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Turned Inside Out: The Rise of Private, Networked, Data-Centric Governance

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Turned Inside Out:
The Rise of Private, Networked, Data-Centric Governance

by

Niklas Adam Lollo

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Committee in charge:
Professor Dara O'Rourke, Chair
Professor Massimo Mazzotti
Professor David Anthoff

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Abstract

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The pursuit of more sustainable consumption and production of consumer goods has taken an inside-out turn. Instead of external stakeholders devising carrot-and-stick methods of influence, industry players like brands, retailers, and platforms are increasingly finding value in sustainability governance. Able to collect data streams inaccessible to stakeholders, with the market power to implement rapid changes transnationally, and guided by a vision of Industry 4.0, there has been renewed hope in private solutions to public issues. Firms are arguing that they can leverage their considerable power to achieve what NGOs and governments have struggled to achieve in thirty or so years: comparable and actionable data, market transparency, supply chain and product innovation, and enforcement of labor and environmental standards. Using interdisciplinary methods and novel empirical research, I describe and assess the emerging phenomenon of private, networked, data-centric governance (PNDG). First, I present a literature review of sustainable consumption. I demonstrate that the potential impact of so-called citizen consumption is extraordinarily limited, and argue that structural policies and politics are more likely to yield the necessary transformative change. My empirical work, in turn, focuses on production networks. In chapter three, through data analysis, surveys, and case studies, I examine the Higg Index, an apparel-industry wide initiative to collect and utilize environmental and social data. I find that after ten years, the Higg Index is a scale without a diet—it solves a number of measurement issues, but fails to address root issues of incentives and transparency. In chapter four, I perform a primarily econometric analysis of an intervention in a Thai clothing factory. My analysis demonstrates factory worker compensation formulas can incent higher productivity through higher wages, thereby showing a financially viable path towards living wages. And yet, the project highlights limitations on potential gains absent further external pressure by organized labor, NGOs, governments, or consumers. By offering novel empirical insights, as well as describing the phenomenon of PNDG, my findings inform ongoing policy debates, industry investments, and stakeholder projects. While PNDG holds promise, it needs to be complemented with more external accountability mechanisms that promote stronger incentives.

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Any errors that remain are my own.

1. Introduction

While corporate influence in the regulation of sustainability has typically led to greenwashing (Delmas and Burbano 2011), there is an emerging hope for, and even faith in, private solutions to public issues (Sandel 2012; Büthe and Mattli 2011). With complex, dynamic, transnational supply networks, increasingly enabled by online platforms, many argue that traditional government regulation is simply not up to the task of governing environmental, social, and labor outcomes (Ruggie 2014). Yet, neither are individual corporate initiatives (Vogel 2008; Dauvergne and Lister 2012). Instead, governance networks, comprised mostly of industry actors and non-governmental organizations, are considered more capable of managing a complex set of issues arising within opaque production networks (Zeitlin 2010; Thorlakson, de Zegher, and Lambin 2018; Lambin et al. 2018; Fransen 2018). The faith in these private governance networks has been buoyed by a revolution in information and communication technologies(O'Rourke 2014), as well as increasing intersection with traditional public authorities (Toffel, Short, and Ouellet 2015; Gereffi and Lee 2019; Lambin and Thorlakson 2018; Bartley 2018). Increasingly ubiquitous data, advances in analytics, and widespread technological uptake have many stakeholders cautiously optimistic that the elusive goals of transparency, accountability, and innovation are within reach (O'Rourke 2014; Gardner et al. 2019). This is a new era of what I term private, networked, data-centric governance (PNDG).

While private governance initiatives have been around for some time, PNDG is a new model, one in which firms have decentered NGOs. Instead of being a primarily external accountability framework where third-party actors dig for information, collate diverse datasets, and deploy that in market campaigns (O'Rourke 2005; Bartley 2007; Bullock 2017), industry players like brands, retailers, and platforms are increasingly rules makers, not rules takers (Chouinard, Ellison, and Ridgeway 2011; Bartley 2018). Instead of being primarily reactionary to forestall regulation or protect their brand (Vogel 2008), increasing numbers of firms and industry groups are generating and leveraging novel data streams primarily for financial gains from branding as sustainable, managing risk, or moving towards Industry 4.0 (van der Vegt et al. 2015; Rüßmann et al. 2015; Bateman and Bonanni 2019).

Firms are arguing that this data can be leveraged to do (financially) well, while doing (socially) good. This win-win proposition is tantalizing for stakeholders, who are offered positions on governing councils and partnerships in capacity-building programs (Baur and Schmitz 2012; Greer, Keane, and Lin 2010). Moreover, there remains the hope that this "quality" data will eventually be utilized for real transparency, accountability, and enforcement mechanisms (Chouinard, Ellison, and Ridgeway 2011; De Búrca, Keohane, and Sabel 2014; Lambin and Thorlakson 2018).

Despite a renewed faith in private solutions in some quarters, there remains healthy skepticism of techno-corporate optimism (Lebaron, Lister, and Dauvergne 2017; Bartley 2018). Sustainability is not a straightforward goal to describe and then achieve, if that is even a possibility (Montiel and Delgado-Ceballos 2014; Milne and Gray 2013). There are tradeoffs and feedbacks between objectives, like how polyester fabric requires less water than cotton, but generates more carbon emissions (Reich-Weiser and Dornfeld 2009) as well as pollutes waters and air with microplastics. Similarly, there might be agreement that factory worker wages should increase, but disagreement if it should be based on a "living" or "fair" or "prevailing" wage. There is disagreement over how a goal gets defined and what steps should be taken to achieve it, if any (Edwards, Hunt, and Lebaron 2019). The labeling of indicators have significant discursive impacts, even if the measure fails to match the framing (K. E. Davis, Kingsbury, and Merry 2012; Lohmann 2009). So, despite claims of inclusiveness and commitment to solutions, there is justified concern the PNDG model affords corporations too much power in setting the targets, conducting the measurements, and enforcing the standards, with devastating effects for those communities most impacted by corporate actions (Human Rights Watch 2018; Ruggie 2013).

Based on empirical research in apparel factories in Thailand, China, and Bangladesh, I have evaluated the effectiveness of several of the most promising new private governance projects. I have been foremost concerned with the immediate outcomes of these interventions, such as do worker wages increase and do carbon emissions decrease. These immediate outcomes are then positioned in their institutional context to assess whether they are likely to improve over time to reach ultimate goals of, to continue those examples, living wages or zero net carbon emissions. This contextual analysis also considers the procedural effects of specific interventions: which objectives are selected and how are they pursued, who is included in the decision-making, and how is power distributed.

1.1. Faith in Markets: The Conceit of the Citizen Consumer

The rise of the citizen consumer, who spend money in accordance with their values in order to effect some political change, has become a dominant frame and discourse (Barr, Gilg, and Shaw 2011; Micheletti and Stolle 2012). The citizen-consumer is part of a larger faith in markets to solve social problems (Sandel 2012).

Of course, this faith has resulted from a self-fulfilling prophecy. An argument for reducing geographic constraints on capital and removing regulatory "burden" has left traditional governmental regulatory mechanisms severely weakened (Rosen 2002; Baud and Durand 2011). With this 30-year assault on the efficacy of government, private mechanisms that can traverse transnational space appear as the most likely, if not the only, avenue towards sustainable consumption and production (Bartley 2018; Locke 2013; Fransen 2018; Bartley 2007; Zeitlin 2010; Cashore 2002; Bartley et al. 2003).

There is a widespread belief that innovative processes and products will enable ever-greater efficient resource use, and the forces of creative destruction will bring forward new organizations that solve emerging and/or pressing issues (J. Asafu-Adjaye et al. 2015). Indeed, since the 1990s, market campaigns, in addition to lobbying for laws or regulations, have been a core NGO strategy (O'Rourke 2005). This is the premise of non-state market-driven (NSMD) governance: the market could generate sufficient incentives for sustainable development given an absence of government intervention (Cashore 2002).

NMSD is fundamentally an outside-in process. Non-profits or governments, existing outside the market, worked to set standards and agendas (R. P. Appelbaum et al. 2000; Abbott and Snidal 2009; Büthe and Mattli 2010; Lambin and Thorlakson 2018), monitor corporations (Esbenshade

2004; O'Rourke 2003; Short, Toffel, and Hugill 2016b), build capacities (Berliner et al. 2015; Locke 2013; Greer, Keane, and Lin 2010), and extract commitments through public shaming (Edwards, Hunt, and Lebaron 2019; Bartley and Child 2014). But a major project has been to disseminate information that registers with citizen consumers existing preferences or changes their preferences towards certain values (Bullock 2017). Then, ideally, companies perceive consumer decisions are based on certain non-market values and preferences, and thus seek to change their products and processes to align with them (Fung 2007).

The citizen-consumer project has been successful in some respects: a majority of consumers have stated they would prefer, ceterus paribus, to consume products that are considered sustainable. So, Dara O'Rourke and I conducted a literature review, Chapter Two, of so-called "sustainable consumption" (a close cousin of citizen consumption and ethical consumption). Despite the growing demand for sustainable goods and services, we found three main issues with the NMSD strategy of influencing consumers. First, the data has never been sufficient to drive meaningful change. Third-parties have always struggled to gain access to credible and meaningful data sources. Information is rarely easily comparable across companies. So even if consumers did have certain values, the data is too uncertain to make significant market impacts. With incomplete information delivered in inconvenient ways, consumers are liable to focus on other priorities such as price and functional quality. Of course, sustainability is increasingly considered part of the functionality of the product (i.e., durability and non-toxicity), but ascertaining this information relies on unregulated branding and other partial indicators.

Second, consumption is deeply embedded in social structures. At present, consumers are ensnared in social and financial structures that encourage if not demand consumption for reasons other than sustainability. Individuals are continuously compelled to purchase more goods and services because of continual technical or social obsolescence, both of which are driven by corporate manufacturing or marketing strategy (Pope 2017; Stahel 2016; Ellen MacArthur Foundation and McKinsey & Company 2014). While sustainability may be important in some product categories, price, quality, and branding remain the key determinants of purchasing habits (O'Rourke and Ringer 2016). It is not simply an individual act that information alone can solve. Of course, interventions are increasingly savvy, utilizing "nudges" (Ölander and Thøgersen 2014; Moseley and Stoker 2013), leveraging social networks (Axsen and Kurani 2012; Thomas and Sharp 2013), and tapping into broader social and economic policy changes, from top-down policy changes (e.g., "beyond" GDP) to collocated housing, public transit, and workplaces (Bengtsson et al. 2018; Spangenberg 2014; Willis and Schor 2012).

Third, even if advanced data analytics could extract key sustainability insights and be delivered to consumers, this system would not solve the issue of ever-increasing consumption (Putt Del Pino et al. 2017). There is a growing body of research that consumption growth tends to swamp any gains to efficiency (Alcott 2010; 2008), in part because gains in efficiency tend to lead to greater consumption whether through income effects or through moral licensing (Chitnis et al. 2013). The bulk of empirical evidence points towards resource use and environmental impact being highly coupled with economic activity (Parrique et al. 2019; F. Cohen, Hepburn, and Teytelboym 2019).

We argue in Chapter Two that interventions need to be focused on the larger goal of sustainability transitions (Weinstein, Turner, and Ibáñez 2013). Whereas the dominant approach is often to enhance the efficiency of consumption, much literature has shown that sufficiency measures, those that reduce resource use, are more likely to achieve environmental and social well-being (Figge, Young, and Barkemeyer 2014; Bengtsson et al. 2018). We challenge the idea that transforming consumption means changing consumers. Instead, corporations, government policies, and social norms may be more influential targets, even if they are more challenging politically.

Instead of focusing on other targets, many actors have doubled down on the consumer hypothesis, buoyed by the growth in online and/or otherwise digitally-enabled consumption. Tools such as the GoodGuide[1] and Provenance[2] are trying to provide meaningful sustainability information to consumers as near as possible to the point-of-sale. Moreover, organizations like CoolClimate[3] have organized game-ified competitions to change individual and social behavior towards more sustainable efforts.

And yet, it is firms who are leveraging the digital revolution to great effect. Of course, much of consumption takes place at least partly online: consumers purchase through online platforms, are influenced on social media, and can customize products before purchasing (Rigby 2011). At the same time as companies are pouring resources into data science operations to increase, predict, and direct demand, they are also realizing these operations can be leveraged to address their sustainability concerns[4].

1.2. Taking Over: Corporations Turn Governance Inside Out

Perhaps recognizing sustainability as a discursive and material force to be reckoned with, and thus fearing stronger regulation or public pushback, many corporations have been working to turn the old model of NSMD inside out (Bartley 2007; Vogel 2008). Instead of outside organizations constructing the market, firms have begun to realize they can exert control over the shape of sustainable consumption and production (Banerjee 2008; Chouinard, Ellison, and Ridgeway 2011; Büthe and Mattli 2011).

In order to under the mechanics, it is important to view the network of sustainable consumption as an *apparatus* (Agamben 2009), composed of actors, beliefs, discourses, relationships, and so forth. Michel Foucault provides a description of an apparatus in a 1977 interview:

> What I'm trying to single out with this term is, first and foremost, a thoroughly heterogeneous set consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral, and philanthropic propositions-in short, the said as much as the unsaid. Such are the elements of the apparatus. The apparatus itself is the network that can be established between these elements... by the term "apparatus" I mean a kind of a formation, so to speak, that at a given historical moment has as its major function the response to an urgency. The apparatus therefore has a

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[1] GoodGuide: **https://www.goodguide.com/#/** Accessed February 2020.
[2] Provenance: Every product has a story, **https://www.provenance.org/**. Accessed February 2020.
[3] CoolClimate Network: https**://coolclimate.berkeley.edu/.** Accessed February 2020.
[4] **https://www.theguardian.com/sustainable-business/technology-enable-sustainable-consumption-talkpoint.** Accessed February 2020.

> dominant strategic function... I said that the nature of an apparatus is essentially strategic, which means that we are speaking about a certain manipulation of relations of forces, of a rational and concrete intervention in the relations of forces, either so as to develop them in a particular direction, or to block them, to stabilize them, and to utilize them. The apparatus is thus always inscribed into a play of power, but it is also always linked to certain limits of knowledge that arise from it and, to an equal degree, condition it. The apparatus is precisely this: a set of strategies of the relations of forces supporting, and supported by, certain types of knowledge. (Foucault 1977 via Agamben 2009)

In this description, the crucial link between power and knowledge within a network of forces is made. Power and knowledge are co-constitutive: who has power can produce knowledge that serves the interests of power. But the relationship between those in power and the production of knowledge is not so stable, nor assured. The overall strategy of the apparatus does not emerge from any single boardroom, conference, or seminal document (Foucault 1978). New tactics, new forms of expertise, new relationships, and new possibilities can destabilize current relations and produce new ones.

Scholars of governance today see a world of poly-centricity (Ostrom 2010; Jordan et al. 2015) or regime complexes (Abbott 2012; Keohane and Victor 2011; Green and Auld 2016). In these frameworks, actors have been broken down into their various relationships and capacities (Lambin and Thorlakson 2018; Gereffi and Lee 2019). From there, other scholars have prescribed arrangements like global experimentalism that take advantage of strengths and weaknesses of each actor (De Búrca, Keohane, and Sabel 2014; Overdevest and Zeitlin 2014). This material and discursive reimagining of governance has led to new formulations of old political ideals like accountability, authority, and legitimacy (Ansell and Torfing 2016; Bernstein 2011; Papadopoulos 2016; Karlsson-Vinkhuyzen 2016; Green 2014; Zurn 2018; S. Park and Kramarz 2019; Bäckstrand 2006). It is in this milieu that firms have begun to turn NSMD governance inside-out.

It may not seem consequential who generates the data to make the system work, as in both NSMD and its inside-out version, transparency and innovation are intended to form a positive feedback loop. Yet there are clear advantages for organizations to control the process, and the inside-out model has several advantages for firms. First, they have a controlling stake in setting the agenda, standards, and metrics. Second, they are in control of data, which is a growing asset class. Third, they can perhaps be perceived as legitimate governors, or at least, responsible actors for whom the most stringent regulation is not necessary.

These potential effects led us in Chapter Three to begin a study in 2015 on a prominent instantiation of the inside-out process. To do so, we examined the very initiative described by the (Chouinard, Ellison, and Ridgeway 2011) Harvard Business Review article: an industry-wide initiative known as the Higg Index. The Higg Index, and specifically the Facility Environmental Module (FEM), is an effort to collect and utilize environmental data from textile manufacturing facilities around the world. With over 50% of the apparel market share represented in the Sustainable Apparel Coalition (SAC), the FEM has the potential to make significant change if it were to be success.

Moreover, as production has become trans-nationalized, consumption and production have become more fragmented, dynamic, and stretched, transforming it from “chains” to “networks”

(Choudary 2017; Gereffi 2018). Despite recent consolidation (Gereffi 2014), many brands and retailers source from the same factories. With sometimes upwards of twenty buyers, these factories often receive conflicting incentives, thus a lack of incentive for a factory to make a costly capital investment. Thus, the FEM promises greater coordination and collaboration between buyers and suppliers than ever before. Despite firms' strong predilection towards independent action, there are also strong incentives for coordination. Though firms would like to gain all the benefits, they are unwilling to bear all the risks, the structure of the industry dictates that they cannot act unilaterally, and unilateral action is not sufficient, and thus not legitimate.

Our assessment examined the FEM's effectiveness in five areas, which correlated the project's theory of change: (1) Standards; (2) Collaboration; (3) Capacity-Building; (4) Incentives; and, (5) Improvement. First, we conducted data analysis of the first five years of FEM data. In addition to identifying statistical trends, patterns, and key drivers of FEM scores, we assessed the FEM survey collection procedures to make inferences about data quality. We then identified and surveyed 500 top-performing facilities (according to various FEM metrics) in China and Bangladesh. China and Bangladesh were chosen because of their prominence in apparel production, yet divergent market positions and conditions. China produces more and higher-value products, has a higher GDP per capita, strong authoritarian government, and generally more advanced facilities. Bangladesh, on the other hand, is an emerging leader in ready-made garment production, with less well-enforced regulation and lower GDP per capita. In this survey, we asked facility managers responsible for the FEM about their experience in relation to the FEM's implicit and explicit theory of change. After this survey, I visited several facilities in both Bangladesh and China. Through structured, in-depth interviews, I probed how the FEM exactly fit within that facility's environmental and business strategy. I also gathered documentary and observational evidence for how facility managers made strategic environmental decisions.

When evaluating the FEM's ability to set and communicate clear standards, we focused on two broad criteria: achieving scale/coverage and being accessible/coherent at varied locations. In this respect, the FEM over the years of study 2013-2017 was increasing in prevalence, however factories still reported through surveys and visits that they were filling out multiple sustainability-related audits for their different buyers. And while the FEM is now available in more languages, the roll-out has been slow, increasing the likelihood for miscommunication.

When evaluating if the FEM has furthered collaboration amongst buyers and suppliers, we evaluated both the quality and quantity of collaboration. While we found some evidence that buyers adopted a more hands-on approach with select factories, the FEM was not the primary mode of engagement nor the driver of this improved collaboration. The FEM has remained mostly a compliance mechanism. Similarly, the FEM did not appear to increase collaborative efforts between brands, between suppliers, or a mix of each.

We assessed the FEM's ability to improve factory capacity in two ways. First, the FEM aimed to provide a framework for management to incorporate, evaluate, and respond to environmental issues. The evidence showed that general and environmental management did appreciate the FEM for its comprehensiveness, as well as its linking previously disparate areas together in a single "dashboard". Second, we assessed to what extent FEM, independent of buyers, supplies "best practices" to facilities. On this second measure, the FEM was not the mechanism by which facilities improved, beyond compliance measures. The FEM was not an effective means to identify, spread, and scale promising solutions. A more pragmatic approach that favors coordinated experimentation with suppliers might be more effective (Zeitlin 2010).

While the three previous aims—setting standards, enhancing collaboration, and supporting capacity-building—all indirectly change facility incentives, we then assessed whether meaningful, direct changes to facility incentives had occurred. We did not find much of any evidence for the FEM substantially and directly influencing meaningful incentives, such as increased orders, better order-terms (financial as well as logistical), and more customers. Unfortunately, the greater security of more and higher quality contracts is always the most meaningful benefit (Amengual, Distelhorst, and Tobin 2019).

Finally, the FEM was intended to improve overall environmental outcomes. Unfortunately, we could not properly evaluate this proposition without external data mapped onto facility-level changes. Without proper data-tracking of facility performance, comparison between facilities, and data on local environmental conditions, there is no conclusive data as to whether changes induced by the FEM have improved overall environmental performance.

Overall, we argue that the FEM could be said to have a foundational, but not transformative impact. It has started to resolve some coordination issues within the industry by setting standards and facilitating conversations. Yet, it has not been successful at driving many changes into factories or into buyer-supplier relationships. Despite the ideal of sustainability data leading to changes in buyer decisions (Bateman and Bonanni 2019), these environmental commitments remain constrained by economic incentives.

And the incentives are not sufficient for the necessary transformative changes to the industry. Firms remain incredibly reluctant to share any sustainability data that threatens them economically, even if influencing consumption and investment (Bullock 2017; Chowdhry, Davies, and Waters 2013; Fridell 2019), thus maintaining accountability, is the road to legitimacy and avoiding government regulation (Schleifer, Fiorini, and Auld 2019). The Higg Index prioritized building a technical structure and aligning corporations on standards and reporting procedures and providing "insider visibility", instead of consumer transparency. This has failed to generate much incentives beyond those corporations had before the process. Some, if not most, simply participate for the warm glow of being part of the club. Of course, when firms are able to act independently, they can be incredibly proactive. And one of the key components of the Higg Index—its data-centric focus—has real economic appeal for many buyers.

