ESSAYS ON COMMUNITY FOCUSED SUPPLY CHAINS

By

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ABSTRACT

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Businesses are increasingly being called upon to improve their Environment, Social and Governance (ESG) performance. The need to tackle a range of concerns, both environmentally and socially, can be seen in the United Nations' 17 development goals set forth in 2015. Beyond governments and regulators, businesses themselves are increasingly aware of the importance of addressing such issues. Two hundred of the top CEOs of the country have emphasized the importance of the role that businesses play in confronting community-related issues and Diversity, Equity and Inclusion (DEI) (Murray 2019). In a series of three essays, this dissertation focuses on the social and environmental sustainability aspects of ESG, thus contributing substantially to the overall domain of sustainability.

The first essay examines the impact of leader-worker disability status similarity on front-line manufacturing worker productivity using micro-data gathered from a real-world organization in Michigan. It contributes to the nascent field of inclusive operations and explores how organizations can both be profitable and inclusive of traditionally marginalized workers. The essay focuses on the moderating influence of direct supervisors with a disability on workgroup productivity as the number of workers with disabilities increases. Results suggest that a direct supervisor with a disability does indeed benefit the productivity of workers with disabilities. This benefit, however, is the mitigation of potential productivity declines as the number of workers with a disability increases in the workgroup. A follow-up qualitative study is

performed to understand the mechanisms of the productivity benefit by interviewing 50 workers and supervisors with and without disabilities across three organizations.

The second and third essays focus on the issue of water, a resource that is increasingly important as an environmental concern. As a resource shared between communities and firms, water is an essential component of building sustainable cities and communities.

The second essay examines trade-offs and synergies experienced by organizations when reducing water use and carbon emissions using secondary panel data of large firms. Previous research has found differing results of organizations trading off carbon emissions and water. Some have found reducing one comes at the expense of the other, while other research has found organizations can reduce these two concerns jointly. This past research, though, has generally been qualitative and at the facility level, without quantitative analysis at the firm level. This research fills this gap by providing a firm-level examination of such potential trade-offs using a combination of Data Envelopment Analysis and econometric methods.

The third essay uses a vignette experiment with real-world procurement professionals to examine how buyers weigh the competing environmental concerns of carbon emissions and water use reductions in the supply chain against supplier location (local vs. offshore suppliers). The results show an overwhelming preference for local suppliers with lower carbon emissions, to the extent that a supplier with a superior overall environmental performance may be passed over in pursuit of local suppliers with marginally lower carbon emissions.

This dissertation is dedicated to my wife, Kate, who has made my life immeasurably better.

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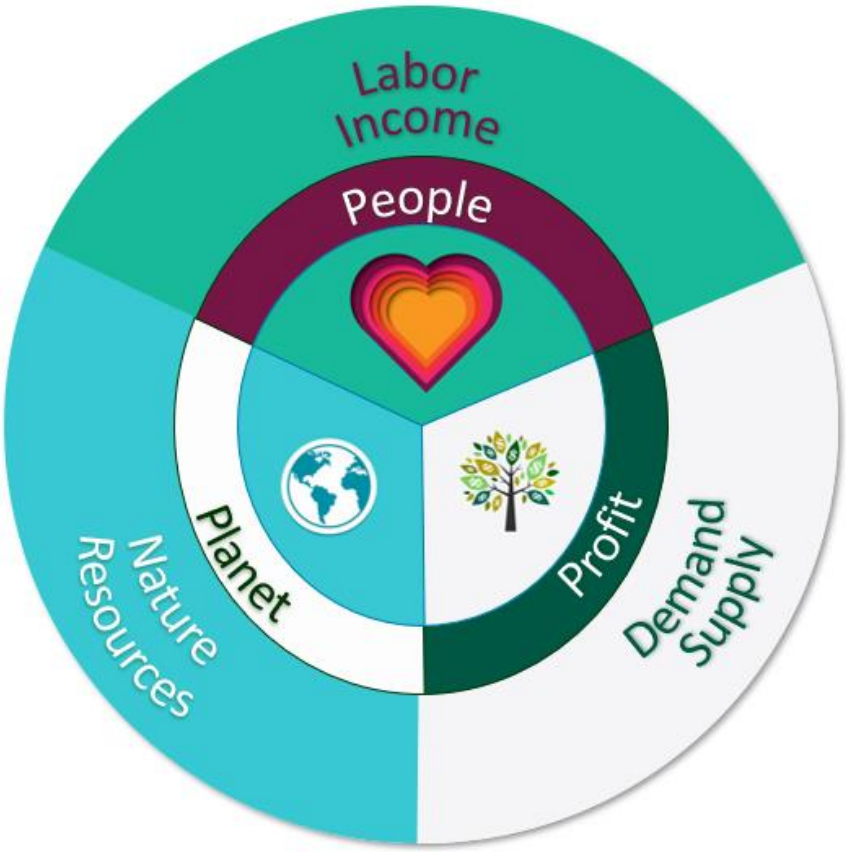
Firms operate within communities in a symbiotic relationship that allows both to exist side-by-side. Firms provide services and products for individuals in the community. Inversely, the community provides the workers and resources which the firm depends on. Without the labor hours and resources provided by the community the firm would not function, and without the coordinated operations of the firm the community would be lacking for many of the things we take for granted in modern society.

Figure 1.1 Symbiotic Relationship of Business and Community



This symbiosis is visible when considering the "3 Ps" of sustainability: People, Planet and Profit. To firms, people are the labor that allows them to operate while the community receives back stable incomes needed to satisfy day to day needs. The community shares its

natural resources, and in return the firm provides back something of greater use to individuals than the raw components themselves. Firms provide the products that individuals desire, while the community generates sufficient demand to make the production economically viable. Each relies upon the other, giving something and receiving something.

Yet, this relationship is often not equally beneficial to both parties involved. Climate change has a direct impact on human health and mortality (Lelieveld et al. 2019, Watts et al. 2019), which comes with quantifiable economic costs that are not being paid by those firms contributing to climate change but instead by individuals and health systems (Henderson 2020). Low wages and underemployment force workers onto government assistance, pushing operational costs the firm should be bearing onto the communities in which they operate (O'Connor 2014). This is enormously risky for firms. As social and environmental concerns push humanity to make changes, many businesses will have difficulty justifying that their benefits to society outweigh the costs they are pushing onto the communities in which they operate. These considerations have led the Business Roundtable, a group of CEOs that provide vision for the private sector, to change their view of a business as an entity which maximizes shareholder value to one that maximizes stakeholder value (Murray 2019). This creates an opportunity to explore how firms can operate in a way that allow them to co-exist beneficially with those individuals they impact, ensuring continued access to the valuable resources provided by the community.

The United Nations (2015) proposed 17 Development Goals, shown in Figure 1.2, with the aim of addressing pressing societal challenges. Poverty (Goal 1), hunger (2), decent working conditions (8), inequality (5 and 10) and an inclusive society (16) are socially based goals that firms can have a direct impact on through how they interact with their workers. As an

organization's operations are intimately linked with its human resources (Boudreau et al. 2003), even day-to-day shop floor decisions can have an impact that ripples back into the community. Health (3), clean water (6) and energy (7), sustainable communities (11), responsible production (12), climate action (13), life on land (15) and under the water (14) are all impacted by how an firm creates the products and services that it provides. Acting in a way that damages the environment and natural resources in the surrounding area damage both the ecology and health for the persons, plants and creatures living there.

Figure 1.2 United Nations Sustainable Development Goals[1]

In this dissertation I aim to explore how firms can operate beneficially within the communities they exist both from a social and an environmental perspective. Specifically, I focus on inclusive employment of workers with a disability and firm water usage as topics that directly impact communities and individuals while also being substantially affected by business practices. The first essay focuses on workers with disabilities, and how organizations may be able to improve their productivity in the workplace through inclusive management practices. The

[1] Image Source: https://sdgs.un.org/goals

second and third essays focus on water, a novel but critical sustainability topic that has a direct impact both on organizations and communities.

2. Chapter 2: Does leader disability status influence the productivity performance of teams with workers with disabilities? An empirical study in the apparel industry.

2.1 Introduction

Inclusion is attracting significant attention in both the academic literature (Kalkanci et al. 2019) and popular press (Guadiano and Hunt 2017, Kubik 2018). The United Nations has identified inclusion related to people with disabilities as an integral part of its Sustainable Development Goals (2015), with the employment of people with disabilities being called the "The New Green" and deemed "as important as environmentalism" (The Economist 2012). Morath (2019) suggests that individuals with disabilities are the new "hidden workforce" of America. The importance of this topic arises from the substantial proportion of the population affected by a disability. In the United States (US), 27.2% of the population and roughly six million workers, about 3.7% of the workforce, have a disability (United States Census Bureau 2018) which are employed across a wide range of organizations and industries (Hernandez and McDonald 2010).

Organizations may specifically target employing workers with disabilities for reasons beyond the general need for workers. From an external perspective, employing individuals with disabilities can bring reputational benefits as the organization is socially responsible (Spataro 2005, Lysaght et al. 2012). There can also be financial benefits from programs such as Ability One[2]. From an internal standpoint, the hiring of a diverse workforce fulfills an organization's social commitments (Meacham et al. 2019), which potentially leads to lower turnover and stronger employee commitment (Chaudhary 2017) as employees identify with those aspects of

[2] Ability One is an independent federal agency with the express purpose of providing employment opportunities for blind or significantly disabled individuals and veterans. Ability One certification opens up opportunities to supply the United States Department of Defense. More information can be found at: https://abilityone.gov/

an organization that reflect most positively on them (Hsu and Elsbach 2013). Besides increased diversity and lower turnover, the productivity implications of employing individuals with disabilities are also important (Lindsay et al. 2018, Narayanan and Terris 2020).

Studies have found that workers with disabilities may be less productive (Stewart et al. 2003, Lerner et al. 2004). It could be because managers have a limited understanding of training and supporting employees with disabilities (Foster 2007, Zanoni 2011, Houtenville and Kalargyrou 2015, Williams-Whitt et al. 2016). The role of managers for the performance of workers with a disability is critical as these workers may have substantial variation in skills (Miralles et al. 2007) and potentially a limited range of tasks they can perform (Zanoni 2011). Further, accommodations for workers with disabilities create a new layer of complexity for their supervisors and workgroup (Williams-Whitt et al. 2016). Thus, managerial support is a key factor for the performance of workers with disabilities (Foster 2007).

In general, direct supervisors have a critical influence on the performance outcomes of workers due to their position as primary points of contact and intermediaries between workers and management (den Hartog et al. 2004). The role of a supervisor in managing workers is even more important for employees with disabilities (Tompa et al. 2008). As individuals interact with employees on a day-to-day basis, supervisors "*may have the potential to help [individuals with disabilities] overcome the barriers and facilitate the process*" (Tompa et al. 2008, p. 17). Specifically, managing the complexities of accommodations on the line when employing workers with disabilities requires a high degree of trust and communication between the supervisor and workers with disabilities (Williams-Whitt et al. 2016). In this regard, there is potential for the supervisor's characteristics to directly impact the accommodation process if the supervisor has personal experience with disability since they may be more empathetic to workers

with disabilities (Shaw et al. 2003). Accordingly, this research focuses on the impact of the presence of a leader with disabilities on the productivity of a team of workers with disabilities[3].

In examining the productivity implications of teams of workers with disabilities that have a supervisor with a disability, this study overcomes two key barriers that have constrained prior studies to provide unique and actionable insights for organizations. The first barrier is a lack of granular data to enable meaningful empirical analysis of outcomes associated with the employment of workers with disabilities. Such data has the potential to provide clues as to how firms may design groups that include workers with disabilities to be better performing, leading to the creation of "superior" inclusivity. Second, while the employment of individuals with disabilities is of broad interest, past research has been primarily qualitative since a quantitative assessment of the impact of employing individuals with disabilities is challenging due to the difficulties in obtaining suitable data. In this regard, Lindsay et al. (2018) note that little attention has been given in this space to the use of large-scale micro-data for empirical analysis. The current investigation is unique in that it draws on micro-data focused on specific tasks in apparel manufacturing, collected from a single organization and spanning multiple years.

The second barrier is the difficulty of understanding the potential psycho-social mechanisms that underlie the productivity implications of leaders with disabilities in settings where workers with disabilities are deployed. Understanding these mechanisms is challenging since disabilities are diverse, and randomization in these settings is not practical. Accordingly, this study builds on the quantitative portion by taking a qualitative approach to understanding these mechanisms by interviewing both supervisors and workers in a post-hoc analysis using a standardized set of questions (see Appendix 1.1). The interviews were conducted in the

[3] In this research, team and workgroup are used interchangeably.

organization providing the quantitative data and two other organizations unrelated to the focal firm that employ workers with disabilities in large numbers. All three organizations employ workers with disabilities as part of their corporate strategy. Two of them are Work Integration Social Enterprises (WISE), including the focal firm, and the third is a large commercial organization. Thus, this study builds knowledge through a multi-method approach that combines quantitative analysis with a qualitative study. The combination of quantitative and qualitative analyses provides insights into team design for workers with disabilities and has important implications for the design of an organization's upward mobility programs.

The rest of the study is organized as follows. First, a brief description of the focal firm and its context for the quantitative analysis is provided in section 2. Next, in section 3, relevant literature is briefly reviewed. Section 4 develops the hypotheses. Section 5 contains the quantitative analysis and results. Section 6 describes the post-hoc qualitative interviews that build an understanding of the mechanisms underlying the results. Lastly, the discussion and conclusion are presented in sections 7 and 8, respectively.

2.2 Focal Organization and Study Context

The setting for the quantitative portion of this study is Peckham Inc., located in Lansing, Michigan. Founded in 1976, Peckham is a non-profit vocational rehabilitation organization that employs an ethnically and culturally diverse workforce. The organization's mission is to provide opportunities for workers with disabilities to improve work skills and develop independence by offering vocational and training services for its workforce. A more detailed overview of the firm can be found in Narayanan and Terris (2020). The firm has operations across multiple business areas, including apparel, environmental services, farms, business services, packaging, and supply chain solutions.

This study focuses on Peckham's largest business unit, apparel manufacturing with two production facilities approximately 50 miles apart. Peckham's apparel business operates through the Ability One program and manufactures primarily for the defense industry with certifications for ISO 9001:2008 and CARF[4]. Peckham is also registered through the United States Department of Labor for its apprenticeship training program, which provides comprehensive sewing training and workforce development. The workforce of each facility consists of workers with and without disabilities with the majority of employees having some form of disability. The employment environment of the firm can be characterized as competitive integrative employment since no distinction is made between individuals with disabilities and those without disabilities on the job.

The firm uses a modular system of apparel production. The modular production system is ideally suited to team-based apparel production. It is ideal from the standpoint of the empirical analysis that this study undertakes in examining the moderating influence of a team leader with a disability on the impact of the number of employees with disabilities on a team's productivity. In contrast to individual incentivization, the team receives collective incentives based on the achievement of productivity targets. Additional theoretical details on the modular production system can be found in Berg et al. (1996) and Abernathy et al. (1999).

As a leading community rehabilitation program in Michigan, the firm has a recruiting team with relationships across several stakeholders within the state and outside to facilitate the recruitment of persons with disabilities. These recruiting teams are aided by Peckham's Vocational Service Specialists (VSS) who help in the assessment of individual disabilities and placement of individual employees across the various business lines within the firm. The firm

[4] CARF is a community accreditation program that evaluates programs such as Peckham Inc. for the quality of rehabilitation programs. http://www.carf.org/home/

also assists in placing individuals in other outside agencies when it cannot find an internal opening compatible with an individual's skills.

As team members are recruited and placed in the apparel manufacturing unit, they are provided sewing training. Thus, anyone assigned to the apparel manufacturing production line has skills within this domain. The firm grades sewers on three skill levels – basic, medium, or difficult. Workers are allocated within the line based on their readiness to undertake specific tasks. Employees with disabilities in a line are provided accommodations that depend on the nature of their disabilities. Each employee is paired with a VSS representative that works with the individual on their unique needs and accommodations after assignment to the manufacturing unit. These accommodations range from providing employees extra breaks to changes in tasks depending on how employees perform within the line. In other situations, accommodations could also include advocacy, limiting time on the line, varying break times, encouraging employees to speak up, and help with building relationships with colleagues within the line, among other things. Accommodations are designed to overcome individual restrictions, whether they are physical or cognitive. In traditional lines, such accommodations may be minimal as well as potentially create challenges for other employees as they place additional constraints on team leaders (e.g., Zanoni 2011, Narayanan and Terris 2020).

Team leaders have oversight responsibilities for the apparel manufacturing lines and work with managers overseeing the shop floor to ensure smooth operations. For the most part, team leaders work directly with line employees and serve as the key interface between frontline workers and management. Team leaders are also responsible for target achievement within the lines. Most team leaders are promoted internally from frontline workers since employees are trained on the line. The firm's commitment to providing employees with disabilities an

opportunity for competitive work can be seen in the fact that workers with and without disabilities work side by side. Finally, team leaders also play a pivotal role in ensuring that employees get appropriate opportunities to be productive and perform well, working collaboratively with the VSS group.

2.3 Literature review

Organizations often focus on the challenges associated with workers with disabilities because employers may expect significant barriers and performance challenges when employing them (Cavanagh et al. 2017). Even when upper management supports workers with disabilities, there can be a disconnect between the policies put in place and the policies implemented on the shop floor which can stymie needed operational support for workers with disabilities (Schur et al. 2005, Kulkarni and Valk 2010). There can also be a lack of professional support and job-specific training (Schur et al. 2009) for workers with disabilities which could leave them underequipped and demotivated. An additional challenge that organizations must consider when managing workers with disabilities is variability in the ability to perform certain tasks (Miralles et al. 2007, Costa and Miralles 2009). This variability affects the types of tasks employees with disabilities can perform in a work environment (Zanoni 2011).

Despite challenges, many organizations have found workers with disabilities perform well. Meacham et al. (2019) found that among firms that had hired an employee with an intellectual disability, 97% would do so again. Similarly, workers with physical disabilities are generally described as competent (Unger and Kregel 2003, Golub 2006). In a survey of US companies, employees with disabilities were rated nearly identical to those without disabilities in overall job performance on average (Hernandez and McDonald 2010). However, there are

studies with results that have found workers with disabilities perform worse than other workers (Stewart et al. 2003, Lerner et al. 2004).

The support that an organization provides for workers with disabilities is likely a substantial factor in explaining differences in performance (Snyder et al. 2010). For example, supportive management practices are associated with better productivity for workers with disabilities as managers have a substantial impact on the ability of workers with disabilities to perform their job through the ability to make changes in operations, manage workloads, and approve accommodations (Gates 2000). Additionally, when an organization accepts a worker with a disability, the focus changes from a worker's limitations to their abilities (Golub 2006). Overall, a positive attitude toward employees with disabilities improves their confidence (Olson et al. 2001) and likely their performance.

The issues discussed above are all aspects of the workplace which center on a worker's interactions with their immediate supervisor. Supervisors substantially impact performance as a primary point of contact that can influence a worker's experiences through communication and day-to-day interactions (den Hartog et al. 2004). Accordingly, this study focuses on the impact of supervisors with a disability on performance outcomes in a production setting where employees have disabilities.

2.4 Theory development and hypothesis

Leader-Member Exchange (LMX) theory focuses on the two-way relationship between leaders and followers. It posits that the relationship between a leader and follower is determined by follower characteristics, leader characteristics, and the interpersonal relationship between the leader and the follower (Dulebohn et al. 2012), with a high-quality LMX relationship improving worker performance (Gerstner and Day 1997). While LMX theory pertains to individual

interactions between employees and their supervisors, it has ramifications at the group level (e.g., Gajendran and Joshi 2012) as the empowerment, or self-efficacy, provided by LMX can translate to the group level (G. Chen et al. 2007).

This study contends that interactions between direct supervisors and workers, and the consequent relevance of LMX, are even more critical within settings where team members with disabilities are deployed. Studies within the disability context note that direct supervisors of workers can be a barrier in the integration of workers with disabilities even if the broader corporate culture accepts the workers (Schur et al. 2005). Drawing from these observations, this study contends that the presence of a leader with a disability, relative to their non-disabled counterparts, positively moderates workgroup productivity as the number of workers with disabilities in the team increases or the ratio of workers with disabilities in the team increases based on the following rationale.

First, literature on LMX theory suggests that perceived similarity improves relationship quality (Dulebohn et al. 2012) while perceived dissimilarity lowers it (Liden et al. 1993). Individuals who are similar may be more comfortable in their relationships, leading them to be more open about their experiences (Byrne 1971). Leaders with disabilities, rather than those without, may better relate to the unique challenges faced by workers with a disability. The increased empathy that is likely to arise from the shared experience of disability between leaders and workers could lead to better communication on how to best achieve goals and tasks by the workers (Jablin and Putnam 2004). As the number of individuals in the team with disabilities increases, such communication could have a more profound effect as more and more workers with disabilities in the group interact with the supervisor, leading to more workers that would be influenced by such interactions.

Second, workers with disabilities are often supported with accommodations without which daily work challenges would not be addressed. Accommodations consider individual abilities in reference to tasks and may require the formation of new routines that are adjusted to a specific individual. In addition, the accommodation process may require trial-and-error (Williams-Whitt et al. 2016) which could create difficulties when determining standard operating procedures to overcome challenges. As the number or ratio of workers having disabilities in the team increases this may have a negative impact on the team productivity owing to the need to manage a substantial number of accommodations. A supervisor with a disability may better understand the challenges faced by workers with disabilities through their personal experience, leading to an improved ability to administer such accommodations effectively.

Third, another challenge for supervisors is the greater variability in ability that workers with a disability have (Miralles et al. 2007) which can restrict the types of jobs those workers can do on the production line (Zanoni 2011). The greater the number and ratio of the workgroup having a disability, the more difficult it will be to match workers with disabilities with their optimal task, potentially creating ability-task mismatches. These are likely to impact productivity negatively. As the number of accommodations and task-ability mismatches increases, workgroup complexity and the cognitive burden placed on the supervisor increase, increasing the need to communicate with workers more closely to manage these challenges. The shared experience with accommodations that a supervisor with disabilities has may better facilitate a constructive conversation with workers regarding tasks.

Fourth, accommodations for one employee can generate challenges related to feelings of fairness with other employees (Colella 2001). Studies note that supervisors need to manage their communication and interactions with other employees, including workers without a disability,

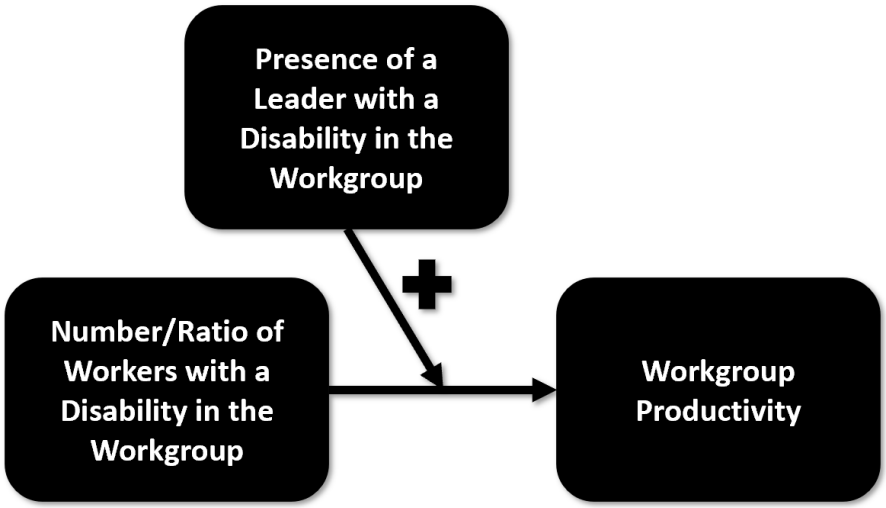
when managing the accommodation process for an employee with a disability. Other workers may feel that they are not receiving the same level of support. This requires additional effort and understanding, also referred to as a "bulge in the balloon" for the supervisor's efforts, putting time and effort into one part of the workgroup can create difficulties in other parts of the workgroup (Williams-Whitt et al. 2016, p. 375). This can be challenging given the varying abilities of the workers on a team and the varying accommodations that different individuals within a team can require. As the number of employees with a disability grows within a team, these interactions need to be carefully managed. Otherwise, teams may experience additional conflicts due to the accommodations. Prior studies have suggested that friction is likely generated within teams due to others' accommodations and that friction manifests in the interactions between supervisors and employees (Zanoni 2011). Leaders with disabilities may be able to manage these challenges more aptly since they may better convince other employees about the overall necessity and benefit to the overall workgroup given their own experiences, allowing them to alleviate fairness concerns. Overall, these considerations form the basis for Hypotheses 1a and 1b:

Hypothesis 1a*: The presence of a leader with a disability beneficially moderates workgroup productivity such that as the <u>number</u> of workers with disabilities in the workgroup increases, a workgroup that has a leader with a disability present in the workgroup will be associated with superior productivity relative to when there is no leader with a disability present in the workgroup.*

Hypothesis 1b*: The presence of a leader with a disability beneficially moderates workgroup productivity such that as the <u>ratio</u> of workers with disabilities in the workgroup increases, a workgroup that has a leader with a disability present in the workgroup will be associated with*

superior productivity relative to when there is no leader with a disability present in the workgroup.

