How Digital Technologies Impact Tolerance to Modern Slavery in Supply Chain Networks: An Institutional Theory Perspective

This study develops a socio-technical model to understand the tolerance level of modern slavery in firms across supply chains. The regulative, mimetic and normative pressures have been incorporated as network characteristics induced by digital technologies. Our model institutionalizes the role of digital technology in transforming these pressures to affect the tolerance to modern slavery. We have combined agent-based simulation on networks, adopting a complex system perspective, with discrete choice methods, an established economic theory, for simulating numerous organizational choices with respect to tolerance level as a function of network pressures to model tolerance of modern slavery in supply chain network. In this theory paper, we study the impact of organization-specific and general-purpose technologies on tolerance due to their effect on each kind of pressure. Our findings suggest that the proposed simulation model with network pressures based on empirical data captures the real-world tolerance distribution and tolerance in the supply chain network is sensitive to each kind of technology. The sensitivity of tolerance is highest in response to the organization-specific digital technology inducing regulatory pressure, followed by general-purpose technology affecting normative pressure.

Key words: Institutional Theory, Tolerance, Digital Technology, Supply Chain Network, Simulation Model, Modern Slavery

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1 Introduction

Digital technologies offer capabilities to reduce the tolerance of various partners to modern slavery in supply chains. Modern slavery manifests in the supply chains, as the human rights of workers are often a concern across many partners in large supply chains. Formally, modern slavery in a supply chain may represent "the exploitation of a person who is deprived of individual liberty anywhere, from raw material extraction to the final customer, for the purpose of service provision or production" (Gold et al. 2015, p. 487). Significant instances of modern slavery are more likely to be found in the supply chain of labour-intensive industries and source raw material from high-risk exposure countries. Food, clothing, textile, apparel and more recently, the information and communication technology sector in supply chain networks are being studied extensively by researchers to detect cases and provide an optimal solution to the problem (Benstead et al. 2021, Stevenson and Cole 2018). Even tech giants such as Tesla Inc, Apple Inc, Alphabet Inc, Microsoft

Corp and Dell Technologies Inc have been accused of being complicit in the death of children in the Democratic Republic of Congo. Some children were forced to mine cobalt in unsafe working conditions and were paid as little as $1.50 per day.[1]

Supply chains are networks of partners wherein the adoption of digital technologies can potentially influence tolerance to slavery across partners. However, the relationship between digital technology and modern slavery is hard to unravel. At large, modern slavery is a concern for many firms, and most firms have to abide by an ethical code of conduct, beyond the scope of corporate and social responsibility (New 2015). The level of tolerance, i.e. a level of acceptance of modern slavery, is also associated with one's legitimacy in the market. Indeed, the pressure to reduce tolerance to modern slavery comes from various environmental, social, and economic influences, broadly categorized in this study as regulative, mimetic and normative pressures, based on institutional theory. Institutional theory predicts that firms make changes in their structure, policies, and practices in response to tackling serious issues such as modern slavery (Cole et al. 2019, Crane 2012, Scott 2001). It suggests that, over time, firms will converge on a set of homogeneous responses which deems them as legitimate and conventional in line with institutional isomorphism (Meyer and Rowan 1977). Despite technologies, legislation, global norms and other robust mechanisms, the lack of tolerance among organizations is rather surprising. Digital technologies may influence the traditional pressures from the institutional environment, impacting tolerance to slavery through different pathways.

The impact of technology runs at notably two scales, i.e. "organization-specific"- which varies across the organization–based on its region of operation and market capitalization and "general-purpose"- which remains the same across all organizations irrespective of region and market capitalization. This asymmetry can be due to the scope of technology itself. Some technologies are integrated and intended to serve a specific organization in the supply chain network. At the same time, some may have a homogeneous impact on all organizations in the supply chain network. For instance, organizations that deploy mobile phone applications to be used by vulnerable workers and other firms in modern slavery environment can provide easy access to training resources, sharing information between authorities and reporting concerns on mistreatment.[2] On the other hand, the example of digital technologies that have a generalized impact can include analytical

[1] https://www.reuters.com/article/us-usa-mining-children-trfn-idUSKBN1YK24F

[2] Alibaba group holding limited developed Tuanyuan, a mobile app that reported on abduction cases and adjusted the radius of surveillance as per the cases. It was credited with saving 611 missing children as of 2017. https://www.borgenmagazine.com/modern-slavery-in-asia/

tools or geospatial satellites. For example, a recent project by Stop the Traffic, IBM, and the Edelman Predictive Intelligence Centre underline the general role of analytics, as it consolidates the intelligence and produces insights on illicit human trafficking operations and the routes it follows.[3] Similarly, using remote sensing techniques and geospatial tools, Boyd et al. (2018) were able to detect slavery of migrant workers in strawberry fields of Southern Greece. Another general-purpose technology, blockchains used by Diginex[4] can preserve incorruptible information, which is otherwise at the risk of being convoluted by firms to appear legitimate in society.[5] The scale of the effect of these two different forms of digital technology organization-specific and general-purpose can be different on different institutional pressures that impact tolerance. Also, depending on the level at which a technology induces difference, the path to effect on tolerance may vary. However, little is known about how the two technologies influence tolerance to slavery in a supply chain network, the key gap addressed in this theory building paper.

The research gap is important to fill as the idea of technologies being a social force in transforming organizational tolerance to slavery is a nascent one and less examined. Previous research has examined other dynamics in various seminal works (LeBaron et al. 2017, Martin-Ortega 2017, Marshall et al. 2016, Birkey et al. 2018, Gold et al. 2015). Across these works, we have become aware of the role played by disclosure strategy, detection, and remediation practices. There has been some focus on the role of technologies (Berg et al. 2020, Boyd et al. 2018, Cole et al. 2019, Boersma and Nolan 2020). Our work extends these domains of works by outlining the role of two different types of technologies–organization-specific and general-purpose–using a network dynamic computational model, examining changes in tolerance to modern slavery in a supply chain network. Our paper presents a deeper assessment, comparing the nature of the impact, i.e., heterogeneous or homogeneous, due to the organization-specific and general-purpose technologies. Often researchers have fallen back on institution theory to justify converging public responses by bigger firms in response to modern slavery issue (Flynn and Walker 2020, Sayed et al. 2017, Christ et al. 2019, Busse et al. 2017). Adding to their study, we define institutional pressures as network characteristics in the supply chain. By developing a model based on the interconnectedness of firms in a social network, we expand on Grimm et al. (2016) work as our study enables examination of modern slavery at multiple levels, be it global, multi-region or multi-tier etc., in the supply chain.

[3] `https://medium.com/modernslavery101/the-role-of-technology-in-modern-slavery-9adff1826b04`

[4] Diginex Lumen is a web-based platform that gives a centralized and technology-driven risk-mapping tool

[5] `https://www.cfr.org/blog/responsible-recruitment-through-technology-path-forward`

Given the variation in technology in inducing pressures to reduce tolerance levels in the supply chain, we are motivated to study the differential impacts, in this theory building paper. We use empirical data on 50 companies from the information and communication technology industry and build a simulation model conducive to understanding modern slavery, which showcases a social, technical, and contextual supply chain network. We conceptualize the acceptance of modern slavery in firms using a supply chain network perspective underlining the role of tolerance across partner organization. Specifically, the regulative, mimetic, and normative pressures have been incorporated as network characteristics induced by digital technologies. We study the impact of digital technology at organization-specific and general-purpose levels in the supply chain comprising focal organization, tier-one supplier, and sub-suppliers, which are interconnected. Our findings suggest digital technologies' impact on tolerance differs depending on the type of technology, organization-specific and general-purpose, and the type of pressure the new technology induces, i.e. regulative, mimetic, and normative.