1.3. Industry 4.0: Value in Sustainability Data

Brands and retailers have been steadily adopting data-based techniques for lean supply operations, just-in-time delivery, demand forecasting, marketing, and product development (Abernathy et al. 1999; Choudhary et al. 2012; Rüßmann et al. 2015; Fourcade and Healy 2017). People increasingly shop online, where they can rapidly compare multiple products across a number of specifications or allow algorithms to generate personalized recommendations.

Platforms like Amazon that connect vast numbers of consumers and producers have become dominant economic powers (Parker, Van Alstyne, and Choudary 2016; Vallas and Schor 2020). Despite the increasing fragmentation and dynamism of supply networks, data enables firms to offer still faster delivery and greater customization than ever before (Tseng and Hu 2014; Cachon and Swinney 2011). The intimate relationship between business and data is well-captured by the moniker Industry 4.0 (Rüßmann et al. 2015; Lasi et al. 2014).

In general, three types of firms have sensed a favorable market strategy in sustainability: (1) The large and prominent, like Nike and Walmart, who are subject to the bulk of stakeholder criticism and institutional pressures (Bartley and Child 2014; Delmas and Toffel 2004; 2010; Hartmann and Moeller 2014; Hawn, Olga 2020); (2) The technologically-advanced, like Apple, Google, and Amazon, who have a competitive advantage (Angeles 2014; Bateman and Bonanni 2019); Or, (3) the sustainability brands, like Patagonia, whose customers demand and expect sustainability leadership (Fowler and Hope 2007). By taking the lead, firms mostly make investments that make them more resilient to supply chain (and regulatory) risks (Robins 2014; van der Vegt et al. 2015; Short, Toffel, and Hugill 2016a; O'Rourke 2014; Mefford 2011) or represent co-benefits to improving supply chain operations (Locke, Qin, and Brause 2007; Distelhorst, Hainmueller, and Locke 2016). These investments, if not already cost-effective, are made more affordable through stakeholder support (Lambin and Thorlakson 2018), and in some cases, consumer premiums (Carfagna et al. 2014).

Moreover, most of these interventions involve new data flows, firms are able to leverage the goal of sustainability to gain greater access to information, which is increasingly beneficial to business in matching supply-and-demand, negotiating with manufacturers, and managing supply networks. These data flows are also aligned with an emerging vision of Industry 4.0. This techno-optimistic vision imagines a flexible, modular, efficient flow of materials and value within production and consumption networks, aided by algorithms, automation, and data (Spence and Rinaldi 2014).

Chapter Four examines an intervention focused on improving worker wages in a clothing factory. Yet the choices made in its implementation reflect an eye towards Industry 4.0. In one sense, it shows that sustainability can be embedded in these techno-optimistic visions, and in another, it shows that sustainability can be used to justify these workplace changes.

The study covers a two-year, worker-compensation intervention in a cut & sew apparel factory in Thailand. Aimed at raising worker wages, this project sought to demonstrate that a compensation system which distributed gains more fairly could raise worker productivity. It was presumed that this compensation improvement would complement previous human resource investments. The facility and brand had previously worked to improve the skills of workers, implement social dialogue systems, and allow for more line-level worker feedback to management. While factory management ultimately directed the project, the brand was highly involved in coordination, support, and assurance to the factory.

In this case, the brand is eager to improve its suppliers' capability for Lean production and Industry 4.0 as well as enhance its sustainability credibility. The supplier was keen to strengthen their relationship with the brand in order to secure and ensure more and more favorable contracts into the future. But there is a third gain beyond more capable production and sustainability credibility: data itself. The data itself is an asset, because of what it allows a company to do. The supplier had previously not been systematically collecting, tracking, and analyzing data on worker productivity, nor relating that to wages. For a long time, data has been used by employers to gain more from workers (Rosenthal 2018).

The significance of data also turned on the axis of trust. When shared, the data the allowed supplier and buyer, as well as factory management and workers to trust one another. The supplier was concerned that demonstrating an increase in productivity would lead to reduced margins on future orders thus imperiling profits which were dependent on the worker wage increase. Workers were understandably concerned that working harder would lead to decreased rates and thus diminishing any returns to productivity. Assurances were made between parties that no one would be worse off by the intervention, but nevertheless, long-term assurances were not able to be given. The supplier hoped that the close relationship with the brand meant that margins would not be reduced in future contract negotiations. And with workers, the factory hoped that by showing salaries had not decreased from what would have been paid under an old compensation regime, that workers would be contented.

The primary intervention involved changing worker compensation frameworks across a subset of production lines. This begot a secondary effect which was to increase the data capabilities of the factory: the facility invested in automated data collection technology to replace the traditional paper-system. The analysis primarily consisted of a difference-in-difference regression analysis using daily, production-line-level data. This was supplemented with semi-structured focus groups spread over the length of the project.

The analysis was primarily statistical. We first determined if and by how much the wage increases influenced productivity, the central measure of treatment success. By examining impacts on other worker behavior variables like turnover, absenteeism, tardiness, quality, teamwork, and effort, as well as focus groups that explored how workers perceived the wage increases, we evaluated different mechanisms that led to productivity increases. Finally, we assessed the intervention’s effects on firm outcomes including profitability.

In the analysis of the worker wage intervention, we first determined that productivity did in fact increase by 8-10%-points. We also found that wages increased 4.2-9.7% for line workers, attributable to the change in compensation structure. Yet, one line did not see any productivity gains and only slight wage increases. So, we examined whether workers perceived the wage increases, since perception of benefit and fairness are important precursors to motivation. Indeed, workers in the line that did not yield productivity increases did not believe the wage increases were sufficient enough. They thought the intervention would have yielded more benefit. While most workers were skeptical, believing that productivity increases would lead to ever-increasing targets, eventually came to trust management over time, and soon expressed that they wished their fellow workers would get the same benefit as them. While we concluded that the wages were motivating for some groups, we wondered what changes the workers made to improve their performance. Based on focus groups, workers—while very stressed—did not report any extra pressure (though not less either) due to the intervention. We found that workers mostly reduced their tardiness, improved their attention to quality, and were less likely to leave the company. These behavioral changes likely yielded the improved productivity, which also led to improved profits for the factory, from increased productivity as well as reduced turnover. We did not find evidence for changes in types of behaviors.

Overall, the research found that there is potential for wage increases to workers through greater sharing of productivity gains within a framework that emphasizes the importance of benefitting workers. Yet, while wages increased a meaningful amount for workers, it was clear that this approach would not be sufficient to achieve and maintain a living wage for workers. For that to occur, the brand would likely need to increase payments per order, improve related buying practices, and make sure those enhanced terms led to living wages for workers (Anner, Bair, and Blasi 2012; H. Park and Dickson 2008). It appears that worker unions or enforcing government standards are still necessary.

And yet, the reported success of this new compensation strategy has attracted other brands and suppliers. The supplier quickly rolled it out within the factory and had plans to do so in other factories within the factory group. Further, the learnings from the project were planned to be shared across tier one factories in the brand's portfolio, and to other brands at industry conferences. Thus, we are able to see the flow of these interventions across existing networks, as well as potentially creating new digital ties, laying the groundwork for Industry 4.0. Private and networked governance are intimately related to advances in and discourses around data technologies (Kline 2015; J. E. Cohen 2016; Tufekci 2017).

1.4. A New Era of Private, Networked, Data-Centric Governance

Information and communication ecosystems may be heralded as enablers of accountability across complex, fragmented, transnational spaces (O'Rourke 2014; Gardner et al. 2019), but at these same technologies actually play a major role in producing that complexity and fragmentation (Rüßmann et al. 2015; Abernathy et al. 1999). Data and technology have become a central part of doing business and doing governance (K. E. Davis, Kingsbury, and Merry 2012). The introduction of digital technologies into global governance portends major changes in power and scale (Morrison et al. 2019; O'Neil 2016). They can enable greater surveillance and control (Zuboff 2015), encode discriminatory and unequal relationships (Benjamin 2016; O'Neil 2016; Eubanks 2018; Pasquale 2015), present tools for collective liberation (e.g., "open science" and "open source") (Weber 2004; Chopra and Dexter 2008), or enable greater accountability. Stakeholders are also rapidly working to avail themselves of data-based tactics to steer the apparatus towards sustainability (Stock and Seliger 2016). From blockchain[5] to an open-source factory map[6] to digitized worker financial diaries[7], stakeholders have leveraged technology to enhance accountability through transparency. Increasing deployment of sensors, LIDAR-enabled satellites, and smart phones enable new possibilities for transparency and accountability

[5] Provenance: Every product has a story, **https://www.provenance.org/**. Accessed February 2020.
[6] Open Apparel Registry, https://info.openapparel.org/. Accessed February 2020.
[7] Garment Worker Diaries: The Lives and Wages of Garment Workers, **https://workerdiaries.org/**. Accessed February 2020.

(Gardner et al. 2019; Godar et al. 2016; Atkinson 2013), or alternately, surveillance and control (Zuboff 2015).

Despite these ongoing technologically-enabled governing battles, firms are seizing control. Though International Relations scholars may still defer to governments (Babic, Fichtner, and Heemskerk 2017), the current structure of production and consumption tends to position corporations as the most powerful actors, at least within many countries they operate (Bartley 2018). They are gatekeepers to suppliers (Van Der Ven 2018), highly influential over consumers (Fourcade and Healy 2017), and all governments are dependent on them for revenue and employment (Baud and Durand 2011). Corporations' power is inextricably bound up with widespread discursive commitments to economic growth, innovation, and efficiency (J. R. Brown and Martinsson 2018; Spangenberg 2010; Pope Francis 2015; Russell and Vinsel 2016).

We are moving from an era of NSMD into a new one of private, networked, data-centric governance. Like NSMD, PNDG privileges market-driven solutions, but the inside-out turn means that firms are increasingly rule-makers, instead of rule-takers. Like NSMD, it is enmeshed in a world of networked relationships, but PNDG privileges business relationships over stakeholders. And like NSMD, PNDG is focused on information flows, but it is increasingly technologically-advanced, and data-centric, tied into the vision of Industry 4.0. Both are predicated on transparency, but PNDG prioritizes insider visibility.

Each chapter of the dissertation offers further insights into particular tactics of the PNDG strategy, yet the chapters make no explicit reference to PNDG. The chapters primarily pose the question: How and under what conditions are these interventions effective? The Conclusion summarizes and offers reflections on the material, political, and discursive effects of private, networked, data-centric governance. It closes with an evaluation of PNDG and policy recommendations.

2. Sustainable Consumption: Literature Review[8]

2.1. The Consumption-Sustainability Dilemma

We face a deep cultural and social dilemma: One of the central goals of individuals, corporations, and governments—increased consumption—is also at the heart of our greatest ecological, equality, and health risks (Jackson 2009). As William Greider and many others have warned, “if industrial growth proceeds according to its accepted patterns, everyone is imperiled. Yet, if industrialization is not allowed to proceed, a majority of the world’s citizens are consigned to a permanent second-class status, deprived of the industrial artifacts that enhance life’s comfort, the tools that multiply human choices” (Robins 1999, 13).

Early concerns about the limits to growth—the contradictions inherent in the goal of infinite growth on a finite planet (Speth 2008; Meadows et al. 1972)—particularly its assimilative capacity, have been compounded with newer concerns about the limits of growth—how consumption-led growth consistently fails to satisfy human development and societal goals (Jackson 2009; Speth 2008; Kallis 2015). Global demographic and consumption trends indicate that we face major environmental and human health risks if consumption and production systems continue on current trajectories.

2.1.1. Environmental Impacts

Since 1980, we have exceeded many key ecological indicators (Victor 2012; Hoekstra and Wiedmann 2014). Current rates of extinction are 100 to 1,000 times those of normal conditions (Rockström et al. 2009); approximately 60% of the world’s ecosystem services have been degraded or overused (Dasgupta and Ehrlich 2013). In 2009, an influential study asserted that “three of nine interlinked planetary boundaries have already been overstepped” (Rockström et al. 2009, 472). These planetary boundaries, including biodiversity, climate change and nitrogen cycle disruption, are thresholds for environmental degradation processes that put multiple species at risk.

On climate change alone, the data are overwhelming. Since 1990—the base year for many international agreements—global emissions have risen nearly 60% (Le Quéré et al. 2014), with consumption-based emissions rising at a rate of approximately 3% per year (Druckman and Jackson 2009). These increased greenhouse gas emissions are overwhelming the planet’s assimilative capacity (Martínez-Alier 2012; McKibben 1989), driving unpredictable climatic shifts, rising global temperatures, increasing droughts, and increasing frequency and severity of storms.

2.1.2. Health and Social Impacts

In addition to environmental risks, affluent nations are suffering from increasing rates of so-called lifestyle diseases such as obesity, heart disease, type 2 diabetes, childhood cancers, and fertility problems (Jackson 2009; Speth 2008; The Global Commission on the Economy and

[8] A version of this chapter was previously published in the journal Annual Review of Environment and Resources with co-author Dara O’Rourke (see O’Rourke and Lollo 2015). I acknowledge this co-author’s contributions and thank him for permitting me to reproduce and adapt this material as part of my dissertation.

Climate 2014; Akenji and Bengtsson 2014). The dominance of positional consumerism—consumption driven by concerns for status and social competition rather than utility—has left individuals with greater levels of stress and dissatisfaction (Jackson 2009). A somewhat controversial literature points to indicators suggesting a decreasing quality of life associated with economic growth beyond certain thresholds (Galli et al. 2012; Easterlin 1974). This research calls into question the assumption of an unending straight-line relationship between economic affluence and well-being (Victor 2012).

2.1.3. Inequality and Justice

Furthermore, the benefits—economic development, material possessions, etc.—and costs—pollution, waste disposal, hazardous jobs, etc.—of resource use have also been unjustly distributed (Martínez-Alier 2012). Environmental justice researchers have documented the inequitable distributions of environmental "bads," calling into question the ability of economic growth to fairly benefit all communities and address distributional inequities in national, international, and intergenerational contexts (Martínez-Alier 2012).

2.2. Sustainable Consumption as Decoupling

In response to the consumption-sustainability dilemma, a range of initiatives have emerged within the past 25 years under the broad rubric of sustainable consumption. This field was defined by participants at an international gathering in Oslo in 1995 as the "use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations" (Norwegian Ministry of the Environment, 1995 via Di Giulio et al. 2014, 53). Researchers built on this initial definition to further specify that, "the sustainability of consumption acts is defined by the degree to which individual acts… contribute to creating or sustaining external conditions that allow all human beings to meet their objective needs today and in the future" (Di Giulio et al. 2014, 54).

International, national, and local sustainable consumption initiatives have taken up this effort by focusing primarily on improving the material and energy efficiency of products and production processes, with the overarching goal of decoupling economic growth from environmental impacts and resource use. The Organization for Economic Co-operation and Development (OECD) made "green growth" its 2011 slogan (Lorek and Spangenberg 2014; OECD 2011); the 2012 United Nations Rio+20 Conference on Sustainable Development focused on the "green economy" as its response to the consumption-sustainability dilemma (Barbier 2012). Although they may seem different, green growth, green economy, sustainable consumption, and sustainable development initiatives share a core focus on decoupling negative environmental impacts from the economy through gains in efficiency, framing solutions as a win-win for the economy and the environment.

2.2.1. Technological Efficiency and Decoupling

Innovation focused on "factor ten" efficiency improvements—from product dematerialization, to eco-substitution, decarbonization, energy efficiency, intensifying production, servicizing, etc.—has been central to initiatives to decouple consumption and environmental impacts (Tukker 2014). Many multinational companies have voluntarily led the charge in eco-efficiency improvements, especially in areas where they see economic benefit, such as reducing energy, water, packaging, and waste in their supply chain processes and products (O'Rourke 2014). Between corporate actions and government programs, there have been very real improvements in vehicle fuel efficiency (Schoettle and Sivak 2013), appliance energy efficiency (Meyers, McMahon, and McNeil 2005), and water use efficiency (Gleick 2003). In a recent debate about eco-modernism, researchers presented a convincing catalog of decouplings in food systems, water use, mineral and oil consumption, air emissions, and more (Ausubel 2015).

2.2.2. Greening Markets and Growth

Significant emphasis in both the practice and theory of sustainable consumption has focused on market-mediated sustainability initiatives. Fitting within the green economy, this focus supports market mechanisms directing sustainability innovation. The underlying hypothesis is that "rational" consumers "vote with their dollars," thereby incentivizing sustainability innovations in the marketplace (Hobson 2002). In keeping with market theories, a primary intervention for policymakers and nongovernmental organizations (NGOs) has been to supply information to consumers on the environmental benefits and impacts of products (Hobson 2002).
A key component of this strategy is better measuring environmental impacts stemming from supply chains and product life cycles. Indeed, we have seen significant improvement in these areas, such as the development of carbon footprints (and carbon markets), life-cycle impact calculators, virtual water calculations, and industry-specific measurement tools such as the apparel industry's Higg Index (O'Rourke 2014; O'Shea, Golden, and Olander 2013). The next step in the greening of the economy is to have companies internalize externalized costs to incent innovations in the use of resources, energy, water, etc., and to motivate reductions in pollution and waste. Whether to prepare for future regulation or to unlock economic benefits from efficiency, several companies have begun internally tracking and pricing carbon and even developing environmental profit and loss reports (O'Rourke 2014).

In some areas, technological innovations and socioeconomic trends have nurtured business model innovations—such as leasing services rather than selling products—that have the potential to make the allocation, use, and end-of-life management of goods much more efficient. We briefly introduce these innovations below, initially only in the forms in which they currently support decoupling strategies. Later, we discuss their implications for broader strategies of sufficiency and sustainability.

Product-service systems

Product-service systems (PSS)—capitalizing on advances in technology and environmental awareness—aim to provide consumers with services typically derived from personally owned products. Through PSS, consumers are freed from the burdens of ownership and can decide when a service is most needed. In theory, this holds the potential to reduce demand for production by enabling a smaller number of products to be more fully utilized by more consumers. Companies are thereby incentivized to make products more durable, to optimize product maintenance, and to extend the useful life of products (Tukker 2015). A well-known example is a company that sells the service of floor-covering instead of a carpet product and that has reduced materials flows by 30% (Boons and Lüdeke-Freund 2013). Importantly, PSS for transportation have gained considerable market traction, with companies supplying fleets of vehicles available for rent for short periods from decentralized stations.

Collaborative consumption

Collaborative consumption represents a broad collection of business models including redistribution networks, peer-to-peer resource sharing, and PSS (Botsman and Rogers 2010). Although collaborative consumption, or more colloquially the "sharing economy," has been common throughout history, in recent years the uptake of advanced technology and increasingly dense urban networks have enabled larger and more efficient networks that scale sharing operations (Hamari, Sjöklint, and Ukkonen 2016). These systems offer the potential for a more resource-light economy while facilitating broader access to products (Leismann et al. 2013). New online services, for example, have served as robust secondary markets for goods and services. New enterprises have unlocked an entirely new hospitality industry based on people "sharing" their homes; other companies have built systems that facilitate peer-to-peer product swapping, sharing, and donating. The evidence is mixed on whether the sharing economy actually advances resource conservation (Schor 2014b); however, it appears in theory to offer a pathway to less resource and product-intensive consumption.

Circular economy

The circular economy is the newest name for initiatives focused on closed-loop systems for production and consumption. The aim is to redesign value chains to support flows of materials in circular systems, by designing products and infrastructures for refurbishment, reuse, and recycling (Ellen MacArthur Foundation and McKinsey & Company 2014). Extended producer responsibility laws have played an important role in requiring companies to design for end-of-life management and other environmental issues (Walls 2006), as various industries in large manufacturing economies—Japan, Germany, and China—have implemented circular economy principles (Geng et al. 2013). If resource constraints drive higher prices, more innovative and integrated systems will likely be developed as society's "technical metabolism" of energy, water, and materials aims to mimic nature's "biological metabolism" of resources (Ellen MacArthur Foundation and McKinsey & Company 2014).

2.3. The Limits of Weak Sustainable Consumption

Efficiency-focused sustainability initiatives have an absolutely critical goal of decoupling economic activity from environmental impact. As the IPAT identity (Impact = Population * Affluence * Technology) (Holdren and Ehrlich 1972) lays out, negative ecological impacts increase as affluence and population grow, and decrease with technical efficiency improvements. For our purposes here, we refer to technological innovations (the T in IPAT) broadly as strategies to make consumption more efficient, that is, producing more units of output per unit of resource inputs, thereby helping to decouple environmental impacts from economic activity.

Although we continue to see significant improvements in the technological efficiency of production and consumption, there is a major debate in the literature about whether these efficiency initiatives have reduced overall negative environmental impacts and resource use (Jackson 2009; K. Knight and Schor 2014; Jorgenson and Clark 2012; Antal and van den Bergh 2014a; Pothen and Schymura 2015). When considered alongside rising population and affluence trends, it is critical to evaluate whether these initiatives can support absolute reductions and long-term sustainability imperatives (Allievi, Vinnari, and Luukkanen 2015). Essentially, although technological efficiency improvements are necessary to meet sustainability targets, we also need to know in which situations and with which strategies they can be sufficient (Figge, Young, and Barkemeyer 2014).

