany*. Oxford: Oxford University Press.
- Levy DL (2008) Political contestation in global production networks. *Academy of Management Review* 33(4): 943-963.
- Lund-Thomsen P and Lindgreen A (2014) Corporate social responsibility in global value chains: Where are we now and where are we going?. *Journal of Business Ethics* 123(1): 11-22.
- Lund-Thomsen P and Nadvi K (2010) Clusters, chains and compliance: Corporate social responsibility and governance in football manufacturing in South Asia. *Journal of Business Ethics* 93(2): 201-222.

- Lund-Thomsen P and Pillay RG (2012) CSR in industrial clusters: An overview of the literature. *Corporate Governance: The International Journal of Business in Society* 12(4): 568-578.
- McAdam D (1996) The framing function of movement tactics. *Comparative Perspectives of Social Movements: Political Opportunities, Mobilizing Structures, and Cultural Framings*. Cambridge, UK: Cambridge University Press, pp.338-355.
- Mezzadri A (2012) Reflections on globalisation and labour standards in the Indian garment industry: Codes of conduct versus 'codes of practice' imposed by the firm. *Global Labour Journal* 3(1): 40-62.
- Mezzadri A (2014) Backshoring, local sweatshop regimes and CSR in India. *Competition & Change* 18(4): 327-344.
- Milberg W and Winkler D (2011) Economic and social upgrading in global production networks: Problems of theory and measurement. *International Labour Review* 150(3-4): 341-365.
- Nadvi K and Halder G (2005) Local clusters in global value chains: Exploring dynamic linkages between Germany and Pakistan. *Entrepreneurship & Regional Development* 17(5): 339-363.
- Nadvi K and Raj-Reichert G (2015) Governing health and safety at lower tiers of the computer industry global value chain. *Regulation & Governance* 9(3): 243-258.
- Neilson J and Pritchard B (2009) *Value Chain Struggles: Institutions and Governance in the Plantation Districts of South India*. Chichester, UK: John Wiley & Sons.
- Norton T, Beier J and Shields L, et al. (2014) *A Guide to Traceability: A Practical Approach to Advance Sustainability in Global Supply Chains*. New York: United Nations Global Compact and BSR.

- Ponte S and Gibbon P (2005) Quality standards, conventions and the governance of global value chains. *Economy and Society* 34(1): 1-31.
- Ponte S and Sturgeon T (2014) Explaining governance in global value chains: A modular theory-building effort. *Review of International Political Economy* 21(1): 195-223.
- Sayer A. (2010) *Method in Social Science: A Realist Approach (Revised 2nd Edition)* London: Routledge.
- Schmitz H (2006) Learning and earning in global garment and footwear chains. *The European Journal of Development Research* 18(4): 546-571.
- Schrempf-Stirling J, Palazzo G and Phillips RA (2013) Ever expanding responsibilities: Upstream and downstream corporate social responsibility. In: Lindgreen A, Maon F, Vanhamme J and Sen A (eds) *Sustainable Value Chain Management: Analyzing, Designing, Implementing, and Monitoring for Social and Environmental Responsibility*. Farnham: Ashgate, pp.353-68
- Scott WR (2013) *Institutions and organizations: Ideas, interests, and identities*. London: Sage Publications.
- United Nations (2018) Goal 12: Ensure sustainable consumption and production patterns. *Sustainable Development Goals: 17 Goals to Transform Our World*. Available at: www.un.org/sustainabledevelopment/sustainable-consumption-production (accessed 3 February 2018).
- Wilkinson F (1983) Productive systems. *Cambridge Journal of Economics* 7(3/4): 413-429.
- Wilkinson F (2003) Productive systems and the structuring role of economic and social theories. In: Burchell B, Deakin S, Michie J and Rubery J. (eds) *Systems of Production: Markets Organisations and Performance*. London, UK: Routledge, pp.10-39.

Yeung HW-C and Coe N (2015) Toward a dynamic theory of global production networks. *Economic Geography* 91(1): 29-58.

Zald MN (1996) Culture, ideology, and strategic framing. In: McAdam D, McCarthy JD and Zald MN (eds) *Comparative perspectives on social movements: Political opportunities, mobilizing structures, and cultural framings*. Cambridge, UK: Cambridge University Press, pp.261-274.