2 Theoretical Background

2.1 Conceptualising Tolerance to Modern Slavery

Studying tolerance to slavery is a complex issue as it requires the integration of multiple parameters which represent the view of every actor in the supply chain. Our study underlines the idea of tolerance levels as multifaceted concept to benchmark companies on their modern slavery scores. A higher tolerance score indicates that an organization is strict against slavery, while a lower score depicts a lack of stringency. We highlight the parameters across organizational and the worker perspective.[6] Supply chain visibility is a critical factor for effective supply chain risk management. The companies adopt a series of practices to curb modern slavery based on academic research and real-world observations. The most widespread detection practice reported in the disclosure statements is a supplier audit against a code of conduct, either directly or via a third party.[7] So, we examine information on auditing, purchasing practices, supplier selection, high-risk sourcing countries and location of low-tier suppliers.[8]

At the employee front, distorted and unmonitored recruitment process becomes the first step in employing slave labourers, which begins by deceiving individuals into entering the supply chain followed by trafficking and finally deployment to slavery sites (Gold et al. 2015). The employees stuck in the modern slavery environment are the most neglected but the most affected group

[6] `https://knowthechain.org`

[7] Auditing is solely done through interviews conducted by authorities but is feared to be affected by corruption and revelation of only the desired documents

[8] These have also been used in earlier works by Marshall et al. (2016), Busse et al. (2017), Christ et al. (2019)

of individuals, making the tolerance to their state high. Giving workers the voice, platform, and mechanism to report on violations is an integral method for bringing down the instances of slavery (Taylor and Shih 2019, Martin-Ortega 2017). Understanding how organizations educate labour on their rights, monitor recruitment agencies, and register their employees' grievances gives essential information on the tolerance level of the company. Reduce tolerance manifests in initiatives to empower workers, collect information and improve transparency at multiple tiers. In case of violation of any code of conduct or labour rights by the suppliers, the firms put ahead a series of corrective action plans to deal with non-compliance. Stevenson and Cole (2018), Christ and Burritt (2018) study remediation practices used by buyers to oversee and manage compliance by suppliers and sub-suppliers. Expanding on these papers, our conceptualization of tolerance includes remedy actions, training, and corrective action plans of firms. A more detailed understanding and definition of the parameters have been provided in the online appendix Table 5 and 6. We consider the idea of tolerance vital because it is indicative of the value supply chains create for society. Value is legitimized logic for action; it represents the right thing to do in a community. A greater tolerance indicates a lesser priority on what is right, indicative of a tardy if not irresponsible firm response to modern slavery.

2.2 Conceptualising Institutional Pressure

The role of institutional pressure in shaping organizational responses has been studied in the context of internet-enabled supply chains (Liu et al. 2010), environmental practices (tat ????), banking industry (Ang and Cummings 1997) and information technology industry. As the relational network between firms becomes more complex and differentiated, organizations start developing a more rationalized and formal structure in response to the institutionalized environment. Such organizations follow an isomorphic structure, become more elaborate, legitimate, and consequently, more likely to survive.

Some seminal works in supply chain management literature have referred to institutional theory to study the role that pressures can play in dealing with modern slavery. Flynn and Walker (2020), Flynn (2020) use the theoretical lens of institutional pressures to predict that firms make specific changes in their policies and practices in response to slavery acts. They find firm size and industry to be significant parameters influencing such responses in addition to the pressure from multi-stakeholders, NGOs and international accords. Christ and Burritt (2018), Christ et al. (2019) suggest that a stronger regulative mechanism and a normative paradigm increase transparency and mimetic pressure drives online disclosure. Barrientos (2013) call for regulatory reform and research on the involvement of trade unions and NGOs to hold the global production network accountable. Marshall et al. (2016) present information disclosure strategy as a guidance tool for managers by discussing forms of pressure on companies.

These forms of pressure have been referred to develop a theoretical understanding of how firms connected in a supply chain network influence each other's tolerance levels. Based on DiMaggio and Powell's[9] typology and seminal papers on institutional theory, we identified three types of pressures i.e., regulative, normative, and mimetic and study their impact on maintaining tolerance levels in information and communication technology industry (See online appendix Table 4). These act not only as a medium of scrutiny for organizations linked to modern slavery but are a means to hold the entire network accountable.

2.3 Conceptualising Network Influence on Institutional Pressure

Social network models conceive of firms to be interdependent rather than independent and view network structures as providing opportunities or constraints on a firm's decisions and actions (Choi and Kim 2008). Being aware of the suppliers direct and indirect relations can help buyer firms control the flow of information and goods. Wu et al. (2010) hypothesize that buyers can immensely influence the relationship (co-opetition) between suppliers. Any disruptions along the supply chain by companies at any tier can have severe consequences for the buyers, thus motivating them to influence the nature of these relationships. Touboulic and Walker (2015) study the horizontal relationship between supplier-to-supplier facilitated by the buyers in the food industry. Benstead et al. (2021) study horizontal collaboration for the fashion and textile industry using a relational view to respond to modern slavery legislation and find a socially sustainable competitive advantage for firms that collaborate. Busse et al. (2017) adopt a design science approach to increase buyer's supply chain visibility across the network and identify hotspots by using stakeholder knowledge as a valuable resource. Grimm et al. (2016) suggested the use of supply chain mapping as a way of identifying and understanding the structure of the multi-tiers that go beyond tier-one suppliers. After all, the action of supply chain partners can influence the focal organizations to take more responsibility for their sub-suppliers associated with modern slavery.

[9] DiMaggio and Powell (1983) have referred to institutional pressure as a mechanism of control exerted on organizations through an institutional environment operated by regulators, stakeholders, and their peers, entrenched in a network

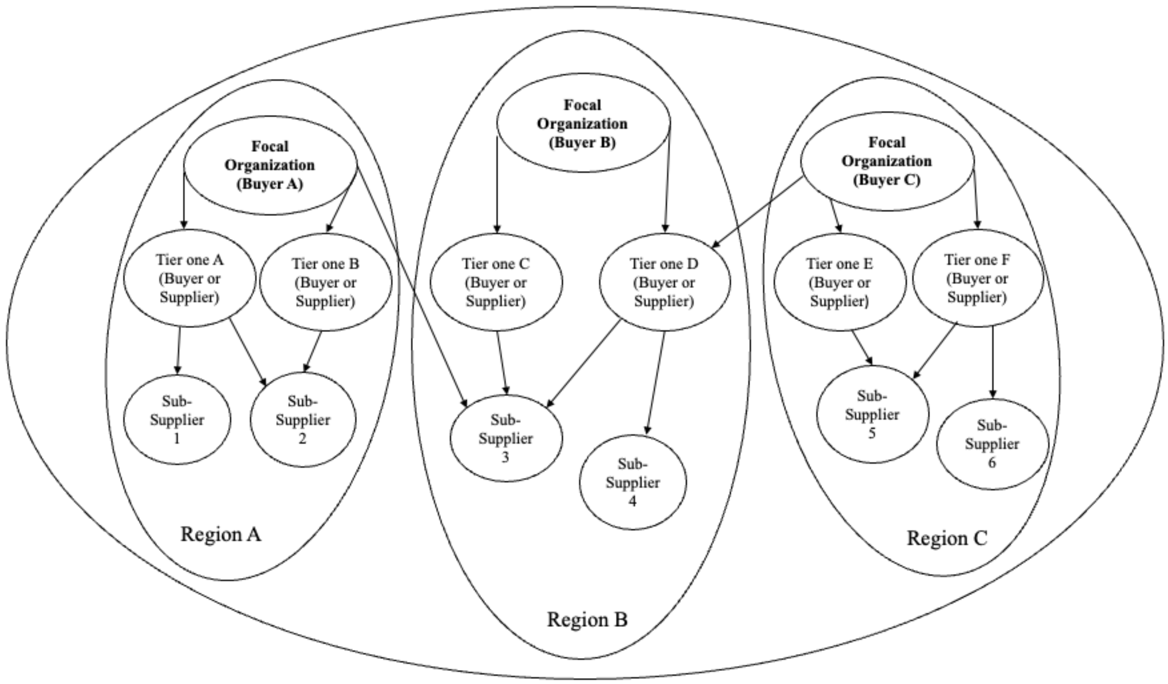

Figure 1 Supply chain network modelled with institutional pressure across three regions