2.3.1. Growth in Population and Affluence

Current models predict both population and economic growth will continue to increase throughout the century. Recent population estimates have increased their projected peak population number from 7.2 billion today to 9.6 billion in 2050, to 11 billion by 2100 (Gerland et al. 2014). Economic growth, and the included consumption of resources (despite the theoretical possibility of total decoupling (Georgescu-Roegen 1975)), is predicted to grow by approximately 2-3% per year (Lorek and Spangenberg 2014; United Nations 2015) over this same time period. Several scholars have labeled the recent and projected growth period—in population, consumption, and impacts—the Great Acceleration (Steffen et al. 2015).

In this article, we are unable to explore population issues. We treat population as an exogenous variable and essentially a multiplier of impacts. Population of course is not exogenous and can be mitigated by policies such as promoting economic opportunities for women, education and literacy programs, greater access to contraception, decreased infant mortality rates, etc. (United Nations 2015; Mace, Terama, and Coulson 2013).

Consumption (the Affluence factor in IPAT) is our focus. Breaking down projected global gross domestic product (GDP) increases of 2-3% per year, we see average per capita income expected to increase by 300% by 2050 (Lorek and Spangenberg 2014), with some predicting this increase will arrive a decade faster (Kharas 2010). By 2034, the world economy is projected to be $200 trillion (in purchasing power parity), up from $63 trillion in 2009 (Kharas 2010).

To date, developed countries have of course been responsible for most of the environmental impacts from consumption and production. US households, for example, represent 4% of the global population; however, they account for 20% of global emissions of greenhouse gases, with per capita emissions four times the Chinese level (Jones and Kammen 2011; 2014). There are some encouraging, although modest, signs of decoupling in developed countries. US per capita vehicle miles traveled, fuel consumption, and number of vehicles, all appear to have peaked in 2004 (Sivak 2014), and we have seen energy use reductions in homes and increases in ride-sharing services. Millennials are a key demographic that have shown signs of reducing some forms of consumption (M. J. Cohen 2013), such as a declining interest in owning cars (Kent and Dowling 2013; Hopkins and Stephenson 2014).

However, a significant portion of future environmental impacts will come from developing countries as they grow. The OECD recently estimated that the global middle class will grow from a population of 1.8 billion in 2009 to 2.9 billion by 2030 (Kharas 2010). The Intergovernmental Panel on Climate Change (IPCC) predicts between 67% and 75% of CO_2 emission increases between 2000 and 2030 will come from developing countries (Barker et al. 2007).

China presents an important case study, as the largest current emitter of greenhouse gases, accounting for 25% of global emissions (Antal and van den Bergh 2014a) even with its relatively low per capita emission level. Indeed, China appears poised for a similar consumption-based economic growth model as the West. Chinese per-capita meat consumption doubled from 1990 to 2000, and total cars jumped from one to six million over the same period (Myers and Kent 2003). Average per capita living space increased from 8.1 to 32.4 m^2 from 1978 to 2008, and energy use from construction increased from 7.89 Metric tons carbon equivalent to 38.12 Metric tons carbon equivalent (Hubacek, Feng, and Chen 2011). China now adds over 20 million vehicles per year to its roads.[9] In 2010, China accounted for 13% of global car sales, up from 1% in 2000 (Kharas 2010), and is now the world's largest car market and the second-largest luxury market (Schroeder 2014). Estimates are that by 2020, private consumption will account for 43% of China's economic growth (Schroeder 2014), when 75% of the population will be defined as middle class ($10-$100 per person per day of spending power) (Kharas 2010).

Other emerging economies such as India are not far behind in creating a global consumer class. In 2000, India had 132 million middle class consumers, with incomes greater than $10,000 per year, who contributed 15 times greater CO_2 emissions than the rest of their population (Myers and Kent 2003). Consumption levels in India are expected to quadruple by 2025 (Anantharaman 2014), with half of Indian consumers expected to have middle class incomes by 2025 and 500 million more Indians living in cities by 2039 (Kharas 2010).

2.3.2. The Scale and Scope Required

An Ecomodernist Manifesto argues that, "[d]ecoupling human well-being from the destruction of nature requires the conscious acceleration of emergent decoupling processes" (John Asafu-Adjaye et al. 2015, 18). This strategy, which is broadly shared (The Global Commission on the Economy and Climate 2014; OECD 2011; Schmalensee 2012), pins future sustainability squarely on the shoulders of decoupling economic growth from environmental impacts through technological innovations that support efficiency improvements (particularly in energy and food systems) (Ausubel 2015).

Our track record of progress in efficiency gains over the past 30 years highlights that current rates of efficiency improvements are insufficient to ameliorate the environmental impact entailed by increases in population and consumption levels (Le Quéré et al. 2014). As just one important example, since 1990 increases in carbon intensities have declined by 0.7% per year, while populations have increased by 1.3% per year and real incomes by 1.4% (Antal and van den Bergh 2014a). Similarly, though improvements in material intensities may have mitigated impacts, absolute global materials use still increased by 56% from 1995 to 2008 (Pothen and Schymura 2015). We have not seen absolute reductions in environmental impacts (Pachauri et al. 2014), nor has there been much evidence to date for significant relative decoupling (K. Knight and Schor 2014). Population growth and increases in affluence (and consumption) are simply overwhelming efficiency improvements (Jackson 2009; Alexander 2014a).

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[9] http://www.statista.com/statistics/233743/vehicle-sales-in-china/. Accessed September 2015.

The Copenhagen and Cancun summit goals of keeping global average temperature rise below 2 degrees roughly translates to holding atmospheric carbon levels at or below 450 parts-per-million (Girod, van Vuuren, and Hertwich 2014). To accomplish this, the IPCC states that emissions need to be reduced between 40 and 70% by 2050 compared to 2010 levels and achieve net zero emissions by 2100 (Pachauri et al. 2014). Another estimate calls for emissions reductions of more than 80% by 2050 (Antal and van den Bergh 2014a), which translates into carbon intensities almost 130 times lower than today—essentially Factor 100 improvements. Whichever calculation we choose, many researchers now agree that with current trends in population and consumption growth, decoupling economic growth from even just greenhouse gas emissions (not to mention loss of biodiversity, eutrophication, etc.) will require much faster resource intensity reductions per unit of GDP (Kallis, Kerschner, and Martinez-Alier 2012).

Rebounds and unintended consequences

Gains in efficiency not only need to increase in rate and quantity, but also in resiliency. Research has demonstrated efficiency gains may be subject to rebound effects, whereby increases in efficiency actually lead to increases in product use, which dampens or even swamps efficiency benefits (Figge, Young, and Barkemeyer 2014; Loftus et al. 2015). These types of unintended consequences can lead to an overestimation of the benefits of innovations focused on efficiency. Though this literature is contested, a growing body of evidence suggests that rebound effects can limit benefits to only 30-60% of theoretical potentials (Druckman et al. 2011; Chitnis et al. 2013; Wiedenhofer, Lenzen, and Steinberger 2013; Saunders 2013; Murray 2013; Azevedo 2014).

Similarly, there appears a certain efficiency myopia. Benefits are expected in engineering estimates—the accepted form of modeling benefits—to accrue to one sector or product, but not impact the broader economy. Income effects, where income saved through efficiency in one area is spent in another part of the economy, are one example where important system effects may not be properly accounted for (Druckman et al. 2011; Saunders 2013; Antal and van den Bergh 2014b). Moreover, although many companies are developing more efficient products and practices, core incentives remain to sell more products, not reduce absolute impacts. Still other times, the efficiency myopia permits innovations to fail to target the three main impact areas of consumption—transport, housing, and food—which drive 70 to 80% of environmental impacts (Jones and Kammen 2011; Wiedenhofer, Lenzen, and Steinberger 2013). Finally, efficiency narrowly-defined may end up shifting burdens onto other environmental issues, while failing to address root drivers (Antal and van den Bergh 2014a).

2.3.3. A Focus on Strong Sustainable Consumption

Focusing entirely on decoupling avoids examining how current lifestyles and systems generate significant environmental and social problems. The decoupling framework fails to understand the complex system of production and consumption, thereby allowing for an inappropriate amount of substitutability amongst economic, ecological and social resources and benefits. Efficiency strategies alone often ignore issues of equitable distribution and development (an issue we discuss later), while distracting from a needed focus on absolute reductions in environmental impacts. To be clear, efficiency measures such as ramping up renewable energy are an absolutely necessary part of an effective strategy. Yet, efficiency alone fails to effectively address the scale and scope of our consumption and sustainability challenges.

A growing and diverse group of academics and practitioners has emerged recently calling for strong sustainable consumption. This line of research advances a pre-analytical framework that conceives of the economy within society within the environment (Costanza et al. 2013). This framework is systems-based, thus strong sustainable consumption research aims to examine the tensions between ecological, economic and social priorities, and seeks to develop strategies that balance aims of efficiency, sufficiency and resiliency.

This basis has led researchers to examine current power structures, directly questioning levels and forms of affluence, advancing more equitably distributed consumption in addition to technologically improving the efficiency of consumption (Fuchs et al. 2015). The diverse group of scholars identifies reforms and processes to address unsustainable consumption from a systems perspective. Thus, though like weak sustainable consumption they focus on the most environmentally impactful areas: transport, housing, and food, their research yields distinct policy insights that diverge from technology-focused innovation. They advocate for social and political processes and innovations to assist rapid decreases in private automobile use and meat consumption (Allievi, Vinnari, and Luukkanen 2015; Druckman and Jackson 2010), transit-oriented development, decreased food waste, increased recycling, repairing, sharing and reuse of goods (Barrett and Scott 2012), and equitable levels of consumption in the developing world (Spangenberg 2014).

2.4. From Individual to Structural Change

As more researchers in the sustainable consumption community have come to share the need for strong sustainable consumption, the issue of how to achieve such changes in a politically, socially and economically viable manner has become a central research topic (Druckman and Jackson 2010; Speth 2012; Costanza 2014). A system of strong sustainable consumption is a difficult proposition in a society presently focused on growth in consumption. Economic progress is thoroughly embedded in social norms, personal habits, individual decisions, power structures, laws and cultures. Thus, strong sustainable consumption researchers argue convincingly for a fuller understanding and appreciation of the logics and decision processes of the actors—consumers, business, and government—and the systemic nature of so-called lock-in of unsustainable activity. With this knowledge and framework, we can design more effective and resilient interventions or processes to support a transition to truly sustainable consumption (Lorek and Fuchs 2013).

2.4.1. Individual Logics

Mythologized as rational and utility maximizing in economic theories, individuals' consumption habits are in reality motivated not just by personal needs for food, clothing, housing, and transport, but also by desires for novelty, status, social comparison, and respect (Jackson 2009; Veblen 1899). Products become part of the so-called extended self, communicating to peers and society about identity, affiliations, and ideals (Jackson 2009). Although some consumption is certainly about meeting basic needs, it also represents a system of status, meaning and cultural connection (Jackson 2009). Evidence is now clear that this so-called positional consumption can create a self-perpetuating cycle, where increasing levels of consumption become normalized, and further consumption is then necessary to keep up or stay ahead (Sekulova et al. 2013; Assadourian 2010). Individuals who do try to shift from consumerist lifestyles experience significant financial, emotional, and social conflict, in part due to a lack of tangible alternative lifestyle options that deliver equivalent status, self-worth, etc. (Cherrier 2009; Markkula and Moisander 2012).

Changing individuals

Supported by analysis primarily based in market research, consumer surveys, and focus groups, past strategies to change individual behavior have centered around information provision. Researchers reported that a majority of consumers would like to purchase greener, healthier, and more sustainable products. A central puzzle in this research has been that consumer purchases consistently deviate from their reported sustainability preferences. This is referred to as the attitude-behavior gap (Jackson 2005). We now know that information provision strategies have largely been unsuccessful at closing this gap (Gifford 2014; Ölander and Thøgersen 2014). In response to findings on the limitations of information provision, behavior-based sustainability research has tried to more fully understand consumer decision-making processes.

Several insights into decision-making have emerged from consumer behavior, social psychology, and behavioral economics research over the past twenty years. A now well accepted conclusion of this research is that individuals are not fully rational actors (partly explaining the ineffectiveness of information provision) (Kahneman 2011; Simonson 2014). Instead, consumer decisions are contextual and affected by psychological processes (or cognitive biases) such as habit, social norms, bounded rationality (where decisions are limited by our own cognitive limitations and information access), loss aversion (where people fear losses much more than gains), cognitive depletion (where we have a limited pool of self-control and willpower), temporal constraints (where time pressures distort decisions), anchoring (where a first piece of information can bias a decision), and peer influence, to name just some of the most important (Abraham and Michie 2008). Through trying to understand the predictable irrationalities of consumers, behavioral interventions such as choice editing (where the range of choices are actually reduced) and smart defaults (where the default option is the most sustainable or healthy choice for people) have been developed that either aim to limit cognitive bias or to utilize bias to drive sustainable action (Ariely 2008).[10]

Individuals have competing concerns and pressures in the marketplace (Tsuda, Hara, and Uwasu 2013), limited time to make decisions, and limited information about the impacts and options for action. Several behavioral interventions have been designed to respond to these constraints. The most prominent such example involves eco-labeling efforts that aim to create simple, salient indicators for decisions. To date, although eco-labeling has grown in numbers and product category coverage (some estimates are that there are now more than 400 eco-labels in the United States and Europe), it has had fairly limited impact on mainstream consumers or mainstream brands and products (Hallstein and Villas-Boas 2013; Bratt et al. 2011; Dendler 2014). Eco-labels can be effective and are needed; however, they need to be better integrated and contextualized within complex decision-making environments of mainstream consumers (Ölander and Thøgersen 2014; Thøgersen 2010; Sunstein 2013).

[10]For policymakers in particular, these decision-making insights can be useful to avoid policy failures stemming from implementation, procedural, and acceptance issues (Ghazeli, Antal, and Van Den Bergh 2012).

Sustainable consumption information ideally should be tailored to the situation and individual (Eppel, Sharp, and Daviesa 2013), as well as framed saliently and concretely (Sunstein 2013). Choice editing—a strategy now employed by some retailers and employers—can frame a decision such that individuals are more likely to choose the sustainable option. Creating a sustainable default option can effectively utilize status quo bias (where people prefer to buy the "normal" product) without restricting choice (Moseley and Stoker 2013; Sunstein and Reisch 2013). Similarly, anchoring (where information is presented carefully to frame poor options and guide people to better options) can be employed, such as in a rating system or pricing scheme.

As mentioned, one common motivator for consumption is social concern for status. Thus, a promising area of behavioral interventions involves a focus on social influence (Salazar, Oerlemans, and Van Stroe-Biezen 2013). Invoking descriptive norms—what "others are doing"—can have a significant effect, although this could cause regression to a less impactful mean (Ölander and Thøgersen 2014). Invoking injunctive norms—what people "should do"—also shows potential to move people in a positive direction (Thomas and Sharp 2013). Interventions ideally should be delivered via friends, family, peer groups, or trusted intermediaries (such as NGOs or celebrities), depending on who is trusted and with whom specific groups of people identify (Eppel, Sharp, and Daviesa 2013; Salazar, Oerlemans, and Van Stroe-Biezen 2013). However, even situational cues connected to social norms may not be able to counter competing concerns and norms (Steg et al. 2014; Dietz 2014).

Social influence research is still uncertain about when it leads to a kind of herding versus to more transformative social learning (Salazar, Oerlemans, and Van Stroe-Biezen 2013). Although herding can be useful in situations of uncertainty or crisis (Ghazeli, Antal, and Van Den Bergh 2012), social learning is important for longer-term norm creation (Moseley and Stoker 2013; Steg et al. 2014).

Providing feedback on actions can also help overcome a lack of information on the efficacy and impacts of consumer choices. Similarly, providing feedback on the actions of others can be useful to demonstrate shared responsibility and social norms (Ghazeli, Antal, and Van Den Bergh 2012). Yet feedback is often presented in tandem with rewards, either economic or status-related. These rewards may increase the salience of individual and economic motivation, thereby impeding long-term efficacy of interventions and crowding-out other-regarding behavior (Eppel, Sharp, and Daviesa 2013). Rewards might still be considered for sufficiently large gains from one-time events (such as the purchase of an electric vehicle or roof-top solar installation).

To complicate things further, most situations encounter multiple biases, demonstrated by research that has shown that one-dimensional interventions often produce marginal benefits compared with synchronized treatments (Tukker et al. 2010). Thus, synchronized treatments need to be studied further (Osbaldiston 2013). Although this adds to the complexity of any intervention, it ultimately will benefit the efficacy of integrated policies (Ghazeli, Antal, and Van Den Bergh 2012).

Furthermore, due to the complexity of behavioral interventions, a key goal of behavioral research has been to identify interventions that persist or spill over into other behaviors (Thomas and

Sharp 2013). Research on habit formation has shown potential—via "if, then" plans applied at "moments of change"—to create new behavioral patterns (Eppel, Sharp, and Daviesa 2013; Duhigg 2012). Current research however, is divided on the impacts of so-called catalyst behaviors (Gifford 2014; Eppel, Sharp, and Daviesa 2013; Willis and Schor 2012). For instance, if actions such as recycling are simply perceived as household routines (not connected to environmental values), then spillover is unlikely (Thomas and Sharp 2013). Status-based interventions may also generate internal and external spillover due to identity formation, peer effects, and social norms.

Limitations of individual behavior change

Most individuals in the developed world currently consume beyond sustainable levels (Jackson 2005; Eppel, Sharp, and Daviesa 2013). Even individuals who conceive of themselves as environmentalists and conscious consumers still make unsustainable choices (Chitnis et al. 2013; Thomas and Sharp 2013).

This disconnect can be attributed in part to the tendency of some behavioral interventions to be in direct competition with billions of dollars in marketing from corporations (Assadourian 2010), rapid product obsolescence, easy credit systems that encourage debt-driven spending, transportation infrastructures that incentivize single-occupancy vehicle transit, work dynamics that encourage consumption, and prices that make it more affordable to purchase less sustainable options (Sekulova et al. 2013; Duhigg 2012). Governments further spur consumption spending through tax policies, price controls for food, transport and consumer durables, trade agreements, monetary policy, as well as subsidies for resource extraction and manufacturing.

Moreover, consumerism is the dominant economic and cultural paradigm of the 21st century. Greater division of labor and longer work hours incentivize consumption instead of nonmarket, household, or do-it-yourself activity. Work-life culture is increasingly a work-consume culture (Power and Oksana 2012). Technological innovations are increasingly geared toward facilitating consumption nearly anywhere, anytime. Abstract notions of success and progress are defined economically, and the media cites GDP and stock market indices as measures of daily progress and stability. As Assadourian argues, this deep culture of consumption "stems from decades of engineering of a set of cultural norms, values, traditions, symbols, and stories that make it feel natural to consume ever larger amounts—of food, of energy, of stuff… and over time 'consumers' deeply internalized this new way of living" (Assadourian 2013, 115). Due to the multiplicity of influences on consumption, a narrow approach to change consumer behavior appears to be a weak lever (Akenji 2014; Isenhour 2011).

2.4.2. Integrating Behavioral and Structural Change

If we take an integrated understanding that actors and their behaviors are conditioned by one another and also by the structures they inhabit, we are compelled to develop more comprehensive solutions that embed multiple behavioral interventions within broader structural reforms.

Interesting research has begun to emerge in this area of behavioral-structural integration, and provides useful insights into novel social and market developments, such as the collaborative and circular economies (Leismann et al. 2013). In particular, research has shown structures—markets, institutions, and policies—impart norms and values (Sandel 2012; Thompson and Schor 2014; O'Neill 2012), and thus more than providing pathways of action, can generate feedback loops of learning (Fremstad 2014). Indeed, collaborative economy researchers have focused a fair amount on the values of the movement (Heinrichs 2013; Belk 2014). Research has hinted that individuals who participate in novel economic arrangements are likely to become politically engaged when their mode of living conflicts with traditional powers (Kallis, Kerschner, and Martinez-Alier 2012). Moreover, certain ecologically minded consumers are beginning to position their actions as part of collective processes, asserting that truly sustainable lifestyles necessitate political and collective decisions (Carfagna et al. 2014).

2.4.3. Behavior Change of Structural Actors

Effective sustainable consumption—that addresses environmental, social, and equity issues—likely requires addressing unsustainable infrastructures and institutions of consumption (Lorek and Spangenberg 2014). Thus, we need to understand why certain infrastructural and institutional decisions are made and attempt to influence those decision processes. One path that has been studied seeks to apply behavioral insights to changing corporate and government practices around consumption, with the goal of motivating sustainable products, services, institutions, and infrastructures.

2.4.4. Business Logics

Companies are under intense pressure to continuously grow revenue. Wall Street's focus on earnings growth means most firms are locked into a cycle of competing to increase the throughput of products and services as their core strategy to grow sales and earnings. Shareholders demand profit-optimizing, risk-minimizing strategies, even if they require externalizing costs.

Changing business

Researchers have begun applying behavioral psychology to changing corporations; however, this is less developed (Ghazeli, Antal, and Van Den Bergh 2012). Although business processes tend to obviate individual irrationalities, there are biases that underlie corporate dynamics and patterns, such as status quo bias, inertia, routines and bureaucracy, satisficing (rather than profit maximizing), loss aversion, risk aversion, and reputational concerns. Understanding these biases and designing targeted interventions can help to advance business model experiments that focus on longer time horizons and that direct competition and innovation engines on solving sustainability challenges.