Figure 2.1 Theoretical Framework



The theoretical model of the moderation hypothesis is depicted in Figure 2.1.

2.5 Quantitative Study of Focal Firm

2.5.1 Data Collection

The quantitative data for the study was obtained from three sources within Peckham. First, in Peckham's apparel unit production system, data is entered each day in Excel spreadsheets for different garments produced within the facility. This data contains daily production data as well as production target achievement. This data came from the production floor and was embedded in several hundred worksheets which were carefully collated. Second, information on the hours worked on the line by the workers, skill level, job category (leader/worker) were obtained from the Human Resources Management Department. This information was based on employee time stamps, but data were anonymized before being shared. This information was matched to the production sheet based on the garment identifier for the day that the employee received wage credit. Third, data on the disability status of workers in the

workgroup was obtained from vocational rehabilitation and human resources. This information was codified to anonymize the specific nature of the disability related challenges due to legal restrictions. Disabilities are classified into cognitive and physical. Cognitive disabilities were related to mental disabilities, traumatic brain injury, learning disorders, emotional or behavioral impairments, post-traumatic disorders, and chemical dependence or substance abuse. Physical disabilities include any general physical challenge such as deaf employees and employees with visual or mobility impairment.

An independent medical practitioner determines disability status and that determination is then communicated to the focal organization. These statuses are then used to determine employee restrictions. To ensure privacy, worker information was anonymized and aggregated to the group level by Peckham to ensure that the research team could not identify individual workers.

The data compilation and analysis were conducted at the workgroup-day level. While specific individual or workgroup identifiers were not available, the garments produced each day were tracked within the production spreadsheets. Based on the information provided, a workgroup is assigned to work on a particular garment for a period with the same general group of workers and leaders working that production run of the garment, with different workgroups working on different garments. Based on this, workgroups were indirectly tracked over time by following production runs of specific garments.

Overall, 82 different garments were produced during the study period with color variations of an otherwise unique garment grouped as a single number. This resulted in 49 unique garment types. The compiled data produced a panel dataset of daily production across these garment types from October 2011 through June 2017. The original data spanned a total of

16,951 garment-days of data. Observations where worker or supervisor disability status was not available were dropped from the analyses to keep the analysis complete to settings where leader disability status is identified. Further, situations where less than three workers or no leaders were present in the workgroup were removed. Based on robustness checks performed and presented later in the paper, the minimum workgroup size did not affect the results.

2.5.2 Model Variables

2.5.2.1 Outcome Variable

Productivity Measure: TM Hours per Garment (ln) – Total number of hours that each employee worked in the line (adjusted for breaks) divided by the number of garments produced on the given day. Measures are logged to improve the meaningfulness of interpretation (Wooldridge 2015, pg. 41). Since this variable measures the amount of time to produce a single garment a lower number represents better productivity.

2.5.2.2 Main Effects

Number of Workers with a Disability – This variable is the first of the two main effect variables. It captures the absolute number of workers in the workgroup with a disability and thus the number of individuals potentially requiring an accommodation.

Ratio of Workers with a Disability – This variable is the second of two main effect variables. It is the ratio of workers in the workgroup with a disability. This captures the increasing potential and resulting complexity of ability-task mismatch.

Leader Disability – A dummy variable to indicate if a leader with a disability was present in the workgroup. The value is 1 if a leader with a disability was present in the workgroup and 0 otherwise. This variable is interacted with the number of workers with disabilities and ratio of

workers with disabilities to examine the moderating effect of the presence of a line leader with a disability.

2.5.2.3 Control Variables

Number of non-disabled workers – The number of workers in the workgroup without a disability is used as a control for the number of workers with a disability regression. Since the ratio of workers with disabilities incorporates the number of non-disabled workers, this was not included as a control variable in that regression.

Number of workers in the workgroup – The number of workers in the workgroup overall was used as a control in the ratio of workers with a disability regression.

Average worker skill – The average skill rating of workers within a workgroup is used as a control in both the number of workers with disabilities regression and the ratio of workers with disabilities regression. The rating system ranges from 1 (basic skills) to 4 (master sewer) and was provided by the company. For the most part, the skill levels of workers in a line ranged from 1 to 3.

Fixed effects – Several fixed effects were included to account for garment complexity and time. These fixed effects control for the general time-invariant variables driving productivity. Specifically, fixed effects for years (2011-2017), month, and day of the week were included to account for time specific effects. To account for site specific variation, an indicator variable was included to control for the effect of the production facility (there were two in the sample). To account for complexity and other garment specific heterogeneities, garment (49 unique garments) fixed effects were also included.

2.5.3 Descriptive Statistics

Descriptive statistics and correlations can be found in Table 2.1. The dependent variable, TM Hours per Garment, is non-logged in this table to improve interpretability. All observations are at the workgroup-day level and track the production runs of specific garments over time.

Table 2.1 Descriptive Statistics of Main Effect, Outcome and Control Variables

Variable Name	Mean	S.D.	1	2	3	4	5	6	7	8
1. TM Hours per Garment	1.69	4.98	1							
2. Lead. with Dis. in the Group	0.49	0.50	-0.05	1						
3. Number of Leaders	1.59	1.06	0.05	0.35	1					
4. Number of Workers with a Dis.	11.00	6.84	0.01	0.17	0.45	1				
5. Ratio of Workers with a Dis.	0.70	0.17	-0.08	0.09	0.01	0.27	1			
6. Numb. of Non-Disabled Workers	4.64	3.20	0.08	-0.12	0.42	0.54	-0.46	1		
7. Total Number of Workers	14.86	8.95	0.05	0.05	0.41	0.95	0.02	0.76	1	
8. Average Worker Skill	2.69	0.33	0.21	0.21	0.08	-0.15	-0.33	0.08	-0.11	1

2.5.4 Empirical Methodology

The data contain both cross-sectional (multiple garments) and time-series elements (same garment across several days) which create correlations that are both contemporaneous, due to having multiple garments running in the same factory at the same time, and serial, due to daily production of the same garment. To account for these factors, Prais-Winsten regression (the xtpcse package in Stata) was used in accordance with other studies such as Staats and Gino (2012) and Narayanan and Terris (2020). The approach accounts for contemporaneous correlation across garments, serial correlation over time, and is robust to heteroskedasticity issues. The estimated empirical model is below:

$$y_{gt} = \beta_0 + \boldsymbol{\beta} * \boldsymbol{X}_{gt} + \boldsymbol{\lambda} * \boldsymbol{Z}_{gt} + u_{gt} \qquad (1)$$

$$u_{gt} = \rho u_{g,t-1} + e_{it} \qquad (2)$$

In the above set of equations, y_{gt} is the dependent variable indicating productivity of the workgroup *g* in time *t*. $\mathbf{X}_{gt}$ indicates a vector of independent variables: the number or ratio of

workers with disabilities, a dummy variable indicating whether a leader with a disability is in the team, and the interaction term between the number or ratio of workers with disabilities and the dummy variable for the leader with a disability, with coefficients of the independent variables represented by the vector $\boldsymbol{\beta}$. $\mathbf{Z}$ is the vector of control variables with $\boldsymbol{\lambda}$ indicating the vector of coefficients with time-invariant fixed effects for specific garments, day, month, year, and site with their respective indicator variables. Lastly, u_{gt} is the composite error of the AR(1) disturbance with autocorrelation coefficient ρ and the idiosyncratic error e. To capture the dynamics of a team working environment, the analysis was restricted to workgroups with at least three individuals. However, the results hold regardless of minimum workgroup size (discussed later in the robustness checks section of the paper). The analysis was also restricted to workgroups where there is at least one leader present.

2.5.5 Results

2.5.5.1 Primary Results

Table 2.2 presents the results of the regression analysis associated with the number of workers with a disability. The results show a leader with a disability has a beneficial impact on productivity outcomes for workers with disabilities. In the full model, increasing the number of workers with a disability within the team reduces productivity by increasing the labor hours to produce a garment ($\beta = 0.01$, $p < 0.01$). In contrast, the presence of a leader with a disability in the workgroup off-sets the decline in productivity ($\beta = -0.01$, $p < 0.01$) as the number of workers with a disability increases as shown by the interaction term. The dependent variable in the research context is hours of labor to produce a garment so higher numbers indicate lower productivity. Specifically, each additional worker with a disability reduces productivity by increasing labor hours per part by roughly 1%. However, the inclusion of a line leader with a

disability in the workgroup improves productivity by reducing labor hours per part by roughly 1% for each additional worker with a disability in the workgroup. Thus, the negative main effect is mitigated.

Table 2.2 Number of Workers with a Disability Prais-Winsten Regression

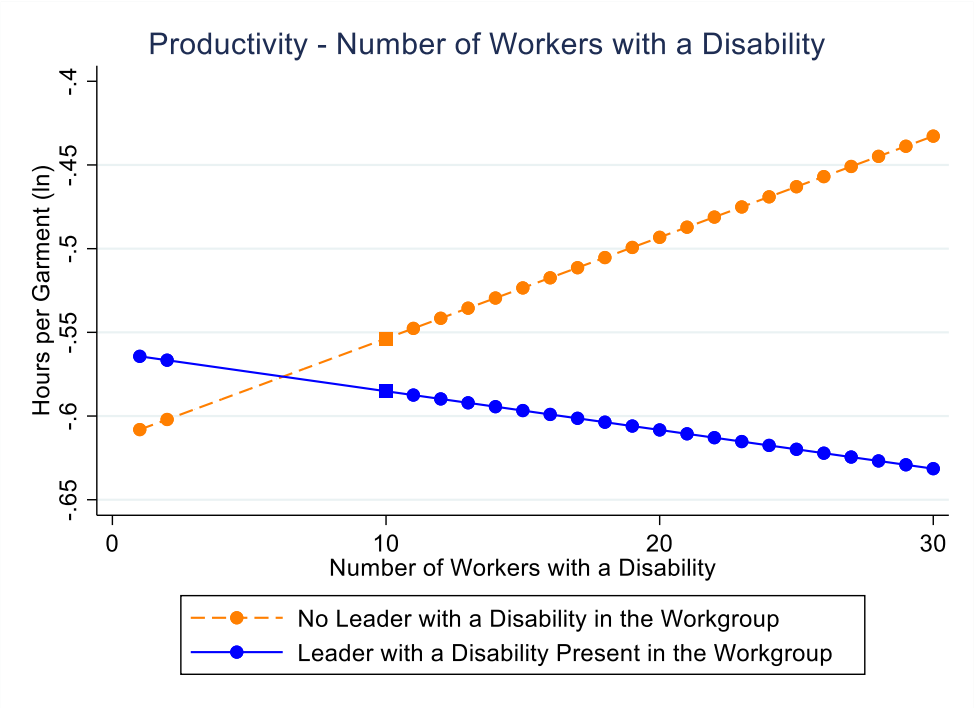
	Controls Only		Main Effects		Full Model	
Numb. Workers w. Disability			0.00	(0.00)	0.01***	(0.00)
Leader with a Disability			-0.04***	(0.01)	0.05**	(0.02)
Numb. Workers w. Dis.* Ldr. w. Dis.					-0.01***	(0.00)
Number of Non-Disabled Workers	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Number of Leaders	-0.01*	(0.01)	-0.00	(0.01)	0.00	(0.01)
Average Worker Skill	-0.07***	(0.03)	-0.06**	(0.03)	-0.07***	(0.02)
Constant	1.94***	(0.09)	1.93***	(0.11)	1.96***	(0.11)
Garment, Time, Site Fixed Effects	Included					
Observations	9,565		9,565		9,565	
R-Squared	0.93		0.93		0.93	
ρ	0.38		0.37		0.38	
Wald Chi-Squared	121,117.68		121,632.34		123,397.67	

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

These results validate hypothesis 1a that line leaders with a disability have a beneficial moderating impact on the workgroup's productivity as the number of workers with a disability in the workgroup increases. Thus, the primary benefit of a line leader with a disability is not a direct improvement of productivity, but rather mitigating a potential productivity decline as the number of workers with disabilities in the workgroup increases. This effect becomes apparent in Figure 2.2 which presents the marginal plot for the productivity outcome. As seen in Figure 2.2, increasing the number of workers with disabilities in the workgroup does not substantially affect workgroup productivity when a line leader with a disability is present in the workgroup. For workgroups without a leader with a disability, however, the mitigation effect is absent. Adding

additional workers with a disability to the workgroup in this latter case reduces workgroup productivity, supporting Hypothesis 1a.

Figure 2.2 Simple Slopes Number of Workers with a Disability Productivity



Beta difference test p-values: circle: < 0.05, square < 0.10.

Table 2.3 presents the results for the hypothesized beneficial moderating impact of a leader with a disability as the ratio of workers with a disability in the workgroup increases. Here the focus is on the proportion of the workgroup with a disability, instead of the absolute number of workers with a disability. Again, as in the case with the number of workers with a disability in the workgroup, as the ratio of workers with a disability in the workgroup increases, productivity declines ($\beta = 0.09$, $p < 0.10$). The interaction term of ratio of workers with a disability and a leader with a disability being present in the workgroup shows that the presence of leader with a disability offsets the reduction in productivity as the ratio of workers with a disability increase ($\beta = -0.10$, $p < 0.10$).

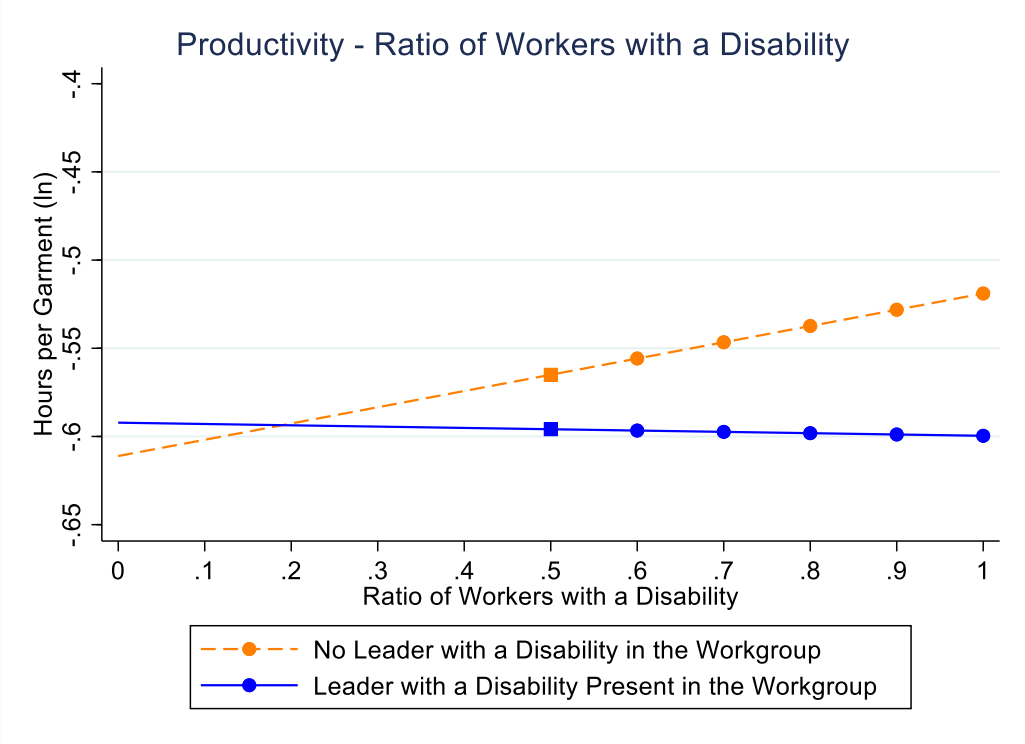
Table 2.3 Ratio of Workers with a Disability Prais-Winsten Regression

	Controls Only		Main Effects		Full Model	
Ratio Workers w. Disability			0.04	(0.05)	0.09*	(0.05)
Leader with a Disability			-0.05***	(0.01)	0.02	(0.04)
Ratio Workers w. Dis.* Ldr. w. Dis.					-0.10*	(0.06)
Number of Workers	0.00***	(0.00)	0.00***	(0.00)	0.00***	(0.00)
Number of Leaders	-0.00	(0.01)	0.00	(0.01)	0.00	(0.01)
Average Worker Skill	-0.04	(0.02)	-0.04	(0.03)	-0.04	(0.03)
Constant	1.86***	(0.11)	1.84***	(0.11)	1.81***	(0.11)
Garment, Time, Site Fixed Effects	Included					
Observations	9,565		9,565		9,565	
R-Squared	0.93		0.93		0.93	
ρ	0.38		0.38		0.38	
Wald Chi-Squared	121,460.63		122,031.28		120,832.96	

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

Figure 2.3 provides marginal plots of the interaction effects for the productivity results presented in Table 2.3 and shows a similar effect to that seen in Figure2. 2. When the ratio of workers with a disability in the workgroup is low, there is no statistically significant difference in the workgroup's productivity irrespective of the presence of a leader with a disability. As the ratio of the team being workers with a disability in the workgroup increases, productivity declines. If a leader with a disability is present in the workgroup, the productivity declines are offset. Thus, the key productivity benefit of a leader with a disability is in offsetting potential declines in productivity as the ratio of workers with a disability increases in accordance with Hypothesis 1b.

Figure 2.3 Simple Slopes Ratio of Workers with a Disability Productivity



Beta difference test p-values: circle: < 0.05, square < 0.10.

2.5.5.2 Endogeneity

One potential concern with the data is the assignment of leaders to workgroups for which they would be best suited. In our case, this would be problematic if line leaders were assigned to workgroups based on the disability composition of the workgroup due to some unobservable skill or experience in managing workers with disabilities. Conversations with personnel at Peckham indicate that this is not the case. When discussing why a leader may be assigned to a workgroup, management described several criteria that are used to assign leaders to workgroups, none of which included workgroup disability status. For the supervisor, assignment to roles were based on their patience, communication at large, sewing skills and teaching ability.

All employees within the sewing facility went through a Sewing 101 training (an introductory training for basic sewing skills). Once this training was passed no distinction was

made of disability status on the line, only sewing skill mattered. During interviews with supervisors at Peckham they noted that disability status was not considered for worker assignments, once they passed the basic training. For example, one supervisor with a disability said "*Nope. That is not [considered]. The only, only time it would be consideration would be if the machine that we are putting them on needs to be elevated or lowered for their situation*." Another supervisor without a disability stated "*It's based on how they performed in the Sewing 101. And then what our production needs are on the floor…at the assignment level there is not whether the employee has a disability or not is not a criteria*."

While there is no intentional effort being made to consider disability status in assignment decisions, an effort was made to account for endogeneity through econometric approaches. Since the data contains no theoretically justifiable instruments that could account for why leaders or workers are assigned to a line, there are challenges in using an instrumental variable approach. Though leaders with a disability can be considered a treatment, the analysis looks at a moderating effect instead of a pure treatment and control group, in addition to using panel data, so propensity score matching was not viable as it is traditionally used for cross-sectional data. Considering these factors, an instrument-free gaussian copula approach is applied (Park and Gupta 2012). This is an instrument free technique which separates a potentially endogenous variable as being made up of a non-normally distributed exogenous component and a normally distributed endogenous component. After identifying the endogenous portion, the joint distribution of the potential endogenous regressor can be modeled using copula terms which are essentially the inverse normal of the cumulative density functions of the potential endogenous regressor (Park and Gupta 2012).

For this method to identify the endogenous and exogenous portions of the variable the distribution must be non-normal and continuous. A Shapiro-Wilk test of non-normality confirmed this for number of workers with a disability ($W = 0.91$, $p < 0.01$), its interaction with the presence of a leader with a disability ($W = 0.96$, $p < 0.01$), ratio of workers with a disability ($W = 0.98$, $p < 0.01$) and the interaction of ratio of workers with a disability and the presence of a leader with a disability ($W = 0.95$, $p < 0.01$). Since leader with a disability was a binary variable, an inverse normal cdf of the distribution was not considered. Further, our primary variables of interest are solely the interaction terms. The computed copulas can then be added as control variables in the primary regression. The results are presented in Table 2.4. The interaction term for both number ($\beta = -0.01$, $p < 0.01$) and ratio ($\beta = -0.17$, $p < 0.05$) of workers with a disability confirm our main results.

Table 2.4 Copula Approach

	Number of Workers with a Disability		**Ratio** of Workers with a Disability	
Number/Ratio of Workers with a Disability	0.01***	(0.00)	0.17**	(0.07)
Leader with a Disability	0.06***	(0.02)	0.05	(0.04)
Number/Ratio of Workers w. Dis.*Lead w. Dis.	-0.01***	(0.00)	-0.17**	(0.07)
Number/Ratio of Workers Copula	-0.01	(0.02)	-0.02*	(0.01)
Interaction Term Copula	0.03	(0.03)	0.02*	(0.01)
Constant	1.96***	(0.11)	1.76***	(0.12)
Observations	9,565		9,565	
Number of Workers/Non-Disabled Workers/Leaders and Average Skill	Included			
Garment, Time, Site Fixed Effects	Included			

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

While there are no instruments that would be considered theoretically sound to use, there are some that could be somewhat justified to take an instrumental approach to build upon the copula approach. To ensure identification, three instruments were created, one each to predict the number/ratio of workers with disability, leader with disability, and the interaction term of the

two. These instruments were focused on the presence of workers and leaders with disability on other lines. Community rehabilitation programs have a mandate of having a minimum proportion of individuals with disabilities employed within the facility, but there are still workers without disabilities employed in the facility. This means that those workers with a disability are spread among lines within the facility mixed among workers without disabilities. Given this, allocation of individuals with disabilities to a specific line may be correlated to the allocation of individuals to other lines (even though assignments are not driven by this criteria), given that factories have a relatively fixed set of workers. This correlation may also carry to the presence of leaders across lines. Furthermore, workgroup composition of "other" lines cannot drive productivity of a focal line. Given this logic, the three main variables were instrumented with respective variables for other lines that are based on the prior day's work group composition. Since workgroup composition is relatively stable day to day as workers and leaders tend to work on a production run until completion, using the prior day's values would further remove other groups composition to the focal day's productivity.

Specifically, for number/ratio of workers with a disability in the workgroup the prior day's ratio of workers with a disability in other workgroups was used. A greater ratio of employees with disability on other lines in the facility will be negatively correlated to the ratio of workers with disabilities on a focal line given the finite number of workers with disabilities, and the need to allocate a certain portion of the workhours from individuals with disabilities. For the presence of a leader with a disability in the workgroup, the number of leaders with a disability in other workgroups was used. As more leaders with disabilities are employed in other lines, it likely reduces the chances that a leader with a disability is available for a current line. Further, roughly 90% of the observations have 0 or 1 leaders with a disability, hence using number of

leaders with a disability in the first stage regression rather than ratios was deemed appropriate. Finally, for the interaction terms, these two instruments are combined to create an instrument for the interaction term of the number of leaders with a disability in other workgroups the prior day interacted with the ratio of workers with a disability in other workgroups the prior day and the same for ratio of workers with a disability as well (Balli and Sørensen 2013). Overall, this model as a simultaneous system is just identified. It was run using Stata 16's cmp package using robust standard errors as a simultaneous system. To achieve convergence the first stage regression for leader disability status was estimated using a linear probability model, an alternative method for estimating binary dependent variables using OLS (Wooldridge 2010, pg. 562). The results of the analysis can be found in Table 2.5. The first stage regressions do confirm these instruments as statistically significant predictors of the variables of interest.

The results show that the coefficient of the interaction term for number of workers with a disability ($\beta = -0.01$, $p < 0.01$) continues to be significant. However, the coefficient of the interaction term for the model with ratio of workers with a disability is insignificant ($\beta = -0.01$, $p = 0.93$), though the direction is consistent. We also observe the main effects for the ratio regression are no longer significant in this regression as well. Within the framework, this robustness check reveals that the results continue to hold for the regression models focused on number of workers with disabilities but do not provide support for the ratio of workers with a disability regression.

Table 2.5 Number/Ratio of Workers with a Disability Instrumental Variables Regression

	Number of Workers with a Disability		**Ratio** of Workers with a Disability	
Number/Ratio of Workers w. Disability	0.01***	(0.00)	0.04	(0.10)
Leader with a Disability	0.10*	(0.05)	-0.04	(0.09)
Number/Ratio. Workers w. Dis.* Ldr. w. Dis.	-0.01***	(0.00)	-0.01	(0.13)
Number of Non-Disabled Workers/Total Workers	0.00	(0.00)	0.00***	(0.00)
Number of Leaders	0.00	(0.01)	-0.00	(0.01)
Average Worker Skill	-0.06**	(0.01)	-0.03	(0.03)
Garment, Time, Site Fixed Effects	Included			
Observations	9,565			
Number/Ratio of Workers with A Disability First Stage Regression Instruments				
Other Lines Ratio Workers with a Disability Lag	-4.82***	(0.53)	-0.16***	(0.02)
Leader with A Disability First Stage Regression Instruments				
Other Lines Number Leaders with a Disability Lag	-0.03***	(0.00)	-0.03***	(0.00)
Interaction Term First Stage Regression Instruments				
Other Lines Number Leaders with a Disability*Other Lines Ratio of Workers with a Disability Lag	-0.49***	(0.06)	-0.03***	(0.00)

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

As one other endogeneity check, Wilkins (2018) recommends the use of lagged dependent variables since the inclusion of such variables is likely to suppress the effect of the independent variables, particularly in long-time series data. In this setting, the use of a lagged dependent variable partitions out the effects of line specific issues and improvements that can drive productivity changes, and consequently accounts for potential endogeneity challenges as well. These results are presented in Table 2.6. Similar to the instrumental variable regressions using cmp, the result for the interaction term of number of workers with a disability ($\beta = -0.01$, $p < 0.01$) is significant but the result for the ratio interaction is not significant ($\beta = -0.03$, $p = 0.59$), although the sign of the coefficient is consistent with our main results once again.