Inferring from this relationship between buyers and suppliers in the literature, we develop a supply chain network. We classify the focal organization as the buying firm; the first-tier suppliers are the firms that have a direct relationship with the buying firms and business relations with supplying firms at tiers below. Finally, supply chain tiers refer to the "distance between a company and its supplier and indicate that there can be several different business relationships that link a company and a below-the-first-tier". Figure 1 demonstrates a conceptualization of a supply chain network distributed across three regions. The firms remain interconnected through the various regions at multiple tiers across the globe. The organizations at each level have their tolerance levels against modern slavery, influenced by the three kinds of pressure. The regulative, normative and mimetic pressures are transformed into a more strong force when leveraged with digital technology. The following subsection discusses this in more detail.

3 Research Model

3.1 Digital Technologies Induced Pressures: Organization-Specific and General-Purpose

We aim to use the institutional theory perspective to understand the impact of the incorporation of digital technology in the supply chain on tolerance to modern slavery. Before studying the effect of technology-induced pressures on tolerance, we verified whether network pressures sufficiently explain current tolerance distribution. We also verified that lower hierarchical levels like region, tier and market capitalization further validate network pressure's explainability of tolerance in supply

	Organization-Specific Technology	General-Purpose Technology
Definition	The available/designed technologies intended to serve in short range in supply chain network	The available/designed technologies intended to serve in long range in supply chain network
Impact	The impact on tolerance varies based on region and market capitalisation of the firm adopting technology	The impact on tolerance is homogeneous across the supply chain network irrespective of region and market capitalisation of the firm adopting technology.
Example	Mobile applications used by organizations to seek information, provide resources and generate feedback from workers	Geo-spatial tools to monitor modern slavery hotspots, trace human trafficking instances and collect data across supply chain network
Technical	$\sum_{R,M,n} OST(P_n)$	$GPT(P)$

Table 1 Organization-Specific and General-Purpose Technology: R(Region), M(Market capitalization, n(organization), SCN(supply chain network),$\sum_{R,M,n} OST(P)$: Organization specific technological impact on tolerance calculated using some way (OST function) of accommodating technological impact,$GPT(P)$: General purpose technological impact on tolerance calculated using some way (GPT function) of accommodating technological impact

chain network. Additionally, we assess the effects of organization-specific and general-purpose technologies. Pressure could be more homogeneous or heterogeneous across the population. Different types of technology can induce different types of pressures. So, depending on the type of pressure a technology induces, the scale of effect on macro-level tolerance can be relatively high or low. We verify that,

The proposed mimetic, informal regulatory and normative pressures provide a possible explanation for real world tolerance distribution of organizations at macro level and lower levels of hierarchy-regional level, market capitalization level and tier level through their interconnectedness in network and there is systemic heterogeneity in relationship between network pressures and tolerance of organizations of different regions and market capitalization.

3.1.1 Digital Technology Induced Regulative Pressure

Regulative pressures are exerted by formal and informal forces which are induced upon an organization from other influential firms or entities upon which they depend and by legislative expectations in the society within which they function (DiMaggio and Powell 1983). Formal institutional elements such as national slavery laws, including UK Modern Slavery Act, California Transparency in Supply Chain Act 2010, Australia Slavery Act and international agreements by ILO, Walk Free Foundation, Business and Human Rights prohibit slavery (See online appendix for more on legislations in Table 3). These legislations led to the emergence of social auditing, questions on purchasing practices of firms, responsible reporting, and establishment of supplier code of conduct, among other mechanisms (Benstead et al. 2021). They act as a direct regulator compelling the firms to respond and report on modern slavery activity across their supply chain network. The regulatory bodies give explicit prominence to rule-setting, sanctioning activities and inspect organizational conformity (Scott 2001).

In some circumstances, firms only respond to government mandates in anticipation of potential concerns over legitimacy and legal sanctity.[10] The visibility of focal organizations means that reluctance on some tier of their chain can affect their position. Compliance by companies is linked to compliance by their suppliers. As a result, the companies at top tiers become responsible for enforcing and indirectly regulating their sub-suppliers. Sayed et al. (2017) suggest that focal organizations end up becoming agents of the state. Thus, focal companies become responsible for implementing and enforcing regulatory standards in their supply chain.[11] The way regulatory pressure manifests itself is through the pressure generated from focal organizations. Thus our focus is on measuring its impact on the supply chain network.

The focal organizations face agency costs due to the conflicting nature of principal and agent relations. The owner wishes to maintain the firm's legitimacy, and thus monitoring modern slavery across the supply chain becomes essential. The digital technologies deployed at the local level can reduce the *monitoring cost* for the focal organizations (Gurbaxani and Whang 1991). Technological tools such as worker reporting tools have been identified as mechanisms to detect, report and disclose the cases of modern slavery in supply chains through mobile applications (Boersma and Nolan 2020, Taylor and Shih 2019). Local organizations could use worker feedback technologies to reach many employees and collect information on working conditions and remediation practices followed by the affiliated organizations. This can give an edge to focal organizations in making better decisions about which supplier is a better bet and maintaining a set tolerance level in their supply chain network. Whereas general-purpose technologies such as blockchains are useful but harder to adopt across the entire chain. Thus, we propose that

Proposition 1: Tolerance to slavery is more sensitive to an organization-specific digital technology leveraged to induce the regulative pressure, as opposed to a general-purpose digital technology leveraged to induce regulative pressure.

[10] Nike and Coca-Cola which lobbied against the passing of an anti-slavery bill. The bill would impose various restrictions on the import of goods from the Uyghur region of China as the cases of forced labour have been identified.`https://www.forbes.com/sites/ewelinaochab/2020/12/02/are-we-all-complicit-in-modern-day-slavery/?sh=1003a14d50d1`

[11] "Although direct pressures on sub-suppliers are not as common, motivating first-tier suppliers to consider environmental factors in their supply chain management helps firms manage their sub-suppliers indirectly" (Grimm et al. 2016)

3.1.2 Digital Technology Induced Normative Pressure

Normative pressure comes from ethical obligations that organizations feel towards their societies due to a perceived expectation of doing the right thing, following a dignified set of values. (DiMaggio and Powell 1983, Scott 2001). The norms are established latently in a society by a range of stakeholders who act as gatekeepers against slavery (Busse et al. 2017).[12] Flynn and Walker (2020) find media germane in investigating and publicizing instances of socially irresponsible activities For example, due to constant nudging by stakeholders, activist groups and condemnation by media in 2016, Nestle gave its admission of forced labour involved in the supply chain rooting from Thailand's seafood industry.[13] Barrientos (2013) reported the role of NGO pressure in improving labour standards and monitoring buyers to uphold the code of conduct. Strong partnership with stakeholders globally, i.e. across multi-tiers in the supply chain network, enables stronger compliance and closer collaboration between firms to deal with the issue.