Initial research suggests that invoking risk (Ely et al. 2013; Hallstedt, Thompson, and Lindahl 2013) may be a key lever to change business as the discussion over stranded assets in fossil fuel portfolios and climate risks for global firms demonstrates loss aversion concerns (Robins 2014). Risk to a firm's reputation, supply chain, and market might also push companies to develop more sustainable processes and products (Seuring and Gold 2013), which then might cause them to support more stringent regulation that gives them a comparative advantage. Furthermore, pressures by external stakeholders, which create reputational risks for individual employees and which target relational and moral considerations of company leaders, seem effective in motivating firms to change.

Another key sustainability intervention may be to develop and enforce sustainability reporting and accounting, or environmental profit and loss statements. Several prominent firms have begun voluntarily producing serious sustainability reports. The US Securities and Exchange Commission has begun requiring disclosure of environmental liabilities. However, more stringent implementation of reporting will require businesses to internalize externalities and optimize production with respect to resource depletion and environmental concerns. This would also help alter the accounting methodologies used by businesses, changing which decisions look good on paper, thereby changing risk profiles. With integrated metrics and greater transparency in reporting, public perceptions and impact investors could apply pressures to motivate firms to align business with environmental goals (O'Rourke 2005).

Recent legal developments—such as the creation of benefit corporations—also seek to support and shield sustainability-minded companies from shareholder profit maximization pressures (Kanig 2012). These changes hold the potential to align high-level sustainability goals with internal corporate decision processes, a place where more research is critically needed.

2.4.5. Government Logics

Governments similarly have significant challenges to break from biases toward consumption growth (Hobson 2002; Anderson and Bows 2011). Consumer-led economic growth is a dominant paradigm from the United States to China to the poorest countries in the world. Government institutions depend on taxes generated via consumption, with one of the most glaring examples being sales taxes supporting state and local government agencies. But more than just filling public coffers, geopolitical power (Speth 2008), economic and social stability (Jackson 2009; K. W. Knight, Rosa, and Schor 2013; Keynes 2006), poverty alleviation (Martínez-Alier 2012), and even social progress (Spangenberg 2010) are largely considered dependent on economic growth.

Changing government

Governments, of course, have their own internal dynamics, bounded rationalities, self-interested individuals, political battles among competing interests, bias toward short-term social stability (and re-elections), myopia, inertia, and lack of accountability (Ghazeli, Antal, and Van Den Bergh 2012; Kubiszewski et al. 2013). Several researchers have proposed more transparency and participation within policy processes as strategies to at least partially ameliorate problems of public accountability and regulatory capture (Spangenberg 2014; Ghazeli, Antal, and Van Den Bergh 2012; Costanza et al. 2013). More research is needed to assess how these strategies might affect preferences, attitudes, and values of government officials.

New metrics of progress and development may be key to help governments break from consumption-biased decision processes (Norgaard 2011). If the public assesses policymakers in part by the rise and fall of indicators such as GDP, then new metrics such as the Genuine Progress Indicator (Bagstad, Berik, and Gaddis 2014), the Index for Sustainable Economic Welfare (van den Bergh and Antal 2014), combined biophysical and social indicators (O'Neill

2012), and the Gross National Happiness (GNH) Index (Brooks 2013) may enable governments to demonstrate progress while advancing transformational policies.[11] Though there is significant variance between these metrics, for the most part, they explicitly include values for inequality, biodiversity, and greenhouse gas emissions. In this way, short-term concerns can be more effectively balanced so long as there are clear metrics for long-term goals for which governments can be held accountable. Moreover, these new measures enable policy comparisons that can assist public communication and adaptive governance (O'Neill 2012). That said, much research is needed to resolve difficult variable-weighting issues as well as to make these indicators more actionable for policymakers. Although we have seen several governments begin to experiment with tracking "happiness," "well-being" and sustainability alongside GDP, we have not seen these measures connect deeply into policies and practices (Kubiszewski et al. 2013). Moreover, there are still challenges in measuring qualitative issues such as "well-being" and "flourishing" (van den Bergh and Antal 2014; Akenji and Bengtsson 2014).

Table 2-1 presents some of the key barriers and interventions currently being tested to shift the practices of individuals, corporations, and governments around the world.

Actor	Cognitive barriers	Key interventions
Individuals	Bounded rationality, loss aversion, habit, social norms, peer influence	Simplification, smart defaults, social influence, feedback, structural change
Business	Status quo bias, risk aversion, satisficing, reputational concerns	Stakeholder pressure, public-private partnerships, new metrics, internalizing externalities, new business models
Government	Bounded rationality, political battles, myopia, short-term bias, lack of accountability	Transparency, participatory democracy, new metrics of progress

Table 2-1: Cognitive barriers and interventions in systems of consumption and production.

2.4.6. Changing Culture

System changes for sustainable consumption will likely co-evolve with culture changes. Assadourian argues that our "norms, stories, rituals, values, symbols, and traditions" influence nearly all of our life choices, in part by being codified in our public and private institutions (Assadourian 2013, 113). Thus, culture change can be seen as a by-product of and influence on changes in actors.

Many researchers have come to the conclusion that an integrated imagining is critical for the success of a post-consumerist society (Lorek and Spangenberg 2014; M. J. Cohen 2013; Speth 2012; Wilk 2010; Moloney and Strengers 2014; Schor 2014a; D. E. Collins, Genet, and Christian 2013). This vision, with a reconstruction of understandings of wealth, affluence, and the "good

[11] A more limited yet still impactful shift has been the social cost of carbon, which has helped usher in environmental policies in the United States that might have otherwise failed standard economic cost-benefit analysis. (Pizer et al. 2014)

life," needs to be codified in dominant societal institutions "to normalize an alternative set of practices, values, beliefs, stories, and symbols" (Assadourian 2013, 119), and to serve as a guide for new lifestyles and infrastructures. Indeed, current practitioners—individuals, businesses, NGOs, and governments—need the support of a unified community collectively addressing broader principles (Lorek and Spangenberg 2014; Schor 2014b). Some research has pointed to the ability of influential leaders (Meadows 1999) or of institutional codification (Assadourian 2013) as effective methods of disseminating alternative narratives. However, research is still needed on methods to effectively spread alternative narratives to actors locked into consumption paradigms.

For guidance, we might look to certain niche contexts, where the codification of alternative narratives has been effective. The inclusion of "Buen Vivir" or "good living" principles into the national constitutions in Ecuador and Bolivia has given a novel cultural framework that redefines affluence and creates a legal basis for sustainable development (Gudynas et al. 2011). Similarly, the development of the GNH Index in Bhutan has been surprisingly influential as a guide to an alternative development paradigm (Brooks 2013). Although western countries may be far from creating rights for nature (Assadourian 2013), the French, British, German, Canadian, and Chinese governments have all followed Bhutan's lead and begun to incorporate measures of well-being into their national assessments (Brooks 2013). These codifications can signal to businesses, individuals, and communities that sustainability implications should be part of standard decision processes (Assadourian 2013).

2.5. Achieving System Change

Vitally, researchers are realizing interventions need to be connected to a coherent, comprehensive strategy that addresses both scale and scope. This requires a more complete understanding of system dynamics—actor roles, relations between actors, and relationships with dominant structures—and methods to address those dynamics—behavioral, structural, and institutional interventions, at key leverage points—to break from unsustainable processes and to generate positive sustainability feedback loops (Forrest and Wiek 2014; Farla et al. 2012; Videira et al. 2014). An emerging research area of complex adaptive socioecological systems might provide insights to identify key leverage points and understand connections between actors, norms, rules, and other system dynamics (Levin et al. 2013). Though it may be impossible to characterize comprehensively, better modeling of system dynamics can help actors identify the most effective, efficient, salient, and key leverage points. Donnella Meadows' elucidation of places to intervene in a system is a foundation for this type of analysis (Meadows 1999).

Research shows interventions and transformations occurring at one level can affect other levels (almost simultaneously) (Farla et al. 2012; Loorbach and Wijsman 2013). Regulation and new analytical frameworks support sustainable forms of PSS and novel business models (Tukker 2015; Leismann et al. 2013). Stronger social programs and better city planning enable reduced consumption lifestyles (Schor 2012; Alexander 2012). NGOs offer "transparency, accountability and expertise" (Bäckstrand 2011, 672) to implement strong policies and regulations, and identify policy windows that allow sustainability niches to be advanced (Seyfang and Longhurst 2013). Social movements advance policies through pressure on governments (Farla et al. 2012). Urban areas can test innovations at multiple scales (Grimm et al. 2008). Individuals collaborate in governance through citizen science, normative discussions, consumer policing, and social innovations such as resource sharing (Jackson 2009; Hinton, Bickerstaff, and Bulkeley 2011; Thompson and Schor 2014). Moreover, bottom-up efforts can support culturally appropriate, resilient, and adaptive governance systems by providing templates for system redesign (Seyfang and Haxeltine 2012). More research is needed to develop clearer and more effective policies involving infrastructure, norms, and regulations.

2.5.1. System Dynamics in a Transition

Over the past 20 years, sustainability transition studies have sought to better understand and facilitate efforts to transform sociotechnical and/or socioecological systems. A central finding has been that transition is a long, complex, and uncertain process (Farla et al. 2012; Lachman 2013) that involves learning, coevolution, and adaptation at multiple levels (Geels 2011; Geels and Schot 2007). Sometimes framed through niche-regime interactions (Markard, Raven, and Truffer 2012), transition studies explicitly look for pathways to develop small technological or social innovations from market niches into fuller regimes.

Given national and international political gridlock around sustainability issues, many researchers have instead analyzed the effects of less powerful actors—civil society, social movements, entrepreneurs, city and regional governments—and the potential of bottom-up transitions as a means of achieving significant change (Speth 2012; Seyfang and Haxeltine 2012; Lipschutz and McKendry 2011; Feola and Nunes 2014). As just one example, developments in the food sector provide a range of niche innovations such as permaculture, pasture cropping, integrated farming, "slow food," community-supported agriculture, and farmer's markets (Ellen MacArthur Foundation and McKinsey & Company 2014; Isenhour 2011; Schor 2012). It is of course not clear that a sustainable and equitable society can be built through bottom-up measures alone. For one of these niches to eventually become a regime, it must be scaled, replicated, and diffused across spaces, cultures, and institutions (Feola and Nunes 2014; Stutz 2012).

This complex dynamic makes initiatives such as collaborative consumption and the circular economy difficult to fully appraise. They are likely important and needed components of sustainable systems. However, at this point, it is not clear they are truly sustainable. They are important, nonetheless, as they offer alternatives to traditional consumptive practices and a growth economy (Leismann et al. 2013; Schor 2014b).

We need to move beyond case studies toward a coherent framework and adaptive plan for sustainability transitions. Research and practice should focus on developing, testing, and analyzing multiple transition pathways (Ely et al. 2013; Lachman 2013), identifying and developing strategies for adaptive collaborations while taking into account competing interests (Farla et al. 2012), and more effectively invoking positive and negative feedback loops between actors, structures, institutions, and norms (Videira et al. 2014). Ultimately, the transition to significantly more sustainable systems must be supported by the coordinated actions of city, state, and federal policymakers, as well as nonstate actors, each focused on processes of learning, iteration, and scaling.

A multilevel, niche-regime framework provides a lens for scaling innovations (Geels 2011; Drake et al. 2013; Shove and Walker 2010). Government agencies, NGOs, and firms need to focus on both the internal processes of niche development and the external processes to support, learn from, and advance new systems of consumption and production. Roles include managing public expectations, advancing supportive and reinforcing structures and institutions, creating support and learning networks (Thompson and Schor 2014; Seyfang and Haxeltine 2012), and accumulating and sharing financial and intellectual resources (Farla et al. 2012). Governments in particular can advance policies—such as the elimination of subsidies for existing unsustainable regimes, stricter regulation of dirty industries, taxing pollution, etc.—while investing in research and development for sustainability niches. Governments can also reduce risk for innovators, procuring sustainable innovations, and advancing transparency and public participation in policy setting, potentially through new metrics of progress. These processes require active coordination and intervention at multiple levels by diverse stakeholders to identify and overcome infrastructural, behavioral, economic, and institutional barriers to niche development, while creating structures and institutions that support and reinforce positive processes (Forrest and Wiek 2014).

2.5.2. Economic Transition Strategies

When strong sustainable consumption strategies are discussed, there is an almost palpable fear that efforts to transform or decrease consumption will have calamitous economic and social impacts. Our economy seems to be built as much on aspiration, striving, and rewards of affluence as it is on fear, insecurity, and threats of poverty. In the current economy, it is easy to understand why any move to slow consumption or economic growth would be viewed as illogical, if not antithetical to so-called progress. For governments, corporations, and ultimately individuals, a slow or no-growth economy holds the potential for disaster via a downturn in profits, stock prices, employment, taxes, government spending, and debt repayment (Ayres et al. 2013).

A small group of academics has taken on this line of reasoning and resistance to sustainable consumption. Initial modeling shows that with planning, and step-wise processes, it may be possible to reduce consumption without creating the negative spiral mainstream economists and politicians fear, in essence, decoupling the resiliency of the economy from economic growth (Antal and van den Bergh 2013). One key policy involves gradually stepping down consumption with production, then creating systems of work sharing, to protect against increases in unemployment (Victor 2012; K. W. Knight, Rosa, and Schor 2013). Peter Victor's model of the Canadian economy under a planned degrowth scenario shows that with several key policies, such as a gradual work hour reduction to 25% of current levels alongside a substantial carbon tax, unemployment, poverty, and the debt-to-GDP ratio can actually decrease (Victor 2012). Contrary to recent research by Piketty & Goldhammer (Piketty and Goldhammer 2014), slow to no-growth scenarios need not produce more inequality and can in fact, with regulation, lessen inequality. A key relationship here is the elasticity of substitution between labor and capital, although more modeling and theory are needed to understand whole economy effects (Jackson and Victor 2014). In theory, productivity improvements from innovation can be rewarded with reduced work hours and then reduced consumption (K. W. Knight, Rosa, and Schor 2013; Norgård 2013).

Sustainability transitions, despite lower per capita incomes for individuals in developed countries, do not need to adversely affect well-being. This outcome can result partly from non-welfare-reducing or cash-positive environmental actions (Dietz et al. 2009), and partly because well-being is determined by more than just income (Kubiszewski et al. 2013). Changing consumption patterns, when done right, may offer a so-called double dividend of environmental and social benefit (Jackson 2009). Encouragingly, Druckman & Jackson were able to map out a reduced consumption scenario that meets key quality of life criteria at a level of greenhouse gas emissions 37% lower than 2004 UK per capita levels (Druckman and Jackson 2010).

We also need to consider the distributional effects of policies that seek to change consumption. Policies should ensure low-income groups are not harmed in such a transition. Several researchers have called for some form of redistribution as key to equitably reducing consumption levels (Spangenberg 2014). This may entail the provision of a basic income, taxes that essentially lead to a maximum income, the full pricing of environmental externalities, and taxation of luxury and positional goods. More broadly, nonmarket and nonstate efforts could be analyzed for contributions toward community resilience, local provisioning, personal fulfillment, and ecological sustainability.

2.5.3. Crisis-Driven Transformation

Given the current political climate—from Washington to Beijing to the halls of the United Nations—it seems unlikely that government actors will initiate needed policies to foster a sustainable consumption transition. However, as the so-called Great Recession of 2008 showed, crises beyond the control of government actors, whether another global recession or a water or climate crisis, may drive large-scale change in consumption practices (Schor 2014a). Shocks can also cause reflection and higher-order learning (Castán Broto et al. 2014). It is thus critical to have policies and programs ready when policy windows open. This is not the ideal scenario. However, it may be the most likely to motivate government action (Antal and van den Bergh 2013).

Reforms will need to consider potential issues with refugees, resource conflicts, and other extreme scenarios. At the micro level, local networks and city policies can help regions prepare for and flourish in times of scarcity. Recently, resiliency has become a central concern of city planners and funders[12]. At a macro level, focus should be on policies to prevent crises and to support adaptive governance (Lorek and Spangenberg 2014).

2.5.4. Equity, Development, and Leapfrogging

Whether crisis-induced, or planned, the path toward sustainable consumption must be centered around commitments to equity, inclusion, and just transitions (Muraca 2012). The poorest in the world, and even the poor within rich and middle-income countries, must not be punished in the transition to sustainability. In fact, if we are to continue any form of consumption-led growth, it should focus on the consumption of basic needs: safe housing, healthy food, clean water, etc.

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[12] See the Ford Foundation (**http://www.fordfoundation.org/issues/metropolitan-opportunity/just-cities**) and Rockefeller Foundation (**http://www.100resilientcities.org/**). Accessed September 2015.

And simultaneously, any reductions in production should be implemented with an eye toward development and employment impacts on the poor, and their need to develop robust and resilient economic systems.

Economic development, poverty reduction, inequality, and sustainability are deeply interwoven (Spangenberg 2014; Schor 2012). As one very small piece of this, the use of territorial-based emissions accounting in international agreements has allowed developed economies to claim decreased emissions intensities when reductions mainly resulted from the off-shoring of carbon-intensive industries (Druckman and Jackson 2009). Besides the inherent inaccuracy in accounting, this offshoring also exacerbates inequity by allowing greater consumption in rich countries while driving environmental degradation through resource extraction, water depletion, deforestation, soil erosion, biodiversity loss, and pollution in poorer countries (T. O. Wiedmann et al. 2013). A shift toward consumption-based accounting of emissions is a step toward greater accuracy and international equity (T. Wiedmann 2009; S. J. Davis and Caldeira 2010).

Moreover, although the majority of reductions should come from developed countries, emerging middle class consumers in developing countries will be critical to meeting sustainability targets. Developing country investments in infrastructure are critical for environmental impact reductions (The Global Commission on the Economy and Climate 2014). As China and India's growth, powered in part by coal, continues faster than global growth, emissions intensity reductions may be swamped (Pachauri et al. 2014). The most hopeful scenario may be for developing countries to leapfrog western development, and to develop energy, socioeconomic, and infrastructural pathways that avoid unnecessary externalities (Lachman 2013; Hoornweg, Bhada-Tata, and Kennedy 2015; DeCanio and Fremstad 2011). The aim should be for equitable consumption within overall sustainable levels.

2.5.5. Toward Postgrowth New Economics

Ultimately, the consumption-sustainability dilemma leads us back to the challenge of providing viable alternatives to consumption-led economic growth (Alexander 2014b). The new economics, degrowth,[4] and postgrowth movements have come the closest to idealizing integrated transformations that build off behavioral, cultural, and systems insights, with the goal of significantly changing transport, housing, energy, and food systems (Demaria et al. 2013; Kallis, Kerschner, and Martinez-Alier 2012). Drawing from the idea that unsustainability is a crisis of the entire socioecological system, these movements aim to develop qualitatively different systems that are centered around resilient societies operating within ecological limits (Schumacher 1973). They call for principles of ecological and social responsibility for all actors, scale-matched governance for efficient action and integration across these scales, use of the precautionary principle, adaptive management, full-cost accounting, real democratic participation (Costanza et al. 2013), and an eye toward equity and intergenerational justice (Howarth 2011). Importantly, they try to break from "eco-bourgeois" perceptions toward frames that are agreeable to middle class aspirations (Holt 2014). This is key, as it is clearly different to choose a reduced consumption lifestyles than to be forced into one (Alexander 2012; Trainer 2014).

Unfortunately, many academics and practitioners in this movement currently fail to connect with other actors across issue areas or lack perspective on systemic interconnections (Videira et al. 2014). There is a need for more thorough appraisal of new economy initiatives, moving from specific case studies to integrated systems-level analysis of changes, understanding potential feedback loops, risks, barriers, and side-effects. An ecological macroeconomics currently in development will be helpful to allow practitioners to situate their actions within a broader framework, as well as to enable policymakers to create appropriate policies, institutions, and infrastructures to support transitions (Rezai, Taylor, and Mechler 2013; Jackson et al. 2014). At this point, the postgrowth literature still has much work to do to develop and coordinate actors within a broader vision of system change (O'Neill 2012; Videira et al. 2014; Alexander 2014b).

2.6. Conclusion

Given current trajectories of population and consumption growth, it is clear we face impending sustainability crises. Advances in industrial ecology, life-cycle assessment, and environmental sciences have helped to identify our greatest impact areas: energy, transportation, housing, and food systems. However, current efforts that focus on efficiency and market-based solutions are insufficient to solve even our climate change challenges, let alone account for intergenerational sustainability and equity. Truly sustainable consumption entails moving from efficiency improvements to lifestyle changes, to broader culture changes, to socio-technical system changes.

Proposals for Factor 100 decoupling, 100% renewable power for transport and housing, and rapid decreases in the use of private automobiles, meat consumption, etc., will likely require a move to more equitable forms of consumption, post-consumerist institutions, structures, and cultures, and postgrowth economics. The pathway to these transformations requires new frameworks, tools, and interventions for transitioning to and then sustaining future systems. Diverse fields of research—from social psychology to ecological economics to sustainability transitions—now point toward new theories, policies, and innovations for transforming consumption and production. These literatures and practices need to be further developed, and then integrated, tested, and implemented. Deep system change is likely only possible if we view interventions and actions through an integrated lens of behavioral, structural, institutional, and cultural change, and then situate these changes within a systems framework for learning, iteration, and scaling.

Ultimately, if we are serious about sustainable consumption, we will need to develop and test a coherent package of integrated, adaptive, and reinforcing policies that address individual cognitive biases as well as deep infrastructural systems, and that support a scalable transition toward real prosperity, equity, and environmental sustainability.