Table 2.6 Lagged Dependent Variable

	Number of Workers with a Disability		**Ratio** of Workers with a Disability	
Number/Ratio of Workers with a Disability	0.00*	(0.00)	0.00	(0.05)
Leader with a Disability	0.03*	(0.02)	-0.00	(0.03)
Number/Ratio of Workers w. Dis.*Lead w. Dis.	-0.00***	(0.00)	-0.03	(0.05)
Lagged Dependent Variable	0.65***	(0.01)	0.65***	(0.01)
Constant	0.75***	(0.09)	0.71***	(0.09)
Observations	7,290		7,290	
Number of Workers/Non-Disabled Workers/Leaders and Average Skill	Included			
Garment, Time, Site Fixed Effects	Included			

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

Finally, a simple check was done on the raw data across two groups (where a leader with disability is present and teams where there is no leader with a disability) using a simple t-test. These results are presented in Table 2.7. Of note in Table 2.7 is that there are statistically significant differences in the number of workers, ratio of workers with disabilities, and number of workers with disabilities across the two groups. The differences in Table 2.7 suggest that a leader with a disability is on average is a part of larger groups which have more workers with disabilities and a higher ratio of workers with disabilities. In general, these can create additional challenges in managing the team due to span of control challenges and the potential productivity declines seen by the main effects for number and ratio of workers with a disability in Tables 2.2 and 2.3. Overall, this bolsters the merit of the results by showing leaders with a disability generally manage more challenging workgroups, albeit restricted to our specific context.

Table 2.7 Descriptive across workgroups with leader with and without disabilities

Variable Name	No Leader with Disability		Leader with Disability		
	Mean	Std. Dev.	Mean	Std. Dev.	t-statistic (p-value)
Number of Workers	14.41	8.53	15.32	9.34	4.95 (p<0.000)
Number of Workers with a Disability	9.83	6.02	12.21	7.39	17.26 (p<0.000)
Ratio of Workers with a Disability	0.68	0.14	0.71	0.19	8.38 (p<0.000)
Observations	4,864		4,701		

2.5.5.3 Workgroup Size

The main analysis was conducted using a minimum workgroup size of 3 to define a team, but to ensure this did not affect our results we run our main results again using different minimum workgroup sizes. These results are presented in Table 2.8.

For the number of workers with a disability, the coefficient remains consistent and significant regardless of minimum workgroup size, roughly a productivity improvement that is equivalent to the productivity decline as the number of workers with a disability increases. However, for the results for ratio of workers with a disability the results are non-significant when the minimum workgroup size is reduced to 2 but become more pronounced as workgroup size increases. Not only does the interaction term become more significant the higher the minimum workgroup size, the coefficient on the interaction term also becomes increasingly negative and thus a greater improvement to productivity. With small workgroups the impact of potential task mismatch is minimal, but as the workgroup size increases managing this becomes increasingly important and the benefit more pronounced.

Table 2.8 Different Minimum Group Sizes

	Number of Workers with a Disability		**Ratio** of Workers with a Disability	
Minimum Group Size of 2				
Number/Ratio of Workers with a Disability	0.01***	(0.00)	0.08*	(0.04)
Leader with a Disability	0.05**	(0.02)	-0.00	(0.04)
Number/Ratio of Workers w. Dis.*Lead w. Dis.	-0.01***	(0.00)	-0.07	(0.05)
Constant	1.96***	(0.10)	1.84***	(0.11)
Observations		9,857		
Minimum Group Size of 4				
Number/Ratio of Workers with a Disability	0.01***	(0.00)	0.12**	(0.07)
Leader with a Disability	0.06***	(0.02)	0.04	(0.05)
Number/Ratio of Workers w. Dis.*Lead w. Dis.	-0.01***	(0.00)	-0.13**	(0.07)
Constant	1.98***	(0.11)	1.60***	(0.12)
Observations		9,182		
Minimum Group Size of 5				
Number/Ratio of Workers with a Disability	0.01***	(0.00)	0.17***	(0.06)
Leader with a Disability	0.06***	(0.02)	0.07	(0.05)
Number/Ratio of Workers w. Dis.*Lead w. Dis.	-0.01***	(0.00)	-0.17**	(0.07)
Constant	1.90***	(0.11)	1.68***	(0.12)
Observations		8,828		
Number of Workers/Non-Disabled Workers/Leaders and Average Skill	Included in All Regressions			
Garment, Time, Site Fixed Effects	Included in All Regressions			

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

2.5.5.4 Robustness Checks

Several additional robustness checks were conducted to ensure our findings hold. The results of these checks can be found in Table 2.9, with the regressions being identical to the primary result regressions except where noted. Regressions for the number of workers with a disability appear in the left panel and for the ratio of workers with a disability in the workgroup appear in the right panel.

Table 2.9 Robustness Checks

	Number of Workers with a Disability		**Ratio** of Workers with a Disability	
(1) Alternative Measure – Number of Garments Produced During Target Timeframe to Produce One Garment[#]				
Numb./Ratio Workers w. Disability	-0.00***	(0.00)	-0.02	(0.02)
Leader with a Disability	-0.01**	(0.01)	-0.01	(0.01)
Numb./Ratio Work. w. Dis.* Ldr. w. Dis.	0.00***	(0.00)	0.03*	(0.02)
Constant	0.02	(0.03)	0.05	(0.03)
Observations		9,535		
(2) Alternative Measure – Labor Hours Per Part				
Numb./Ratio Workers w. Disability	0.01***	(0.00)	0.09*	(0.05)
Leader with a Disability	0.05**	(0.02)	0.02	(0.04)
Numb./Ratio Work. w. Dis.* Ldr. w. Dis.	-0.01***	(0.00)	-0.10*	(0.06)
Constant	1.97***	(0.11)	1.81***	(0.11)
Observations		9,528		
(3) LSDV Regression with Garment Fixed Effect				
Numb. Workers w. Disability	0.01***	(0.00)	0.10**	(0.05)
Leader with a Disability	0.07***	(0.02)	-0.00	(0.04)
Numb. Workers w. Dis.* Ldr. w. Dis.	-0.01***	(0.00)	-0.09	(0.06)
Constant	2.00***	(0.10)	1.80***	(0.11)
Observations		9,565		

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

Since (1) is a measure of parts produced during the target timeframe to produce one garment a higher number means higher productivity unlike our other productivity measures where fewer hours per part is preferable

First, in regression (1) of Table2.9, productivity is measured as the number of garments being produced per Peckham's target period to produce one garment (logged to improve interpretability). Given this measures the number of garments produced relative the amount of time it normally takes to produce the garment, a higher number represents better productivity unlike our other productivity measures. For number of workers with a disability ($\beta = 0.00$, $p < 0.01$) and for ratio of workers with a disability ($\beta = 0.03$, $p < 0.10$), the interaction terms confirm our results. In (2) an alternative measure of labor hours per garment was provided by the company through a separate system meant to track the same hours per garment measure. The

results are nearly identical to the main analysis and confirm the primary results. Using this measure also provides some additional assurances about the data as it is meant to track the same information as the dependent variable in our main analysis, but through a separate and independent system. In (3) a least squares dummy variable (LSDV) estimation was used with garment fixed effects. For the number of workers with a disability the results are consistent with our main results. For the ratio of disabled workers, the results are non-significant. However, if the minimum workgroup size is increased to 5 workers, the resulting interaction term ($\beta = -0.16$, $p < 0.05$) confirms the primary results.

2.5.5.5 Summary of Results

The findings of the quantitative analyses provide full support for Hypothesis 1a. As the number of workers with a disability in the workgroup increases, a supervisor with a disability has a beneficial moderating impact on the productivity of the workgroup. The results for Hypothesis 1b did not hold for the instrumental variables or lagged dependent variable regression analyses but held otherwise.

There may be two reasons why the results differ. First, the number of workers with a disability captures an increasing potential number of accommodations in the workgroup, and thus greater potential for challenges in managing these accommodations. Ratios can increase dramatically even in small workgroups with few accommodations, so increasing ratios may not necessarily capture the true challenges that can arise. For example, a workgroup with 2 of 4 workers having a disability and 5 of 10 workers having a disability would have the same ratio but different levels of necessary accommodations and hence the consequent challenges in their management.

Second, the firm actively worked to keep a minimum threshold of productive hours logged by individuals with disabilities at 75% or more. Thus, the ratio of workers with disabilities within a line has a lesser variance, as seen in the summary statistics. This likely obscures the relative impact of the ratio of the number of workers with disabilities. In contrast, the results pertaining to regressions on number of workers do not obscure this effect.

As a final issue, it is also important to note that neither of these models show a detrimental influence on productivity. This is the most conservative interpretation of the results, but it has important implications for inclusivity goals and for facilitating and designing upward mobility programs for employees with disabilities.

2.6 Exploring Psycho-social Mechanisms for the Leader with Disability Status Effect

While the results of the study presented above are robust across multiple methods of analysis, the mechanisms underlying these results cannot be fully explained through a quantitative analysis alone. This is due to the difficulty of isolating relationship and empathy-oriented mechanisms in these settings using only micro-data. To examine the potential psycho-social mechanisms underlying the research findings, a series of structured interviews were performed at Peckham. In addition, interviews were conducted at two other organizations that employ large numbers of people with disabilities. The approach of seeking qualitative data from additional firms provided the following benefits.

First, interviewing a sample of supervisors and workers across three organizations provides more qualitative data than would be possible from a single organization. Second, conducting interviews from organizations other than the focal firm enables an assessment of whether the results may have face validity for other organizations and are not simply artifacts of the focal organization's operating environment. Third, given that the focal organization could be

considered unique, exploration of these issues at other organizations in which a large portion of their workforces have disabilities shows that the key results of the study are generalizable to other settings even if those settings are similar kinds of organizations in their desire to employ workers with disabilities.

2.6.1 Participating Organizations

In addition to Peckham, the focal firm, two other organizations agreed to participate in the interview portion of the project. Company A is a large social enterprise with multiple manufacturing facilities based in Miami, Florida which aims to create opportunities for individuals with disabilities or other barriers to employment. Like Peckham, the organization focuses on employing individuals with disabilities. Through hands-on training, it seeks to increase productivity and promote independence in the workplace. About half of the organization's employees are individuals with a barrier to employment, most of them with a mental or physical disability of some form. The individuals interviewed from this organization were employed in production facilities in the Miami area.

Company B is a large publicly traded organization primarily focused on retail with locations across several countries. Within Company B’s operations in the United States, some facilities have been planned around a workforce that consists primarily of workers with disabilities. Workers with disabilities are targeted for hiring at those facilities when possible. The facility where the interviews were conducted is a large distribution center based in Connecticut.

2.6.2 Interview Procedure

Fifty individuals, ten from Peckham and twenty each from the other two organizations, were interviewed in a semi-structured manner over the course of twelve days between December 2020 and August 2021. From Peckham five frontline workers were interviewed, three with and

two without a disability, and five supervisors, four with and one without a disability. From Company A and Company B, ten frontline workers and ten supervisors were interviewed from each organization, five of each group having a disability and the other five having no disabilities. All individuals participating in the structured interview process were selected by their organizations based on their willingness to participate and share insights. Prior to the interviews taking place, a standardized set of nine scripted questions was created to guide the interview process (see Appendix 1.1). To accommodate individuals at Company A who could not speak English, the questionnaire was professionally translated into Spanish as well as French for Creole speaking workers. Company A provided a translator for the interviews with those who could not speak English to translate questions and responses.

The interview questions were designed to understand the mechanisms underlying results for the quantitative study by exploring concepts discussed in the theory development. When possible, interviews were done individually, with 28 of the 50 interviewees being an individual session. The other interviews were either done in pairs or small groups of up to five individuals due to scheduling constraints within the organization or individual preferences. In any interview with more than one individual, only one category of participant was present. Supervisors with a disability were only interviewed with other supervisors with a disability and so on.

Interviews were performed over videoconference due to COVID-related institutional review board (IRB) guidelines. Interviews lasted up to two hours at the longest for the group interviews and up to just over an hour for the individual interviews. Interviews were recorded with participant consent. The recordings were transcribed and subsequently analyzed. Information was categorized by theme.

2.6.3 Interview Themes

Figure 2.4 Categorization of Concepts from the Qualitative Study

Individuals with a Disability		
Supervisors	Major Themes and Preferences	Workers
Re-training on existing task to achieve competence rather than re-assignment.	**Stability of Task Assignment**	Preference for known tasks (moving positions creates anxiety).
Learning is a continuous process that can take an extended period of time.	**Learning - Single Task Competence**	There can be challenges that slow down learning.
Can personally relate to challenges of having a disability in the workplace.	**Familiarity**	Preference for supervisors and support staff the worker already knows.
Sensitivity during interpersonal interactions.	**Interpersonal Communication**	Preference for soft tones from supervisors.

Individuals without a Disability		
Supervisors	Major Themes and Preferences	Workers
Rotate struggling workers to new roles to see if they perform better.	**Flexibility of Task Assignment**	Knowing multiple jobs is valuable for the workgroup.
Rotate workers for cross-training.	**Learning - Multiple Task Competence**	Learning multiple positions is a means to move up in the organization.

Across the interviews five major themes emerged which were broadly associated with either the ***task*** being performed or the ***relationships*** with other individuals in the workgroup or the organization more broadly. The three themes related to the task being performed were ***stability*** of work assignment, operational ***flexibility,*** and ***learning*** related to the task being performed. Related to relationships were the two themes of ***communication*** and ***familiarity***. The themes from the interviews are presented below, and the interview results are summarized in Figure 2.4.

2.5.3.1 Task

2.5.3.1.1 Stability

Workers with disabilities demonstrated a strong preference for stability in their roles. One worker without a disability at Company B said of his son with autism who worked in the same facility and had the opportunity to move from a split second and third shift schedule to a preferable first shift schedule: "*He works just with what we called the Z team, the split shift… he would go to days if he could have his same position or in his same department*". Workers with a disability at Company B reiterated this sentiment with statements such as "*If I already know what to do, I rather stick to it*". A supervisor with a disability within the same company described what he felt the preference of workers was regarding either moving from one task to another or staying at the same task: "*Across the board, most people would just like to stay in their home department*".

Similar sentiments could be found in Company A. One worker with a disability stated that "*I like my position so I never asked to move, I always stayed*". A supervisor with a disability within Company A also stated a preference for trying to keep a worker within the position they were already in rather than reassigning the worker if there were challenges by saying "*repeating the process and going back revisiting the training [and] performing additional follow up. In the end if all those things are not effective then moving on to perhaps reassigning them*".

At Peckham, similar preferences for stability could be found among the workers with disabilities. When describing the work preferences for workers with disabilities, the desire for stability was reflected in comments such as: "*There are other people that don't want to learn anything else, that are just flying doing what they do*" and "*There are some people as you know, I'm good here I'm happy here. Why are you moving me?*". Supervisors with disabilities at

Peckham had experienced similar preferences by workers with disabilities when stating "*The physically disabled or the emotionally. They tend to stick, you know, find one thing that they're good at their niche and they just stay there*".

2.5.3.1.2 Flexibility

In contrast to workers with disabilities, workers and supervisors without a disability focused on flexibility in the work environment. Flexibility was related to cross-training workers on multiple positions. At Company A, supervisors without a disability stated: "*Hands-on training so basically rotate. If the supervisor determines they had a set of operators is already familiar with a specific operation they move on to someone who does not know the operation*" or another that described their "*Reliance on utility operators who are basically operators throughout the line who know all of the operation.*" The supervisors without disability at Company A saw this flexibility as a requirement for workers to move up in the organization when recounting one interaction with a worker who did not like changing positions where the supervisor stated: "*Because you have never wanted to learn new or other operations…others are advancing above [that] person*". Similar sentiments were found among supervisors without a disability at Company B who stated: "*Where the business need is we need to send people there, so whether they're good there or they're not good there, it gives them a chance to improve that skill*" or "*Every day we in my department we assign different work areas*".

Moving workers into new positions appeared to be a primary response of the supervisors without a disability when workers faced task specific challenges. At Peckham moving workers with task challenges was also discussed by both workers and supervisors without disabilities. One worker stated: "*If after two weeks, that person is still cannot get that job. So they will give him option to do different other things.*" Similarly, one supervisor noted, "*It's just not a good fit,*

they're not able to grasp it, they're really struggling, it's causing them more emotional stress trying to learn. Then we can try to move them to another step" and "*We also move workers around the production floor quite often. So me adding a step to somebody else. They don't necessarily know it's because this worker can't do that step.*" In Company B, a supervisor without a disability used similar strategies, stating "*it wasn't working out, so we made a temporary move based on need for that team member to go to another department*" while workers without a disability explained "*If there was a challenge, then they would just move someone around*" and "*we have a bunch of different departments, so I think if you couldn't make rate in that department they would just move you to a different one*". At Company A, moving workers that had challenges with their tasks was mentioned both by supervisors without a disability, "*It is quite common for when all the means of communicating with someone with or without disabilities have been exhausted the conclusion typically is to examine the possibility of moving to a different operation,*" and by workers without a disability, who stated: "*They don't wait for too long, they change it quickly when they see it don't work out*".

The workers without a disability at Company A found that flexibility to move from one task to another in the organization was desirable. They stated "*Learning the operation is important but also learning different operations*" and "*After I was able to complete [the] operation and be able to work with other machine. Learn how to work with other machines and to complete different operations. After I was able to learn I help others. Working to train them as well as a support system to tell them how to complete those operations and she also said that now the goal I have and most others have is to learn how to complete the different operations that are producing in that area so they able to continue learning every day and are able to complete different operations in the process*."

For the workers with a disability, however, flexibility was not only less desirable, but potentially a source of anxiety. As one worker at Company B stated "*Being put in jobs that I've never done before, I've had panic attacks along the way and all that other stuff and exactly. Anxiety attacks. I did have problems with one function manager over my getting farmed out*[5] *all the time and that made me exacerbated and panic stricken. Sometimes got physically sick*". There were indications that supervisors with disabilities were sympathetic to these anxieties. For example, one supervisor with a disability at Company B stated "*They might have really wanted their friends and stay with their friends, but at the end of the day, it's a job and they know they have to do it*". This anxiety toward change seemed rooted in two other themes, one task related (learning) and one relationship related (familiarity), discussed next.

While most workers with a disability preferred stability over flexibility, it was not universal. One worker with a disability at Company B, when asked about they felt about moving positions responded: "*It breaks up the day*." Another worker with a disability at Peckham discussed how task flexibility helped with their disability when stating, "*For me personally, is beneficial for me to multitask, in one spot with* [Redacted Disability Information] *issues is not good. So, moving around is better for me*."

2.5.3.1.3 Learning

One reason workers with disabilities may be apprehensive about changing tasks and prefer stability is greater challenges in learning. One worker with a disability in company B stated: "*I had to ask to get extra training.*" Another said: "*I need to be taught, you know, I can't just know things right away*". Needing time to learn was also discussed by workers with disabilities at Company A. One worker said "*People with disability, you can't push them too*

[5] At company B "farming out" referred to a worker being assigned to a different department with a different set of tasks.

hard. They need to learn, the people need to learn. You do push them but a little bit. You push them too hard then they're not going to be in the right focus, they going to be turning left and right." Another stated "*Be peaceful so that person can learn even when they have a slow mentality or vision, take your time.*" Needing patience in learning was not isolated to mental disabilities, as it was brought up in relation to physical disabilities as well when one worker at Company A stated "*I was having problems with my vision, so it was just there wasn't no pressure. If I didn't learn it weren't no problem*."

Unlike the supervisors without a disability who focused on moving workers who found tasks challenging, supervisors with a disability seemed to persist in accommodating and providing additional learning time for workers in their current position. As one supervisor with a disability at Company B stated, "*If they're struggling in their own department, we try not to farm them out to another department*." Another supervisor with a disability at Company A described the micro-management he did in his department to allow workers to remain there when he said "*If the person cannot stand the whole day we try to accommodate him so can he can alternate between sit and stand up. If a person is, let's say, limitation is very…well we try to give them not so complicated things to do*".

Overall, while the workers without a disability perceived learning as flexibility and being able to move around to learn new tasks, workers with a disability perceived learning in terms of being stable in one task and having the time to learn and adjust to that task.

2.5.3.2 Relationships

2.5.3.2.1 Familiarity

Combined with learning, familiarity is another theme that emerged in the interviews, particularly for workers with a disability. Workers with disabilities indicated a preference for

working with familiar individuals. One worker with a disability at Company A exemplified this, stating "*I got a counselor for ten years. Or two years. I'm gonna talk to the person. But let's say I got a new counselor, I ain't gonna try to go talk to you because I don't know you.*" Other workers with a disability at Company A reinforced this sentiment stating "*when you have a new person sometimes they don't get you. They don't understand you*" and "*I have my boss's number that I had for 8 years and then she's retired but I still talk to her.*"

While both supervisors with and without disabilities universally expressed the importance of connection with workers, supervisors without a disability frequently discussed bringing in counselors (e.g., vocational specialists) or other individuals outside the normal workgroup when facing challenges. At Company A, the supervisors without disabilities discussed the use of counselors to seek assistance stating that they "*Seek assistance or engagement from a counselor and rely on communicating with the counselor regarding the issue and their recommendation before they handle further*" and "*The engineering department who will help make the changes to the machine and possibly the operation*". The same issue came up at Company B when a supervisor without a disability said "*A team member could work with HR to request an accommodation*" and "*We have their trainers from the [training][6] program that says hey this person it looks like you're struggling here can you help him out*". Workers with a disability preferred interacting with individuals they already know, while supervisors without a disability appeared more prone to seeking help from members outside the workgroup more often.

While the familiarity of workers with their supervisors is one aspect, another is the familiarity of the supervisors to the challenges that workers face. As one supervisor with a disability at Peckham explained "*I have had some team members come to me complaining that*

[6] [Training] refers to a training program targeted to Worker's with a Disability that Company B had specifically created to facilitate disability inclusion.

the supervisor didn't understand and when they when they explained it to me I completely understood their point of view…I'm not going to say that they can't understand but it is more difficult for them understand because I'll be honest, I wasn't born this way it is an accident." Another supervisor in Company A with a disability stated, "*I had a very bad period in my health conditions. So I had to have a lot of accommodations to accommodate my physical limitations. So…they give us some extra time to rest. Things like that. We try to micromanage people as much as we can of course because we know people.*" Similarly, supervisors in Company B stated "*When you can relate, it makes things much easier and it seems like the supervisors that don't really have a harder time with their teams whether it's a person with disabilities or just a person who may have a behavioral issue sometimes ah, you just need to get to know the person and works work* [sic] *through the issue so that you can relate with them better.*" Similarly, another supervisor in company B described how personal disability experience can help supervisors understand the challenges by stating "*We had we had a couple of manager who had a full leg replacements where you know the mobility issues are easier to talk about as a group and they do bubble to the surface a little bit faster.*"

Regarding relatability, one worker with a disability at Company B made the following point about supervisors with disabilities: "*They've gone through some adversity. They've gone through somebody who may be stuttering. Or may have physical disability. Or may or may be somebody on the autism spectrum or. Somebody like you know the different types of disabilities. I think they'd be in better position to understand.*" Another worker with a disability at Peckham shared similar thoughts when they said "*There's a certain there's a level of empathy and understanding. Like, I understand you're having a struggle, I struggle at things to. You're not, you don't feel alone because, quite honestly, I've been in in positions where they didn't have a*

disability so they couldn't quite exactly understand why I was going through. While their disability may not be the same as mine, they at least understand I'm struggling because of said disability that I'm not lazy that I'm not just making things up to get out of work that I actually have a problem."

These examples suggest that personal experiences help a supervisor with a disability better understand the unique challenges of workers with a disability. Of interest was one of the statements from a worker with disability in Company A, who stated "*if you're a supervisor with a disability they can communicate to the ones without a disability on how to deal effectively with their employees who have a disability of some kind.*" This statement points to the ability of a supervisor with disabilities to not only relate directly to workers with disabilities, but also to educate co-workers who do not have disabilities.

On the flip side, a worker in Company B who did not have disabilities also noted their lack of experience with persons with disabilities prior to their time at the company: "*As [I came] into the building, I never experienced anybody really with a disability ever in my whole entire life*". Even for senior managers who have worked in these environments their entire careers, understanding the impact of disabilities can be challenging. When reviewing the results of our interviews, one senior manager with decades of experience at the company relayed the following story: "*we were actually having a conversation one day and I said to her, "I just don't know what it is"* [referring to the worker's productivity challenges] *and she said to me "Well maybe it's 'cause I only have one hand" and I said. "You know, I'm sorry I never even thought about that aspect of your physicalness."* These examples suggest the importance of familiarity.

One supervisor with a disability at Peckham summed up the impact of familiarity with the experiences of workers with disabilities when he said: "*I wasn't born this way it is an*

accident. And before my accident I didn't think the way I do now about anything and everybody so once my world got flipped upside down, I was forced to look at things from a different perspective…If I want to go somewhere new. I'm automatically thinking, okay, do I how do I have any steps or going to be a ramp? Can I get into the bathroom? You know, if I need to do something the private are they going to have an area where I can do that. So when you have a disability, like myself, and you're going somewhere new those that are stresses that run through your brain first. Am I going to be able to do what I need to do without being embarrassed or without being put on display in front of everybody?"