Structural changes and incorporation of technical resources with global impact can help stakeholders connected worldwide to mitigate the risks associated with slavery by reducing the *costs of coordination*. General-purpose technology that operates globally will break the barriers of trust and lead to reliability in information sharing. Boersma and Nolan (2020) suggest that blockchains can strengthen global partnerships. The use of this tool will allow stakeholders in an institutionally distant environment to exert pressure on organizations to uphold the mutually agreed upon norms concerning modern slavery. Resorting to the decentralized nature of blockchain technology, organizations can solve the problem of transparency, reduce the need for intermediaries and enhance their monitoring capability by exerting pressure across their multiple-tier of their supply chain. By using remotely sensed data and geospatial technology, reliable, timely, spatially explicit, and scalable data on slavery activity can be obtained by stakeholders (Boyd et al. 2018, Jackson et al. 2018, Milivojević et al. 2020, McDonald et al. 2021). Thus, blockchain and geospatial technologies will enable stakeholders to take evidence-based actions in supply chain hotspots and maintain due diligence by deploying normative pressure on every organization in the network at the macro level. Hence, we propose that

Proposition 2: Tolerance to slavery is more sensitive to a general purpose digital technology leveraged to induce the normative pressure, as opposed to an organizational level digital technology leveraged to induce normative pressure.

[12] "Frequently considered stakeholder groups include owners, managers, employees, suppliers, customers, competitors, local communities, activist groups, the media, governmental actors, and even the natural environment"

[13] `https://www.theguardian.com/sustainable-business/2016/feb/01/nestle-slavery-thailand-fighting-child-labour-lawsu`

3.1.3 Digital Technology Induced Mimetic Pressure

Mimetic pressure results from standard responses to uncertainty. As per DiMaggio & Powell, organizations model themselves on other organizations when they face ambiguous causes or unclear solutions. In the context of sustainable supply chain management, competition between firms to race to the top has often been cited as a source of mimetic pressure in a network (Sayed et al. 2017). At the same time, many papers on modern slavery in supply chains have shown a strong mimetic element among organizational responses (Stevenson and Cole 2018).[14] Marshall et al. (2016), Schaper and Pollach (2021) implied that intentions to substantive disclosure and responsible reporting stems heavily from following the best practices of peers in a supply chain, apart from the other two sources of institutional pressure.[15] Flynn and Walker (2020) uses the typology of Oliver (1991) to include network involvement as a construct for measuring this effect.

Businesses might not be particularly interested and actively involved in adopting digital tools. Still, the availability of open data can drive competition among suppliers to get better by benchmarking them against their peers. The individual efforts across firms to compete and discover a solution for the problem will lead to collective sense-making for the society as appropriate general-purpose digital technologies are identified i.e. the general-purpose technologies reduces *cost of collective sense-making*. For example, analytical tools can reduce the time taken to identify violations of worker rights. Specifically, it can collate data sets from different sources to identify activities that can otherwise be missed by manual analysis. For an instance, a science against slavery hackathon competition conducted by Thomas Reuters Foundation in 2016 resulted in the development of numerous data visualization techniques that helped identify and direct attention towards trafficking organizations.[16] Thus we propose that,

Proposition 3: Tolerance to slavery is more sensitive to a general-purpose digital technology leveraged to induce the mimetic pressure, as opposed to an organization-specific digital technology leveraged to induce mimetic pressure.

[14] They suggested that "unless organizations follow the leading firms showcasing transparency, firms risk appearing to have something to hide"

[15] Examples of firms such as Adidas (UK) Ltd. that made voluntary disclosure of their supplier list following the disclosures made by rival firm Nike UK) Ltd and Levi Strauss & Co presents evidence of the mimetic pressure (Doorey 2011)

[16] `https://www.reuters.com/article/us-colombia-slavery-tech-idUSKBN1KL0CU`

4 Research Method

We tested our propositions using the KnowTheChain survey of tolerance to modern slavery in supply chain networks (SCN). Our goal is to develop a simulation-based approach and demonstrate that it is a good representation of the tolerance of modern slavery in a global network of organizations. We formulated the behaviour of organizations in the network as a function of network pressures and facilitated deriving theoretical insights into the technological impact on modern slavery by simulation.

4.1 Tolerance to Modern Slavery

The tolerance score of modern slavery is an average of the indicators of tolerance, surveyed and scored by KnowTheChain, measuring the degree to which the organizations are tolerant to modern slavery. KnowTheChain is a resource with tools and strategies which act as a guiding principle for companies that operate under the risk of forced labour in the global supply chains. As addressing the problem of slavery is a complex phenomenon, their goal is to share a benchmark methodology that enables companies to operate more transparently and responsibly. Benchmarking large companies (based on market capitalization) in high-risk industries creates a competitive nature among evaluated firms. It encourages the adoption of best standards and practices to ensure workers' well-being. The methodology is based on the UN Guiding Principles on Business and Human Rights and covers policy commitments, due diligence, and remedy. It uses the ILO core labour standards (freedom of association, the right to collective bargaining etc.) as a baseline for workers' rights. The organization has developed a subset of seven indicators that assess a company's position and the degree to which it intervenes with instances of modern slavery. The literature review on modern slavery suggests that they have been analyzed in fragments but not in a comprehensive setting so far. We combine and analyze the seven parameters. Following this, we will get a vivid picture of the value that a company assigns to the tolerance level in their supply chains.

The measurement of the indicators involves several common sub-components. They are not independently moving and are highly correlated, as shown in Table 1 and Figure 1 in the online appendix. We choose the Bayesian network modelling approach to capture the joint distribution of all the indicators, and the detailed approach can be referred to in the online appendix section 2. From the estimated joint distribution of all indicators, a new sample of indicator scores can be drawn when required. The tolerance score can be calculated as an average of the sampled indicator scores, following the KnowTheChain approach.

The characterization of the complex real-world network can be analyzed using clusters, scaling, centrality and distances as discussed by García Robledo et al. (2016) in Buyya et al. (2016). The network of organizations studied under observation spreads across different continents/regions with different market capitalization levels, high, medium, and low market capitalization. Hierarchically, they belong to three types, only buyers, buyers & suppliers and only suppliers. They are referred to as tiers in SCN. Figure 3 in the online appendix shows these aspects in more detail.

4.2 Behavioural Mechanism / Generative Process

We see the observational data of the organizations' tolerance scores and their characteristics but are unaware of the underlying mechanism. Each company can be considered an individual agent is interacting and exchanging information with all others in SCN. Every organization is inherently competitive, and the purposive behaviour towards competitive advantage results in contingent behaviour (Schelling 2006). In this specific context, the numerous voluntary and obligatory interactions of organizations within the global community exposes them to different degrees of expectation of tolerance from various counterparts in the network. As a result, every organization experiences pressure or motivation to keep up with expectations and improve. The opposite could also be true where no/less expectation on tolerance could weaken the organizational efforts. The global state emerges from their collective adjustment behaviour.

A model that can capture the global outcome based on low-level interactions is a model sufficient to explain the generative process (Epstein 2012). A model is not necessarily a representation of the true underlying process but a close approximation that gives a possible explanation (Ylikoski and Aydinonat 2014). We propose that the network pressures guided behaviour explains existing tolerance to modern slavery, revealing a possible behavioural mechanism driving organizations. We assume that an organization's choice to either strengthens or weaken its efforts against modern slavery results in a higher or lower score of tolerance to modern slavery. An organization's choice is simulated based on the relative presence or absence of pressures in the network, and it is mapped to the corresponding tolerance score. The repetition of this choice dynamics for sufficient time should ideally lead to a stabilized outcome or an equilibrium (Schelling 2006). The fit of the proposed model may be judged by analyzing the similarity of the outcome with the real-world data (Epstein 2012).