3. Sustainable Production: Measurement Without Incentives

3.1. Introduction

It is not surprising to document poor environmental and social practices in the apparel industry. Factories in almost every country have been accused of health & safety, labor rights, and environmental violations. Even if violations ceased, energy use, water use, wastewater emissions, chemical releases, solid waste, etc. are increasing year after year with local and global consequences (Reichel et al. 2014). But to change factories usually requires changing brands and retailers ("buyers")(Gereffi, Humphrey, and Sturgeon 2005), who act as drivers and gatekeepers (Van Der Ven 2018). Non-governmental Organizations (NGOs), over the preceding thirty years, have steadily pressured buyers to make sustainability improvements in their supply chains (O'Rourke 2005). Yet, literally billions of dollars, and many attempts at new environmental standards, codes, monitoring, and capacity building programs have failed to drive significant progress in the environmental performance of the apparel industry (Locke 2013).

Even brands and retailers committed to improving practices have had limited effects. This is due in part to the structure of the global apparel industry. Complex supply webs, with most factories producing for 20 or more buyers, results in mixed messages and requirements sent to factories, and no single buyer having much influence over a given factory's practices (World Trade Organization 2013; Gereffi 2014). Environmental and social standards often conflict with buyer demands on pricing, delivery, and quality (Van Der Ven 2018; Gereffi, Humphrey, and Sturgeon 2005; Coe and Hess 2013; Lebaron, Lister, and Dauvergne 2017; Locke 2013). Despite nods to the "circular economy," the industry remains committed to continued growth in product sales (Putt Del Pino et al. 2017). With the advance of "fast fashion" and retail platforms and algorithms replacing traditional retail buyers, the impacts are accruing faster than improvements.

Against this pessimistic backdrop, an 11-year old initiative—the Sustainable Apparel Coalition—has developed the leading strategy to drive sustainability within the global apparel industry. The Sustainable Apparel Coalition (SAC), aims to support collaboration, information-sharing, and innovation amongst buyers and suppliers that goes beyond existing models of supply chain environmental improvement. The SAC model incorporates voluntary standards, monitoring, and verification along with capacity-building, best-practice identification, and scaling. The SAC envisages a data-driven, collaborative network of continuous problem-solving.

The major initiative of the SAC has been the Higg Index: a suite of six data tools, including factory environmental and labor assessments, a brand environmental assessment, product life cycle analysis, a tool for designers, and a tool for sourcing agents. The Facility Environment Module (FEM), now in version 3.0, is the most developed of these tools. The FEM is an annual assessment of an apparel facility's environmental management capabilities, procedures, and plans. This data is (most often) self-reported by a factory, and then can be shared via the Higg Index platform with any contracted buyers who request it.

This report is the final output of a 3-year analysis of the implementation and effectiveness of the FEM v2.0 on apparel factory practices and performance. This research involved a three-part assessment. First, we conducted a large-N analysis of FEM data from nearly twelve thousand apparel factories across 80 countries over 4 years (2013-2016). This allowed us to track and document trends around environmental outcomes by country, facility type, and year. Second, we surveyed top-performing facilities regarding their environmental programs, with a focus on understanding whether implementing the FEM motivated changes in policies, practices, or innovations. Third, we conducted in-depth case studies of high-performing factories in Bangladesh and China. Through interviews with managers, document review, and facility tours we sought to understand what the very best factories were doing, and what role the FEM played in their efforts to improve performance.

Our research focused on the FEM's effectiveness in five key areas: (1) Standards; (2) Collaborative problem solving; (3) Capacity-Building; (4) Incentives; and (5) Improvement. We should stress: this is a hard problem, with no easy answers. There are many nuances and changing dynamics within each apparel factory. It is also difficult to assert causal impacts from any one initiative or program such as the FEM.

Our overall conclusion is that the FEM is having foundational, but not transformative impacts on factory practices. The FEM is more streamlined and data rich than previous auditing initiatives driven by brands, retailers, and multi-stakeholder programs. And the program improved significantly during our study period from FEM 2.0 to the current FEM 3.0.[13] The FEM has increased environmental evaluations of apparel factories, established baselines, and driven convergence on what gets measured.

And yet, the FEM still lacks critical incentives to change factory practices. We found that the benefits of "reducing audit fatigue," while welcome, are simply not incentive enough to motivate factories to invest in transformative technologies or management practices. The most interesting factory successes have come where buyers invest significant resources and influence in driving FEM adoption and factory environmental performance. Absent buyer intervention, however, it is not clear the FEM is changing core factory behavior. Though FEM 3.0 has improved the collection of actual environmental outputs (i.e., reductions in energy use, water use, effluent emissions, etc.), the behavioral focus still seems to be on processes, systems, and permits.

The FEM needs to provide actionable, business-relevant information to factory managers and buyers. The integration of Zero Discharge of Hazardous Chemicals' (ZDHC) tool in the FEM 3.0 is an example of better support for factory management. The next steps may be to incorporate cost-benefit analysis to drive factory environmental investments and to make the FEM data meaningful for buyer design and sourcing teams. If factories were to receive more or fewer orders based on their FEM score, then there might be sufficient internal incentives for improvement (Porteous, Rammohan, and Lee 2015). Yet this internal mechanism is only likely to be successful if there is external transparency and accountability. The SAC needs to be fully committed to public transparency measures.

This report presents: 1) An overview of the project context and design; 2) an assessment of what the FEM has accomplished; and 3) recommendations for strengthening the impact of the FEM

[13] It remains to be seen what effect the split of the SAC into three separate organizations—adding Higg.co and the Apparel Impact Institute—will have on the FEM.

and Higg Index more broadly. Significant, widespread improvements in environmental practice and technology are urgently needed. We conclude with some reflections on how the FEM and Higg Index can contribute to these environmental goals within a changing apparel and governance landscape.

3.2. Project Context and Research Design

3.2.1. More and Better Supply Chain Information

Apparel production generates a range of environmental impacts. Hazardous chemicals used across the production process (coupled with a lack of effective management and treatment) pose a significant threat to local waterways, as well as to worker health and safety. The fabric dyeing process alone accounts for five trillion liters of water use, while the full life-span of a single t-shirt can consume up to 2700 liters of water (Putt Del Pino et al. 2017). Workers continue to be endangered by unsafe buildings, as well as subjected to adverse working conditions. Wages remain far from a "living wage" in virtually every country in the world (Lau et al. 2017). And the apparel industry as a whole is now responsible for an estimated 10% of global greenhouse gas emissions (Reichel et al. 2014; Putt Del Pino et al. 2017).

Absent a functioning system of international governance (Ruggie 2014), or local governments with the capacity and will to enforce labor and environmental regulations (Distelhorst et al. 2015), we continue to see the emergence of non-governmental systems of regulation and governance (Auld, Bernstein, and Cashore 2008; Bartley 2018). These private systems are often predicated on information. Over the past thirty years, the form of private governance has varied along with the type and quality of the information being shared, which has produced new ways of imagining solutions and encouraged new types of actors and competencies.

In the early 1990s, codes of conduct were focused on compliance with national regulations or international norms, such as a ban on forced or child labor (Esbenshade 2004; Emmelhainz and Adams 1999). Later in the 1990s, buyers began to request information about factory environmental management systems (EMS) and procedures. This led to an emphasis on "capacity-building" where suppliers were supported in implementing these EMS (Locke 2013). Gradually, buyers began to request more information about environmental inputs (e.g. water use, chemicals, etc.) and outputs (e.g., effluent metrics, emissions to air, etc.). This also required more technical capacity from suppliers, which has also supported an industry of third-party consultants (Locke 2013). With this new quantitative data, the most recent governance frameworks are asking suppliers to set targets and begin to demonstrate progress "beyond compliance".

Information is imagined as the key ingredient to foster action. For some, it enables transparency and accountability (Schleifer, Fiorini, and Auld 2019; Bullock 2017). For others, information is central to coordinated efforts to diagnose, test, and iterate solutions (De Búrca, Keohane, and Sabel 2014). For others, information enables consumers and investors to make decisions aligned with their values, thus setting off a virtuous cycle of sustainability (Chouinard, Ellison, and Ridgeway 2011; Fung, Graham, and Weil 2007). Still others see information as essential for capacity-building efforts (Gereffi and Fernandez-Stark 2018). In all, this quest for better information can often lead to an "accountability trap" where efforts are poured into improved accountability mechanisms which never seem to yield improved outcomes (S. Park and Kramarz 2019).

In these information-based systems, there are often two distinct models of information "flows". First, a model we term "insider visibility" is defined by a flow of standards from buyers to suppliers, and a flow of verifications from suppliers to buyers (Bartley 2018). Under the strict definition of "insider visibility," information remains private, though it can be shared through private agreements. The second model we term "transparency" is defined by public accessibility, where third-parties, regulators, and/or consumers are provided access to material information needed to make consequential decisions (Gardner et al. 2019).

While in practice there are many hybrid forms, the difference between broadly insider-visibility initiatives and greater transparency measures is important (Kosack and Fung 2014). It is important for the accountability, legitimacy, and ultimately effectiveness of these initiatives. For either information-flow model to support meaningful material changes, the information provided needs to be appropriate for the objectives, delivered at the right time, fit within existing decision and/or data structures and processes, and available to appropriate decision-makers (Fung, Graham, and Weil 2007).

Insider-visibility systems are most often proposed by buyers or industry more generally. Many buyers believe that external actors often fail to understand their constraints, interests, and processes. Suppliers can often be in agreement with this arrangement since their access to markets is restricted by buyers (Gereffi 2014; Van Der Ven 2018). Yet suppliers are often resistant to greater oversight, especially without clear, demonstrated, meaningful benefits. Still, industry often claims this system posits that information asymmetries lie at the heart of environmental inaction. With this information, buyers can in theory end relationships or decrease orders with poor performers, direct better contracts to higher-performing facilities, and discover and spread promising solutions more rapidly in their supply networks (O'Rourke 2014). Absent such evidence, firms have recently appealed to new cooperative forms of insider-visibility. Since many buyers share suppliers, if information is shared across buyers, it can promote coordination, reduce redundancy, and help resolve free-rider issues.

Naturally, many stakeholders are skeptical of letting business police themselves, and have advocated for greater transparency (Human Rights Watch 2018; Gardner et al. 2019; Kosack and Fung 2014). Transparency-based private governance frameworks envision consistent, accurate, and comparable data, where stakeholders can hold businesses accountable through reputation-focused media campaigns, activist-investing, voting-with-their-dollars, or a centralized process for ratcheting standards (Fung, O'Rourke, and Sabel 2001; Chouinard, Ellison, and Ridgeway 2011). These methods of market activism can incent buyers, who would then pressure their suppliers, to invest in environmental improvements. Other frameworks include public actors as a means of supporting experimentation (De Búrca, Keohane, and Sabel 2014). In essence, transparency adds more means of holding buyers and suppliers accountable, which ultimately promotes legitimacy, and ideally, effectiveness.

And yet, despite information being the central goal of most private governance efforts for the past thirty years, procuring sustainability information has proven exceedingly difficult to execute in the apparel industry (Bartley 2018; Locke 2013). Even the most basic form of supply chain information—simple compliance data—has been marred by inaccuracies. Where information has been produced, the lack of comparability across buyers or products has prevented it from having any real influence. The instability in the complex, competitive, dynamic, and transnational industry renders more grandiose visions of advanced, analytical processes of collecting the right data in a timely fashion to make consequential and costly decisions appear highly dubious.

3.2.2. The Higg Index Proposition

The Higg Index is arguably the most widely-deployed, technologically-advanced, information-based strategy in the apparel industry. The Higg Index originated from tools designed by Nike and the Outdoor Industry Association, and has been further developed by the Sustainable Apparel Coalition (SAC) and its members. It is envisioned as a crucial building block for SAC's vision for continuous improvements at scale.[14]

The SAC, an apparel industry association that counts over 40% of the apparel market as members, was initiated in 2009 by Patagonia, Walmart and a group of brands and retailers. The SAC's primary focus has been to develop and support adoption of the Higg Index, a set of tools for measuring and managing environmental and social performance. With the Higg Index as a focal point, the SAC has convened stakeholders—brands and retailers, suppliers, and select NGOs—in a pre-competitive, collaborative forum for sourcing and scaling better environmental and social practices.

The Higg Index seeks to serve as a mechanism to develop and measure environmental and labor standards, and to provide data and decision-support tools to generate and support the incentives needed to move from policing supply chains to innovating for sustainability. Brands, retailers, and factory managers needed common standards, applied and incentivized by many buyers, along with the capacity-building needed for factories to meet these standards. The hypothesis being that through more collaborative, interactive learning processes, facilities would improve performance while buyers would transform design and procurement. The Higg Index was intended to be a win-win-win: "Through SAC membership, brands, retailers and manufacturers commit to transparency and the sharing of best practices, a full-circle collaboration that benefits all involved."[15] For factories, the proposition was thus: improve performance to gain more sales and better orders, or risk being dropped from global supply chains.

The Facility Environmental Module (FEM), a key component of the overall Higg Index strategy, is the mechanism to hold factories to account. The FEM offers a way to collect and share standardized sustainability information about supplier-factories, as well as to support factories in managing and innovating for sustainability. It is important to note that while the SAC includes some NGOs and third-parties as members, the FEM data for a particular supplier is not shared beyond individual buyer-supplier relationships. Thus, it is considered a "visibility" strategy,

[14] https://apparelcoalition.org/the-higg-index/. Accessed October 2019.
[15] Internet Archive, http://apparelcoalition.org/collaboration-impact/, January 1, 2018

rather than a “transparency” strategy at this point. The SAC continues to discuss whether and how to share the data more widely.

The FEM assessment is completed once annually, and while there are procedures for third-party verification, it is most commonly a self-assessment conducted by the facility management. The FEM has seven categories: Environmental Management, Emissions to Air, Wastewater, Hazardous Waste, Water, Chemicals, and Energy. In each module, there are three tiers of questions that correspond roughly to: 1) Compliance, 2) Measurement, 3) Goal-setting and tracking. These tiers are, in theory, meant to operate as ladders for both buyer and supplier sustainability performance. The FEM released version 3.0 in late 2017, which we touch on, though a majority of our study covers version 2.0. In version 2.0, there were 12 questions which required a quantitative response, such as emissions to air, energy use, and annual production, a number of demographic and feature-focused standardized-response questions (e.g., “Does your facility have a boiler?”), and many qualitative questions permitting free-form responses. Facilities received a total score based on their responses to binary “yes-no” questions. Scores could total up to 700 (100 points for each module), but were normalized to a 100-point scale.

The FEM, in theory, solves a number of issues: consistency in standards, data sharing amongst brands, reducing audit fatigue for suppliers, and verification redundancy. It also advances beyond simple auditing to include capability assessments and goal-setting. During the assessment and in the SAC program, facility management is educated (through Zero-Discharge of Hazardous Chemicals and other collaborators) to make better decisions, in part through comparison against peer-facility benchmarks. Best practices are disseminated through the online platform as well as at multiple yearly manufacturer forums, the annual SAC member meeting, and through informal channels. The SAC outlined the FEM’s benefits to facilities in 2016 as: “Benchmarking by facility type allows facility managers to compare their performance against their peers. The module’s aspirational-level questions give manufacturers clear guidance on hotspots for improvement and outline the current best practices in the field.”[16]

The SAC added in 2018: “The Higg Facility tools create opportunities for open conversation among supply chain partners so businesses at every tier in the value chain collectively perform better.”[17] The SAC’s theory of change—whether implicit or explicit—involves four key components. First, factories need clear standards for performance. Second, there needs to be collaboration and information sharing between buyers, suppliers, and third-parties. Third, factories need capacity-building and training around processes and practices to achieve the standards. Fourth, factories need positive and negative incentives, in part through monitoring and enforcement, to encourage continued investment. All of these together can, iteratively, drive performance improvements down supply chains. We discuss these five performance criteria further in Assessment & Discussion below.

3.2.3. Research Design

This report analyzes whether the standards, measurement, verification, and learning processes advanced through the FEM improve the environmental performance of the apparel industry. We

[16] Internet Archive, **http://apparelcoalition.org/facility-tools/**, March 15, 2016
[17] Internet Archive, https://apparelcoalition.org/higg-facility-tools/, January 1, 2018

seek to understand whether and how the FEM motivates supplier and brand environmental performance improvements. We primarily evaluate the FEM against its own stated goals through quantitative data analysis of all FEM v2.0 data, a survey of a select sample of facilities, and case studies of eight facilities in Bangladesh and China. As FEM v3.0 was rolled out during our study period (2015-2018), we include comparative analysis of v2.0 and v3.0 where possible.

The SAC provided us access to an anonymized version of all 12,678 unique FEM v2.0 audits. The first step was to establish a baseline through evaluating the quality of the questions, data collection, and data analysis procedures of the FEM. In February 2016, we provided our recommendations to an SAC working group to improve FEM survey questions, data collection, analysis, and use of information. We also reviewed a draft of the FEM Version 3.0 and provided further recommendations to the SAC staff. Appendix A contains that report.

We used the FEM data for two purposes. First, we conducted a qualitative review of the assessment. In addition, we analyzed the data for quantitative patterns and insights related to program goals. These include growth in FEM users with attention to geographic and supply-chain coverage and data on environmental performance outcomes. We removed duplicate entries and others that lacked data, but retained most of the assessments. In May 2017, we presented a preliminary analysis to the SAC's membership at the annual member meeting in Bangalore, India.

Second, we used the FEM to find facilities for a survey and case studies. Instead of a balanced dataset, we focused on top performing facilities to understand how the FEM influences factories that at least have the capability to perform well. The top-performing facilities are most likely to have the pre-existing capacity to take advantage of FEM's beyond compliance aims. Granted, the FEM may introduce environmental management practices to low- to medium-performing facilities leading to significant benefits, but we wanted to understand the ability of the FEM to drive continuous improvement, not to encourage simple compliance. Moreover, from a practical standpoint, we were more likely to gain access to high-performing facilities. Both the buyers and the facility were more likely to be proud of their efforts as well as have experience with and trust of outside assessors.

We focused on two countries: Bangladesh and China. We wanted to compare facilities under different regulatory constraints and with different industrial experience. Both countries are leading producers of apparel and have been the focus of media attention, NGO campaigns, and buyer programs to advance sustainability in production. Facilities in both countries have been exposed to third-party interventions such as Clean by Design (CBD), Partnership for Cleaner Textile (PaCT), Zero Discharge of Hazardous Chemicals (ZDHC), and are well-represented in the FEM. Yet facilities in China are likely to be more technologically- and managerially-advanced, with stricter governmental oversight, than facilities in Bangladesh.

In order to identify high-performing facilities in Bangladesh and China, we first created a subset of facilities that had reported in two consecutive years between 2014 and 2016. This restriction allowed us to determine year-over-year performance, find facilities with more FEM familiarity, and facilities that have implemented policies and innovations in response to FEM. We then categorized facilities by type in order to compare like-for-like. The five types – developed in coordination with SAC's data collaborator, Anthesis, and based off of The GAP corporation's analysis – were: (1) "Cut-Sew," (2) "Fabric or Yarn Dyeing," (3) "Garment Dyeing," (4) "Washing," and, (5) "Other".

We then aggregated scores by impact category (i.e., Chemicals, Energy Use, Wastewater, etc.). Grouped first by facility type, and then comparing all facilities together, we identified top performers in each of ten metrics: 2015 & 2016 overall FEM score, 2016 water, GHG, EMS, wastewater, emissions to air, chemicals & waste, and change in overall FEM score between two consecutive years. Top performers were those facilities that performed three or greater standard deviations from the mean. We then selected facilities from China and Bangladesh, resulting in 243 facilities in total.

We then surveyed these facilities, querying facility management and environmental specialists on two key aspects of the FEM experience: driving change and improving collaboration and communication. We were interested to understand whether and how the FEM influenced decision processes, helped implement a new policy or technology, and/or impacted relationships and communication strategies.

The survey contained six distinct focus areas:

(1) **Facility engagement**– What degree of effort did the facility put into FEM response?
(2) **Communication improvements** – Did the facility utilize their FEM response and score in communication with suppliers, brands/retailers, other facilities or regulators? What effect has it had on engagement across these groups?
(3) **Business solutions** – Did the facility, through the FEM, find and enact any financially positive changes?
(4) **Brand relations** – Has the brand utilized the FEM in sourcing decisions?
(5) **Regulatory compliance** – Did the FEM improve regulatory compliance?
(6) **Use by NGO programs** – Did any programs such as Clean by Design, Zero Discharge of Hazardous Chemicals, etc. use the FEM responses to design more effective interventions? Or did their interventions help the facility to improve its performance and FEM scores?

We piloted a draft of the survey in January 2017 with 20 facilities. After refining our focus, removing questions, clarifying the language, streamlining the user experience, and translating into simplified Mandarin, SAC staff distributed the survey in June 2017 over email via the Qualtrics platform to the 243 facilities. We received a total of 132 survey responses, of which 74 were complete responses, for a response rate of 30%. Twenty-seven facilities signaled an openness to follow-up (i.e., for case studies) by providing their contact information in the survey. For our case studies, we again wanted to select the top performing facilities. By top performing, we were interested in facilities who had derived the most value from the FEM.

This selection process yielded a group of fifteen facilities in Bangladesh and China. The Bangladeshi facilities were mainly located near Dhaka and Chittagong, with seven facilities in Dhaka. The Chinese facilities were located near Shanghai and Guangdong. Due to time and travel constraints, we decided to focus on one area in each country, selecting Dhaka and Shanghai. We did not appear to omit any critical characteristics due to this logistical decision.