2.5.3.2.2 Communication

Communication is focal for supervisor-worker interactions. A key aspect of communication brought up by workers and supervisors with a disability was the importance of tone. At Company A, workers with a disability brought up the need for a gentler approach to communication saying "*The supervisors should be softer with some employees. Sometimes they push them too hard and push them too fast and I don't feel like that's right.*" Another noted "*Not that people who don't have a disability are not offended by a harsh tone of voice but it seems to be more so with people with disabilities.*" Similar sentiment was also seen by workers with a disability at Company B when one of them recalled an incident with a manager who wasn't understanding the workers' challenges saying "*he was a nice guy, but there's one time he was just telling everybody a long time ago telling us that we weren't doing our job and you should be aware. We don't need that. We need people to support us in what we're doing because what more you support us, the more we ever get people get our job done.*" Another worker with disability in Company B said "*Show empathy towards the people with disabilities. And if they know how to deal with that, they gotta add some training on knowing how to handle people with*

developmental disabilities and their personalities and their quirks and their and their strengths and limitations."

This stress on communication was also evident among supervisors with disabilities. One supervisor with a disability at Company B stated "*Be understanding. I know in past I've gotten some managers that just might have gotten frustrated or especially with the disabilities that you can't that you can't see some of our team members are autistic, so they think a little bit differently and some of the managers get frustrated. So I just try to you know, let them know you know and to be a little sensitive*."

Another stated "*It goes all the way from 18 year old to 65 year old man, but you just gotta be able to talk to [them] and have a softer touch. You know the yelling and screaming can't happen. I mean, you can't be as abrasive as some of the other places, right?*"

While kindness is appreciated by all workers, one supervisor without a disability at Peckham that had previously worked in more traditional organizations did comment on the distinct cultural difference at the company when stating "*From a work environment where there weren't a lot of workers with disabilities and then you went to Peckham and the workers are more, there's more camaraderie, there's more encouraging each other*."

Collectively, these themes paint a picture of how workers and supervisors with a disability focus on a need for stability in task environment and a personal connection with an emphasis on lower pressures in the workgroup. The workers and supervisors without a disability, in contrast, focused on more traditional operational aspects such as cross-training and flexibility in the workgroup. Given the challenges workers with disabilities can have in learning tasks, stability within tasks can be valuable in allowing them more time learn, in contrast to job rotation

or flexibility. These factors could explain why supervisors with a disability can mitigate productivity declines as the number of individuals with disabilities in a workgroup increase.

2.7 Discussion and Managerial Implications

This research addresses an issue highly relevant to inclusive operations, an emerging area of interest in the field of operations management (Kalkanci et al. 2019, Narayanan et al. 2019), which goes beyond the intersection of human resources and operations management by including the corporate social responsibility (CSR) activities of firms. This study contributes by delving deeper into the stream of inclusion to examine the impact of the presence of a leader with disabilities on workgroup productivity within an apparel manufacturing setting and contributes to the field in several important ways by integrating both quantitative micro-data with qualitative interviews to examine the performance outcomes of inclusivity in the workplace and explore potential psycho-social mechanisms underlying the quantitative results.

First, with a tight labor market and low unemployment expected to become even more severe over the coming decade as projected jobs growth outstrips population growth in the United States (United States Bureau of Labor Statistics 2017), there will likely be a continued growth of what would traditionally be considered marginalized workers in the workplace as has been seen over the past few years (United States Bureau of Labor Statistics 2020). Beyond this, organizations are increasingly being called upon to act in a more socially responsible and inclusive manner. The confluence of a tightening labor market and increasing pressure for CSR activities should combine to make the benefits of employing marginalized workers with disabilities even more important in the coming years to organizations desiring to improve their competitive performance. This research shows that pursuing more inclusive team leadership can help improve productivity when employing a non-traditional workforce.

Second, studies within the realm of rehabilitation have emphasized the importance of supervisors in helping workers with disabilities in returning to work following a disability (e.g., Johnston et al. 2015, Schreuder et al. 2013). Other studies have also noted the importance of supervisors given the bias that workers with disabilities can experience in the workplace (Schur et al. 2005, Snyder et al. 2010, Zanoni 2011). However, few studies examine the impact of the role of supervisors on workgroup productivity. Given the importance of supervisors, this study fills this gap by examining the impact of supervisors with disabilities on team productivity within a workplace. The key finding of this study that supervisors with a disability can mitigate the negative impact on productivity with an increasing number of workers with disabilities in a team helps illustrate the tangible economic benefits of an inclusive workplace and shows how leader worker similarity can play an important role in integrating a diverse workforce.

Of particular interest is that the benefit to productivity from assigning leaders with disabilities to work teams with members having disabilities comes not from a direct improvement of performance but rather from mitigation of reduced productivity as the number of team members with disabilities increases. This result is consistent with LMX theory and the psycho-social mechanisms identified in the structured interview process. Specifically, analysis of marginal effects from results presented in Table 2.2 shows that the presence of a leader with a disability, compared to one without, will improve workgroup productivity roughly 10% when there are 10 workers with disabilities in the workgroup. Similarly, marginal effect analysis in Table 2.3 reveals that a workgroup in which the entire group is comprised of workers with disabilities would have roughly 10% better productivity if a leader with a disability is assigned to the group than if such a leader were not in the workgroup, though the results presented in Table 2.3 do not hold up as robustly as those presented in Table 2.2.

Next, the interaction between the presence of a leader with disabilities and the ratio of team members with disabilities increases was not significant when an instrumental or lagged dependent variable approach was used (see Tables 2.5 and 2.6). An insignificant result in this regard should provide assurance to employers who are contemplating the hiring of a more diverse work force that there are no negative effects on productivity when the ratio of disabled workers on a team is increased. Even though the hypothesis for this analysis was not supported, the nonsignificant results across the main effects and interaction term provide empirical support for pursuing inclusivity goals by showing no detrimental effects to productivity.

Third, unearthing the mechanisms at work within these settings is challenging. With specific regard to workers with disabilities, the management of accommodations for employees with disabilities (Schreuder et al. 2013, Johnston et al. 2015), in addition to the accommodations that team leaders themselves may require, may cause additional challenges within operations. This study obtained qualitative data through a structured interview process to better understand why supervisors with disabilities are beneficial to the productivity performance of workgroups containing workers with disabilities. The qualitative study yielded specific task and relationship-related mechanisms that may underpin the results of the quantitative analysis of the micro-data. First, leaders with disabilities were more likely to provide stability with respect to task and persons the workers interacted with, both of which were desirable to workers with disabilities. This is in contrast to the emphasis placed on task flexibility by both team leaders and workers without disabilities which is consistent with traditional operations management research that has found task variety to be important for improving productivity (e.g., Narayanan et al. 2009, Staats and Gino 2012). Providing stability with respect to a task and giving workers adequate time to master the task appears to be more important to productivity than task variety or job rotation in

this kind of inclusive environment. Second, the qualitative study identified two relationship-oriented mechanisms, familiarity, and communication, that also potentially underlie the main results of the quantitative analysis. It appears that workers with disabilities can better relate to supervisors with a disability.

On the other hand, leaders with disabilities are also familiar with the challenges, difficulties, and struggles that people with disabilities face so they are more attuned to the worker's needs and better able to support them. In addition, tone of voice in communication was another critical aspect. The individuals with disabilities interviewed agreed that leaders with disabilities were more apt to convey support, empathy, and understanding in their tone of voice in contrast to leaders without disabilities. These findings are consistent with the prior rehabilitation research that has identified relationship and communication as key mechanisms facilitating performance (e.g., Johnston et al. 2015, Williams-Whitt et al. 2016). These findings should spur research that further examines the role that familiarity and communication, especially tone of voice, play in facilitating positive operations performance outcomes. While stability, learning support, and empathy could be provided by both supervisors with and without disabilities, the supervisors with disabilities participating in the structured interviews clearly viewed these as focal points of their interactions with their work teams. One senior leader in Company A also noted that empathy in these settings is difficult to replicate even if supervisors are sensitized. Overall, the quantitative analysis and the qualitative follow-up study open up additional avenues for examining how individual abilities/disabilities, in parallel with supervisory oversight, interplay with task characteristics and interpersonal relations among employees can affect performance outcomes and point to the importance of people centric operations (Roels and Staats 2021).

Fourth, this study provided an examination of a workplace in which the non-traditional workforce is the "traditional" workforce. Several social enterprise settings that employ workers with disabilities in both United States and Europe operate similarly. These are called Work Integration Social Enterprises (WISE) that are focused on helping and promoting causes for individuals with disabilities (Battilana et al. 2015, Akbulaev et al. 2019). Workers with disabilities are a key part of these social enterprises (Kerlin 2006). The approach and analysis pursued in this study should apply to these firms and suggest that providing leadership opportunities to employees with disabilities can provide productivity benefits, especially when the workgroups are relatively large.

Fifth, from an LMX theory standpoint, this is one of the first studies that focuses on the interactions of workers and leaders with disabilities. In this context, the study revealed that similarities related to disabilities yield substantial benefits to productivity. The consequences of such similarities have parallels to the concept of affinity groups which are a part of large organizations that focus on better including minority groups (Douglas 2008). These affinity groups are generally intended to make the environment for individuals more congenial. Of interest is a study by Erickson et al. (2014) which found that few employers track these groups within organizations. The results of our study suggest that it is likely that such connections can be formed in production settings, particularly when supervisors and employees have a unique connection that can serve as a source of motivation to both leaders and workers.

Finally, from a managerial standpoint, the primary implication of this study is the assessment of the potential of disability inclusion in the workplace with respect to productivity performance. Organizations may be wary of employing non-traditional workers, such as workers with a disability, since their processes are designed for more traditional workers. However, in

embracing inclusivity, organizations may be able to pursue approaches to that prevent such concerns from being realized. This provides another reason why firms could benefit in making upward mobility an important aspect of their inclusion efforts for people with disabilities.

2.8 Conclusion, Limitations and Directions for Future Research

The study has limitations. First, since the quantitative portion of this study focuses on one industry, and a single organization within this industry, the results may not be generalizable. Yet, we attempted to overcome this limitation by conducting qualitative interviews with other organizations that employ people with disabilities in diverse settings. Furthermore, qualitative studies like this one to unearth mechanisms are recommended when the underlying issues are not clearly known (Eisenhardt 1989). Accordingly, the results of such qualitative mechanisms cannot be substantively established, given the importance of the need to understand the diverse approaches for different disabilities. Yet, this is one of the few studies that empirically analyzes productivity implications with micro-data and then identifies potential mechanisms underlying the results using a qualitative approach. More data driven studies of similar, and dissimilar, contexts are needed to establish the generality of the concepts.

Second, activities and outcomes were examined at the team level since they could not be directly observed at the individual level. Future research should examine the effects of similarity in leader-worker disability status on individual productivity performance.

Third, the data does not allow us to examine specific tasks being performed by the workers, nor how those workers are ultimately assigned to those tasks or how those tasks are designed around the workforce. These limitations can also be present in other studies where team-related performance is examined. Yet, several robustness checks were performed. Furthermore, worker restrictions arising due to disabilities and consequent accommodations may

be varied. This study only provides an aggregate perspective. Additional studies focused on an even more granular examination of the subject may be useful given that anonymized and aggregated group-level data may not establish individual mechanisms.

Fourth, our results focus on relatively lower-skill positions with minimal education requirements. Examining these principles in a higher skill environment could provide additional insights.

Finally, our data focuses on productivity implications of a leader with a disability in workgroups where the environment of employment is friendly towards individuals with disabilities. While the study offers potential mechanisms for the impact, cultivating sensitivity to individuals with disabilities within an organization where there is no such culture can be challenging, and the results may not hold when the team has only individuals without disabilities. Yet, given the broader social need, this is a challenge that future studies can handle.

3. Chapter 3: The impact of environmental performance efficiency on the potential trade-offs between carbon emissions and water use reductions at the firm-level.

3.1 Introduction

Water scarcity, exacerbated by worsening climate change, threatens both communities and the global economy (World Bank Group 2018). Even if firms are able to avoid these broader societal and economic challenges, water scarcity and climate change are direct operational risks (United Nation 2020, pgs. 100-101) which could impact a firm's market valuation (Maki 2020). These are issues firms must address both for themselves, and the markets on which they depend.

While the need to address multiple environmental concerns simultaneously is apparent, the means to do so is not. Technologies aimed at reducing water usage are electricity intensive (Nguyen et al. 2014, H. Li et al. 2020) while carbon reduction technology often require large amounts of water (Ji et al. 2020). These trade-offs can be seen occurring within firms. For example, Bemis Company has experienced such trade-offs when reducing water usage through the "*Use of mechanical refrigeration to reduce natural cooling water use will increase electrical consumption*" while Cabot Corporation has found "*The use of scrubbers for air pollution control requires significant volumes of water*". Bank of America has found trade-offs in both directions: "*We are often confronted with the trade-off between energy/greenhouse gas (GHG) savings and water savings when choosing mechanical systems. For example, water-cooled mechanical systems typically consume less energy, but consume more on-site water. By the same token, air cooled chillers consume less on-site water, but consume more energy*." (CDP 2019b).

Yet, such trade-offs are not unavoidable. More efficient technologies can reduce both water usage and carbon emissions simultaneously (Narayanaswamy and Scott 2001). Process related improvements have also been found to impact water usage and carbon emissions

similarly. Waste reduction and efficiency can reduce both (Fresner 1998, Narayanaswamy and Scott 2001, Kiran-Ciliz 2003), but process improvements such at Just In Time (JIT) increase both due to higher fuel usage (Cherrafi et al. 2016). These linkages can also be seen occurring in firms such as AstraZeneca, which reported: "*Reductions in water use (m3) can lead to reduced water treatment requirements, for example, less heating and energy use (MWh) to produce purified water via reverse osmosis.*" (CDP 2019b).

These individual technological and operational choices are all part of a broader strategy. When the myriad of choices firms have is viewed at a higher level, the combination of potential options that can lead to trade-offs or linked improvements is visible (Procter et al. 2016). Which of these potential paths a firm chooses will impact how they perform across the multiple environmental dimensions as the investments made by the firm set up operational constraints. Firms cannot be the best across all dimensions, and will perform better in areas they concentrate (Skinner 1996, Schmenner and Swink 1998). This sets up the potential for firms to focus their environmental initiatives along a single dimension, potentially forcing trade-offs.

While the concept of trade-offs across operational dimensions at the firm level has received attention (Lapré and Scudder 2004, Rosenzweig and Easton 2010), environmental sustainability has not received similar examination. Firms that focus on select operational dimensions will outperform competitors across those dimensions (Schmenner and Swink 1998). As firms improve their environmental performance, those which approach the performance frontier may be forced to make decisions focusing on one environmental dimension at the cost of worsening performance on the other as initiatives with obvious benefit and minimal downside become harder to find. If firms work to become industry leaders on environmental performance, eventually projects which reduce both carbon emissions and water usage will already be

implemented. This will lead to firms improving one dimension or the other at the expense of the other. This leads to our primary research question: do firms experience trade-offs between carbon emissions and water use reductions as they near the performance frontier of environmental performance? Water usage and carbon emissions are two critical issues firms must address (United Nations 2020, Cates 2021, CDP 2022), but firms may be forced to prioritize one over the other which make them important environmental dimensions to compare.

To investigate this question, we use Data Envelopment Analysis (DEA) to determine the environmental performance frontier using a large panel data set of environmental measures. We combine this measure of the environmental performance frontier with multiple statistical approaches to examine both within and between firms whether there are trade-offs or linkages between reductions in carbon emissions and water usage as firms near the performance frontier.

Rather than finding trade-offs, in general we find that carbon emissions and water use reductions are intertwined. This is in line with the idea of cumulative capabilities (Schmenner and Swink 1998) where firms are able to apply learning from one operational dimension to improve across other dimensions. However, as firms approach the environmental performance frontier these linkages become non-significant.

3.2. Literature Review

3.2.1 The Current State of Research Examining both Carbon Emissions and Water

While the topic of environmental sustainability is broadening (Atasu et al. 2020), water remains a largely under-researched area in major operations and supply chain management journals. Beyond the general need to respond to the worsening environmental crisis across the globe, water is a particularly relevant operations issue. Increasing water scarcity is forcing communities to raise the price of water (Pesic et al. 2013, Sahin et al. 2015), which directly

impacts costs. This is exacerbated by worsening water pollution as less pure forms of water are more expensive to treat for use (Abdulbaki et al. 2017). Beyond costs, a lack of water resources can disrupt a firm's operations (Giannakis and Papadopoulos 2016, R. Tan et al. 2016). Such extreme scenarios are not distant problems firms may face, but rather a tangible risk as regions face potential "zero day" scenarios where they run out of water (Hofste et al. 2019). Firms must respond to increasing global water stress not only because of societal needs, but also because it is in the best interest of the firm itself.

Carbon emissions as an environmental topic within operations (Thies et al. 2019), logistics (Vega-Mejía et al. 2019) and more broadly supply chain management (Farooque et al. 2019, Koberg and Longoni 2019, Martins and Pato 2019) is better established, though. While firms may be failing to achieve carbon emissions related targets they have promised to achieve (Rannard 2022), the need to reduce carbon emissions is well recognized.

These two environmental concerns, water and carbon emissions, are not independent but rather interconnected and firms must work to manage then together (CDP 2022). The need to address both issues is a focus of leading environmental sustainability firms such as Microsoft (Cates 2021) and is even a goal of the United States Army (Procter et al. 2016). This means understanding the interplay of carbon emissions and water use reductions on a broad scale given the potential for trade-offs to occur. Some research has begun to examine the issues of carbon emissions and water use reductions side by side on a broad scale (Muthulingam et al. 2021), but has not addressed the potential impact carbon emissions and water use reductions have on one another. What research has directly examined this relationship has been within a single location and examining proposed projects (Procter et al. 2016) instead of looking at broader trends across multiple firms over time.

3.2.2 Trade-Offs Between Carbon Emissions and Water Use Reductions

"*Disposal of this excess sludge will be mainly by means of incineration, that will require significant fossil energy, and therefore significant carbon dioxide emission*." Arkema (CDP 2019b).

The primary way in which water use reduction increases carbon emissions is through the electricity needed for water re-use (Nguyen et al. 2014, H. Li et al. 2020) and filtering (Uche et al. 2015) technologies. Alongside electricity requirements, pollutants filtered out of water must then be eliminated in another manner (Meza Solana and Juárez Nájera 2016) which potentially creates additional carbon emissions. Chemical applications to reduce long term water use to can also cause more carbon emissions to be generated during manufacturing (Busi et al. 2016).

"*In semiconductor manufacturing processes, PFC gases are used to control chemical reactions such as etching on wafers. As PFC gas is one of a greenhouse gasses, it has been detoxified by introducing a gas detoxification equipment in semiconductor manufacturing processes. A large amount of water is used for the gas detoxification equipment*." Sony Corporation (CDP 2019b).

While the ways in which water use reduction increases carbon emissions tend to be concentrated in a few high impact ways, there are numerous avenues in which carbon emissions reduction technology can increase overall water usage. The use of some renewable energy sources, especially hydro-electric power due to evaporation (Ingwersen et al. 2016) and anaerobic digesters (Abdel-Aal et al. 2020), can consume substantial amounts of water. Biofuels can also consume more water to produce and use than traditional fossil fuels (Duvenage et al. 2013), with the use of completely electric vehicles potentially increasing water usage compared

to traditional combustion engine vehicles depending on how the electricity is generated to power such vehicles (Lee and Thomas 2017, Onat et al. 2018).

While more energy efficient, centralized infrastructure also increases water usage. The more centralized the water system, the larger the piping network that is used. This leaves more opportunities for leaks to occur (Santana et al. 2019). One study found that 10% of water usage can be attributed to leaks (Britton et al. 2013).

3.2.3 Linkages Between Carbon Emissions and Water Use Reduction

"*The approach to Manufacturing Excellence training of employees has positive linkage benefits by introducing the common view that energy, water and raw materials are valuable resources that should be managed carefully and never wasted. For example, saving of hot water implies improvements both in water use and energy use*." Trelleborg AB (CDP 2019b).

Process optimization to remove waste can reduce carbon emissions and water usage simultaneously by decreasing the need for new materials (Fresner 1998, Narayanaswamy and Scott 2001, Kiran-Ciliz 2003). Processes can also be ordered to reduce demand for both water and electricity, such as through more efficient heat transfers that reduce the need for heating and cooling (Kiran-Ciliz 2003). Separate systems can also be interconnected to transfer heat or wastewater from where they are generated as waste to where they could be of potential use (Deymi-Dashtebayaz and Tayyeban 2019). Process improvement is not always beneficial, however, as some techniques have been found to increase both water use and carbon emissions. For example, JIT systems can increase the amount of fuel, and the subsequent water and carbon emissions generated, used for more frequent, smaller shipments (Cherrafi et al. 2016).

Newer, more efficient technologies can also have a mutual benefit by being able to operate with fewer inputs of electricity and water (Narayanaswamy and Scott 2001). Some types

of renewable energy, especially solar and wind power, can reduce the need for both water and the generation of carbon emissions as well (Ji et al. 2020).

3.3 Research Development and Methodology

3.3.1 Research Development

That firms are trading off capabilities as they pursue specific strategic approaches has been discussed in the operations literature for several decades now (Hayes and Pisano 1996, Skinner 1996). Overall, prior research has found that firms do not report experiencing trade-offs between operational capabilities. While there may be some trade-offs occurring at the facility level, when firms with multiple facilities are examined trade-offs are generally not present (Rosenzweig and Easton 2010). Prior research examining trade-offs using secondary data has found similar results. While there can be trade-offs in the short term, over the long run firms are able to improve across multiple operational dimensions (Lapré and Scudder 2004). This would be in line with the idea of cumulative capabilities, where firms can apply learning from one operational area to others (Schmenner and Swink 1998).

However, past research on frontiers has been cross-sectional where longitudinal data is needed to examine the firm's position relative to the performance frontier. Firms that are near the frontier will face different challenges when improving their performance than firms that are further away from it, so the firm's place relative to the performance frontier must be considered (Rosenzweig and Easton 2010). The potential impact of a firm's place relative to the performance frontier could impact the potential for trade-offs among environmental dimensions. As discussed, there are certain initiatives which can reduce both carbon emissions and water usage together simultaneously. As firms near the environmental performance frontier they will move beyond "low hanging fruit" and potentially invest in technologies that require one

dimension to be favored over the other to improve their performance along one dimension. By using panel data we can consider a firm's position relative to the performance frontier as it changes over time.

There is also reason to believe findings on trade-offs could be different for environmental performance than they are for traditional operational performance. Past research on operational trade-offs has focused on dimensions that can be conducive to the transfer of knowledge consistent with cumulative capabilities. For example, Lapré and Scudder (2004) find that airlines improve on service quality and then learn how to provide such quality at a lower cost, thus reducing costs while improving quality instead of experiencing a trade-off between cost and quality. Carbon emissions reductions and water use reductions require different technologies and techniques to reduce. They are also largely separate within processes. Where water is a direct, tangible input in the processes carbon emissions are a byproduct of production. The learning across one dimension may not be transferable to the other.

3.3.2 Developing the Environmental Performance Frontier

One established means to determine a performance frontier is the use of Data Envelopment Analysis (DEA). DEA is a deterministic method using data to assess the relative efficiency of a Decision-Making Unit (DMU) based on a certain set of inputs and outputs. The efficiency of an individual DMU is determined by the ratio of the weighted sum of outputs in the model to the weighted sum of inputs in the model. The efficiency of each individual DMU is then relative to the efficiency of peer observations. This leads to an efficiency score on a 0 to 1 scale, with the most efficient firms on the performance frontier taking the value of 1 among the peer observations, with less efficient firms receiving a lower score (Swink et al. 2006, Jacobs et al. 2016, Dreyfus et al. 2020).

The original formulation of DEA is the CCR model (Charnes et al. 1978). The CCR model assumes a constant return to scale, where the output increases proportionally with the inputs. An alternative to the CCR model is the BCC model (Banker et al. 1984) where a variable return to scale is assumed by adding a convexity constraint. In line with recent empirical research utilizing DEA to determine the relative efficiency of firms we use an input-oriented basic BCC DEA model (Jacobs et al. 2016, Dreyfus et al. 2020).

In the input oriented basic BCC DEA model (Banker et al. 1984) determines the efficiency score through a linear programming model which minimizes the amount of inputs to generate the same level of output.

$$Minimize\ E$$

$$subject\ to: \sum_{p} x_{pi}\lambda_p \leq E x_{if} \forall i$$

$$\sum_{p} y_{po}\lambda_p \geq y_{of} \forall o$$

$$\sum_{p} \lambda_p = 1$$

$$\lambda_p \geq 0 \forall p$$

Where *E* is the efficiency of the for an individual DMU *f*. The amount of the *i*th input for the *p*th DMU is represented as x_{pj}. The *o*th output is expressed as y_{po} and λ_p being the dual variable that determines the improvements needed for inefficient DMUs to become efficient.