5 The Simulation Model

5.1 Formulation

As discussed, we resorted to a system of multiple agents interacting with each other. Such a system can be called a complex system where complexity refers to the difficulty in explaining tolerance without formal mathematical expression relating it to the agent's interactions. Hamill and Gilbert (2015) talk about the benefits of using agent-based modelling for simulating complex systems in economics. An agent-based model (ABM) facilitates the exploration of aggregate behaviour by simulating micro-behaviours at the agent level. Holm et al. (2016) explored and showed the potential of combining discrete choice methods based on random utility, a well-established economic theory, with ABM in improving agents decision model. Thurstone (1927), as cited by McFadden (1986), introduced the idea of a discriminable process through which a comparative judgement of two different stimuli can be passed by observing their attributes. The attributes of stimuli give a measure of utility. In our system, an agent's behaviour is directed by the behaviour of others, and the agent acts upon the comparative observation of its tolerance state with others by contemplating the utility. In our case, the utility of a choice of an agent is dependent on the network pressures, which are based on tolerance score & closeness of agents in their interactions and its own tolerance score. The choice of an agent is assumed to be rational in choosing between possible alternatives based on a series of factors determining the utility (Simon 1955). We used discrete choice logit formulation, a utility-based model, as it readily lends a closed-form expression for calculation of choice probability for simulation and is easy to interpret (Train 2009). We used the weighted combination of the three network pressures (mimetic, regulative and normative) on an agent at a given point as the utility of the choice and tolerance of the agent towards modern slavery may increase or decrease according to the choice. The choice probability is formulated as shown below,

$$P(S/X) = \frac{e^{WX}}{1+e^{WX}} \quad — 1$$

Where,

W = $[w^1, w^2, w^3]$,

X = [Mimetic, Regulatory, Normative],

Mimetic = $\frac{n_S^T d_{Avg}^{T,S}}{n^T}$,

Regulatory = $\frac{n_S^P d_{Avg}^{P,S}}{n^P}$,

Normative = $\frac{n_S^G d_{Avg}^{G,S}}{n^G}$,

Utility(U) = WX

Notations:

S = 1 or 0 indicating increase or decrease of tolerance score from current tolerance score of node,

n_S^P = Number of parent nodes P in state S

n_S^T = Number of nodes in tier T in state S

n_S^G = Number of nodes in entire network G in state S

n^T or n^P or n^G= Number of nodes in tier T or number of parent nodes P or all nodes G in state S

$d_{Avg}^{P,S}$ = Average distance between current node and focal nodes with state S

$d_{Avg}^{T,S}$ = Average distance between current node and nodes in Tier T with state S

$d_{Avg}^{G,S}$ = Average distance between current node and nodes in total network with state S

W^1 to W^3= Weights between 0 and 1 summing up to 1

d = Distance measured using cosine distance between vectors I

I = Vector of indicators of tolerance

5.2 Stochasticity

In the previous section, we introduced the deterministic or observable utility of the discrete choice model, but in the real world, the choice is not deterministic. There is a random or unexplainable component to utility as the analyser can never fully observe all the aspects of agents leading to the outcome (Train 2009). From the fundamental axiom of Random Utility Theory, Louviere et al. (2002) notes that,

$$U^{i,n} = U + \varepsilon^{i,n}$$

Here $U^{i,n}$ is the unobservable random utility, U is observable utility and $\varepsilon^{i,n}$ is the random component of the utility. Simon (1972) says that the rationality of an agent is bounded as well, and the agents may not have the perfect knowledge of parameters of utility. Louviere et al. (2002) show that that the random component is associated with many factors and should not be lumped together as heterogeneity. For instance, random components can be associated with each choice option across demographics, time, agent, utility parameters, etc. So, there are multiple independent and identically distributed (IID) random components. McFadden and Train (2000) show that the mixed logit formulation allows introducing random components at multiple dimensions or choice processes.

In our case, we assumed a latent group (L) formed by region and market capitalization combinations as one dimension and global level as another dimension. We assumed systemic heterogeneity across L, captured by local mean utility parameters and homogeneity captured by global mean utility parameters. So, we have random components for heterogeneous parameters, global parameters and utility itself, as shown in Equation 2.

$$P(S/W,X,L,n) = \frac{e^{(\sum_{L,j} W^{L,j}+\eta^{i,L,j}+\alpha^{G,j}+\eta^{i,G,j})X^{i,n,j}+\varepsilon^{i,n})}}{1+e^{(\sum_{L,j} W^{L,j}+\eta^{i,L,j}+\alpha^{G,j}+\eta^{i,G,j})X^{i,n,j}+\varepsilon^{i,n})}} — 2$$

Where,

$W^{L,j}$=Local weights of network pressures for each L

$X^{i,n,j}$=j pressures changing at every time step

$\alpha^{g,j}$=Global weights of network pressures for entire network

L = Region-Market capitalization groups

n = Number of agents

j represents one out of j pressures and i represents time

Error terms=[$\eta^{i,L,j}$,$\eta^{i,G,j}$,$\varepsilon^{i,n}$]

The [$\eta^{i,L,j}$, $\eta^{i,G,j}$] are assumed to be multivariate normally distributed and $\varepsilon^{i,n}$ is assumed to be normally distributed (Train 2009, Fiebig et al. 2010).

5.3 Initialization and Validation

Agent-based models typically use standard random distributions like random uniform or random normal for initial condition values in simulations (Hassan et al. 2010). Banks (2005) discussed a whole host of statistical distributions that can be used for input modelling for simulation. We used beta distribution for initialization of tolerance scores considering the skewed and bi-modal nature of real tolerance distribution. We have used a fitted Bayesian network for sampling initial indicator scores of tolerance. And we used random partition graph generators from NetworkX (A python implementation of graph algorithms as summarized by Hagberg et al. (2008)) for emulating the real-world network characteristics as described by García Robledo et al. (2016) in (Buyya et al. 2016). A more detailed view of the initialization process is provided in section 5 in the online appendix. We used the tolerance distribution at macro, regional, market capitalization and tier levels as stylized facts for measuring the success of simulation (Gilbert and Conte 1995). We looked at the similarity of real-world tolerance distribution and simulated tolerance distribution for the calibration of our model. While there are many similarity measures available for comparing distributions, as discussed by Gibbs and Su (2002), we choose Kolmogorov–Smirnov (KS) distance and Wasserstein distance for assessing similarity of distributions as they are symmetric measures of distance and easy to interpret. Section 5 in the appendix covers stylized facts, calibration method using an efficient sampling procedure called Latin hypercube sampling (LHS) and similarity measures in detail.

6 Logic of Simulation

Hassan et al. (2010) illustrate a modified logic of simulation revealing the different segments of simulation modelling and interdependencies between stages. We tried to elucidate our process in a similar fashion below in more detail. The choice probability is calculated based on a mixed logit discrete choice model provided the information about the region, market capitalization, network pressures, current tolerance score, indicator scores, and utility parameters.