We then emailed the facility managers using an IRB-approved template. Since most facilities require brand approval before allowing outsiders into their facility, this cold-email format presented risks. In Dhaka, the strategy was successful as four facilities permitted us access to a full day visit including a facility tour, presentation, and interview. Each facility either noted or was most likely to have required brand or top-management permission. Over multiple attempts, we did not receive a response from any Chinese facility. After multiple rounds of unsuccessful emails, we requested support from the C&A Foundation to gain access to Chinese facilities. C&A helped us coordinate field visits with four facilities outside of Shanghai in October 2018.

This deviation from procedure to visit the Chinese facilities changes the quality of comparison with the Bangladeshi facilities. Most of the Chinese facilities were using FEM v3.0 by the time of the visit. Several had never used FEM v2.0. Moreover, the visits were over a year apart. The insights gained are still valuable, but do not permit an accurate comparison. At each facility, we performed semi-structured interviews with management, toured the facility, and reviewed pertinent documents.

In late July 2017 we conducted case studies at four garment facilities in Bangladesh. All of the facilities were located in the greater Dhaka region, in particular, two major industrial areas: Gazipur or Ashulia. One facility was located in an export processing zone. All the facilities supplied garments to either US or EU markets. In October 2018, we visited four facilities in China near Shanghai. We employed a translator while in China, but not in Bangladesh.

3.3. Assessment & Discussion

Using these three sets of data, we evaluate the FEM against its theory of change identified above. The five components, to recap, are:

1. **Standards**: Provide clear, consistent signals to suppliers;
2. **Collaboration**: Support and encourage buyer-buyer, buyer-supplier, and supplier-supplier collaboration;
3. **Capacity-building**: Support and enhance supplier EMS capacity;
4. **Incentives**: Encourage supplier sustainability investments;
5. **Improvements**: Identify, implement, and scale performance improvements.

3.3.1. Standards

The FEM aims to set industry sustainability standards so that suppliers can respond to a single set of criteria. One barrier the SAC notes is that factories often receive mixed signals from their many buyers. While there may be coherence on fulfilling local regulatory requirements, there can often be differences in chemical testing standards as well as expectations for environmental management processes. The SAC is a forum for buyers (and suppliers) to negotiate and agree upon a common set of performance standards and evaluative criteria, which aim to be realized in the FEM. When evaluating the FEM's ability to set and communicate clear standards, we focused on two broad criteria: achieving scale/coverage and being accessible/coherent at varied locations.

Achieving Scale & Broad Coverage

First, an industry standard needs to achieve scale and broad coverage, with a growing number of facilities across multiple supply chain tiers and facility types in different geographic locations. Achieving scale and coverage communicates to suppliers that the standard is becoming a requirement. We should also expect to see the number of other audits and evaluative programs to diminish over time.

<u>FEM coverage is growing</u>

Each year, the number of posted modules has grown, culminating in over 4000 FEM v2.0 modules posted in 2016. 715 facilities submitted assessments in multiple years, and there were also 663 on-site and 79 off-site verified modules. It is likely that 2016 did not see as much annual growth due to buyers waiting for FEM v3.0 before requiring their suppliers to be assessed. Indeed, in the first year of FEM v3.0, the number of assessments increased to 7056.

FEM Growth 2013-2017

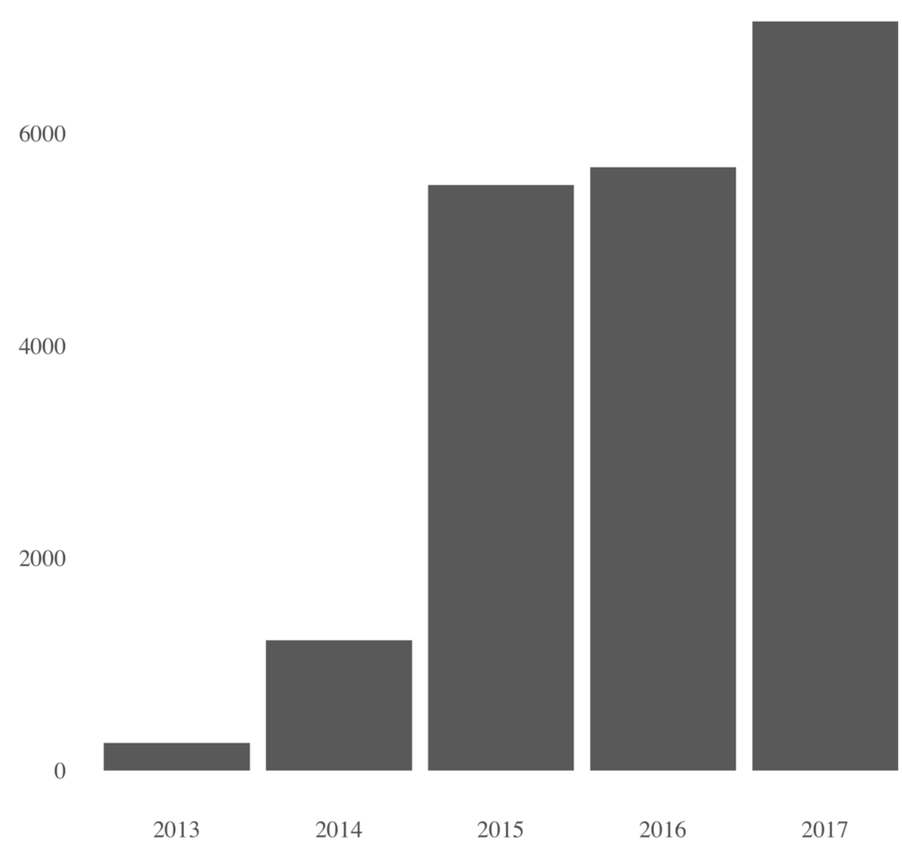

Figure 3-1: FEM modules posted by year.
2013-2016 show FEM 2.0 modules, while 2017 data shows FEM 3.0 modules.

A majority of the assessments are filled out by final-assembly facilities. This is likely because buyers have greater contact with and therefore leverage over these facilities. Brand relationships are absolutely critical for FEM adoption. There is growth in material suppliers and mills, however like with other supply chain initiatives, it has proven more difficult to penetrate lower supply chain tiers.

FEM 2.0 was introduced into 80 countries, with China leading with 5,117 posted modules, India with 1054 posted modules, Vietnam with 1066 posted modules, and Bangladesh with 965 posted modules. This generally matches our expectations given that Chinese facilities still dominate apparel production.

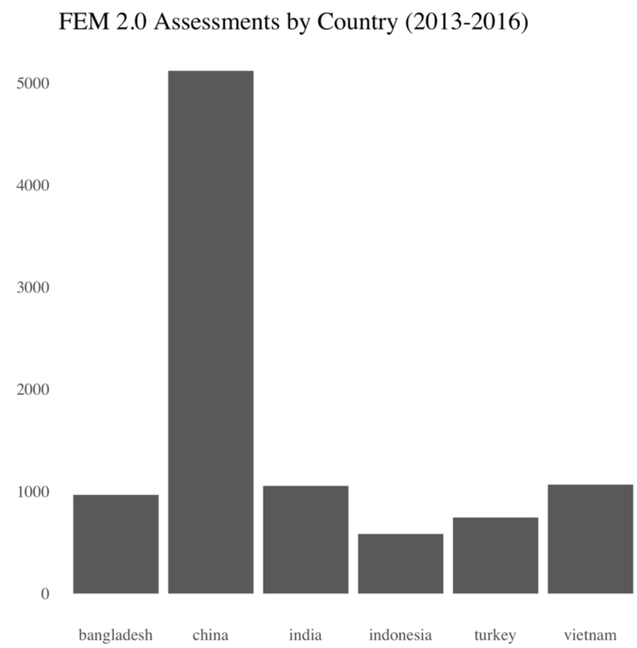

Figure 3-2: FEM 2.0 assessments by country.
Only top 6 countries are shown.

<u>Other assessments remain prominent</u>
The facilities participating in our case studies noted they were still filling out multiple assessments for their various customers. Indeed, with many buyers waiting for FEM v3.0, facilities noted that they still had to fill out multiple buyer assessments. In a few Chinese facilities, we did see evidence that the FEM was beginning to satisfy multiple buyers' requirements.

By 2017, 124 brands and retailers in apparel and footwear had completed their own environmental modules, greatly increasing the number of connections identified within the system and likely motivating further adoption and use by facilities. In fact, Anthesis estimated in June 2017 that 20% of facilities were connected to multiple brands or retailers, likely alleviating some audit fatigue for those facilities.

Accessibility and Coherence

An increasing FEM scale and coverage does not guarantee that factory management understands the standards created by the FEM. An effective standard that spans many different locations should be contextual. Therefore, it should account for different regulatory, cultural, linguistic, and organizational differences that can generate inconsistent interpretations.

FEM remains unclear at times

Our visits to facilities in China and Bangladesh show that facilities are sometimes unclear about how to fill out the FEM assessment. Questions were often not worded clearly enough for facility managers, and buyers and third-party assessors often were not certain either. The FEM does provide support in its companion “How-to Higg” document. However, this was not translated into each language where the facilities were located. One particular problem noted by some facilities was that third-party assessors were not qualified to verify answers or provide support for tier 2—“Measurement”—and tier 3—"Goal-setting and tracking”—questions in FEM v3.0. Since the tiers are meant to provide scaffolding (i.e., support and education) for sustainability improvements, and the third-party assessors are key interlocutors of the Higg Index initiative, this represents a significant barrier to improvement.

Moreover, each buyer may have different requirements based on their own internal goals. This means that even a standardized assessment like the FEM still can generate discrepancies based on various interpretations and standards. Despite the FEM’s promise to alleviate audit fatigue, brands did not have the same standards for FEM responses. For example, while one brand might accept a local environmental lab chemical test, another would require international accreditation. The FEM did not provide guidance for a standard interpretation. As a result, facility scores vary brand-to-brand. This lack of specificity often resulted in extra work for environmental managers and multiple reports. This problem may be exacerbated as more brands begin to use the FEM.

Difficult to compare results across facilities

A major value of standardized information is to be able to compare facilities. Comparison can encourage facilities to improve as well as surface innovations. Facilities are, of course, diverse in their operations and size. However, the FEM v2.0 lacked a clear mechanism to classify facilities by type. For size, there were two questions: annual production weight and annual produced units. The responses were not standardized, nor was it possible to clearly identify faulty information. While flexible for facilities to enter information, the information is nearly unusable without more knowledge of the facility. The SAC has developed a classification procedure for FEM v3.0, but it remains to be seen how effective this parsing will be.

On a similar note, FEM 3.0 did solve one major issue by letting facilities skip sections or questions that were not applicable to their facility type. However, the FEM still lacks other contextual intelligence, such as being sensitive to local regulation.

3.3.2. Collaboration

The SAC is premised on industry collaboration. SAC member forums and conferences aim to bring together buyers and suppliers to negotiate standards and chart courses of action. The FEM as a standard is intended to be a mark of that collaboration. It is also intended to be an object around which collaboration can occur and be furthered. When evaluating if the FEM has furthered collaboration amongst buyers and suppliers, we need to evaluate both the quality and quantity of collaboration. First, we would expect that suppliers believe the FEM accurately represents their factory's conditions and trajectory. If they believe they are being improperly represented, the basis for meaningful collaboration is limited. As a corollary, if the FEM is acting effectively, we would expect that buyer-supplier conversations are moving beyond simple auditing and compliance (though still a critical issue) in favor of increasing discussions on problem-solving and innovation. Second, we would expect to hear from suppliers about more discussions with multiple buyers around the FEM criteria. This would indicate that buyers are collaborating with each other on sustainability strategy within common facilities. Related to this, we might expect suppliers to have greater connections to other suppliers around the FEM, to identify and implement improvements that have worked in peer facilities.

Quality of Collaboration

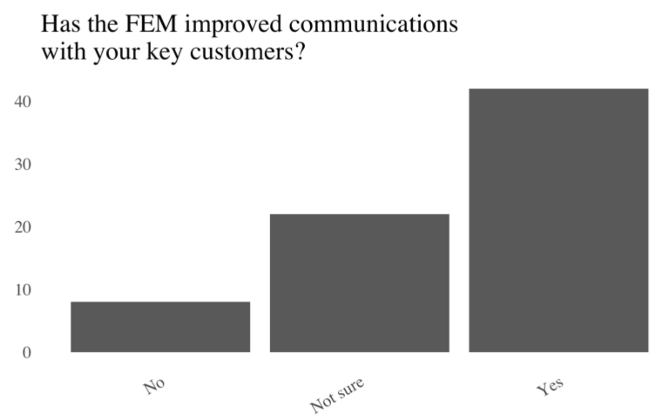

Figure 3-3: Survey results for: Has the FEM improved communications with your key customers?

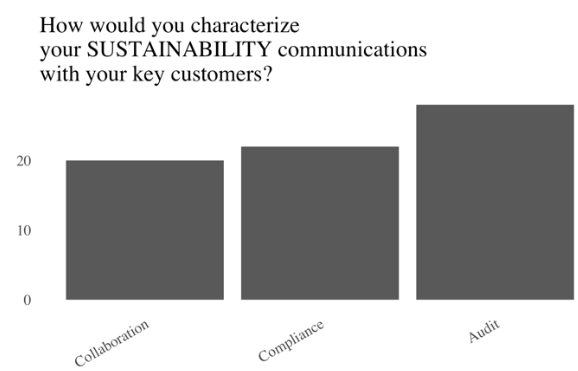

Figure 3-4: Survey results for: How would you characterize your sustainability communications with your key customers?

Facilities believe generally that their relationships have improved with their buyers. While attributed in part to the FEM, this may be a result of a general industry trend. Buyers, especially those selling customized, fast fashion, have begun to tighten relationships with key customers. Yet, case studies and surveys show that facilities are not receiving much feedback from buyers directly about the FEM. Figure 3-4 shows that sustainability communications, even with top-performing facilities, have remained mostly compliance-oriented. Despite this general trend, one facility noted that the buyer would host trainings with multiple facilities, as well as one-on-one trainings. Further, buyer support has been essential for more substantive environmental investments. So, while some buyers have adopted a more hands-on approach with select factories, the FEM has not been the primary mode of engagement nor the driver of this improved collaboration.

Similarly, as discussed above, the FEM does not appear to be reducing duplicative sustainability efforts substantially at this point. At one facility in China, there was evidence that buyers were collaborating on standards and improvements. Nonetheless, the majority of collaboration seems to be between a single buyer and supplier, limiting the quality of any one particular collaborative effort.

Quantity of Collaboration

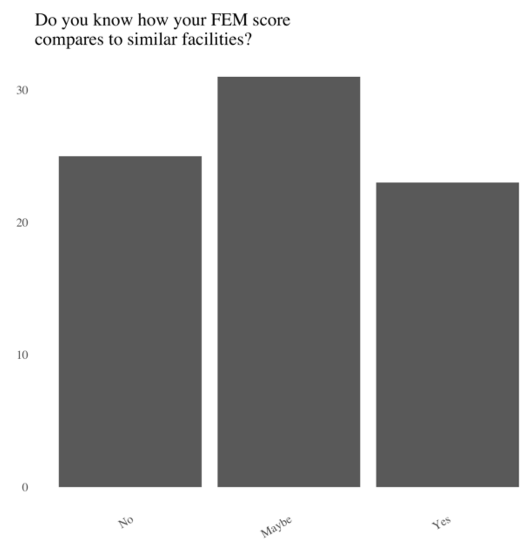

Figure 3-5: Survey results for: Do you know how your FEM scores compares to similar facilities?

One major potential area for increased collaboration is between facilities. However, to date, facilities have seldom used the FEM to communicate or learn from peer facilities. The FEM data dashboard does not display comparisons with relevant facilities, nor offer solutions that have been tried-and-tested by other facilities. Facilities are not able to communicate with one another via the FEM platform. Factory management noted numerous times that seeing evidence of benefits other factories have found from environmental innovations would support their efforts.

3.3.3. Capacity-building

In part through effective standards and improving collaboration, the FEM aims to enhance facility capacity to make environmental improvements. Factory capacity includes environmental management systems, technical knowledge, procedures for turning information into action, and procedures for learning. We can assess the FEM's ability to improve factory capacity in two ways. First, the FEM aims to provide a framework for management to incorporate, evaluate, and respond to environmental issues. The FEM, as a prescriptive framework, seeks to direct managerial attention and encourage improved environmental management systems. We can assess factory capacity in part by examining FEM score trends. If FEM scores increase, certainly with tier one scores (i.e., “compliance” or foundational characteristics), it would indicate that facilities have increased capacity for further improvements. Second, we can assess to what extent the FEM provides best practices to facilities. While this does not directly enhance the capacity of the facility, it reduces the dependence of facility environmental improvements on buyers, which is a potential constraint given multiple buyers and so on.

Enhancing Environmental Management

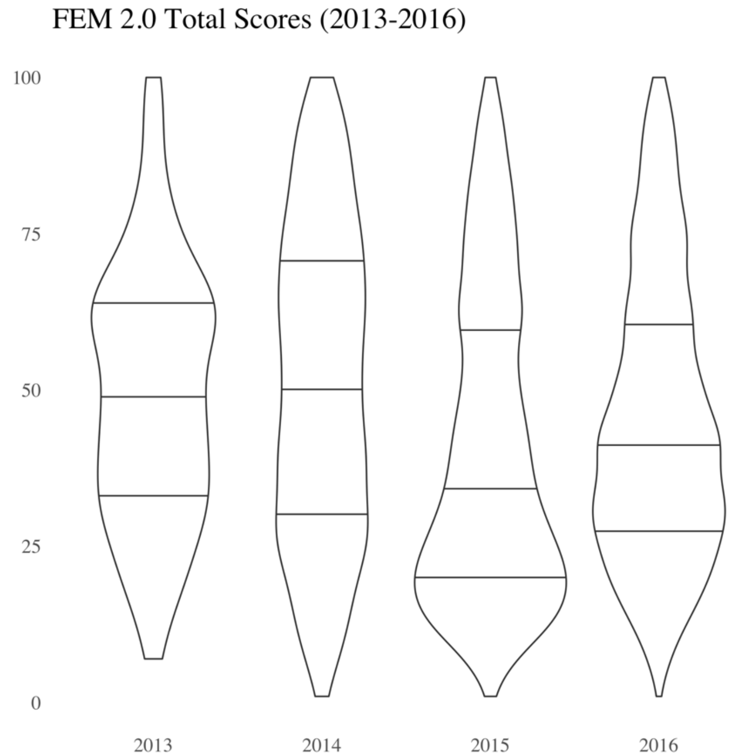

Figure 3-6: Violin plot of FEM 2.0 total score by year.
The length of each violin shows the overall range of scores in that category, while the width shows the proportion of facilities at a given score. The plot does not account for increases in total number of assessments over the timeframe. The horizontal lines indicate quartiles at the 25%, 50%, and 75% levels. Scores range from 0-100. The plot shows total scores generally decreasing since 2013, though increasing from 2015 to 2016. This trend occurs as many more facilities filled out the FEM, so there could be a few reasons—selection bias, clarification of questions, type of facility manager filling out the assessment, etc.—for the decrease.

Median total FEM scores were highest in 2014. However, these early adopters likely present sources of bias: better performing facilities, less clear question interpretation, lack of adequate guidance from SAC and buyers, and little verification procedures. However, after the steep drop-off from 2014 to 2015, scores rose substantially in 2016. This is may be due to facilities adopting practices that were low-hanging fruit (i.e., tier one “compliance”), as well as buyers becoming more familiar with the process and providing necessary guidance and assistance.

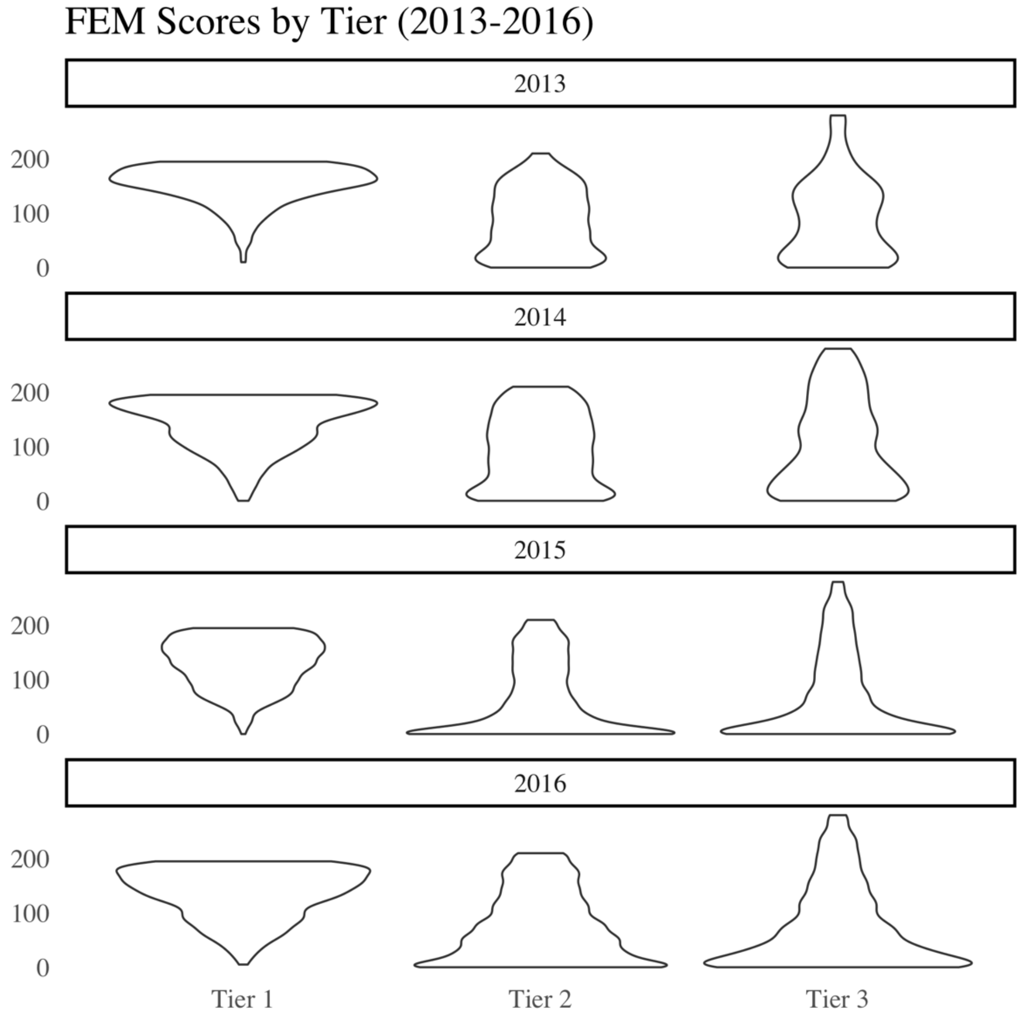

Figure 3-7: Violin plot of FEM 2.0 tier score by year.
The length of each violin shows the overall range of scores in that category, while the width shows the proportion of facilities at a given score. The plot does not account for increases in total number of assessments over the timeframe. The horizontal lines indicate quartiles at the 25%, 50%, and 75% levels. Scores range from 0-200 for tiers one and two, while tier 3 scores range from 0-300. The important part of this plot is the shape of each violin. Across the years, most facilities are scoring well in tier 1—"compliance", while most facilities struggle to score higher in tier 2—"measurement"—and tier 3—"goal-setting and tracking".