In our context, a DMU is the firm-year observation in line with past research. DEA for each year was run separately for each industry, to give a set of efficiencies which were relative to their industry-year peers (Jacobs et al. 2016, Dreyfus et al. 2020). In line with Jacobs et al.

(2016) we group peer observations by sub-industry to account for the industry specific context of processes and technology. Thus, an industry was defined as all firms sharing a single 3-Digit NAICS code. To normalize the scale for each variable used in the DEA we divide the value by its industry-year mean value for that variable.

To establish an overall environmental performance frontier we used scope 1 and 2 carbon emissions as one input, with total water usage the other. Our output was total revenue of the firm for the year in US Dollars. To reduce the impact of changes in the value of money over time revenue was normalized to the 2005 Consumer Price Index (CPI). With three combined inputs and outputs the minimum number of industry-year observations needed to run the DEA is nine as the rule of thumb for running DEA is to have three times the number of inputs and outputs (Jacobs et al. 2016), so we only include those observations with at least nine total observations for their industry-year group of observations.

3.3.3 Methodology

With the environmental performance frontier defined using DEA, we use multiple statistical approaches to examine potential trade-offs as the firm approaches the performance frontier. First, we take a pair of econometric approaches to examine the potential for trade-offs as firms approach the frontier over time. The first of these is to directly compare the impact of changes in water intensity year over year on the changes in carbon intensity year over year at various levels of closeness to the environmental performance frontier using Stata 16's panel data package (xtreg) package with fixed effects to control for firm specific time invariant heterogeneities. If we were to find a negative and statistically significant coefficient it would indicate that as firms are reducing their water usage it is leading to an increase in carbon emissions. This approach is in line with recommendations made by Rosenzweig and Easton

(2010). The second approach is to use a dummy variable approach similar to Lapré and Scudder (2004). For this, a trade-off is defined as one of carbon intensity or water intensity decreasing, indicating an improvement on that dimension, with an increase of the other, indicating a worsening on that dimension. We run a panel logit regression (xtlogit in Stata 16) with fixed effects, examining the impact of approaching the environmental performance frontier on the odds of a trade-off occurring. These two approaches look at within firm changes. We take one other approach to examine the possibility of trade-offs between firms at the environmental performance frontier using k-means clustering (cluster in Stata 16) to see if patterns emerge in how firms approach the frontier similar to Swink et al. (2006).

3.3.4 Data and Variables

3.3.4.1 Data Sources

The analysis is performed using two sources of data. The first is TruCost. This panel dataset provides annual measures of various sustainability metrics at the firm level, such as scope 1, 2 and 3 carbon emissions along with water usage. This data provides the core sustainability measures used in this research. Additional financial information and industry classifications are integrated through Compustat, which is linked to TruCost through International Security Identification Number (ISIN) identifier present in both datasets. The data covers the years 2005-2018 with all financial measures normalized to the 2005 Consumer Price Index (CPI) as determined by the United States Federal Reserve[7] to ensure that carbon and water intensity, which are relative to revenue, are not impacted by changes in the value of money over time.

[7] https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1913-

3.3.4.2 Variables

Carbon Intensity (ln): Tonnes of scope 1 and 2 carbon emissions generated by the firm, divided by the firm's total revenue for the year. Variable is logged to reduce skewness and improve interpretability (Wooldridge 2012, pg. 41). (TruCost)

Water Intensity (ln): Cubic meters of water used by the firm, divided by the firm's total revenue for the year. Logged. (TruCost)

Total Revenue (ln): Control variable for total revenue of the firm in USD millions. Controls for changes in firm size and financial resources over time. Logged. (TruCost)

Plant, Property & Equipment (PPE) (ln): Control variable for gross value of plant, property and equipment in USD. Firms with more facilities and infrastructure needed for production will naturally require more electricity and water for utilities. Also helps to control for changes in firm size. Logged. (Compustat)

Market Value (ln): Control for market value of the firm in USD. Firms with greater market value will receive greater focus and scrutiny from the public. Measured as share price multiplied by number of outstanding common shares at the end of the year (Jacobs et al. 2016). Logged. (Compustat).

Descriptive statistics for the primary variables of interest are presented in Table 3.1.

Table 3.1 Descriptive Statistics

	Descriptive Statistics			Correlations			
Variable	Obs.	Mean	Std. Dev.	1	2	3	4
1. Carbon Intensity	35,475	524.80	1,986.17	1			
2. Water Intensity	35,475	39,593.22	285,692.30	0.47	1		
3. Total Revenue	35,475	9,657.76	22,151.18	-0.03	-0.01	1	
4. Environmental DEA	35,475	0.27	0.27	-0.18	-0.12	0.05	1

3.4 Results

3.4.1 Examining the Efficient Frontier

Table 3.2 provides an overview of the DEA efficiency measures broken down by the 3 Digit NAICS code industry. Overall, of the 35,475 observations included in the DEA analysis 1,696, or roughly 4.8% of observations, were at the frontier. This comes out to 2.48 observations at the frontier per industry-year peer group.

Manufacturing is the largest portion of the sample. Overall, sub industries tend to have average efficiencies in the 0.2-0.4 range. The Retail and Accommodations industries have a noticeably higher mean efficiency, indicating less of a difference in the most efficient firms from the average firm.

Table 3.2 Descriptive Statistics of DEA by Industry

Industry	NAICS	Obs.	Obs. at Frontier	Mean	Industry	NAICS	Obs.	Obs. at Frontier	Mean
Mining and Extraction	211	700	50	0.29	Retail	445	322	42	0.56
	212	938	15	0.07		448	294	37	0.54
	213	350	29	0.29		452	476	35	0.48
Utilities	221	1,792	56	0.09	Transportation and Warehousing	481	322	47	0.76
Construction	236	546	38	0.32		482	196	69	0.81
	237	812	32	0.32		483	434	46	0.37
Manufacturing	311	924	35	0.32		488	392	35	0.38
	312	686	21	0.22	Information Services	511	686	26	0.34
	315	168	20	0.37		515	406	30	0.28
	316	140	16	0.31		517	1120	35	0.20
	322	350	29	0.37		518	126	40	0.80
	324	574	20	0.22		519	308	52	0.61
	325	2548	40	0.14	Financial	522	3108	35	0.26
	326	196	21	0.43		523	1204	55	0.18
	327	588	43	0.33		524	1316	37	0.22
	331	1064	24	0.14	Real Estate	531	1652	41	0.19
	332	406	29	0.40		532	153	54	0.76
	333	1484	39	0.27	Prof. Services	541	1120	49	0.37
	334	2632	34	0.12	Administrative Support	561	378	41	0.38
	335	686	20	0.21	Health Care	621	126	14	0.18
	336	1330	38	0.42	Arts	713	182	16	0.24
	339	434	24	0.24	Accommodations	721	252	38	0.56
Wholesale Trade	423	392	30	0.30		722	252	26	0.55
	424	266	31	0.48	Other	999	476	37	0.22
Retail	441	168	25	0.51		Overall	35475	1696	0.27

Table 3.3 provides the descriptive statistics for the environmental performance efficiency over time. Interestingly the mean efficiency can be seen decreasing slightly over time. This would indicate the gap in efficiency between the most efficient firms and the rest of firms in the peer groups is increasing over time which would lead to the average firm having a lower overall efficiency.

Table 3.3 Descriptive Statistics of DEA by Year

Year	Obs.	Obs. at Frontier	Mean
2005	2534	117	0.35
2006	2534	136	0.33
2007	2534	128	0.28
2008	2534	123	0.28
2009	2534	115	0.28
2010	2534	120	0.26
2011	2533	116	0.26
2012	2534	114	0.25
2013	2534	116	0.23
2014	2534	124	0.24
2015	2534	119	0.24
2016	2534	118	0.25
2017	2534	125	0.24
2018	2534	125	0.24

3.4.2 Panel Regression Approach

Table 3.4 presents impact of year-to-year changes of water intensity on the year-to-year changes of carbon emissions intensity relative to the environmental efficiency of the firm-year observation. The left most regression, Model 1, contains all observations without control variables from Compustat included. Model 2 to the right includes control variables PPE and Market Value. We see here in Model 2 that carbon intensity and water intensity are linked, rising and falling together ($\beta = 0.08$, $p < 0.01$), given the positive coefficient in both regressions. Since both the independent and dependent variables are logged the results are elasticities which can generally be interpreted as percent changes. In the full sample with controls Model 2, a 1% reduction in water usage intensity would result in a 0.08% reduction of carbon emissions intensity. The three regressions on the right are the sample restricted to the portion that is in the top third (Model 3), top ten percent (Model 4) and at the frontier (Model 5) of the environmental

performance frontier determined by the DEA. While all three results on the right are non-significant, they do agree with the full sample results in terms of the coefficient's sign.

Table 3.4 Panel Regression Impact of Year-to-Year Changes at Various Efficiencies

	DV: First Difference of Carbon Intensity (ln)									
	(1) No Controls		(2) With Controls		(3) Top Third Efficiency		(4) 90th Percentile Efficiency		(5) Frontier	
First Difference of Water Intensity	0.12***	(0.01)	0.08***	(0.02)	0.06	(0.04)	0.11	(0.08)	0.05	(0.04)
Revenue (ln)	-0.03***	(0.01)	-0.07***	(0.01)	-0.05	(0.04)	0.12	(0.12)	0.06	(0.13)
PPE (ln)			-0.01	(0.01)	0.06	(0.04)	0.04	(0.12)	0.03	(0.14)
Market Value (ln)			0.10***	(0.02)	-0.02	(0.02)	-0.09	(0.06)	-0.12**	(0.05)
2006										
2007	0.01	(0.01)	-0.00	(0.02)	0.00	(0.03)	-0.04	(0.10)	-0.02	(0.15)
2008	0.02**	(0.01)	0.01	(0.02)	0.01	(0.04)	-0.04	(0.12)	-0.06	(0.14)
2009	0.03**	(0.01)	0.03	(0.02)	-0.01	(0.05)	-0.11	(0.14)	-0.08	(0.22)
2010	0.03***	(0.01)	-0.01	(0.02)	0.03	(0.04)	0.04	(0.12)	0.14	(0.18)
2011	-0.01	(0.01)	-0.03*	(0.02)	0.03	(0.04)	-0.04	(0.12)	0.10	(0.18)
2012	0.03***	(0.01)	-0.01	(0.02)	0.04	(0.03)	-0.01	(0.12)	0.14	(0.14)
2013	0.03***	(0.01)	0.00	(0.02)	0.07**	(0.03)	0.11	(0.13)	0.17	(0.15)
2014	0.07***	(0.01)	0.05***	(0.02)	0.08**	(0.03)	0.13	(0.11)	0.27	(0.16)
2015	0.05***	(0.01)	0.02	(0.02)	0.06	(0.05)	0.08	(0.19)	0.15	(0.24)
2016	0.07***	(0.01)	0.04**	(0.02)	0.08**	(0.04)	0.10	(0.12)	0.31**	(0.15)
2017	0.03***	(0.01)	-0.03	(0.02)	0.04	(0.04)	0.14	(0.12)	0.15	(0.16)
2018	0.00	(0.01)	-0.04**	(0.02)	0.06*	(0.03)	0.15	(0.12)	0.29*	(0.15)
Constant	0.26***	(0.06)	-0.06	(0.10)	0.01	(0.17)	-0.56	(0.43)	0.16	(0.55)
Observations	32941		9941		3117		761		422	
R-Squared	0.04		0.03		0.02		0.08		0.06	

* p<0.10 ** p<0.05 *** p<0.01

3.4.3 Lapre & Scudder 2004 Trade-Off

An alternative approach to examine trade-offs is the use of a dummy variable approach in line Lapré and Scudder (2004)'s examination of cost and quality in the airline industry. A trade-off is defined as one of either water intensity or carbon intensity decreasing, and thus improving, while the other increases year-to-year. We now directly include the environmental efficiency from the DEA as a predictor variable to see the impact of year-to-year changes in efficiency on the potential for trade-offs as firms approach the frontier. Table 3.5 presents the results of the logit regression at various levels of efficiency: all observations in Model 1, top third in Model 2, top ten percent in Model 3 and those firm-year observations at the frontier in Model 4. Since this is a logit regression, the coefficient represents the log odds which can be transformed into an odds ratio by exponentiating the coefficient. For the regression using all observations (β = -0.88,

$p < 0.01$, odds ratio of 0.41) and those observations in the top third ($\beta = -0.63$, $p < 0.01$, odds ratio of 0.53) of efficiency, we find that as firms improve their environmental efficiency the probability of a trade-off reduces. In the overall sample, Model 1, if a firm were to move from the least efficient firm with an efficiency of 0 in the DEA to the most efficient firm the odds of a trade-off would be more than cut in half. For the sample restricted to the 90th percentile and those observations that reach the frontier, the results are again non-significant.

Table 3.5 Trade-Off Dummy Results with Panel Logit Regression

	DV: Carbon Water Trade-Off							
	(1) All Observations		(2) Top Third		(3) 90th Percentile		(4) Frontier	
First Difference of DEA Efficiency	-0.88***	(0.18)	-0.63***	(0.24)	-0.54	(0.40)	0.47	(0.68)
Revenue (ln)	0.15	(0.09)	-0.01	(0.19)	-0.03	(0.39)	0.68	(0.73)
PPE (ln)	-0.03	(0.05)	0.00	(0.11)	-0.14	(0.26)	-0.29	(0.40)
Market Value (ln)	0.02	(0.08)	0.14	(0.17)	0.03	(0.35)	-1.13*	(0.68)
2006								
2007	-0.16	(0.12)	-0.19	(0.22)	0.11	(0.45)	-0.28	(0.74)
2008	0.52***	(0.12)	0.17	(0.23)	0.66	(0.48)	1.44**	(0.70)
2009	0.61***	(0.11)	0.56***	(0.22)	0.48	(0.47)	2.53***	(0.71)
2010	-0.13	(0.12)	0.05	(0.22)	0.50	(0.46)	1.29*	(0.70)
2011	0.48***	(0.11)	0.51**	(0.22)	0.46	(0.48)	1.02	(0.73)
2012	0.28**	(0.12)	0.19	(0.22)	0.50	(0.47)	1.28*	(0.72)
2013	0.01	(0.12)	0.18	(0.22)	0.23	(0.47)	1.16	(0.78)
2014	0.96***	(0.11)	0.62***	(0.21)	0.76	(0.47)	2.02***	(0.76)
2015	-0.00	(0.12)	0.04	(0.22)	0.31	(0.48)	1.57**	(0.77)
2016	0.76***	(0.11)	0.53**	(0.22)	0.84*	(0.46)	2.71***	(0.77)
2017	0.74***	(0.11)	0.49**	(0.21)	0.86*	(0.47)	1.55*	(0.80)
2018	0.51***	(0.12)	0.55**	(0.21)	0.83*	(0.48)	2.59***	(0.80)
Constant	0.26***	(0.06)	-0.06	(0.10)	0.01	(0.17)	-0.56	(0.43)
Observations	9772		2886		644		350	

* p<0.10 ** p<0.05 *** p<0.01

3.4.4 Clustering

While we do not find that firms experience trade-offs as they approach the frontier, there remains the possibility that there are differences between firms. To examine this, we run a k-means cluster analysis for those observations at the performance frontier. As we use revenue as the output for our DEA model, with carbon emissions and water usage as the inputs we use revenue per carbon emissions and revenue per water as our variables for clustering of those observations at the performance frontier. To normalize our variables as they are in the DEA, we divide each variable by its industry mean to normalize the values by industry. We then cluster on

the year-to-year change in revenue per carbon emissions and year-to-year change in revenue per water usage.

When running the clustering we begin with a three-cluster model assuming a balanced cluster, along with one cluster that is more efficient in its revenue generation per carbon emissions and another cluster that is more efficient in its revenue generation per water usage. The clustering is dominated by a single cluster that is highly efficient in its revenue production per both carbon emissions and water usage with small improvements from the prior year on both dimensions that groups almost all observations. This remains even if the number of clusters is changed. For example, in the three-cluster model 1,576 of the 1,579 observations fall into a single cluster that has a year-to-year increase in revenue per carbon emissions of $24.38 per water usage of $264.71. In a five-cluster model 1,570 observations are in a single cluster with a year-to-year increase in revenue per carbon emissions of $7.84 and per water usage of $264.91.

Much like when looking at the impact of changes in efficiency over time within a firm, when clustering to examine whether there are differences between firms, we once again find water use and carbon emissions reductions appear to be linked. There are not discernable differences between firms in how the environmental performance frontier is being reached.

3.4.5 Past Performance

Lapré and Scudder (2004) found that in the long run improvements do occur jointly across quality and cost, but with quality improvements occurring first. In Table 3.6, we take a regression-based approach to examine the impact of past cumulative changes of one environmental concern on the other. For this we use the 2^{nd} and 3^{rd} differences of along one environmental dimension, carbon intensity or water intensity, to look at cumulative changes as a predictor variable for changes of the other dimension in the focal year. While we do find that

past reductions of one dimension have a similar effect on the reductions of the other, the effect is much stronger for the impact of past carbon emissions reductions over the past 2 ($\beta = 0.11$, $p < 0.01$) and 3 ($\beta = 0.04$, $p < 0.10$) on water intensity reductions than the impact of past water use reduction on current carbon emissions reductions. This would indicate that a firm's past, cumulative reductions of carbon emissions have a more substantial impact on current reductions of water than the other way around. Similar analysis at the frontier has non-significant results.

Table 3.6 Impact of Prior Changes on the Other Dimension's Improvement

	DV: First Difference of Water Intensity (ln)				DV: First Difference of Carbon Intensity (ln)			
2nd Difference Carbon Intensity	0.11***	(0.04)						
3rd Difference Carbon Intensity			0.04*	(0.02)				
2nd Difference Water Intensity					0.04***	(0.01)		
3rd Difference Water Intensity							0.01***	(0.00)
Revenue	-0.11***	(0.03)	-0.13***	(0.03)	-0.08***	(0.01)	-0.10***	(0.02)
Market Value	-0.00	(0.01)	0.00	(0.01)	-0.01	(0.01)	-0.01	(0.01)
PPE	0.06	(0.05)	0.08	(0.05)	0.10***	(0.02)	0.11***	(0.02)
2006								
2007								
2008	0.02	(0.03)			0.01	(0.02)		
2009	0.06*	(0.03)	0.04	(0.04)	0.04*	(0.02)	0.02	(0.02)
2010	0.01	(0.03)	-0.01	(0.03)	-0.00	(0.02)	-0.02	(0.02)
2011	0.03	(0.03)	0.01	(0.03)	-0.02	(0.02)	-0.04**	(0.02)
2012	0.05*	(0.03)	0.03	(0.03)	-0.00	(0.02)	-0.02	(0.02)
2013	0.09***	(0.03)	0.07**	(0.03)	0.02	(0.02)	-0.00	(0.02)
2014	0.06**	(0.03)	0.04	(0.03)	0.06***	(0.02)	0.05***	(0.02)
2015	0.15***	(0.04)	0.12***	(0.04)	0.03	(0.02)	0.01	(0.02)
2016	0.08**	(0.03)	0.05	(0.03)	0.05***	(0.02)	0.03**	(0.02)
2017	0.06*	(0.03)	0.02	(0.03)	-0.02	(0.02)	-0.04**	(0.02)
2018	0.06*	(0.03)	0.03	(0.03)	-0.03*	(0.02)	-0.05***	(0.02)
Constant	0.39	(0.25)	0.43	(0.28)	0.01	(0.13)	0.02	(0.14)
Observations	9188		8431		9188		8431	
R-Squared	0.02		0.01		0.03		0.02	

* p<0.10 ** p<0.05 *** p<0.01

3.5 Discussion

This research aimed to examine the potential trade-offs firms may face in trying to reduce both carbon emissions and water usage simultaneously. Past research, and anecdotal evidence from The CDP Project show evidence of trade-offs occurring, but also that carbon emissions and water use reductions can be linked together. These examples are generally at the facility or

product level, and do not examine what is occurring more broadly across the entirety of a firm. In line with calls from past research on how to improve the examination of trade-offs we used longitudinal data that took into account the performance frontier of a firm relative to its peers (Rosenzweig and Easton 2010). Overall, what we find is that reductions of carbon emissions and water usage are linked together, moving in similar ways. However, as firms near the frontier the results become non-significant. This could be due to water usage and carbon emissions reductions no longer being as strongly linked as firms approach the frontier, where firms would need to implement both projects that reduce both as well as those that reduce one while increasing the other. It could also be due to the reduction in sample size, however, as the sign of the coefficient still indicates a linkage.

This research builds upon, and is generally in line with, prior empirical research on trade-offs across operational dimensions (Lapré and Scudder 2004, Rosenzweig and Easton 2010). While anecdotal evidence of trade-offs occurring can be compelling, and can occur for certain projects (Procter et al. 2016), we do not find that trade-offs occurring at the firm level. Managers should not allow the potential for trade-offs to discourage them from attempting to improve individual environmental challenges simultaneously. While some individual initiatives will potentially experience trade-offs between carbon emissions and water use reductions, at an aggregate level a firm improving its environmental performance will not experience trade-offs.

4. Chapter 4: Location and Environmental Biases of Procurement Professionals in Sourcing Decisions.

4.1 Introduction

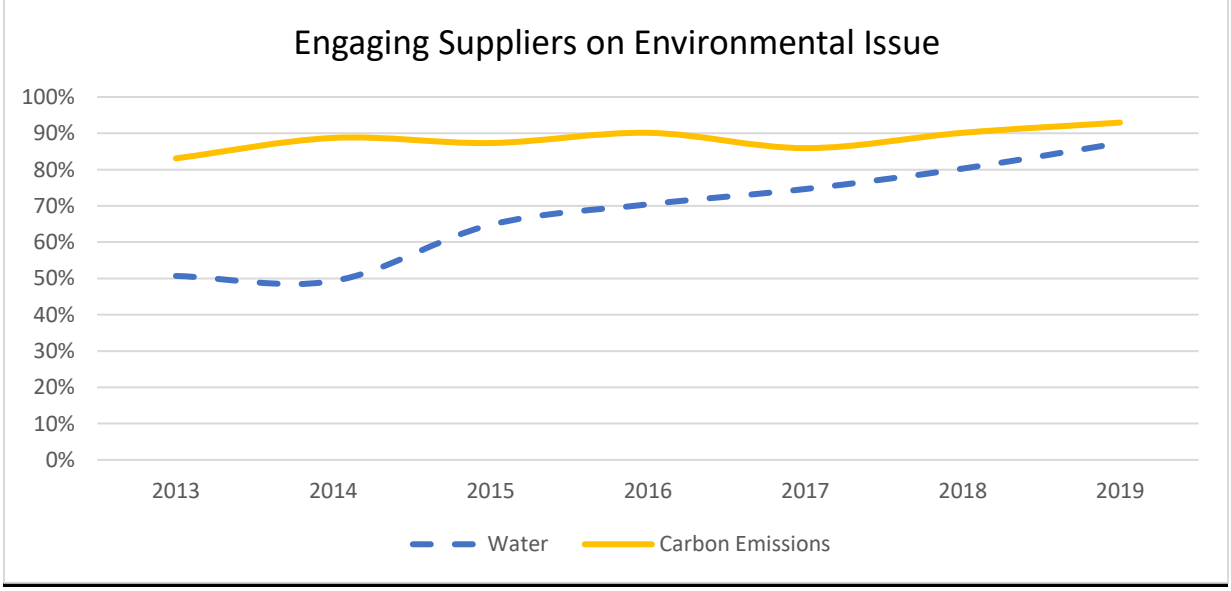
Despite increasingly ambitious environmental initiatives in recent years such as Microsoft's carbon neutrality (Roberts 2020) and aims to be both carbon (B. Smith 2020a) and water (B. Smith 2020b) negative by 2030, internal initiatives are not enough to radically improve environmental performance. Over 90% of a firm's environmental impact comes not from internal activities but is rather due to its supply chain. This creates multiple touchpoints where firms can create environmental damage as well as be exposed to the risks of such environmental issues. Firms must be cognizant of such environmental impact across the supply chain as they strive to maintain the support of both governments and consumers to continue their operations (Bové and Swartz 2016). If firms do not address such issues they could be held liable (Hartmann and Moeller 2014). Yet, the supply chain is an aspect of environmental sustainability that firms often overlook and may struggle to control as suppliers are less motivated to address such issues (Villena and Gioia 2018). A key, but frequently missing component of improving supply chain environmental performance is the inclusion of the firm's procurement department in sustainability related initiatives (Villena 2019). Buyers, who have direct relationships with suppliers and can leverage the firm's combined spend to influence the supplier's policies have the power to influence environmental priorities across the supply chain. However, environmental performance is not a singular dimension but made up of a combination of distinct environmental concerns that must be managed. How buyers weigh competing environmental concerns in sourcing decisions is in need of greater exploration, and the primary aim of this research.

One need look no further than the United Nations Sustainable Development Goals (United Nations 2015) for evidence that environmental sustainability is not a singular metric but rather a combination of components such as water preservation and reductions of greenhouse gases like carbon emissions. Addressing both of these priorities in the supply chain is critical as global warming and increasing water scarcity threaten economies around the globe (United Nations 2016) as well as increase material costs and the risks of disruptions (United Nations 2020). This leaves buyers with multiple competing, potentially mutually exclusive criteria they must balance.