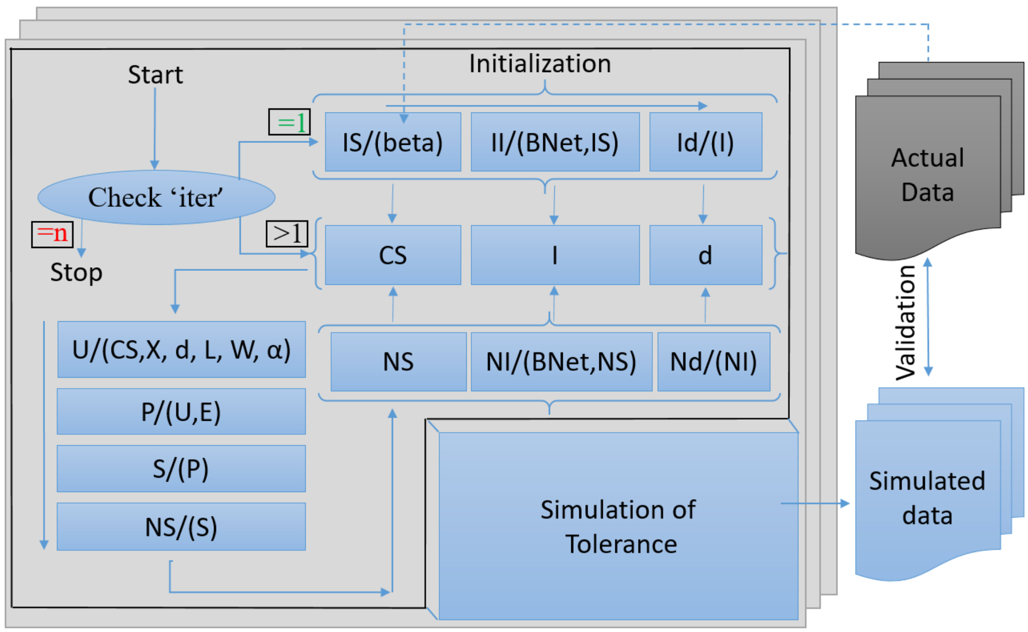

Figure 2 Overall simulation logic;[IS,II,Id] are initial tolerance score, Indicators of tolerance and distance between organizations; beta(beta distribution), BNet(fitted Bayesian network), CS(current score), I(current Indicators), d(distance between organizations : cosine distance between I vectors); [NS,NI,Nd] are new or updated score, Indicators and distance; X(Network pressures), L(Region-market capitalization groups), W & α(utility parameters), E(error components), P(choice probability) and S(Choice of organization)

The Figure 2 gives a detailed layout of step wise operations in simulation of tolerance. The steps depicted are as follows,

1. As the simulation starts, initial tolerance scores of organizations are drawn from a beta distribution. The initial vectors of indicators are drawn from the fitted Bayesian network, and initial cosine distances between organizations in the network are calculated using indicator vectors.

2. Each kind of pressure on an organization is calculated using the formulation laid out in section 4. For instance, the product of the proportion of organizations in the same tier which has

tolerance scores above the current score of the organization under consideration and average cosine distance from such organizations gives mimetic pressure on the organization to strive to improve its tolerance score.

3. For given utility parameters (W across L & α) and calculated network pressures, the choice probability is calculated in the presence of error components using formulation in section 4.

4. Once the choice probability is calculated, a new tolerance score is randomly sampled. For instance, if the choice probability of an organization is high for a range of scores higher than its current score, a score higher than the current score is randomly sampled as a new tolerance score.

5. Once the new tolerance score is drawn, new indicator score vectors are sampled from a fitted Bayesian network. New distances between organizations are calculated as cosine distances between vectors of indicator scores.

6. The above steps are executed for all the organizations in a sequence, and once all organizations tolerance scores are updated, the same steps are executed again starting from the first organization. This sequence of updates is executed iteratively till the desired number of iterations is reached.

7. After terminating the simulation, we compare the stylized facts using the similarity measures and visualizations across different dimensions for validating the model with given utility parameters. Since this is a stochastic simulation, the simulation runs are repeated several times.

6.1 Calibrated Model

We ran simulations for all the samples of parameters drawn from parameter space to represent all regions of the range of parameter space as detailed in section 5 of the online appendix. We have analysed the macro-level tolerance distribution at the end of each simulation by visual inspection and calculated the Wasserstein distance between simulated and real distribution. The parameters shown in Table 2 are found to have produced the tolerance distribution with the least distance.

Group($L = R * MC$)	Mimetic(w^1)	Regulatory(w^2)	Normative(w^3)
NrA and High	0.974	0.01	0.017
NrA and Med	0	0.235	0.765
NrA and Low	0.33	0.33	0.33
Eur and High	0.33	0.33	0.33
Eur and Med	0.005	0.982	0.013
Eur and Low	0.001	0.88	0.111
Asia and High	0.33	0.33	0.33
Asia and Med	0.742	0.201	0.057
Asia and Low	0.141	0.249	0.61
Global	0.000295	0.034	0.036
	α^1	α^2	α^3

Table 2 Utility parameters across L: R (Region: North America, Europe and Asia) and MC (market capitalization: High, Med and Low), w^1, w^2 and w^3: organizational level systemic heterogeneous parameters and α^1, α^2 and α^3: general purpose homogeneous parameters

For the parameter set shown in Table 2, we looked at distributional similarity at global level, regional, tier and market capitalization levels. We found that the simulation produced a very similar cumulative density function (CDF) compared to real-world tolerance distribution at all the levels of inspection. Comprehensive visualization of the similarity of CDF of simulated tolerance distribution with real-world tolerance distribution at all levels of inspection can be found in section 5 in the online appendix. Now that we have calibrated our model, we can simulate hypothetical scenarios for technological impacts.

7 Simulating Effects of Technology

The technological impact can be incorporated in at least two ways. We have simulated the organization-specific technological impact through amplification of systemic heterogenic utility parameters corresponding to one of the network pressures as the use of new organizational specific technologies can make one pressure more conducive through the network than the other across L, which accrues to a global effect. We have simulated the general purpose technological impact through amplification of global or general-purpose utility parameters to one of the network pressures as general-purpose technologies can make one pressure more intense than the other homogeneously across organizations. We introduced two additional scaling factors σ^j and σ^{Gj}, which take value 1 in the base scenario, which makes the model equivalent to calibrated model in the base case. The scaling factors σ^j and σ^{Gj} are then changed one at a time to simulate the technological impact in both the ways mentioned above.

$$P(S/W,X,L,n) = \frac{e^{(\sum_{L,j} \sigma^j W^{L,j} + \eta^{i,L,j} + \sigma^{Gj} \alpha^{G,j} + \eta^{i,G,j}) X^{i,n,j} + \varepsilon^{i,n})}}{1 + e^{(\sum_{L,j} \sigma^j W^{L,j} + \eta^{i,L,j} + \sigma^{Gj} \alpha^{G,j} + \eta^{i,G,j}) X^{i,n,j} + \varepsilon^{i,n})}} — 3$$

Since we have already calibrated the simulation model, we will keep the calibrated model parameters as the base parameters. We then scale the organization-specific parameters corresponding to mimetic, informal regulatory and normative pressures one at a time while keeping all other parameters unchanged. We repeat the same for general-purpose global parameters one at a time while keeping all others unchanged for simulation runs.

To measure the changes in outcome, we can use traditional regression analysis. Still, the simulation outcome is a result of complex relationships from input space, and the relationship is highly non-linear. Even if there is a linear relationship, traditionally expected R^2 for accepting such analysis is at least 90 percent, which is a challenge for traditional models themselves with existing linear relationship (Ten Broeke et al. 2016). Pianosi et al. (2016) provides a detailed review of sensitivity analysis and explain that regression fails if the relation is not monotonic and is highly non-linear. The other approaches, like variance-based approaches, rely heavily on the assumption that the variance captures uncertainty fully (Pianosi et al. 2016). We prefer a density-based approach as it does not rely on any single moment like variance and uses an entire range of outcome (Pianosi et al. 2016).

Pianosi and Wagener (2015) use CDF to measure the changes in outcome. They constructed a sensitivity index to rank the parameters by finding the difference between empirical unconditional CDF and empirical conditional CDF when a parameter is fixed. They use average Kolmogorov–Smirnov(KS) distance from different fixed values of the parameter to calculate the differences and use it to rank the factors. In our case, we calibrated the simulation model and are changing the scaling of one parameter at a time from its nominal value several times. We apply the same methodology and calculate differences in CDF using KS distance and average out KS distance for all the scaled perturbations of one parameter. Finally, we rank factors based on KS distance. The following visualizations in Figure 3 show the outcome variability of input parameter perturbations by scaling using σ^j and σ^{Gj} respectively .