Indeed, most facilities appear to be meeting FEM tier 1—"Compliance". This makes sense since it entails establishing regulatory compliance and basic EMS procedures. Thus, it aligns with many brands minimum requirements. However, we see from the violin shapes in the figure below that most facilities are struggling to reach tier 2 and 3. In FEM v2.0, facilities were able to gain points in tier 3 without first gaining tier 2, but this is no longer possible in FEM v3.0.

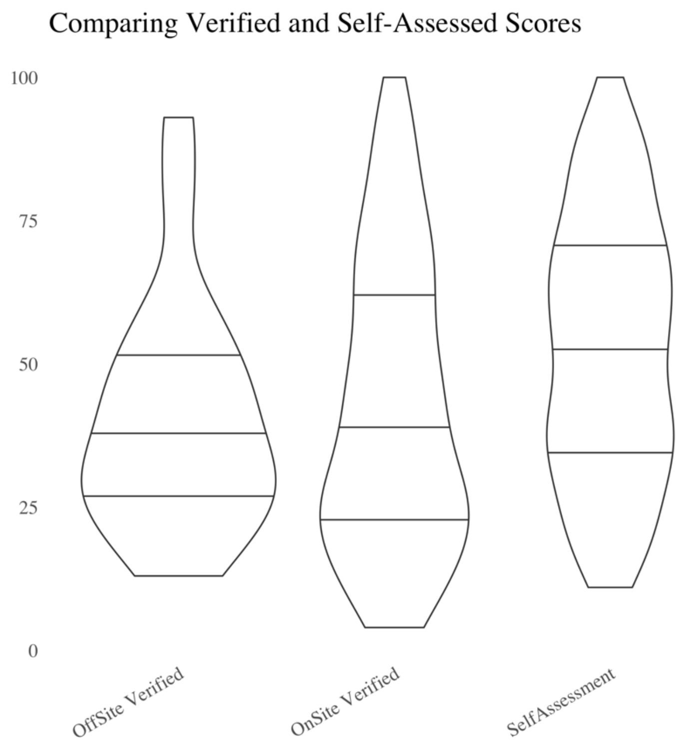

Figure 3-8: Violin plot comparing facilities that had both verified and self-assessed scores. *The length of each violin shows the overall range of scores in that category, while the width shows the proportion of facilities at a given score. The horizontal lines indicate quartiles at the 25%, 50%, and 75% levels. The figure indicates that self-assessment tends to inflate scores.*

FEM 2.0 data is still quite unreliable due to self-assessment bias. Scores are consistently inflated during self-assessments. It is not clear whether this inflation is due to misinterpreting the questions, unclear standards for affirmative answers, or deceit. Nevertheless, verification has tended to lower factory scores and should be considered standard practice going forward, especially if environmental performance data becomes more of a central priority (versus the current focus on process data). It is interesting to note that on-site verification led to higher scores than off-site. It is not clear which method is generally more accurate, as both have advantages and disadvantages. This is a potential area for further study, especially considering the cost-savings available by off-site verification. That said, there are many potential co-benefits from on-site verification such as capacity-building and collaboration.

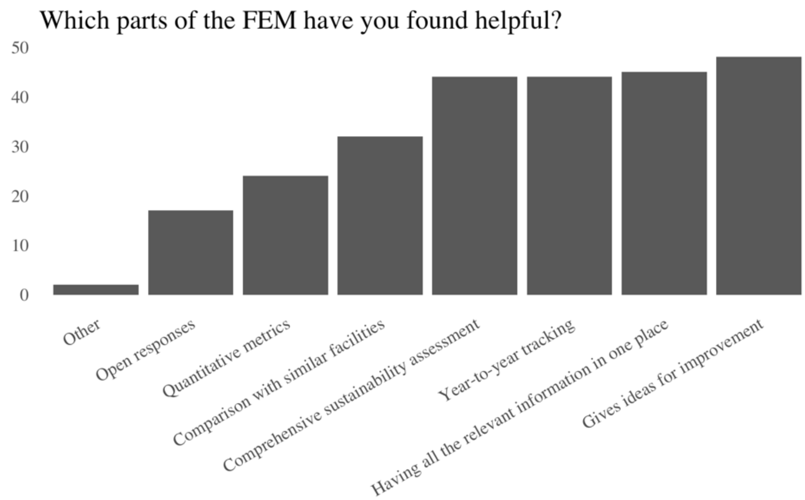

Figure 3-9: Survey results for: Which parts of the FEM have you found helpful?

From our survey and field visits, factories did report that the FEM had captured their attention. Once the FEM was implemented, the four Bangladeshi facilities all noted better company-wide integration across environmental categories. Top-level management was able to get a snapshot of the range of environmental programs. The section scores provided useful heuristics for allocating investment. Furthermore, the FEM helped those facilities craft a coherent vision for their environmental program, where previous efforts were scattered, limited, and marginalized.

Most of the Bangladeshi facilities were already tracking some parts of their environmental impacts, whether through the GHG Protocol or some other mechanism. The FEM complemented that data-tracking by nudging the facilities to set and track goals. The facilities appreciated goal-setting because they felt it provided a more accurate reflection of their environmental management capacity than a static score. Finally, all the facilities agreed the FEM helped lay the foundation for future changes.

Identifying and sharing solutions

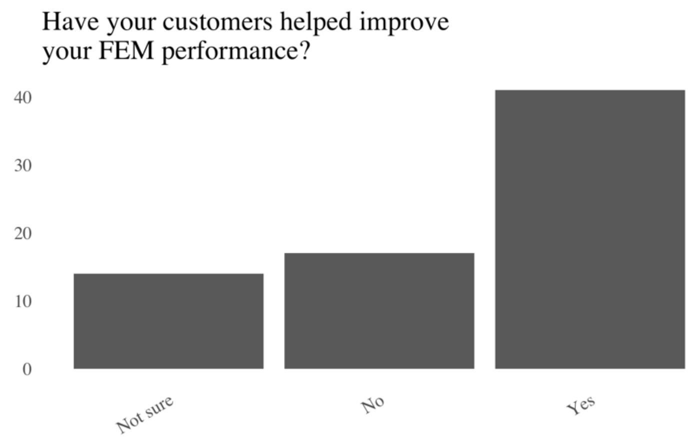

Figure 3-10: Survey results for: Have your customers helped improve your FEM performance?

The FEM was often most successful when coupled with buyer engagement and support. In one sense, buyer support is welcome, and quite possibly necessary to get factories to implement environmental improvements. Yet, it does not meet the full potential of a data-centric system, as it still depends on good intentions and almost personal interactions. By relying on buyers, without better coordination, also means facilities with multiple buyers may be receiving conflicting information. This limits the FEM's potential for success at scale.

While the FEM effectively focuses attention, it does not provide solutions for facilities. For example, what are the best practices for a facility of a given type and region? For the most part, facilities find their solutions through their in-house team, a third-party program like PaCT or Clean by Design, or a buyer. Case studies and surveys show that the FEM pairs well with third-party initiatives. The FEM provides high-level goal-setting, while the third-party initiatives provide concrete solutions. The FEM has started to integrate some of these tools with its partnership with ZDHC. However, a quick cost-benefit analysis tool or tighter integration with third-party providers would be very helpful.

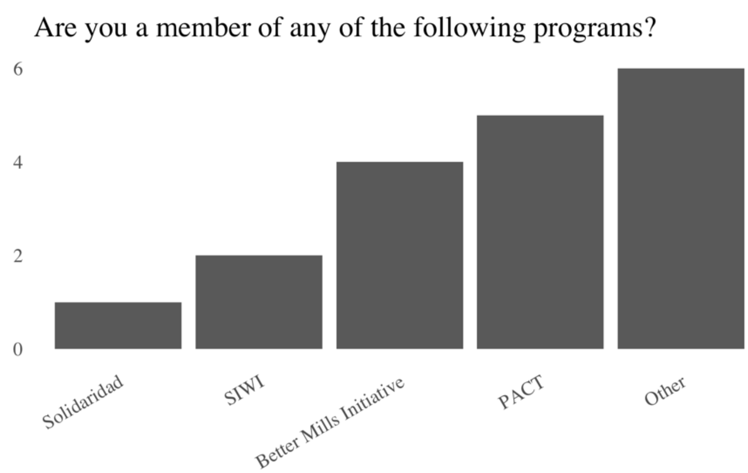

Figure 3-11: Survey results for: Are you a member of any of the following programs?

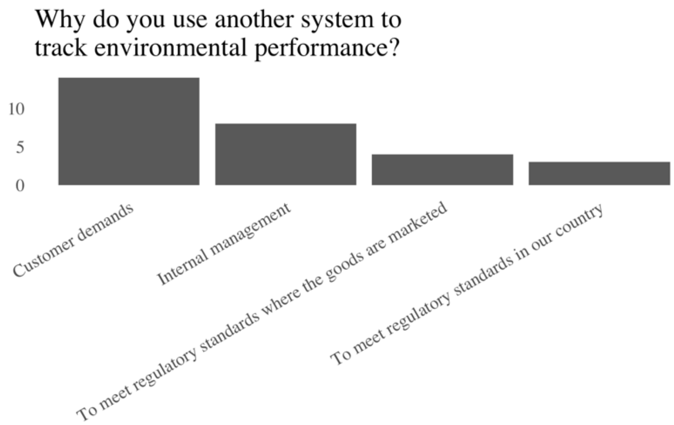

Figure 3-12: Survey results for: Why do you use other EMS systems besides the FEM?

Beyond buyer support, the use of third-party environmental impact assessments has been critical for developing solutions. These reports have helped facilities assess investment potential. This data was at times then fed into the FEM goal-setting section (tier 2). The most comprehensive assessment we encountered was PaCT. However, simple environmental assessments conducted by consultants were also very effective. These identified low-hanging fruit as well as set out a pipeline of future changes. Encouragingly, facilities believed they would be able to undertake the environmental assessment using in-house expertise, given the template provided by the consultants. Other innovative practices included requesting and monitoring FEM scores from upstream suppliers. This is encouraging as it shows the FEM taking root in supply chains and facilities becoming engaged participants rather than passive users.

3.3.4. Incentives

Changing outcomes is largely dependent on changing incentives. The three previous aims—setting standards, enhancing collaboration, and supporting capacity-building—all support changing incentives indirectly. By making information clearer and actionable, facility management can potentially interpret changes as beneficial to their facility, instead of as a burden. The FEM also should ultimately reduce the number of audits a facility needs to conduct, which should save them money and staff resources.

For facility management, the benefits that matter are those that will position their facility and factory group for financial growth. They are keenly attuned to changes that will result in increased orders, better order-terms (financial as well as logistical), and more customers. These are potential direct changes to facility incentives that are likely to have a large effect on environmental outcomes should they be tied together. We evaluate the FEM's direct effects to facility incentives.

Direct Effects to Facility Incentives

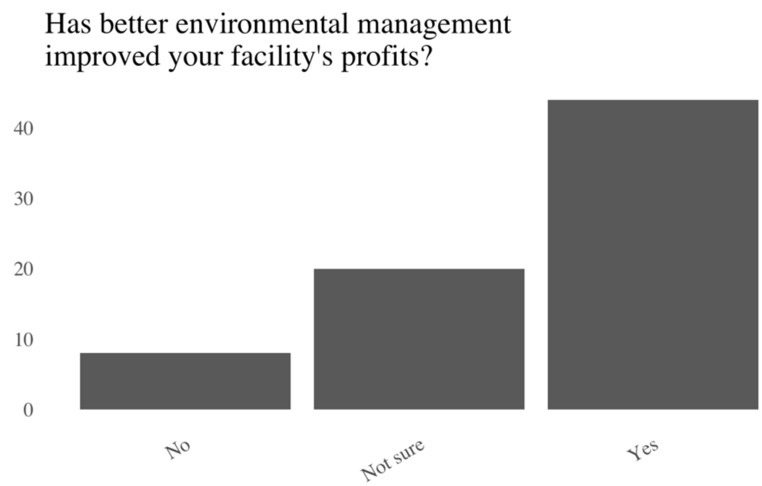

Figure 3-13: Survey results for: Has better environmental management improved your facility's profits?

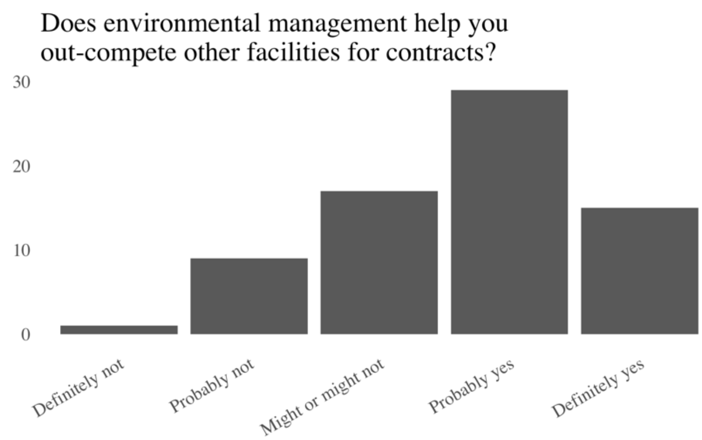

Figure 3-14: Survey results for: Does environmental management help you out-compete other facilities for contracts?

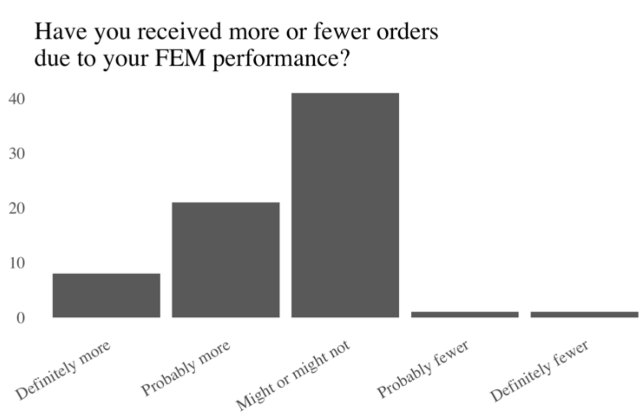

Figure 3-15: Survey results for: Have you received ore or fewer orders due to your FEM performance?

Facilities acknowledged that environmental management generally benefits them through cost savings. When facilities were asked a more direct question about contract competition, the response was more mixed. The majority believed that their environmental management did help them win contracts, however there were a large number of unsure and unlikely responses. This is an indication that facilities might see financial benefits in other areas, for instance, from resource conservation and efficiency gains. Yet, the FEM would be much better at providing financial value to facilities if they knew their FEM performance would influence the contracts they receive from buyers. Facilities in Bangladesh would have liked to use the FEM data to market themselves to buyers. However, they were unsure of how to do so and if it was effective.

The SAC should consider how the FEM could be leveraged to gain new and better production contracts. Both facilities and buyers need clearer guidance on what they can publicly disclose. The FEM is currently not linked into any of the other Higg Index tools, such as the design or sourcing modules. FEM data needs to be delivered at the right time, to the right people in the most accessible format in order to become a more consequential piece of information for buyers. Overall, we do not see much evidence for the FEM substantially and directly influencing facility incentives. Thus, gains due to the FEM can be expected to be severely limited.

3.3.5. Improvement

Through these interventions into standards, collaboration, capacity-building, and incentives, the FEM is invested in driving tangible improvements in environmental outcomes. To properly evaluate whether this has been the case, it would be necessary to use data external to the FEM. However, publicly available data on environmental performance is difficult to access, and even more difficult to attribute to individual facilities. So, we rely on our three data sources to draw preliminary, not definitive, conclusions. We first look for improvements that facilities are making to their processes, inputs, or technology. Then, we examine whether there is sufficient information to ascertain whether there are environmental performance improvements.

Improvements to processes, inputs, or technology

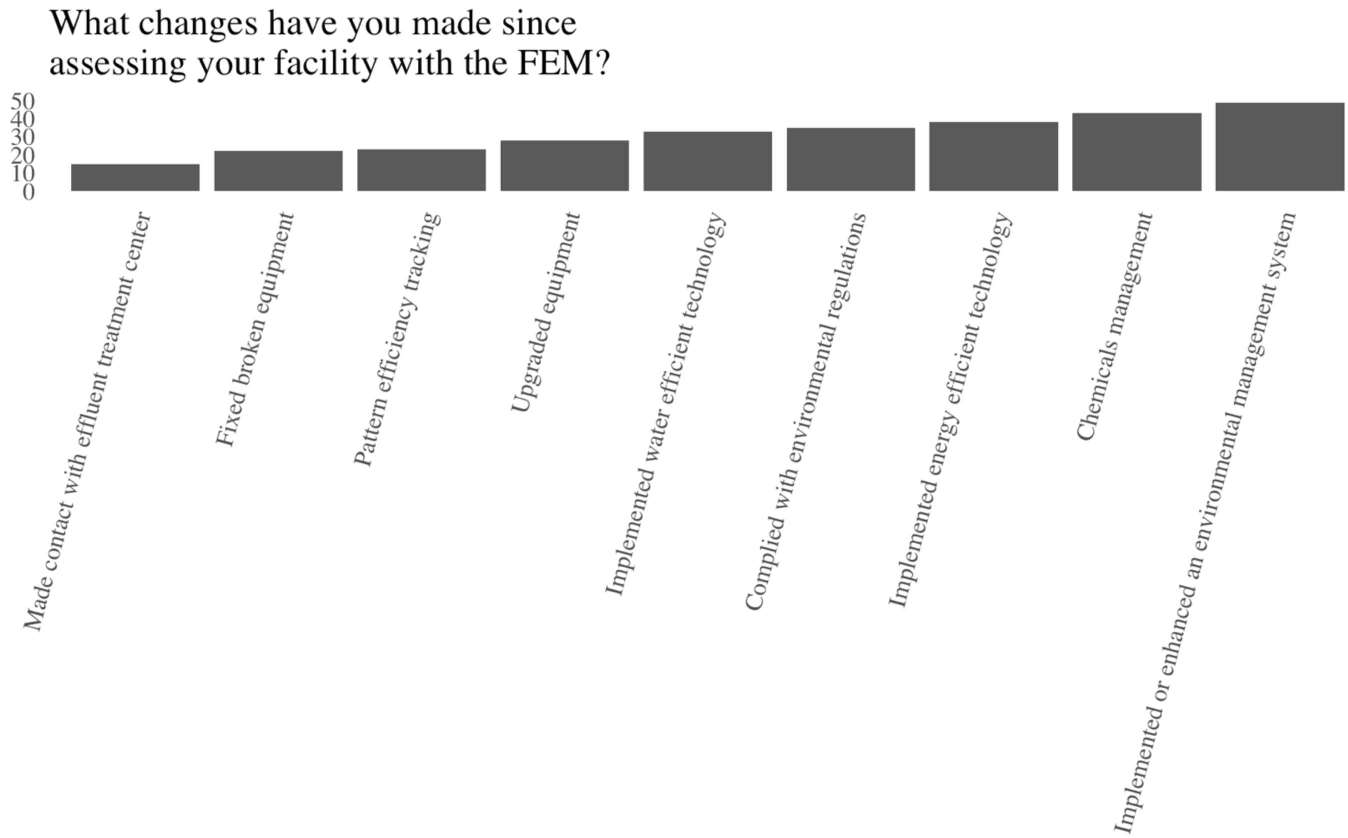

Figure 3-16: Survey results for: What changes have you made since assessing your facility with the FEM?

Figure 3-17: Survey results for: Did the FEM process help you identify any specific areas for improvement that you did not already know about?

Facilities are making improvements after using the FEM. However, it is not clear the FEM is a major driver of these changes. A majority of respondents noted the FEM did not help them identify a specific improvement area. One facility noted that the manufacturer forum in

Bangalore, India in May 2017 gave them several ideas regarding chemical management. This shows the SAC, beyond the FEM, is an important mechanism for distributing and advancing solutions.