With suppliers unlikely to be proactive about environmental issues (Villena and Gioia 2018), a buyer's sourcing decisions can play an important role in improving the environmental performance of the supply chain. For example, the introduction of environmental considerations into sourcing decisions had a dramatic impact on the environmental performance of Honda's first tier suppliers in Japan. Compared to the first year of reporting in 2001, the carbon emissions per unit of production were 28% lower in 2018, and water per unit of production down 11% compared to the first year of reporting in 2009 (Honda 2018b). While Honda provides an illustrative example of how engaging suppliers can improve the environmental performance of the supply chain, it also highlights how different environmental concerns can receive different levels of priority in such engagement. Honda began engaging suppliers on carbon emissions eight years before it did on water, and the annual rate of reduction per unit of production was greater for carbon emissions. Even now, Honda's current green purchasing guidelines emphasize reductions of greenhouse gas and carbon emissions while only stating suppliers need to comply with local regulations in regard to water (Honda 2018a). Honda is not alone in showing a distinct preference to address certain environmental concerns before others. Examining the set of 71

firms that reported annually to The CDP Project (formerly the Carbon Disclosure Project) on supplier engagement related to both carbon emissions and water from 2013 to 2019 we can see that around 90% of those firms have engaged suppliers on carbon emissions over the entire period while engagement on water has lagged behind, as shown in Figure 4.1. Considering these firms have reported on issues related to both carbon emissions and water usage each year, which only a small fraction of firms that report do with the vast majority reporting on only carbon emissions, such firms could be considered on the forefront of taking a more holistic approach to environmental sustainability and even then we still see a clear preference toward addressing carbon emissions in the supply chain. This is despite the fact that water scarcity is a tangible risk in the supply chain which investors are paying greater attention to (Maki 2020). Water is a global, operational and financial risk for organizations.

Figure 4.1 Engaging Suppliers on Environmental Issues



Alongside earlier engagement on carbon emissions, Honda did not expand its green purchasing guidelines globally until a decade later in 2011 (Green Car Congress 2011), instead focusing in on its local home market of Japan. Honda, like other firms, has access to a global

supply base where the closest supplier may not necessarily have the best performance. Even if the local supplier does have superior performance on a single preferred metric, it could lead to substantial environmental disservice across other metrics which the buying firm does not work to address in the supply chain.

This leads to our primary research interest: do buyers have biases in how they value supplier location and competing environmental considerations when making sourcing decisions? If buyers ignore water related concerns in the supply chain, especially if limiting their geographic preference to local suppliers, suppliers with an overall superior environmental profile across both carbon emissions and water could be overlooked in pursuit of a narrow set of criteria. This could be especially detrimental in densely populated regions with a large manufacturing base. Consider the Trinity River in the Dallas-Fort Worth area of the United States. Outside of the rare period of heavy rainfall, the river is nearly undiluted wastewater (Sedlak 2014, pg. 149). This region, among many others, requires improved water management. If corporate buyers in the region prefer local sourcing with a focus on reductions in carbon emissions as the primary environmental metric, it will worsen water stress in a region that cannot support further strain on its water resources.

With recent supply chain disruptions putting even greater focus on where suppliers are located, such biases are important to understand. Water is a local resource, with limited replenishment in each region. If recent events reverse the globalization of supply chains and move more manufacturing back to where the end product is produced and sold, it would also bring with it all the environmental disservice along the supply chain to that local area. If supply chains become more geographically concentrated, and water is marginalized as an environmental concern it could lead to firms simply exchanging one risk for another: disruptions from logistics

challenges to disruptions due to a lack of local water resources. A benefit of a global supply chain is that water consumption can be spread out among various regions with their own water resources, resources that can't easily be transferred from region to region. Increased local production would create a greater need to address water in the supply chain, something buyers may not be inclined to do. Environmental and location criteria in sourcing decisions are inter-twined when environmental concerns beyond carbon emissions are considered. Cap-and-trade programs can make carbon emissions fungible across regions of production, but water cannot be treated as such. This leads to a multi-criteria decision where buyers must weigh not only a supplier's location, but also how location impacts on the environmental focus of sourcing decisions.

We use construal level theory to hypothesize just that: a preference for both local suppliers as well as reductions of carbon emissions in the supply base over reductions of water usage. Construal level theory focuses on how distant concepts are perceived and has been applied to environmental sustainability before (Wiesenfeld et al. 2017, Barnes 2019). More abstract concepts, like environmental sustainability (Wang et al. 2019), are viewed distantly and thus preferences are based on social norms. Given carbon emissions seeming dominance as a preferred environmental concern, this would lead to water use reductions being marginalized in sourcing decisions. We also theorize a preference for local suppliers based on economic nationalism, or the preference for local economic benefit. To investigate this, we administer a vignette experiment to real-world procurement professionals which was pre-registered with the Open Science Foundation.

Our findings are even stronger than we initially hypothesized. While we expected to find a general preference for carbon emissions reductions, we did theorize that this preference would

be weaker when considering local suppliers given the tangible nature of water both in production and for individuals personally. We in fact find the opposite, a slightly greater preference for carbon emissions reductions among local suppliers. We also expected a preference for production to be non-local when suppliers are environmentally damaging in line with past construal level theory "Not In My BackYard" (NIMBY) research findings. We find no such thing, but rather an across-the-board preference for local suppliers to the point where a non-local supplier with a superior environmental performance may be ignored in favor of a local supplier. If current trends do lead to a greater focus on local sourcing, it could have detrimental environmental impacts as firms ignore non-local suppliers with superior environmental performance and continue to overwhelmingly focus on carbon emissions reductions when in fact a broader focus is required as the supply base becomes more locally concentrated. Corporate buyers are one of the few groups with the financial leverage to affect environmental performance in a meaningful way, and if a more holistic approach is not taken a greater focus on local sourcing could have a detrimental impact.

4.2. Literature Review

4.2.1 Environmental Concerns

Carbon emissions across the supply chain is an area that has received extensive attention, as shown by recent sustainability focused literature reviews in operations management (Thies et al. 2019), logistics (Vega-Mejía et al. 2019) and supply chain management (Farooque et al. 2019, Koberg and Longoni 2019, Martins and Pato 2019). Among these five literature reviews carbon and greenhouse gas emissions are discussed frequently and in depth while water related issues are only mentioned tangentially three times. The need to address carbon emissions across the

supply chain is well established, while water related issues have received less attention despite being of critical importance to businesses.

The importance of water for individuals and communities is self-evident, but it is just as critical for firms. Water is both an input and an output either directly or indirectly for almost every product bought or sold (Hussain and Wahab 2018, Y. Li and Han 2018, Pal and Gander 2018, Pervaiz et al. 2018). From a risk management perspective, water may be even more critical to understand in a supply chain context than carbon emissions, given that water shortages can create the same type of disruptions as any other material shortage for the firm (Giannakis and Papadopoulos 2016, R. Tan et al. 2016) and its suppliers (Xu et al. 2019). Past research has found suppliers are less motivated to implement carbon reduction initiatives (Villena and Gioia 2018), and while similar research related to water usage is absent there has been findings from at least one large OEM that suppliers are not willing to implement water management strategies even if the buying firm does (Sehnem and Oliveira 2017). The need to find ways to address water concerns in the supply chain is thus critical, as extreme water stress creates "day zero" scenarios where water could be shut off due to a lack of availability—a situation that nearly happened in Cape Town, South Africa in 2018 (Hofste et al. 2019). However, efforts to address carbon emissions or water usage can often be mutually exclusive as water use reduction technologies require large volumes of electricity that generate carbon emissions and current technologies used to reduce carbon emissions can require large volumes of water (Nguyen et al. 2014, Ji et al. 2020), suggesting that firms cannot simply target one and assume the other to reduce along with it. A balanced and multi-pronged approach is needed. Indeed, a singular focus on one environmental concern has been observed to hamper efforts to address the other within firms. For example, AbbVie cut funding to its water conservation efforts in order to further fund

energy use reduction initiatives: "*Projects were funded that support other areas of AbbVie's EHS footprint reduction commitment (e.g. energy use, waste reduction, etc.) resulting in funds being unavailable for water conservation projects (for example, $200,000 capital and $100,000 expense could be potentially diverted away from water projects in order to fund other environmental projects). The impacts on the environment could be significant if a water project was not funded in an area where water-stress is an issue*." (CDP 2019b). The fact that energy use reduction and water conservation require their own separate projects shows that the two require independent responses and showcases how biased priorities can shift funding away from addressing other environmental concerns such as water.

4.2.2 Supplier Location

While water related topics in the supply chain have received little attention, supplier location decisions and their environmental implications are well studied. There is generally a preference for locally made products (Siemieniako et al. 2011, Kipnis et al. 2012), with the place of production of primary concern, rather than the location of the facility's owner (Knight 1999). There are several firm-level benefits associated with local sourcing. Buyers are more familiar with local suppliers (Trent and Monczka 2003), who in turn can also streamline operations for the local market (Garavelli 2003). In addition, the proximity of local suppliers reduces the need for long transportation routes, reducing carbon emissions (Elhedhli and Merrick 2012) and enabling rapid, small lot size deliveries to support Just-In-Time logistics systems (Waters-Fuller 1996, K.C. Tan et al. 2002). Local sourcing also reduces complexity as there is no need to pass locally made products through customs (Birou and Fawcett 1993), as well as the shorter lead times reducing volatility (Holweg et al. 2011). There are also social sustainability considerations,

with local sourcing strengthening the local economy (Seuring et al. 2008, Walker and Preuss 2008).

However, local sourcing is not always environmentally friendly. Just-In-Time systems can actually increase carbon emissions due to smaller, more frequent shipments (Ugarte et al. 2016). At the same time, larger, less frequent shipments have been found to reduce overall carbon emissions (Tang et al. 2015), and greater distance can actually reduce carbon emissions per unit of cargo even further as ocean transport is more fuel efficient than truck shipments when the amount of cargo transported is considered (Kissinger 2012). Non-local suppliers may also be more efficient at producing products (Saunders and Barber 2008), be able to achieve greater economies of scale by producing for a global market (Rasmussen 2010), and afford environmentally friendly, but expensive, technologies that could not be purchased at a smaller scale (T. Chen et al. 2016).

Within this context, this research fills gaps in the literature in three distinct ways. First, it incorporates water into environmental sustainability decisions from a sourcing perspective. While prior literature has focused on carbon emissions as a defining environmental metric, it is not alone as an environmental consideration. If buyers focus on carbon emissions as the singularly critical environmental criterion, it may cause other issues in the supply chain to not be addressed as a single metric is pursued to the detriment of overall environmental performance. Second, this paper brings a multi-criteria environmental perspective to supplier location decisions. In the supplier location decision cites provided above in this section carbon emissions was universally considered the metric for environmental sustainability. Suppliers have heterogenous overall environmental profiles which must be considered, and those suppliers with the best overall environmental performance may not be located near each other. Buyers must

therefore consider how much they value the supplier's location against their overall environmental profile, a decision that has received little attention in current literature. Third, this paper specifically focuses on buyers, the ones making the actual sourcing decisions. If buyers are the bridge between the firm and its suppliers (Villena 2019), their sourcing decisions will have a dramatic impact on the environmental performance of the supply chain. Understanding how buyers react to these multi-criteria environmental decisions is critical but largely missing.

4.3. Theory and Hypothesis Development

Construal level theory focuses on how perceptions of distance may alter an individual's attitudes. The theory focuses on the way information is processed based on proximity across various dimensions of distance: (1) spatial distance, i.e., how far away something physically occurs, (2) temporal distance, i.e., how far in the future something occurs, (3) social distance, i.e., whether the event impacts others which the individual knows or is familiar with, and (4) hypothetical distance, i.e., how likely something is to occur. The more distant an event is along these dimensions, the more it is thought of as a high-level construct, rendering it more abstract. Perceptions of such constructs are based on collective values. As a the distance is reduced, thinking on a topic becomes more concrete and anchored in details—these closer concepts are then called low-level constructs (Wiesenfeld et al. 2017, Barnes 2019).

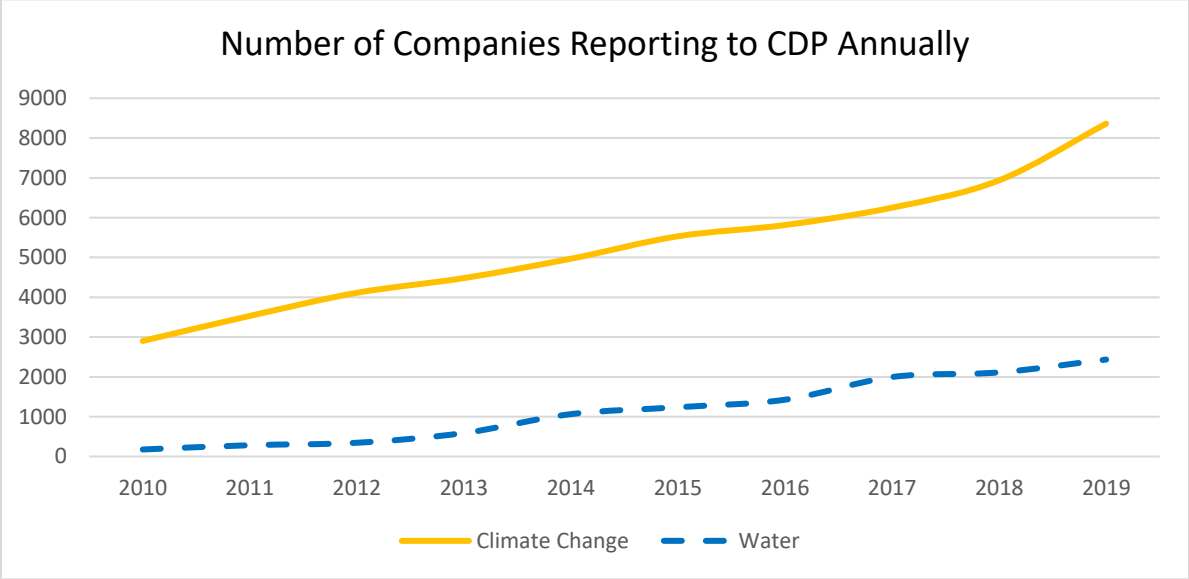
Construal level theory has seen prior application in sustainability research focused on how location affects environmental preferences and attitudes. Specifically, around the topic of "Not In My BackYard" (NIMBY), which examines how distance from an environmental concern alters an individual's perceptions (Gifford et al. 2014, Lujala et al. 2015, Mueller et al. 2017, Barnes 2019). Though prior application of construal theory in sustainability research has been from the standpoint of a consumer or citizen, construal level theory in general has been applied

to organizational research to examine how distance may impact an individual's intentions and efforts (Wiesenfeld et al. 2017). Given that managers view different sustainability topics as distinct (Pagell and Gobeli 2009), with a buyer's attitudes on a particular sustainability topic influencing their commitment and intentions toward that topic (Swaim et al. 2016) there could be distinct differences in how carbon emissions and water usage are valued given the distance to the buyer.

Consider a sourcing decision focused on the environmental profile of two suppliers that are geographically distant to the buyer. Since these suppliers are non-local, there are no considerations about how the decision will directly impact the buyer and their community, but simply general values of environmental performance. In this scenario sustainability is a distant, high-level construct, as environmental sustainability is generally viewed (Wang et al. 2019). When the concept is abstract, and thus the construal level is high, individuals tend to focus on broader collective concerns (Wiesenfeld et al. 2017). In this high distance scenario, we theorize a strong preference for carbon emissions reductions. Beyond the general focus on carbon emissions in the media and high-profile environmental agreement such as the Paris Climate Accord, there is evidence of businesses favoring carbon emissions as an environmental metric, and this would influence the preferences of buyers within those firms. One example of such bias can be seen in the types of reports that are submitted to the CDP Project, a non-governmental organization (NGO) that collects voluntary sustainability reports from companies. In 2010 2,903 companies filed reports related to carbon emissions and climate change, while 176 filed reports related to water related activities (CDP 2010b, 2010a). From 2010 to 2019 the number of companies reporting on climate and carbon emissions increased by 6,502 to 8,361 companies while those reporting on water only increased by 2,169 to 2,345 (CDP 2019a, 2019b), not even

the number of firms reporting on carbon emissions in 2010. These trends can be seen in Figure 4.2, which shows not only the greater priority for carbon emissions related reporting at the beginning of the period, but also the faster growth of such reporting. Firms viewed carbon emissions as an area that was more important to report on in 2010, and that can be seen continuing in the future with an increasingly larger gap over time in terms of the number of reporting firms. By 2019 the number of firms reporting on water wasn't even to the level of firms reporting on carbon emissions in 2010. Both issues must be addressed, but one is clearly receiving priority in a way that could be suppressing water related initiatives.

Figure 4.2 Sustainability Reporting by Topic to CDP



Given the current priority in the business community to address carbon emissions, we would expect this to influence sourcing decisions. When environmental sustainability is considered from a high-level, the buyer will default to collective values, which seem biased toward carbon emission reductions. Thus, we hypothesize a strong preference for carbon emissions when environmental sustainability is considered in the supply chain at a high level among non-local suppliers.

Hypothesis 1*: If choosing between two non-local suppliers, a buyer will be more likely to choose a supplier with lower-than-average carbon emissions and higher-than-average water usage than a supplier with lower-than-average water usage and higher-than-average carbon emissions.*

Now we consider a decision in which the buyer is selecting between local suppliers. While carbon emissions can have a long-term impact on an individual's health (Dong et al. 2021), the impact on an individuals day-to-day life is generally minimal. Water, however, is integral to all individuals on a daily basis. Drinking, sanitation, and a myriad of other activities ensure that each day an individual is interacting with water. Such interactions would make water a low-level construal construct.

Indeed, there are many instances of business-related water use directly impacting communities and the individuals within them. For example, hedge-fund-owned farms in California, while operating within their legal water rights, have used so much water as to leave local residents with insufficient amounts for drinking or basic household needs (R. Smith and Vanek Smith 2020). Philadelphia Cream Cheese opened a factory in rural New York state which takes up over 80% of the town's daily water use, reducing the town's reservoir to dangerously low levels (Patterson 2019). Industrial farms along the Nile river are starving long-standing, but smaller family farms of water (Scheck and Patterson 2019). While these examples are at the extreme end of business-related water consumption, they emphasize how water overconsumption is felt by communities.

While not all buyers, or perhaps even most, will have personally experienced a local water impact some inevitably will. Droughts are common in the American west and other parts of the world, so even if not directly impacted by business related overuse individuals have a high probability of having experienced water stress. When considering impacts that are close, as

opposed to distant, an individual's thinking shifts to a more detail oriented mindset (Wiesenfeld et al. 2017). This will make those local water events salient, and thus give water use greater weight in sourcing decisions compared to when the suppliers are non-local.

Hypothesis 2*: If choosing between two local suppliers, a buyer will be more likely to choose a supplier with lower-than-average water usage and higher that average carbon emissions than if choosing between two non-local suppliers.*

While the first two hypotheses focus on how a supplier's location can affect a buyer's preference for the environmental profile of the supplier, Hypothesis 3 reverses this and examines how a supplier's environmental profile impacts the location preference. Consider a sourcing decision between a local and non-local supplier with identical environmental profiles which are either universally "good", having lower than average water usage and carbon emissions, or universally "bad", where the suppliers are environmentally damaging.

On one hand, a preference for locally-made goods has been found across the globe in areas such as the United States (Knight 1999), Europe (Siemieniako et al. 2011, Kipnis et al. 2012) and China (Parker et al. 2011). In addition to the general preference for locally made products, businesses can also be subject to significant coercive pressures to do so. For example, both the current president of the United States, Joe Biden, and the previous president, Donald Trump, have taken actions to emphasize American production despite differing political views (Hughes 2021).

On the other hand, there is a preference for environmental damage to be non-local. This is an area where construal level theory has been previously applied to sustainability related research. Specifically, around the topic of "Not In My BackYard" (NIMBY), though mostly from a public policy perspective. When considering infrastructure projects (Mueller et al. 2017)

or other environmentally problematic sites (Gifford et al. 2014), individuals are more opposed to environmental damage and view the associated risks as higher the closer they are personally to the site. When it comes to the actual environmental hazards that can occur from environmental damage, individuals also view local hazards as being more threatening than non-local ones (Lujala et al. 2015), with the subsequent environmental damage viewed as less consequential when it is in another part of the world (Barnes 2019). Thus, when the decision will lead to a known and substantial negative environmental impact, the preference will be to push the environmental damage to a non-local area.

When there is little difference between the environmental performance of suppliers, buyers then have the power to keep production that is environmentally benign in the local area while pushing environmental damage to other regions. Given the general preference for purchases to be local, but for environmental damage to be non-local, we hypothesize:

Hypothesis 3*: If choosing between local and non-local suppliers,* ***(A)*** *when choosing between companies with equal and lower than average carbon emissions generation and water usage, a buyer is more likely to choose a local supplier, but if* ***(B)*** *choosing between companies with equal and greater than average carbon emissions generation and water usage, a buyer is more likely to choose a non-local supplier.*

4.4. Methodology

4.4.1 Experimental Design

Following recent research which aims to gain insights into individual attitudes in business decisions (Hartmann and Moeller 2014, Polyviou et al. 2018), this research uses a vignette study focused on sourcing decisions. In a vignette experiment the participant is provided one or a set of scenarios with various manipulations and asked to respond to questions presented about the

scenario(s). Vignettes are an established experimental method for supplier selection research using real world (Eckerd 2016), and an experimental method that is especially appropriate when the context of the manipulation matters (Eckerd et al. 2021) as is the case with our research question. The vignette was built in Qualtrics' survey software, using a dynamic path that adjusted the sustainability profile of suppliers as participants selected suppliers. These dynamic paths allowed us to explore which dimensions the participant held either sacred (i.e., refusing to switch away from) or secular (i.e., willing to switch away from if a more preferred option was presented). Randomization was used to ensure that sustainability profiles and supplier locations were randomly presented first or second to reduce ordering effects.

To help ensure the validity of our experiment, we pre-registered the hypothesis and theory on July 27, 2021 on the Open Science Foundation Website. The pre-registration document can be found at: https://osf.io/fx28y. Pre-registration was performed before any data was collected. There are two minor deviations from the pre-registration. First, while the sentiment and content of our hypotheses did not change, the wording was slightly altered to make the hypotheses easier to understand and read. Second, our sample size is slightly different than the pre-registration. The funding secured for this study allowed for more participants than originally estimated. As such, our sample is 25% larger than our original target. We also decided against including a student sample alongside our procurement professional sample as it did not contribute to the aims of our study.

4.4.2 Basic Vignette Set Up

The main portion of the vignette was administered a series of text-based scenarios reviewing the sustainability profiles of potential suppliers. There were three sets of scenarios provided. The first set was for non-local suppliers (H1), the second for local suppliers (H2), and

the third when comparing local and non-local (H3). For the non-local and local sets, two scenarios were randomized. The first scenario presented one supplier with higher-than-average carbon emissions but lower than average water usage, with the other supplier having the opposite. For the second scenario presented, whichever dimension was presented as "low" for the supplier first that was selected was changed to average **OR** the dimension presented as "high" for the supplier that was not selected was changed to average. This change was done at random also. In the set of scenarios for comparing local and non-local suppliers both suppliers either had higher than average carbon emissions and water usage, or lower than average. One supplier was labeled as being local and the other non-local with the order of whether the local or non-local supplier was presented first randomized. Since participants were all from the United States or Canada, the United States was used for the local location, while Vietnam was used for non-local. These scenarios were used for the hypothesis testing. Vietnam was chosen as the location for the non-local supplier as it is a country which provides products globally but is not the most common location to source. Thus, the non-local location would be realistic but one the participant would be less likely to have established beliefs about. Carpet was chosen as the sourced product for similar reasons, a product that would be realistic in the setting but one that participants would be less likely to have prior beliefs about.

The overall flowchart of the vignette with a full review of what participants read while completing the vignette is in Appendix 1.2 through Appendix 1.5.

4.4.3 Methodology

Given the participants were working through multiple, independent scenarios, each with a binary choice, we require a method of analysis that accounts for the fact that each response is nested within an individual participant. Individuals are further nested within the industry. For

multiple response vignette studies with such nesting a multilevel model is required (Aguinis and Bradley 2014, van Gerwen et al. 2018). Since our outcome is a binary choice, we use a multilevel logit regression model (melogit in Stata 16.1) for the main analysis. The first level was the participant, with the industry in which the participant has worked most as the second level. In instances where a participant made only one selection due to the narrowing-down to a singular scenario, a multilevel model was still used with the industry as the first level identifier and the participant not included as a level. The results do not change in terms of sign or significance, or magnitude, when using a standard logit regression or when including industry dummies instead of using industry as a second level in the regression.

Since each supplier within a scenario is given an environmental profile that is opposite of the other (one with high carbon emissions and low water usage, and vice-versa) or with different locations and the same environmental profile, the characteristics are collinear for both suppliers. As such, the primary dependent variable is the probability of choosing the first supplier presented. The main independent variable is the first supplier's carbon emissions, as that being high or low also dictates the first supplier's water usage and the characteristics of the second supplier. For scenarios where the suppliers locations are manipulated, the first supplier's location is also used. For robustness we also provide the same analysis for choosing the second supplier as well. An additional benefit of using this approach is that it will help control for ordering effects.