Based on these outcome differences in CDF, we calculated KS distance for each parameter scaling, which acts as an index for parameter prioritization, visualized in Figure 4. Also, we verified that all KS distances are significant by calculating critical value as suggested by Pianosi and Wagener (2015).

8 Results

After running simulations for the LHS samples repeatedly to account for stochasticity, we find that the simulation outcome with minimum earth mover distance (EMD) with real data accurately represents the real world tolerance distribution at the macro level and all lower levels of hierarchy- region, market capitalization and tier level. The visualization of overlapping CDF's of real-world data and simulated data further verifies the success of the simulation. The corresponding parameters of utility reveal systemic heterogeneity of organizations as they are different for all the latent groups (L) based on region-market capitalization. The validation of simulated outcome with real-world tolerance distribution and the systemic heterogeneity revealed in parameters verifies our first observation.

The visual inspection of variation in simulation outcome in CDF plots due to scaling, representing technological induction of pressure, one parameter at a time from the nominal or calibrated

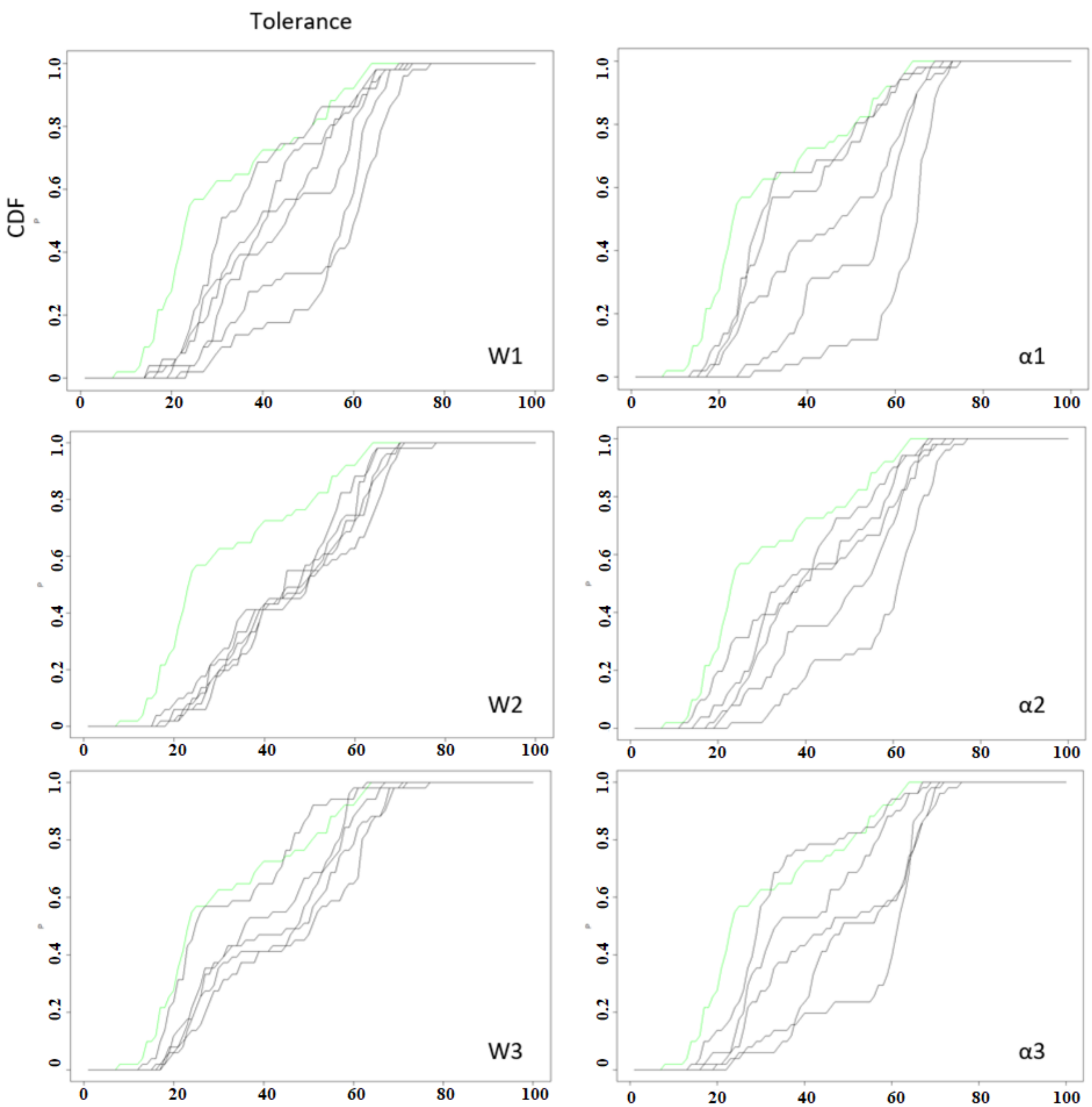

Figure 3 Outcome variability with respect to perturbations of each utility parameter using σ^{j} and σ^{Gj}. Green: CDF with calibrated utility parameters.

model parameters shows variation in simulated tolerance compared to calibrated model's tolerance distribution. This indicates the sensitivity of tolerance in SCN to each kind of digital technology. Further, the sensitivity index calculated using average Kolmogorov Smirnov distance between calibrated model outcomes and varying technological induction of each kind show that the effect of technology of each kind on variability in simulation outcome is significantly based on a critical

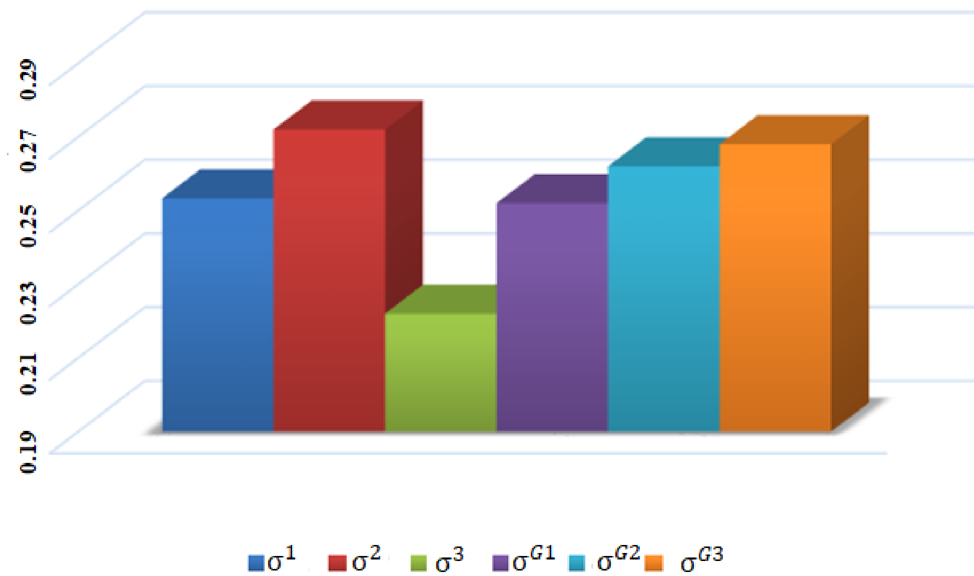

Figure 4 Sensitivity index constructed using average Kolmogorov–Smirnov distance of varying outcomes from calibrated model outcome

value calculated at 0.05 significance level.

The relative ranking based on sensitivity index calculated shows that the organization-specific technology affecting regulatory pressure has the highest sensitivity, followed by general-purpose technology affecting normative pressure, general-purpose technology affecting regulatory pressure, general-purpose technology and organization-specific technology affecting mimetic pressure and organization-specific technology affecting normative pressure in that order. The relative ranking of sensitivity,

1. Between general-purpose and organization-specific technologies showed that,

(a) Organization-specific technology inducing regulatory pressure has higher sensitivity compared to that of general-purpose technology inducing regulatory pressure verifying proposition 1.

(b) General-purpose technology inducing normative pressure has higher sensitivity compared to organization-specific technology inducing normative pressure verifying proposition 2.

(c) Organization-specific technology inducing mimetic pressure has similar, though marginally higher, sensitivity compared to general-purpose digital technology inducing mimetic pressure showing that both general-purpose and organization-specific technology may have similar effects on tolerance differing from proposition 3 that one is higher than the other.

The pilot simulation we ran, before the actual simulation, with best fit beta distribution generated a close tolerance distribution compared to real data ruling out the possibility of data being an outlier. Besides, our deliberate choice of beta distribution with slightly different parameters than the perfect fit to the data did not hinder the simulation in producing a close representation of real-world distribution. It demonstrated how the initialized distribution moved towards real-world distribution over simulation time.

9 Discussion and Conclusion

In this study, we develop a socio-technical model to understand the tolerance level of modern slavery in firms across supply chains. We integrate several variables to incorporate the organizational and employee perspective on modern slavery levels that underlines tolerance. Our paper provides a theoretical framework for analysing the tolerance to slavery between and within multiple tiers of the supply chain. The need for maintaining tolerance emerges from pressure arising from an organization's institutional environment. We characterize the regulatory, mimetic and normative pressure in the global supply chain by establishing network relations based on the theoretical foundations in previous research.

Finally, our model institutionalizes the role of digital technology in transforming these pressures to affect the tolerance level of modern slavery. We assume that technological inductions have a different path to affect tolerance. Given the local heterogeneous relationships with network pressure, we model the effect of organization-specific technology on tolerance to be concentrated at the organization level, which aggregates to the macro level. Given the global invariant relationships with network pressures irrespective of the organizations, we model the effect of general-purpose technology on tolerance homogeneously at the supply chain network level. Our findings suggest that tolerance in the supply chain network is sensitive to each kind of digital technology. The sensitivity of organizations towards tolerance is highest in response to the organization-specific digital technology inducing regulatory pressure, followed by general-purpose technology affecting normative pressure.

Contribution

This study makes theoretical and empirical contributions to the supply chain management field. The literature in supply chain management has utilized an institutional theory lens to understand a firm's response to modern slavery by using different parameters for each type of pressure (Flynn and Walker 2020, Sayed et al. 2017, Christ et al. 2019, Busse et al. 2017). We contribute to modern slavery literature by analyzing the firm's response to modern slavery as contingent behaviour driven by the pressures defined as network characteristics instead of referring to the pressures as parameters. The pressures can now be examined as the influence of players in the supply chain.

Recently researchers started developing a keen interest in studying the role of digital technologies such as blockchain, satellites, mobile phone apps etc., in influencing modern slavery (Boyd et al. 2018, Benstead et al. 2021, Cole et al. 2019). The earlier research only used technologies to detect instances of modern slavery, collect data or enable transparency in supply chains. Further research was required in this area to understand the impact that variation in these technologies can have on the tolerance levels of the organization. Thus, expanding this line of argument, our paper contrasts and compares the organizational-specific and general-purpose technologies.

One of the major gaps in the research on modern slavery in the supply chain has been the limitation in studying the problem at multiple tiers, given the invisible nature of the problem (Grimm et al. 2016, 2006). We have introduced the distance in supply chain network, borrowing from social networks perspective of the distance between friends or people, between organizations based on their tolerance. Thus, this research develops a new socio-technical framework that studies tolerance of modern slavery by combining institutional theory, digital technology and supply chain network. With our framework, researchers can now examine any organization at any tier located in any region in any supply chain. The interconnectivity studied can be used to make inferences about any firm's influence in the supply chain and its actions to manage multiple partners. The traditional modelling approaches consider independent constructs or parameters deemed useful to model an outcome. But most real systems involve behavioural aspects. The independence of cause and effect doesn't hold. Simulation models are useful in capturing such dynamics.

We have provided a detailed development of an agent-based simulation model of the behaviour of organizations in the supply chain network. Unlike a simple behavioural rule-based system, the decision model in this paper uses a discrete choice formulation for the latent choice of an organization which minimizes the risk of the ill-specified formulation. With this framework, researchers can test the integrity of existing assumptions and theories concerning modern slavery. It also helps researchers formulate and quickly test new theories of modern slavery in an artificial environment reducing the cost(time and financial) of conducting a real-life experiment for insights. Our simulate gives a possible way to simulate and account for the changes due to digital technologies. Any 'before and after' data collected on tolerance in supply chain networks related to the integration of technologies can be used to validate and measure the effectiveness of the technology. One of the major challenges in utilizing socio-technical simulations for insights is the computational cost involved in calibrating such a system. We demonstrated that in the absence of knowledge of prior distributions of parameters, efficient sampling procedures reduce the computational cost to a great extent. It helps researchers overcome the challenge of using computational cost and leverage the socio-technical simulation models of tolerance of modern slavery. As an initiation, we have built a simple programming tool based on python, which we intend to make public soon. It can be used by researchers of tolerance of modern slavery in supply chain networks to design experiments similar to those discussed in our paper accompanied by a user-friendly user interface for quick analysis of the vast amount of data generated by simulation.

Limitations and Future Direction

The current paper primarily looks at the organizational perspective. But a deeper look at the system gives scope for incorporating consumers and employers sensitivity explicitly to modern slavery perspective through their network relationship with organizations and among themselves. One can look at it from the point of view of the cost of losing consumers or employers in relation to the organization's tolerance of modern slavery. We have assumed that perturbations due to technological innovations are instantaneous and simultaneous across the organizations under scope within the supply chain network. But one could study the diffusion of technological innovations impact on tolerance. Finally, limited data is available on tolerance to modern slavery in supply chain networks over a longer period. Given such data, one can look at tolerance to modern slavery from a time series or causal point of view by looking at the organization's history and informing simulation with parameters capturing auto-regressive and multivariate temporal aspects of organizations history concerning tolerance to modern slavery.

Managerial Implications

The paper has several managerial and policy implications. As the results suggest, pressure from focal organizations can play a major role in modifying the tolerance level in a supply chain network. Their efforts can motivate their suppliers and sub-suppliers to follow the modern slavery code of conduct. Thus, organizations such as Apple, Amazon, Microsoft, etc., i.e., large buying firms, should extend their influence and exercise their contractual power. They can exert pressure directly or indirectly beyond first-tier suppliers and mandate compliance to fair purchasing practices, recruitment, and the code of conduct. Moreover, organizations can leverage digital technologies to deal with several issues. Blockchain can be used to monitor every unit of suppliers and sub-suppliers in the network enabling transparency. Satellites can be deployed to assess high-slavery risk "hotspots" and raw material procurement locations. The use of mobile phones at the organizational level can engage workers directly threatened by modern slavery. Enabling the use of such technology at an organizational level can induce better detection of slavery instances and lead to immediate remediation where required.

Owing to the values and norms that come with responsible supply chain management, firms should be held accountable and scrutinized by policymakers and stakeholders. Policymakers and the state should promote the laws on modern slavery more as a tool that leads to substantive disclosure and not as a mere reporting tool. Moreover, by inferring from our study on organization-specific and general-purpose technology, policymakers can make better decisions about the deployment of technologies at different scales. In conclusion, the emerging research towards the impact of digital technology on modern slavery can provide essential solutions to deal with this grave issue.

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