4.4.4 Scales and Questions

The full exposition of the demographic questions, manipulation checks, questions about attitudes toward sustainability and measurement scales can be found in Appendix 1 alongside the vignette. Demographic questions were administered at the beginning of the survey since we had

specific criteria for our sample. Namely, actively working procurement professionals living in the United States and Canada over the age of 18. Thus, we needed to terminate any potential participants not meeting those criteria. All other questions occurred once all portions of the vignette were completed.

We include a number of measurement scales to control for potential personal biases. To control for the participant's innate social biases, scales for Social Desirability (Cronbach's $\alpha = 0.77$) along with a control scale for feelings of Unity with Nature are added from Hartmann and Moeller (2014), which control for a person's desire to look more socially desirable and preference for environmental sustainability, respectively. To control for an individual's attitudes toward globalization and purchasing non-local products we include scales for Economic Globalization (Cronbach's $\alpha = 0.86$) attitudes from Riefler (2012). Scales related to Institutional Pressures (Cronbach's $\alpha = 0.82$) are also adapted from Liu et al. (2010). After these scales we also add in questions directly asking about the participants attitudes and knowledge about specific environmental issues.

4.4.5 Sample

An initial test sample of 40 participants from mTurk was used to ensure there were no technical issues as individuals took the vignette experiment. One issue with how individuals were directed through the vignette was discovered, which was subsequently corrected. This sample was set aside after checking for technical issues and not used.

Qualtrics was contracted to administer the vignette to actively working procurement professionals in the United States and Canada. Participants received a financial payment for fully completing the vignette and all survey questions that followed the vignette. The survey was sent to a total of 2,800 participants. 344 responses were received, and of those 315 were deemed

acceptable. There were four reasons for a response to not be acceptable: (1) The participant failed a pair of manipulation checks at the end of the experiment that asked two basic questions about sustainability, (2) non-sensical responses were provided such as writing "yes" to open-ended questions, (3) "speeding" through the survey and (4) beginning but failing to complete the survey. Qualtrics defined "speeding" as taking less than one half the median time to complete the entire survey, which we agreed to. The median time to complete the vignette was 546 seconds, thus any responses completed in under 273 seconds were deemed unacceptable.

Since a third-party company was used for the data collection, we do not have information on respondents who received the survey but did not respond. However, to check for potential biases of responses we can examine demographic characteristics of those individuals that were kept in the main sample with those individuals who did not complete the survey or whose response was deemed unusable. Table 4.1 shows the comparison of demographic and survey scale responses for the sample that was kept compared to those responses deemed unacceptable. The demographic information was collected at the beginning of the survey as to terminate respondents who did not meet our basic criteria (at least 18 years of age and working in procurement) so all 29 of the responses that were not deemed acceptable had basic demographics information. The survey scales were administered at the end of the survey as to not prompt participants, so depending on where the participant abandoned the survey there were either 10 or 11 responses collected. Other than participants who completed the survey having a higher annual income, we do not find any significance between those participants that provided an acceptable response, and those that did not. Given the lack of statistically significant differences across the other categories, differences in income alone will likely not lead to a concerning bias.

Table 4.1 Testing for Bias of Incomplete and Unacceptable Responses

Demographics at Start of Experiment			
Variable	Kept	Not Kept	p-value
Years of Work Experience in Procurement	7.12	6.52	0.29
Age	41.57	41.34	0.92
Education Level Increment	3.88	4.00	0.54
Participant Income Increment	6.57	5.14	0.05
Gender (1=F, 2=M)[8]	1.58	1.55	0.76
Observations	315	29	
Scales at End of Experiment			
Variable	Kept	Not Kept	p-value
Average Economic Globalization	5.11	5.13	0.97
Average Social Desirability (Reversed)	4.73	4.05	0.21
Unity with Nature	5.40	5.10	0.53
Company Values Sustainability	3.70	3.45	0.39
Participant Values Sustainability	3.86	3.81	0.87
Carbon Emissions Reductions Important	5.52	5.70	0.71
Water Use Reductions Important	5.37	5.90	0.24
Observations	315	10 or 11	

4.5. Results

4.5.1 Main Results

4.5.1.1 Non-Local Scenarios for Hypothesis 1

Table 4.2 shows the percent of participants who chose the supplier with lower carbon emissions or water usage, along with the p-value of a two-sided proportion test (prtest in Stata 16) compared to a 50% to 50% split as one would assume if the choice were random. In the initial selection, 69% of participants selected the supplier with lower carbon emissions. Of those 218 individuals, 61% once again chose the supplier with lower carbon emissions, despite the supplier now having a worse overall environmental profile. In contrast, for the 97 participants that initially chose the water efficient supplier, only 54% chose the water efficient supplier again

[8] Participants were given a non-binary gender option as well as the option to not list gender, as can be seen in the appendix, but all participants responded with either male or female.

in the second scenario and the proportion test was non-significant. Participants were more likely to select the lower carbon emissions supplier and hold that choice sacred.

Table 4.2 Proportion Tests for NonLocal/NonLocal

First Scenario – Environmental Concern Preference Overall		
	Number	Percent of Total
Carbon Emissions	218	69%
Water Usage	97	31%
P-Value of Proportion Test	0.00	
Second Scenario – Initially Chose Carbon		
Carbon Emissions	134	61%
Water Usage	84	39%
P-Value of Proportion Test	0.00	
Second Scenario – Initially Chose Water		
Carbon Emissions	45	46%
Water Usage	52	54%
P-Value of Proportion Test	0.48	

Table 4.3 we provide the results of the multilevel logit regression for the scenarios using non-local suppliers only. We find that an increase in carbon emissions for the first supplier dramatically reduces the probability of choosing this supplier ($\beta = -0.68$, $p < 0.01$, odds ratio of 0.51). Since this table is a logit regression the output is the log odds which can be translated to the odds ratio by exponentiating the coefficient. In this case, -0.68 would translate to an odds ratio of 0.51. The first supplier being the supplier with the higher carbon emissions reduced the probability of it being selected by roughly half.

Table 4.3 Melogit Regression for Non-local Scenarios

	DV: Chose First Supplier			DV: Chose Second Supplier		
	Coeff.	Std. Err.	P-Value	Coeff.	Std. Err.	P-Value
First Supplier's Carbon Emissions	-0.68	0.13	0.00			
Second Supplier's Carbon Emissions				-0.79	0.13	0.00
Years Working in Procurement	-0.07	0.05	0.12	0.07	0.05	0.13
Age	-0.01	0.01	0.44	0.01	0.01	0.45
Coercive Pressures	0.06	0.08	0.43	-0.07	0.08	0.43
Normative Pressures	-0.05	0.11	0.67	0.04	0.11	0.71
Mimetic Pressures	0.10	0.11	0.34	-0.10	0.11	0.37
Company Values Sustainability	0.15	0.16	0.34	-0.18	0.16	0.28
Participant Values Sustainability	-0.09	0.15	0.57	0.11	0.15	0.49
Econ. Globalization - Freedom	-0.16	0.12	0.20	0.13	0.12	0.29
Econ. Globalization - Technology	0.06	0.13	0.66	-0.03	0.13	0.82
Econ. Globalization - Goods	0.00	0.14	0.99	-0.01	0.14	0.96
Social Desirability - Resentful	0.21	0.08	0.01	-0.22	0.08	0.01
Social Desirability - Get Even	-0.06	0.08	0.44	0.06	0.08	0.44
Unity with Nature	-0.05	0.11	0.67	0.03	0.11	0.77
Values Carbon Reductions	-0.07	0.12	0.57	0.06	0.12	0.60
Values Water Reductions	-0.03	0.11	0.81	0.05	0.11	0.67
Highest Level of Education	0.00	0.12	0.99	0.04	0.12	0.73
Region - United States	-0.07	0.24	0.78	0.04	0.24	0.86
Gender - Male	0.16	0.23	0.48	-0.19	0.23	0.40
Constant	2.45	0.94	0.01	0.44	0.93	0.63
Observations		624[9]			624	
Wald Chi-Squared		40.14			46.09	

We find overwhelming support for Hypothesis 1. When choosing between non-local suppliers, there is a strong preference for suppliers with lower carbon emissions instead of lower water usage.

[9] The regression is run using both the scenarios provided for the non-local section, so the sample size is twice the number of participants, 630. However, the regression has only 624 observations, instead of 630, as we had unintentionally not made one question for a control variable required (What value does the company you work for place on environmental sustainability relative to other companies in its industry?) and three individuals did not respond to this question. The results do not change in any meaningful way ($\beta = -0.67$, $p < 0.01$ for the First Supplier's Carbon Emissions variable) when this variable is excluded and thus having the full sample of 630 observations.

4.5.1.2 Local Scenarios for Hypothesis 2

To test Hypothesis 2, participants were provided the same scenarios as for the non-local context, with the difference being that the participant had to choose between two suppliers that were local. The percent of participants making each selection and proportion test p-values are presented in Table 4.4.

Table 4.4 Proportion Tests for Local/Local

First Scenario – Environmental Concern Preference Overall		
	Number	Percent of Total
Carbon Emissions	228	72%
Water Usage	87	28%
P-Value of Proportion Test	0.00	
Second Scenario – Initially Chose Carbon		
Carbon Emissions	143	63%
Water Usage	85	39%
P-Value of Proportion Test	0.00	
Second Scenario – Initially Chose Water		
Carbon Emissions	39	45%
Water Usage	48	55%
P-Value of Proportion Test	0.33	

For the scenario comparing only local suppliers we find that participants had an even stronger preference for suppliers with lower carbon emissions. In line with our results for Hypothesis 1, we find that a greater proportion of the participants selected the supplier with lower carbon emissions. In fact, an even larger portion than the results for Hypothesis 1. This is contrary to Hypothesis 2 in which we theorized to find a relatively greater preference for the supplier with lower water usage, when compared to the non-local scenarios for Hypothesis 1. Not only does a larger proportion of participants select the supplier with lower carbon emissions, but we also find that participants are more likely to hold carbon emissions sacred. While the increases in loyalty to the preferred sustainability criteria are small, we do observe a shift

toward, and not away, from a preference for carbon emissions when the scenarios use local suppliers.

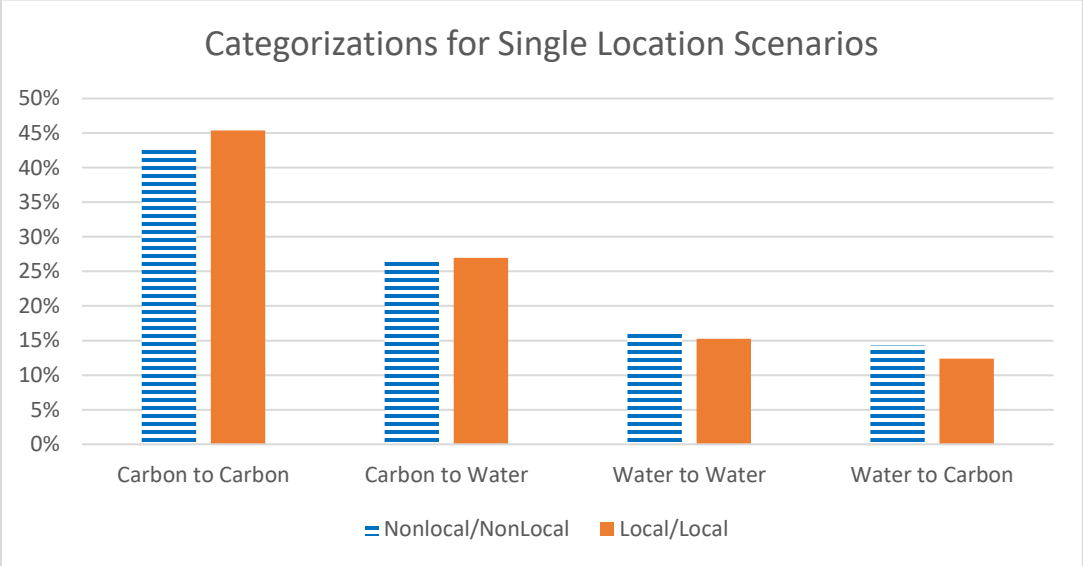
The multilevel logit model results for the Hypothesis 2 results are presented in Table 4.5. The results confirm that when choosing between local suppliers, there is an even greater aversion to selecting the first supplier if it had higher carbon emissions ($\beta = -0.84$, $p < 0.01$, odds ratio of 0.43). As such, Hypothesis 2 is not only unsupported, but the results in fact suggest the opposite of what was theorized.

Table 4.5 Melogit Regression for Local Scenarios

	DV: Chose First Supplier			DV: Chose Second Supplier		
	Coeff.	Std. Err.	P-Value	Coeff.	Std. Err.	P-Value
First Supplier's Carbon Emissions	-0.84	0.15	0.00			
Second Supplier's Carbon Emissions				-1.06	0.18	0.00
Years Working in Procurement	0.04	0.05	0.37	-0.02	0.05	0.71
Age	0.01	0.01	0.61	-0.01	0.01	0.51
Coercive Pressures	0.11	0.09	0.20	-0.09	0.09	0.33
Normative Pressures	-0.06	0.11	0.61	0.04	0.12	0.77
Mimetic Pressures	0.03	0.11	0.77	0.00	0.12	0.98
Company Values Sustainability	-0.03	0.17	0.84	0.01	0.18	0.95
Participant Values Sustainability	-0.06	0.16	0.72	0.07	0.17	0.68
Econ. Globalization - Freedom	-0.31	0.13	0.02	0.33	0.14	0.02
Econ. Globalization - Technology	-0.12	0.13	0.36	0.12	0.15	0.40
Econ. Globalization - Goods	0.37	0.15	0.01	-0.41	0.16	0.01
Social Desirability - Resentful	-0.04	0.08	0.66	0.04	0.09	0.65
Social Desirability - Get Even	0.18	0.08	0.03	-0.18	0.09	0.05
Unity with Nature	0.09	0.11	0.45	-0.10	0.12	0.43
Values Carbon Reductions	-0.25	0.13	0.06	0.28	0.14	0.05
Values Water Reductions	0.24	0.12	0.04	-0.29	0.13	0.02
Highest Level of Education	0.33	0.12	0.01	-0.37	0.14	0.01
Region - United States	-0.10	0.25	0.69	-1.06	0.18	0.00
Gender - Male	-0.01	0.23	0.98	-0.02	0.05	0.71
Constant	-0.66	0.95	0.49	-0.01	0.01	0.51
Observations		624			624	
Wald Chi-Squared		46.10			45.34	

As noted in section 4.4.2, each participant saw two scenarios in both the non-local and local scenario sets: An initial scenario with the suppliers having opposite environmental profiles and a follow up scenario where the supplier that was chosen had a relatively worse environmental profile compared to the first scenario but still having whichever of lower carbon emissions or water usage compared to the supplier not chosen as it had in the first scenario. This leads to four potential groups each participant could be in for each the non-local and local sets of scenarios: (1) initially selecting a supplier with lower carbon emissions and maintaining that choice in the second selection, (2) initially selecting a supplier with lower carbon emissions and not maintaining that selection in the second selection, (3) initially selecting a supplier with lower water usage and maintaining that choice in the second selection, and (4) initially selecting a supplier with lower water usage and not maintaining that selection in the second selection. Figure 4.3 provides a breakdown of the percent of participants that fell into each category for the non-local and local scenario sets. Participants choosing carbon and holding carbon sacred was the most common selection, with an initial selection of carbon but switching away in the second selection the next most popular selection. Water received far less prioritization overall.

Figure 4.3 Categorizations for H1 and H2



4.5.1.3 Comparing differing environmental profiles

For Hypothesis 3, the goal was to assess how the environmental profile of the suppliers impacted the location preference of suppliers. For this each participant was presented one of two scenarios comparing a local and a non-local supplier. One of the possible alternatives involved comparing two suppliers that have both lower-than-average carbon emissions and water usage for Hypothesis 3A, which theorizes a preference for a local supplier when comparing sustainable suppliers. The other alternative compares two suppliers with both higher-than-average carbon emissions and water usage for Hypothesis 3B, which theorizes a preference for non-local sourcing when production will be environmentally damaging.

The percent of the sample that chose the local and non-local suppliers along the proportion tests are presented in 4.6. For Hypothesis 3A, we find that when choosing between suppliers that have lower-than-average carbon emissions and water use, there is a strong preference for a supplier that is local to the buyer in line with the hypothesis. However,

Hypothesis 3B, which theorized a preference for a non-local supplier when choosing between suppliers that have higher-than-average carbon emissions and water usage, is not supported.

Table 4.6 Proportion Tests for NonLocal/NonLocal

H3A: Choosing Between Suppliers with Good Sustainability Profile		
	Number	Percent of Group
Local	126[10]	80%
Non-Local	32	20%
P-Value of Proportion Test	0.00	
H3B: Choosing Between Suppliers with Poor Sustainability Profile		
	Number	Percent of Group
Local	125	80%
Non-Local	32	20%
P-Value of Proportion Test	0.00	

4.5.1.4 Consistency of Scenario Findings Regression

Alongside the local/non-local scenarios provided to test Hypothesis 3, we also provided each participant two scenarios which combined randomization of both location and environmental profile, instead of only one. To check for robustness of our results, we use these scenarios to examine the combined impact of a supplier's carbon emissions, water usage and location on supplier. The analysis shown in Table 4.7 confirms the general findings thus far. Participants are significantly less likely to choose a supplier with higher carbon emissions ($\beta = -0.90$, $p < 0.01$, odds ratio of 0.41) as suppliers that are non-local ($\beta = -1.19$, $p < 0.01$, odds ratio of 0.30).

[10] The sample size for the proportions is smaller here as each participant received only one of the two potential scenarios (good or poor environmental profile). This also means the samples for H3A and H3B results were independent of one another and do not reflect the same individuals making the same choice.

Table 4.7 Melogit Regression for Local/Non-Local

	DV: Chose First Supplier			DV: Chose Second Supplier		
	Coeff.	Std. Err.	P-Value	Coeff.	Std. Err.	P-Value
First Supplier's Carbon Emissions	-0.90	0.10	0.00			
First Supplier Located in Vietnam	-1.19	0.20	0.00			
Second Supplier's Carbon Emissions				-0.90	0.10	0.00
Second Supplier Located in Vietnam				-1.19	0.20	0.00
Years Working in Procurement	-0.10	0.04	0.01	0.10	0.04	0.01
Age	-0.01	0.01	0.48	0.01	0.01	0.48
Coercive Pressures	0.02	0.07	0.75	-0.02	0.07	0.75
Normative Pressures	-0.02	0.09	0.83	0.02	0.09	0.83
Mimetic Pressures	-0.06	0.10	0.53	0.06	0.10	0.53
Company Values Sustainability	0.02	0.14	0.90	-0.02	0.14	0.90
Participant Values Sustainability	0.07	0.13	0.58	-0.07	0.13	0.58
Econ. Globalization - Freedom	-0.01	0.10	0.92	0.01	0.10	0.92
Econ. Globalization - Technology	-0.06	0.11	0.56	0.06	0.11	0.56
Econ. Globalization - Goods	0.06	0.12	0.60	-0.06	0.12	0.60
Social Desirability - Resentful	0.03	0.07	0.71	-0.03	0.07	0.71
Social Desirability - Get Even	-0.01	0.07	0.93	0.01	0.07	0.93
Unity with Nature	-0.04	0.09	0.65	0.04	0.09	0.65
Values Carbon Reductions	-0.06	0.10	0.58	0.06	0.10	0.58
Values Water Reductions	0.03	0.09	0.79	-0.03	0.09	0.79
Highest Level of Education	-0.12	0.10	0.21	0.12	0.10	0.21
Region - United States	0.05	0.21	0.83	-0.05	0.21	0.83
Gender - Male	0.21	0.19	0.29	-0.21	0.19	0.29
Constant	4.41	0.83	0.00	0.37	0.80	0.65
Observations		624			624	
Wald Chi-Squared		114.35			114.34	

4.5.2 Switching Behavior as the Environmental Profile of a Supplier Changes

The main analysis primarily focused on how participants value location and environmental dimensions in a singular choice. The environmental dimensions of a supplier are not static, however, and can change over time. To better understand how changes in the relative carbon emissions and water use intensity of suppliers over time impacts preference we include a series of quantitative scenarios as a post hoc analysis labeled as “exchange rates”, referencing the concept of exchange rates between currencies where one currency can have a certain value

related to another currency. Are water usage reductions valued one-to-one with carbon emissions or are they valued more or less? Does location impact this? If the value is not one-to-one, how differently are they valued? These exchange rates provide a more granular comparison of water usage and carbon emissions reductions while considering supplier location.

One supplier had carbon emissions in the 90th percentile (with the 50th percentile being average, and higher percentiles indicating poorer performance) and water usage in the 70th percentile. The same as above, the other supplier had the opposite values, and the order in which the suppliers were presented randomized. After the initial selection, the supplier that was not chosen has their lower category (which was 70th percentile in the initial scenario) reduced by 20 percentage points, and the scenario presented again. This continued until the participant changed their selected supplier or the last scenario is reached (where the supplier that was not initially chosen has their better environmental measure reduced to the 10th percentile). Each supplier has a location of either the United States (local) or Vietnam (non-local) assigned randomly, with the potential for both suppliers to be local or non-local.

4.5.2.1 Initial Choice

Table 4.8 Proportion Tests for Chosen Supplier Initial Choice

Environmental Profile of Chosen Supplier		
	Number	Percent of Total
Lower Carbon Emissions	212	67%
Lower Water Usage	103	33%
P-Value of Proportion Test		0.00
Observations		315
Supplier Location Preference (If Presented Suppliers in Different Locations)		
	Number	Percent of Total
Local Supplier	62	53%
Non-local Supplier	55	47%
P-Value of Proportion Test		0.52
Observations		117

Table 4.8 contains the proportion test results for the initial selection in these scenarios. We find a significant preference for a supplier with lower-than-average carbon emissions, and while we find a preference for a supplier that is local, the difference is non-significant.

4.5.2.2 Switching Behavior in the Exchange Rate Scenarios

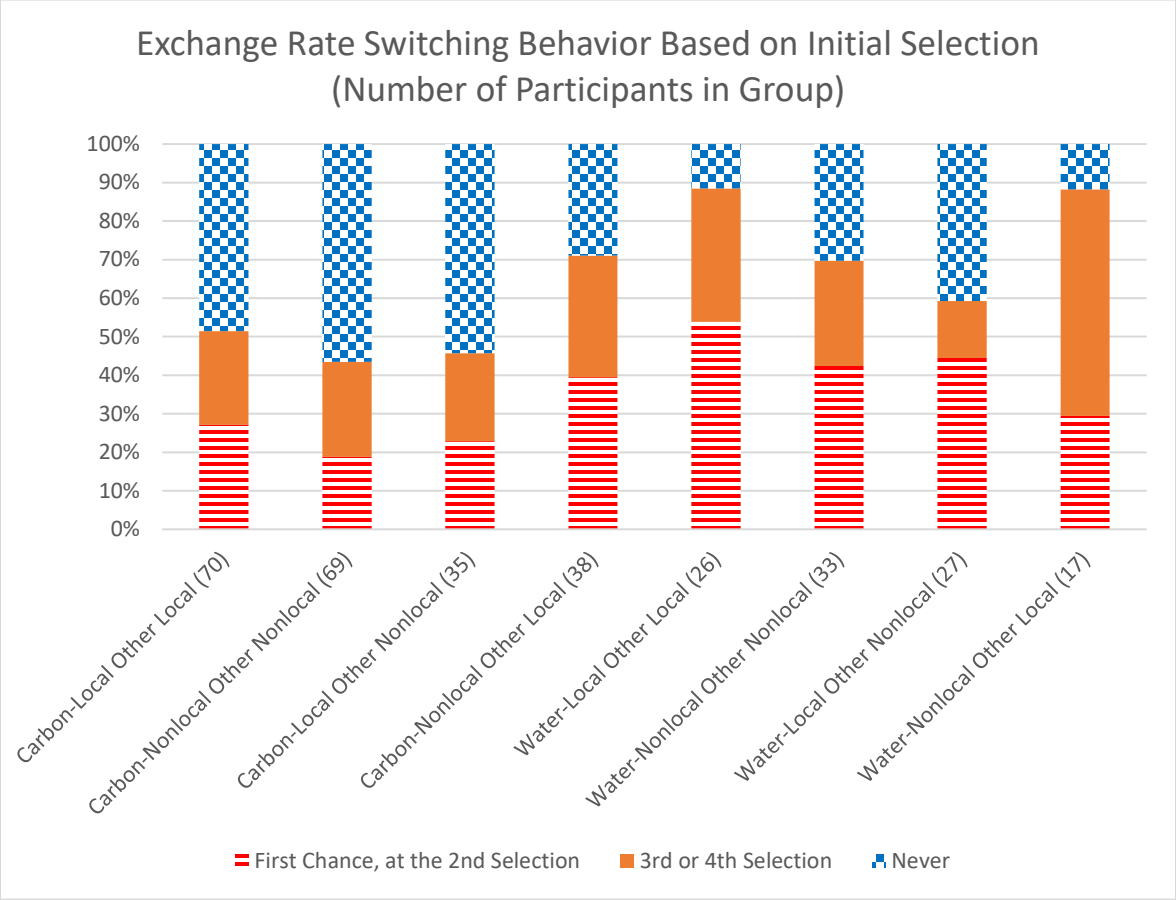
The exchange rate scenarios provide us an opportunity to see how participants hold certain aspects sacred (i.e., unwilling to switch away from a selection with a certain characteristic) and which are secular (i.e., willing to switch away from a supplier with that characteristic) over repeated choices as the environmental profile of the potential suppliers goes from being roughly equivalent to extreme levels of difference. Each participant is assigned to one supplier with lower water usage or carbon emissions and higher levels of the other, with each supplier either being local or non-local. The initial selection thus yields the following four potential categories: (i) Selecting a local supplier with lower carbon emissions than water usage, (ii) selecting a non-local supplier with lower carbon emissions than water usage, (iii) selecting a non-local supplier with lower water usage than carbon emissions, and (iv) selecting a non-local supplier with lower water usage than carbon emissions. Each of these four categories is then considered twice, once for the alternative supplier being local and once for the alternative supplier being non-local since the location of the alternative supplier will affect the decision to select the focal supplier. For example, in the case of two local suppliers, the location would not be a consideration and only the carbon emissions and water usage of the two suppliers need to be considered.

Switching behavior amongst these various choices is presented in Figure 4.4, with the number of participants in each group in parentheses. The blue shading represents the portion of participants that never switched their selection and made the same selection until the set of

scenarios terminated. This would indicate the participant was willing to accept substantially higher amounts of carbon emissions or water usage for a small reduction of the other. For example, if the supplier initially chosen was in the 90th percentile of water usage relative to other suppliers and 70th percentile of carbon emissions, the supplier not initially chosen would have been in the 70th percentile of water usage and 90th percentile of carbon emissions in the initial scenario. By the fourth scenario the water usage would have been the 90th percentile for the supplier initially chosen and 10th percentile for the supplier not chosen, a difference of 80 percentage points, while the supplier initially chosen would have remained at the 70th percentile for carbon emissions and the supplier not chosen at the 90th percentile, a difference of only 20 percentage points. These participants held their selection sacred and were willing to maintain that selection even in the face of an alternative supplier with a substantially better overall environmental profile when considering both carbon emissions and water usage.

The red shading represents those participants that switched their selection at the second selection, which means that they changed immediately once the alternative supplier had an even slightly better environmental profile. The orange shading represents those individuals that switched at the third or fourth selection; these participants had some loyalty to their initial selection but were unwilling to hold that selection sacred in the face of extreme differences.

Figure 4.4 Switching Behavior Based on Selection and Alternative Supplier Location



For those individuals that chose the supplier with lower carbon emissions initially, they showed a willingness to maintain their selection throughout except for in the case in which their initial selection was non-local and the alternative supplier not initially selected was local. This suggest that a substantial separation in water usage was needed to motivate them to switch.

For those participants who initially chose a supplier with lower-than-average water usage, the propensity to hold their choice sacred differed greatly. For participants whose alternative supplier was local, regardless of whether the initially chosen supplier was local or non-local, very few participants held their choice sacred with a high propensity to switch and switch quickly. For participants who initially selected the supplier with lower-than-average water usage, and the alternative supplier was non-local, there was an increased propensity to hold the choice

sacred, especially if the chosen supplier was local, but there was an almost equal proportion who were willing to immediately switch.

The post hoc analysis provides further support for the earlier results. When making sourcing decisions considering both the supplier location and comparing carbon emissions with water usage the participants showed a substantial preference for suppliers with lower carbon emissions. There was also both a willingness to switch away from a non-local supplier and reluctance to switch to a non-local supplier even as the differences in overall carbon emissions and water usage grew substantial if a local supplier was available.

4.5.2.3 Demographics of Those Who Hold Certain Aspects Sacred

In Table 4.9, we use a logit regression to explore participant demographics for those who hold certain aspects sacred throughout the exchange rate scenarios. There are four different aspects that can be held sacred: lower carbon emissions, lower water usage, a local supplier, a non-local supplier. For the Economic Globalization Controls, we use the average of the scales to capture the participant's attitude toward globalization, with a higher number representing a more favorable attitude. The same is done for Social Desirability, with these scales reversed so a higher number represents a greater propensity for social desirability bias.

For participants that hold carbon ($\beta = 0.46$, $p < 0.10$, odds ratio of 1.58), water ($\beta = 1.39$, $p < 0.05$, odds ratio of 4.01) and especially a nonlocal ($\beta = 1.77$, $p < 0.01$, odds ratio of 5.87) supplier sacred, we find that having the other supplier be nonlocal significantly increased the probability of holding that criterion sacred. For participants that hold non-local suppliers sacred, having the other supplier non-local does seem to be the primary determinant, with participants from the United States ($\beta = -0.80$, $p < 0.05$, odds ratio of 0.45) being less willing to hold a non-local supplier sacred. We further find that participants with more years of work experience in

procurement are more likely to hold a local supplier sacred ($\beta = 0.15$, $p < 0.05$, odds ratio of 1.16), which could likely be due to greater insight into challenges associated with global sourcing.

Table 4.9 Demographics of Those Who Hold Sacred Exchange

	Carbon		Water		Local		Nonlocal	
	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.	Coefficient	Std. Err.
Other Supplier in Vietnam	0.46*	(0.27)	1.39**	(0.57)	-0.86***	(0.29)	1.77***	(0.34)
Years of Work Experience in Procurement	0.05	(0.05)	0.12	(0.12)	0.15**	(0.06)	-0.01	(0.06)
Age	-0.01	(0.01)	0.05**	(0.02)	-0.00	(0.02)	0.01	(0.01)
Coercive Pressures	0.13	(0.10)	0.15	(0.15)	0.02	(0.10)	0.06	(0.11)
Normative Pressures	0.11	(0.14)	-0.15	(0.19)	0.04	(0.14)	0.11	(0.15)
Mimetic Pressures	-0.10	(0.13)	0.10	(0.15)	-0.05	(0.14)	-0.00	(0.14)
Company Values Sustainability	0.37*	(0.20)	-0.35	(0.33)	0.37	(0.22)	-0.15	(0.23)
Participant Values Sustainability	0.09	(0.18)	-0.08	(0.35)	-0.08	(0.19)	0.09	(0.21)
Economic Globalization (Average)	-0.38***	(0.14)	0.67***	(0.19)	0.01	(0.15)	-0.02	(0.17)
Social Desirability (Average & Reversed)	0.22***	(0.08)	-0.14	(0.14)	0.10	(0.09)	0.16	(0.10)
Unity with Nature	0.20	(0.15)	0.16	(0.22)	-0.00	(0.13)	0.29*	(0.18)
Participant Values Carbon Reductions	0.27	(0.17)	-0.49***	(0.18)	0.14	(0.14)	-0.09	(0.19)
Participant Values Water Reductions	-0.39***	(0.13)	0.02	(0.27)	-0.29**	(0.12)	-0.17	(0.14)
Highest Level of Education	0.02	(0.14)	0.01	(0.21)	-0.01	(0.15)	-0.11	(0.16)
Region - United States	-0.58**	(0.28)	-0.23	(0.51)	0.18	(0.31)	-0.80**	(0.32)
Gender - Male	-0.09	(0.27)	-0.22	(0.48)	-0.29	(0.29)	-0.13	(0.32)
Constant	-2.56**	(1.06)	-6.60***	(1.89)	-2.48*	(1.27)	-3.44***	(1.17)
Observations	312							

Standard errors in parentheses, * p<0.10 ** p<0.05 *** p<0.01

In terms of holding a supplier with lower carbon emissions sacred, interestingly, we find participants who rate higher on social desirability bias ($\beta = 0.22$, $p < 0.05$, odds ratio of 1.25) and those that state their company values sustainability ($\beta = 0.37$, $p < 0.10$, odds ratio of 1.45) are

more likely to hold carbon emissions sacred. The only demographic characteristic, aside from age, that was found to significantly increase the probability of holding water usage sacred was Economic Globalization ($\beta = 0.67$, $p < 0.01$, odds ratio of 1.95).

4.6. Discussion

In this research we examined how professional buyers weigh carbon emissions and water use reductions in the supply chain alongside supplier location. Using construal level theory as a theoretical lens, we originally hypothesized a preference toward carbon emissions reductions in general, with water use reduction receiving relatively more emphasis for local suppliers compared to non-local suppliers. We also hypothesized a general preference for local suppliers when environmental damage is not a concern, but a preference for suppliers to be non-local when they are environmentally damaging. Our results showed even stronger preferences for carbon emissions reductions and local suppliers than we initially theorized. There was an overwhelming preference for carbon emissions reductions over water use reductions, which was in fact stronger for local suppliers. Alongside this was a general preference for a local supplier, regardless of the of the environmental profile of the supplier.

Theoretically, this paper contributes to both behavioral operations and broader supply chain literature focused on environmental sustainability by linking carbon emissions and water environmental concerns with supplier location decisions. Prior behavioral operations literature has considered internal versus external sustainability initiatives (Buell and Kalkanci 2020), but not considered how different environmental dimensions may be weighed against one another. One need look no further than the United Nations Sustainable Development Goals for confirmation of the need to address both carbon emissions and water (United Nations 2015). If only one environmental concern dominates discussions about environmental sustainability, it

will cause other areas of concern to be marginalized. Given the influence buyers have over the priorities suppliers focus on, and thus the entire supply chain, understanding their preferences is important in the pursuit of creating supply chains that are able to manage multiple environmental issues.

The one-sided view of environmental sustainability was why we had originally hypothesized a preference for carbon emissions reductions in general and may explain why Hypothesis 2 was rejected. In Table 4.9 when examining the demographic characteristics of those who held carbon emissions sacred, we found that the participant's company valuing environmental sustainability and, more interestingly, social desirability bias were statistically significant in increasing the probability of holding carbon emissions sacred. The current social pressures toward carbon emissions could well create long-term environmental challenges as suppliers with a better overall environmental profile are ignored in pursuit of a supplier that has marginally lower carbon emissions.

Our findings of a universal preference for suppliers being local also offer another theoretical contribution. Construal level theory has been applied in the past to environmental issues, specifically in the context of "Not In My BackYard" where individuals prefer for environmental damage to occur somewhere distant to them (Gifford et al. 2014, Mueller et al. 2017), though these prior applications have been at the consumer level around public policy decisions. Our paper examines this topic from the perspective of a buyer who has some power over where environmental damage can occur, unlike the average citizen. Even for suppliers that were environmentally damaging, there was an overwhelming preference for the supplier to be local. This would go against prior findings in construal level theory. The positive that can be taken from this is that there does not appear to be a deliberate preference to offshore

environmental damage, which is one means of reducing pollution in production (X. Li and Zhou 2017). While environmental concerns will still need to be addressed in a more holistic way, we do not find an underlying bias to simply ship the problem offshore and make it someone else's problem. This also highlights the need to better understand how psychological distance may or may not be applicable when making business decisions. Overall, these results suggest that managers are likely to prefer local economic benefit over improvements in environmental outcomes. local suppliers regardless of the environmental profile of that supplier will lead to a supply chain which creates greater environmental damage. If those environmentally damaging suppliers are then clustered in major industrial areas around the buying firm this will not only damage the local environment but also increase risk in the supply chain. If numerous suppliers with that are substantial users of water are clustered in a single area it will strain local water resources and create risks of disruption.

Managerially, we observe a level of loyalty to local suppliers with lower carbon emissions that could create long-term environmental issues across the supply chain. If suppliers that spread resources to address both water usage and carbon emissions are ignored because they are marginally worse on carbon emissions alone or are a non-local supplier it will discourage investment across environmental dimensions. A local supplier is not always the supplier that can most efficiently produce products (Saunders and Barber 2008), and carbon emissions not the only environmental consideration. If firms focus too strongly on a small set of environmental criteria it could lead to ignoring a supplier with a superior environmental profile, especially if that supplier is non-local. The fact that we do find that participants who feel their company values sustainability more and those that have stronger social desirability bias are more likely to

hold carbon emissions sacred would speak to social pressures manifesting in environmental sourcing decisions.

Sourcing decisions are often complex with different suppliers having different strengths and weaknesses. Much like only pursuing the supplier with the lowest piece price could lead to a higher total cost of procuring a part, concentrating solely on a limited set of environmental criteria could create a supply chain with worse overall environmental performance. Firms and the academic literature need to take a broader view of environmental sustainability if the current environmental challenges facing the world today are to be addressed.

This paper is not without limitations. While the scenarios attempt to simulate a sourcing decision, they cannot capture the myriad of other influences that can go into such decisions. Economic considerations, personal relationships and customer requirements can all weigh heavily in such decisions. By using an experiment, we attempt to strip away these considerations to get to the heart of preferences on supplier location and environmental performance across both water usage and carbon emissions but acknowledge that in a real world setting other considerations exist and more likely than not take precedence. Still, environmental and location-based criteria will hold some weight in such decisions and are important to understand as firms try to confront multiple environmental concerns.

APPENDIX

A1.1 Questionnaire for Case Study

1. How are task requirements for a specific job in your production line determined?
2. What is the process for determining a worker's level of ability to perform specific tasks in a production line? What criteria are used?
3. How is the communication with employee handled when a worker has a challenge meeting a task's requirements on the production line?
4. What is the process of providing accommodations for workers when they are needed on the production line? Are task requirements modified if there is a mismatch between the employee's ability to perform the task and demands of the task? Could you provide us with examples from your experience?
5. What are the most important challenges in assuring that accommodations provided to the worker does not impact overall efficiency of the production line? Please provide examples from your work experience.
6. What happens if an accommodation does not resolve a person with disabilities' work-related needs? How are countermeasures handled? Could you please provide an example from your work, if possible?
7. What role does the supervisor play in managing the accommodation process? How can the supervisor become more familiar with employees' challenges? Can you share experiences where the accommodation process worked well, or otherwise, from your work?
8. How do reasonable accommodations provided to one worker impact the workload of other workers in the production line? Could you share examples?
9. How does employing individuals with a varied range of disabilities in the same production line influence the performance of the team?

A1.2 Vignette Scenarios

A1.2.1 General Introduction

The company you work for is in the process of contracting out the construction of a new office building. The builder that will receive the contract is M&S Construction, a large construction company primarily focused on custom-designed commercial and industrial buildings. While all the major design choices have been made there are a few specific decisions left to be made. One of these is the carpeting. M&S has two potential suppliers that can produce the design at the price specified in the contract. They have asked for your input in which supplier you would prefer. Both suppliers have a history of providing good quality and on-time delivery, so there are no substantial economic or operational differences between either supplier. Given

your company's recent initiatives to be more sustainable you have requested sustainability profiles for both companies.

A1.2.2 Non-local Scenarios for H1

The first supplier, Supplier A, is located in Vietnam. They generate (more OR fewer) carbon emissions per square foot of carpeting than most suppliers during production. They use (Opposite of A's Carbon Emissions) water per square foot of carpeting than the majority of other suppliers.

The second supplier, Supplier B, is also located in Vietnam. They generate (Opposite A's Carbon Emissions) carbon emissions per square foot of carpeting than most suppliers during production. They use (Opposite A's Water Usage) water per square foot of carpeting than the majority of other suppliers.

Based on the information provided, which supplier would you choose to manufacture the carpeting?

A1.2.2.1 Non-local Scenario Follow Up

After making your initial choice, M&S Construction received updated supplier sustainability reports for the year. No change is required, but if you wish to change your choice of supplier there would be no impact on the project.

The first supplier, Supplier A, is located in Vietnam. They generate (more OR about as much OR fewer) carbon emissions per square foot of carpeting than most suppliers during

production. They use (more OR about as much OR fewer) water per square foot of carpeting than the majority of other suppliers.

The second supplier, Supplier B, is also located in Vietnam. They generate (more OR about as much OR fewer) carbon emissions per square foot of carpeting than most suppliers during production. They use (more OR about as much OR fewer) water per square foot of carpeting than the majority of other suppliers.

Based on the information provided, which supplier would you choose to manufacture the carpeting?

A1.2.3 Local Scenarios for H2

Same as non-local except the location is changed to the United States.

A1.2.4 Scenarios for Hypothesis 3

The first supplier, Supplier A, is located in (the United States OR Vietnam). They generate (more OR fewer) carbon emissions per square foot of carpeting than most suppliers during production. They use (Same as A's Carbon Emissions) water per square foot of carpeting than the majority of other suppliers.

The second supplier, Supplier B, is also located in (the United States OR Vietnam). They generate (Same as A's Carbon Emissions) carbon emissions per square foot of carpeting than most suppliers during production. They use (Same as A's Carbon Emissions) water per square foot of carpeting than the majority of other suppliers.

Based on the information provided, which supplier would you choose to manufacture the carpeting?

A1.2.5 Additional Local / Non-local Scenarios

The first supplier, Supplier A, is located in (the United States OR Vietnam). They generate (more OR fewer) carbon emissions per square foot of carpeting than most suppliers during production. They use (Opposite of A's Carbon Emissions) water per square foot of carpeting than the majority of other suppliers.

The second supplier, Supplier B, is also located in (Opposite of A's Location). They generate (Opposite A's Carbon Emissions) carbon emissions per square foot of carpeting than most suppliers during production. They use (Opposite A's Water Usage) water per square foot of carpeting than the majority of other suppliers.

Based on the information provided, which supplier would you choose to manufacture the carpeting?

A1.2.6 Exchange Rate Scenarios

Which of the two potential suppliers would you prefer to buy from if your company were in need of a new supplier? A higher number represents a worse environmental impact relative to other potential suppliers, with the 50th percentile being average across suppliers. A company in the 1st percentile generates carbon emissions or uses water per square foot of carpeting that is **less** than all but 1% of all other suppliers. A company in the 99th percentile generates carbon emissions or uses water per square foot of carpeting that is **more** than 99% of suppliers.

Supplier A, located in (the United States OR Vietnam) is in the (70 OR 90)th percentile of carbon emissions generated per square foot of carpeting, while being in the (Opposite of A's Carbon Emissions)th percentile of water used per square foot of carpeting.

Supplier B, located in (the United States OR Vietnam) is in the (Opposite of A's Carbon Emissions)th percentile of carbon emissions generated per square foot of carpeting, while being in the (Opposite of A's Water Usage)th percentile of water used per square foot of carpeting.

A1.2.6.1 Exchange Rate Scenario Follow Up

First: For the supplier not chosen their characteristic, carbon emissions or water usage, that started at 70 is lowered by 20 to 50. If the participant changes their supplier selection, scenarios end.

Second: If the participant continues to choose the same supplier, for the supplier not chosen their characteristic at 50 is lowered by 20 to 30. If the participant changes their supplier selection, scenarios end.

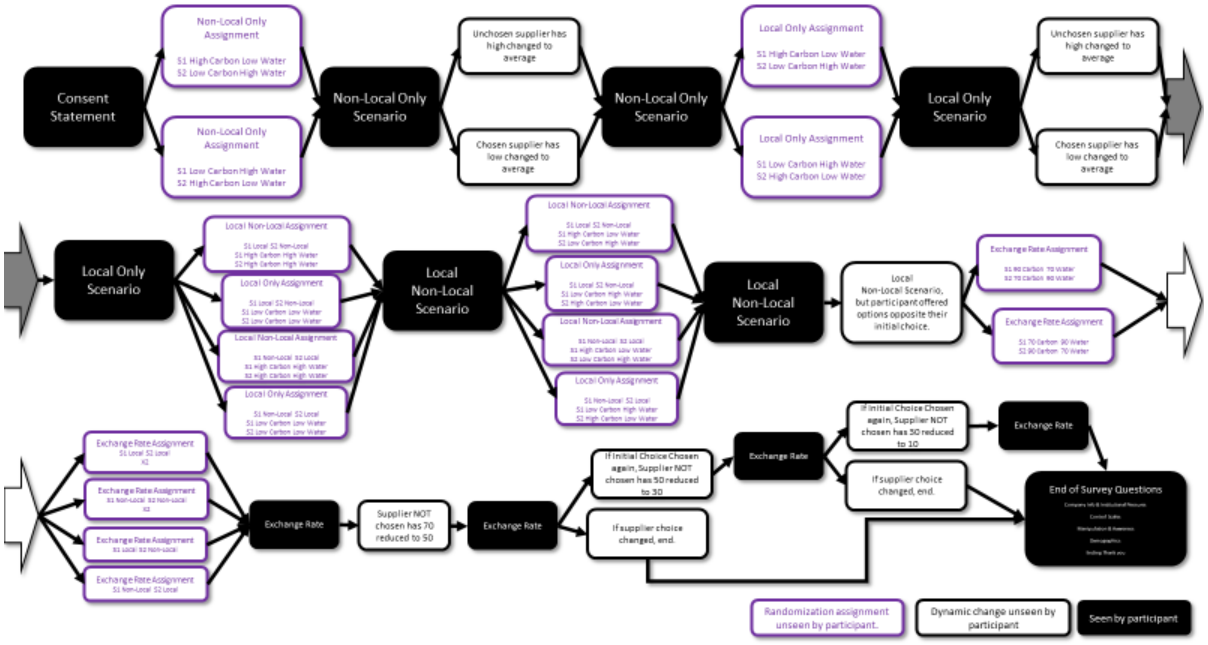
Third: If the participant continues to choose the same supplier, for the supplier not chosen their characteristic at 30 is lowered by 20 to 10. Scenario ends.

A1.2.7 Ending

Thank you for going through the scenarios provided. We have a few final questions to ask about yourself and your opinions to conclude the survey.

A1.3 Vignette Logic Flow Chart

Figure A1 Vignette Flow Chart



A1.4 Demographic Questions

1. What is your profession?
    a. Student (Terminates is selected)
    b. Procurement Professional or Buyer
    c. Manager of Procurement Professionals or Buyers
    d. Other (Terminates is selected)
2. How many years of work experience do you have in procurement or sourcing?
3. What is the industry or industries you have the most experience working in?
4. The annual revenue of the company I work for is, roughly, _____ in millions of USD. If unsure or unemployed, leave blank.[11]
5. Which country or region do you consider home? (Terminates if other than United States or Canada).
6. Within the United States, which state do you consider home? (If United States Selected) **OR** Within Canada, which province do you consider home? (If Canada Selected)
7. Within the state you consider home, which county do you consider home? (If United States Selected)

[11] This question was not included in the analysis due to concerns with the validity of the data. Participants may have not understood the question or intentionally tried to make the response untraceable. Responses ranged from 0 (11 participants) to 65 quintillion USD. 100 trillion was tied for the second most common response (13 participants) after 1 million (17 participants). While responses of 65 billion would be reasonable, which is what 65 quintillion would equate to if considered in USD instead of millions of USD as the question asks, we cannot assume that was the intent. Thus, the question was removed from the analysis.

8. What is the highest level of education which you have completed?
    a. Have not completed a high school degree
    b. High school degree
    c. Two year university or junior college degree
    d. Four year university degree
    e. Graduate or professional degree
9. What is your age? (Terminates if Under 18)
10. What is your gender?
    a. Male
    b. Female
    c. Non-binary
    d. Prefer not to say
11. What is your ethnicity?
    a. Non-Hispanic white
    b. Hispanic and/or Latino
    c. Black or African American
    d. Asian
    e. Native American and Alaska Natives
    f. Native Hawaiians and Other Pacific Islanders
    g. Two or More Races
12. What is your annual household income?
    a. Increments of $20,000 starting at $0-$20,000

A1.5 Scales and Attitude Questions

A1.5.1 Institutional Pressures (Liu et al. 2010)

1. On a scale of 1 (least agree) to 7 (most agree) how much do you agree with the following statements.
    a. The company I work for receives pressure from customers or regulators to become more environmentally sustainable.
    b. Environmental sustainability is a social norm in the industry in which I work.
    c. The most successful organizations in the industry in which I work are more environmentally sustainable than other organizations in the same industry.

A.1.5.2 Sustainability Environment

2. What value does the company you work for place on environmental sustainability relative to other companies in its industry?
    a. Much More
    b. More
    c. About As Much
    d. Less
    e. Much Less
    f. Not Applicable
3. If I were to create the policies for my company, how much would environmental sustainability be emphasized relative to the current policies?
    a. Much More

b. More
c. About As Much
d. Less
e. Much Less
f. Not Applicable

A1.5.3 Economic Globalization(Riefler 2012)

4. In my opinion on a scale of 1 (least agree) to 7 (most agree):
    a. Economic globalization encourages a maximum of personal freedom and choice.
    b. Economic globalization leads to quality and technical advances.
    c. Economic globalization provides consumers the goods and services they want.

A1.5.4 Social Desirability & Unity with Nature (Hartmann and Moeller 2014)

5. In my opinion on a scale of 1 (least agree) to 7 (most agree):
    a. I sometimes feel resentful when I don't get my way.
    b. I sometimes try to get even rather than forgive and forget.
    c. Unity with nature is very important to me.

A1.5.5 Attitudes Toward Environmental Issues

6. In my opinion on a scale of 1 (least agree) to 7 (most agree):
    a. The reduction of carbon emissions generated in production is vital to creating long term sustainability in business and supply chains.
    b. The reduction of water used in production is vital to creating long term sustainability in business and supply chains.
7. I am aware of recent news stories regarding the United States' departure from and rejoining of the Paris Climate Accord.
    a. Yes
    b. No
8. I am aware of recent news stories of water shortages in the state of California in the United States.
    a. Yes
    b. No

A1.5.6 Manipulation Checks

9. When choosing between two suppliers, a buyer is more likely to choose a supplier which generates fewer carbon emissions and uses less water than a supplier which generates more carbon emissions and uses more water.
    a. Yes
    b. No
10. Lesser amounts of carbon emissions being generated has a worse environmental impact than more carbon emissions being generated.
    a. Yes
    b. No

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