From our field visits, facilities demonstrated a number of innovative environmental practices. These changes included high-fixation dyes to reduce water use and chemical use, low-liquor dyeing machines which saved 70% water use over conventional dyeing machines, and steam condensers to reduce water use and conserve energy. Other improvements included: better organized chemicals and waste management processes, rainwater harvesting, auto-dye dispensers, behavior change programs, variable frequency drives, waste sludge dryer, waste incineration boilers, and an exhaust gas boiler.

Environmental performance improvements

There is no conclusive data as to whether these changes have improved overall environmental performance. Without proper data-tracking of facility performance, comparison between facilities, and data on local environmental conditions, it is difficult to make definitive statements on improvements.

The initial FEM v2.0 dataset has allowed us to create baseline environmental performance figures for various facility types. Facility types are not exclusive, so a given facility may be included as both final assembly and printing/dyeing if it fulfills both roles. Thus, the figure below does not show as much deviation between facility types as we might expect.

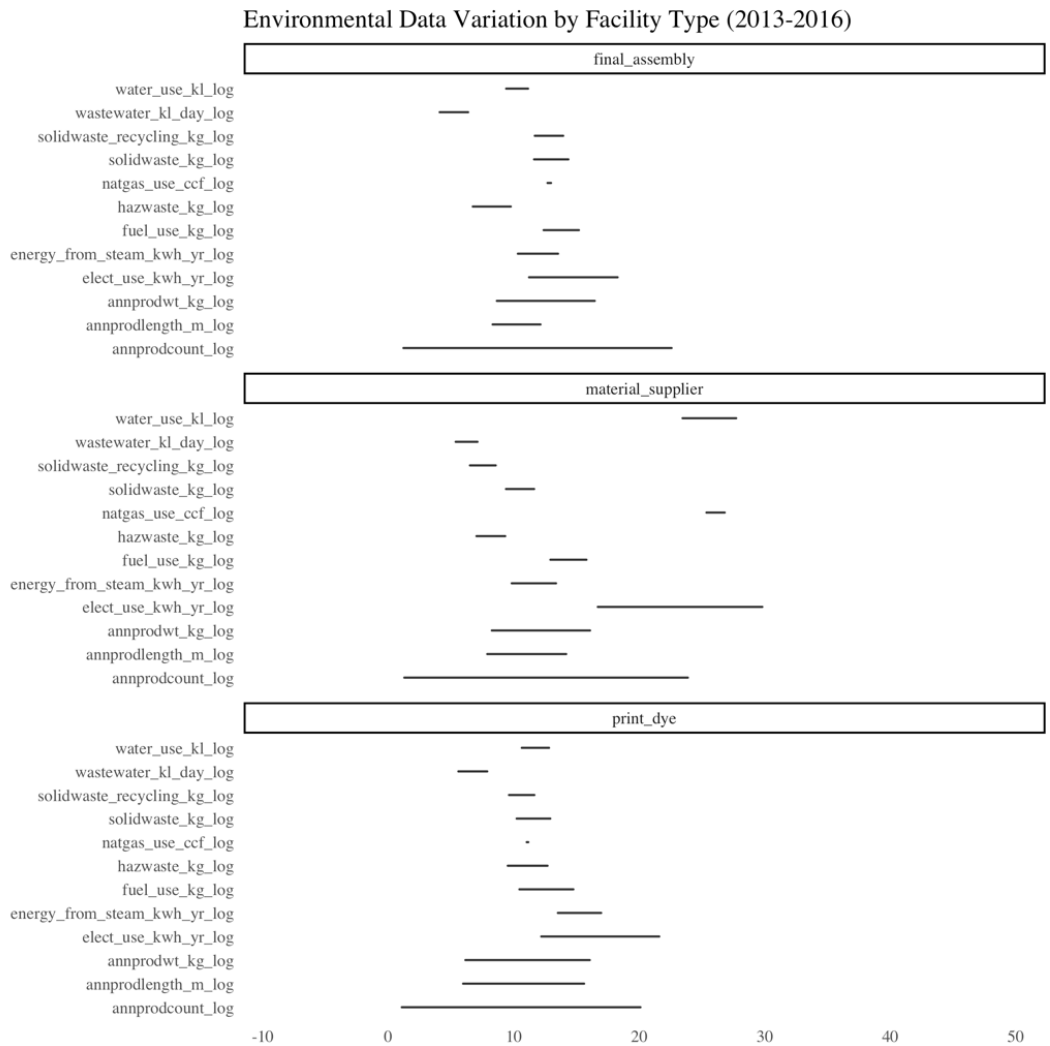

Figure 3-18: Environmental Data Variation by Facility Type (2013-2016).
This plot depicts one of the major issues of the FEM: difficulty comparing facilities. There is extremely high variation in environmental data between facilities of supposedly similar types. Because the data is self-reported, it is unclear whether these differences are due to actual factory conditions, inaccuracies in reporting, or inaccurate facility classifications and comparisons. This high-level information means that the FEM paints a fuzzy portrait of a facility, and further, detailed data collection and analysis is necessary by buyer, supplier, or third-party specialists.

Figure 3-18 depicts one of the larger issues of the FEM: difficulty comparing facilities. There is extremely high variation in environmental data between facilities of supposedly similar types. The 20-point difference between facilities of a similar type is too large of a difference to make sense out of. Discrepancies with annual production figures make it difficult to create an accurate efficiency portrait. More accurate factory size/volume/product comparisons would enable these metrics to be more useful.

Because the data is self-reported, it is unclear whether these differences are due to actual factory conditions, inaccuracies in reporting, or inaccurate facility classifications and comparisons. This high-level information means that the FEM paints a fuzzy portrait of a facility, and further, detailed data collection and analysis is necessary by buyer, supplier, or third-party specialists.

Instead, the FEM could try to track this data with greater frequency. The FEM need not display monthly or weekly water use data, but the data collection and storage should be linked with the FEM so that third-parties and buyers can assist in diagnosing issues as well as surfacing innovative practices. Ultimately, environmental data needs to factor into FEM scoring to create greater incentives for facilities to achieve impact reduction.

Relatedly, the FEM goal-setting feature needs to be better integrated in FEM scoring. Without standards around goal-setting, facilities have consistently set lower targets than they know are possible. For instance, facilities will receive an environmental impact report that shows an investment has a short payback period (e.g. less than one year) and improves energy use by 10%. Instead of setting a five-year target for 15% or 20%, they will set it at 5%, knowing that they will beat it easily. Moreover, facilities often set normalized targets (i.e., efficiency-based targets) because they expect production growth. Despite the efficiency gains, environmental impacts often still increase as production increases. The FEM should aim for impact reductions, not only efficiency gains.

3.4. Recommendations

Apparel production is becoming faster, more dynamic, and data-centric. The Higg Index and FEM would appear well-positioned to take on this digital governance challenge. The Higg Index and the FEM have made steady, incremental progress. Over three versions, the FEM has grown adoption rates and steadily improved features, as part of a vision that combines standards, collaboration, capacity-building, and incentives, to lead towards measurable, continuous environmental impact improvements at scale. However, the Higg Index will need to continue to evolve to be both nimbler and bolder, and to clearly demonstrate meaningful progress.

After eleven years with unsatisfactory improvements in environmental outcomes, there remains a healthy and substantial skepticism of the Higg Index, the SAC, and the industry's ability to drive substantial changes on their own. The FEM has not had a transformative impact on factory environmental performance, and still operates primarily as a measurement and compliance mechanism for buyers. The FEM has not changed the incentives nor integrated environmental performance into existing decision processes. Buyer engagement remains the key driver of environmental performance improvements, but buyer engagement remains minimal and idiosyncratic. The FEM data remains siloed from the SAC's buyer design and sourcing tools.

Within an ever-changing transnational governance and data landscape, and as climate change and other environmental impacts accelerate, the SAC and the industry need to include public transparency and meaningful incentives to drive greater changes. There is a need to now combine standardized data collection with smarter (more context-specific) questions, that are actionable by the factories, that feed into existing incentive structures of buyers, and that support greater public transparency and accountability.

Within the five focus areas (standards, collaboration, capacity-building, incentives, and improvements), the major recommendations for the FEM and Higg Index follow. We begin in reverse order to emphasize more focus needs to be paid to incentives and tangible environmental improvements. Though the SAC originally housed the Higg Index, it has now been spun off into its own company, Higg.co. Thus, our recommendations are directed mostly at Higg.co, while the SAC remains tightly connected.

Improvements: Actual environmental outcomes need to be prioritized and supported, rather than simply measuring processes or reporting.

Steps for Higg.co to consider:

1. Yearly improvements need to be measured and rewarded. Practices, investments, and environmental data need to be separately rewarded.
2. Innovative and high-impact practices need to be open-sourced via the FEM platform.
3. External and contextual environmental data should be a factor in Higg scoring. For example, water use in water-stressed regions should be more important than in water-abundant regions.
4. Facilities should be scored based on their comparison with similar facilities.
5. Facilities should be rewarded for promoting FEM adoption in their own supply chains (tiers two and three).

Incentives: There need to be real incentives for facility improvements. At present, the incentives amount to 10% cost-savings or reducing the number of audits. More meaningful incentives might be growth in sales, signing up a top-tier buyer as a customer, longer-term contracts, higher profit-margins built-in to the contracts, or better payment terms. Poor-performing facilities, if capacity cannot be improved in a timely manner, need to be substituted for higher-performing suppliers.

Steps for the Higg.co to consider:

1. While Higg.co/the SAC cannot promise more and better contract terms, a list of high-performing facilities could be shared with buyers.
2. The FEM needs to integrate into Higg Index tools directed at buyer design and sourcing. There needs to be a simple way for buyers to interpret and find meaning in FEM data, such as a data dashboard.
3. Higg.co should share best practices amongst buyers for how to integrate FEM data into buying practices.
4. The FEM should integrate with facility investment decision processes, potentially by including simple cost-benefit analyses or marginal abatement curves. Potential links to 3rd-party cost-benefit analysis programs such as PaCT should also be considered.
5. Facilities that do not meet local and/or industry standards should be flagged.

Capacity Building: Facility capacity-building needs to be supported, not simply evaluated.

Steps for Higg.co to consider:

1. Facilities should be directed to resources for improving their score.

2. Facilities that demonstrate improvements should be rewarded with access to more materials and trainings.
3. Both questions and support documentation should be translated into local languages.
4. Encourage factories to communicate, compare, and share solutions with other factories.
5. Integrate the FEM with existing 3rd party programs. The improved integration with ZDHC in FEMv3.0 provides a good example.
6. Guidance from verifiers and third-parties needs to be enhanced.

Collaboration: Brands need to be supported and encouraged to collaborate to improve shared facilities.

Steps for Higg.co to consider:

1. Buyers that share a particular facility should be supported and encouraged to collaborate on standards and improvement timelines. Facilities should be able to share one improvement plan with multiple buyers.
2. Buyers need to agree on interpretation of questions and acceptable responses.

Standards: Continue to improve data quality, standards, and verification. Improved data categories and credibility will increase confidence and uptake.

Steps for Higg.co to consider:

1. More research needs to be done to improve accurate comparison between facilities. Key dimensions to consider are size, operations, and location.
2. Questions should consider geographic and regulatory context, and policy divergence from local regulatory standards should be explained. Local regulations can be licensed from existing databases.
3. Verification procedures and training of verifiers need to be standardized.
4. Reduce manual data entry where possible. FEM should consider more regular and granular data-streams instead of annual audits.
5. As supply chains become more data-centric, the FEM data needs to consider incorporating more automated analyses, machine learning, and sensor-based data.

In addition to the five focus areas, we believe the Higg Index should move towards public- and consumer-facing transparency. Providing information that is detailed, granular, regular, and standardized, as well as meaningful to consumers, will unlock incentives to buyers and suppliers. Top-performing producers could receive recognition in the market and encourage continuous improvement and differentiation. Helping top buyers receive the "halo effect" might encourage more brands to invest in data and environmental scientists like they have in social compliance specialists.

3.5. Conclusion

The Higg Index represents an important step in improving the environmental standards and measurement systems for the global apparel industry. However, much remains to be done. The Higg Index is essentially a scale without a diet, a workout plan, or incentives to get in shape. There is measurement. But not nearly enough action to drive real improvements.

There is need now to move from measurement and the good intentions of individual buyers, to a system with clear mechanisms and incentives to identify and drive solutions at scale. And while there is no doubt still need for high-touch capacity building programs, the industry needs to move to faster and broader systems of identifying problems, sharing solutions, and then incentivizing factories to make investments to improve. Poor performing factories will need to be disincentivized (likely losing orders), while good performers receive targeted investments, increased sales, and so forth.

The SAC and Higg Index cannot, nor should they attempt to, solve these issues alone. The FEM is limited by regulatory (in)action. Thus, major political economic changes demand an inclusive approach. Workers, communities, and stakeholders need to be meaningfully involved. Recent successes of “worker social responsibility” and legally binding agreements, show promise in bringing in workers and local governments in these efforts. Stakeholders need to be involved in agenda-setting, directing resources, and monitoring. On top of these efforts, real public transparency will help to build legitimacy, and will create additional incentives for action and innovation. It is time for the global apparel industry to take the next steps in driving sustainability deeply into core business processes and incentives.

4. Sustainable Production: Paying Workers More[18]

4.1. Introduction

Factory worker pay in global apparel supply chains remains a contentious issue (ILO 2014; Rossi, Luinstra, and Pickles 2014). In an industry focused on continuously-increasing efficiency and cost-reductions to meet consumer demands, worker wages have often been squeezed to meet brand, retailer, and supplier profit targets (Selwyn 2016; Anner, Bair, and Blasi 2012). Despite increasing productivity, factory workers have experienced flat or declining real wages around the world (Lee and Sobeck 2012; Vaughan-Whitehead 2014).

While many stakeholders believe worker wages are too low, there is disagreement about what, if anything, can or should be done. Global brands assert that they have limited ability to increase the wages paid by contracted factories, that their suppliers pay "prevailing wages", and that they have little influence over all-important, government-set minimum wages (Selwyn 2016; Bhagwati 2005; Clean Clothes Campaign 2019). Factory managers argue that their margins are too thin and their contracting relationships are too tenuous, among other rationales, to pay workers more (Clean Clothes Campaign 2019). Workers, unions, and NGOs, on the other hand, advocate for a "Living Wage" and assert that brand margins and consumer budgets can accommodate wage increases (Miller and Hohenegger 2017; Fair Wear Foundation 2014; Pollin, Burns, and Heintz 2004; Miller and Williams 2009), and that it can be profitable for factories (Hurst 2013) and beneficial for economic development (Barrientos, Gereffi, and Rossi 2011).

Amidst this longstanding struggle for better working conditions (with wages being one of the most significant issues), the apparel industry is also undergoing rapid structural changes. Known colloquially as "fast fashion", the market is demanding increasing speed-to-market and product differentiation (Cachon and Swinney 2011; Rüßmann et al. 2015). As a result, factory goals have shifted from total output to the continuous flow of high-quality, in-demand styles. At the request of buyers, manufacturers have adopted "Lean" production principles—continuously increasing productivity and quality while eliminating waste—to modernize their factory layouts, machinery, and IT systems (Abernathy et al. 1999; Berg et al. 1996).

These Lean changes to the factory floor have compelled complementary managerial and human resource (HR) policies (E. Appelbaum 2001). It is more common now for factory floor workers to be trained in multiple skills and asked to identify and solve problems without depending on hierarchical decision-making (Ichniowski and Shaw 2003; Boxall and Macky 2009; Sterling and Boxall 2013). Despite these and other advances in HR practices, many Lean factories still employ similar compensation systems as they did 40 years ago (Vaughan-Whitehead 2014). And very few factories align compensation with modern job expectations and factory goals (Helper, Kleiner, and Wang 2010).

[18] A version of this chapter was previously published in the journal PLOS One with co-author Dara O'Rourke (see Lollo and O'Rourke 2020). I acknowledge this co-author's contributions and thank him for permitting me to reproduce and adapt this material as part of my dissertation.

While firm practices can be considered prima facie evidence for efficient and effective policy (Larkin, Pierce, and Gino 2012) (such that sweating workers may actually be a perverse, profit-maximizing strategy), apparel factory management practices are likely to be sub-optimal for a number of reasons (Robertson et al. 2016). One major contributing factor is that though women constitute a majority of apparel factory workers, they rarely occupy management or high-status positions (Christian, Evers, and Barrientos 2013; J. L. Collins 2003). This stark gendering of positions often contributes to antiquated, gender-biased wage discrimination. Other causes of inefficient policy include that managers may lack knowledge (about what workers want, the ideal policy, the benefits afforded by said policy, and so on), skills, or attentional capacity (Bloom et al. 2013; Ichniowski and Shaw 2013; Adler et al. 2017). Instead, management practices may simply correspond to local norms and historical practices (bringing a certain inertia).

Moreover, whether these biases are present or not, as with any business, changing external conditions merit re-examination of firm-level practices. We believe compensation systems—which may already be inefficient—can play a critical role in responding effectively to both the increasing normative pressure to raise worker wages and to meet the new production demands of fast fashion.

Our paper addresses the question: How and under what conditions can wage increases be structured to improve productivity and profitability within an agile and competitive factory environment? Through a two-year quasi-experiment in an operating apparel factory, we assess the effects on productivity and profits of raising worker wages with a re-designed compensation system. We show that, even within current factory margins and constraints, important wage gains (4.2-9.7%) are possible and profitable. Under the treatments, productivity increased 8-10%-points while turnover decreased markedly. We next summarize the relevant literature on compensation to help explain our results.

4.1.1. Motivating workers through wages

The classic way to incent factory workers is by the "piece rate", which pays workers according to their marginal productivity (Lazear 2000; Lazear and Shaw 2007). Because apparel factory work—unlike agricultural picking, a commonly-studied job in wage design—is team-based, most apparel workers are paid according to group piece-rates (what we call a "group rate") (Helper, Kleiner, and Wang 2010; Bloom and Van Reenen 2011; Boning, Ichniowski, and Shaw 2007).[19]

Workers, on the other hand, regulate their behavior in order to optimize between wages received and effort exerted (Miller 2014; Cohn, Fehr, and Goette 2015). Individuals are not simply motivated by ever higher wages; they have a "reference" wage determined by their marginal utility of income (Fehr and Goette 2007; Daido and Murooka 2016; Chang and Gross 2014). Assuming no significant change in preferences, this is essentially the wage workers would be satisfied by. If workers are receiving their reference wage, then a wage increase is likely to have

[19] For a review of literature on improved incentives in other manufacturing contexts, see (Bloom and Van Reenen 2011). Studies such as (Hamilton, Nickerson, and Owan 2003; Boning, Ichniowski, and Shaw 2007) have examined the effect of incentives in US manufacturing, while (Blasi et al. 2009) conducted a review of studies on workplace incentive systems.

no effect, or possibly a negative effect, on productivity (Fehr and Goette 2007). All else equal, once the reference wage is obtained, we should begin to observe diminishing increases in effort, if not compensatory decreases in effort (Cohn, Fehr, and Goette 2015). If living wage advocates are correct, worker wages are currently much lower than their reference wages, and thus wage increases should motivate increases in effort simply because workers want to earn more income.

There are many reasons to believe that the biggest problem with group rates is that they are set too low for workers to earn satisfactory wages. In the apparel industry, worker wages are de facto set by national minimum-wage policy (Clean Clothes Campaign 2019). Factory management, required to pay the minimum wage, often sets the group rate such that workers will achieve the minimum wage when a target output is reached. The goal for workers is of course to beat the target output. However, modern manufacturing demands makes that goal increasingly challenging and frustrating. Target output is determined by the "standard allowable minutes" (SAM) of a given garment and the available working minutes of the production line. There are general, "universal" SAMs calculated by third-party organizations using industrial engineering techniques (e.g., time-measurements of ideal physical movement), though the SAM for each given garment is set through brand-factory negotiation. With downward pressure on the SAM due to brand power, beating the SAM (and thus the target output) becomes harder over time.

The standard practice of "pay for time" compensation, while dominant and presumably efficient, becomes problematic because the difference between the minimum wage and pay-for-performance is minimized. Workers are not motivated to put in additional effort beyond the minimum required to avoid punishment. They are also more likely to leave the job altogether (Record, Kuttner, and Phouxay 2014). On days with new product-styles, more difficult product-styles, or multiple product-style changes (requiring more or fewer workers and/or different machines), simply working for overtime (when pay increases by time-and-one-half) becomes the best method to maximize take-home pay while minimizing effort. Even though it costs the factory more per labor hour, managers accept overtime as normal business practice, as it allows them to accommodate variable order sizes, hire fewer full-time workers, flex worker hours during production peaks, and not have to lay off workers during slow periods (Robertson et al. 2016; Raworth and Kidder 2009).

Incentivizing increases in productivity through increasing compensation is likely to fail if several other conditions are not met. First, workers need to trust management. If workers believe that the group rate (or SAMs) may be subsequently lowered once they demonstrate higher productivity, workers may avoid increasing their effort (Bloom and Van Reenen 2011). Second, workers need to perceive the expected wages as fair given the effort to obtain them (Miller 2014; Cohn, Fehr, and Goette 2015). Third, workers need to have control over processes that would increase productivity (E. Appelbaum et al. 2001; Becker and Huselid 1998; Schuler and E. Jackson 2014; Ku 2019). Fourth, problems arising from the free rider issue inherent to group rates—every worker receives the same wage, which can lead to higher-skilled or harder-working workers becoming de-motivated—can be significant (Helper, Kleiner, and Wang 2010; Boning, Ichniowski, and Shaw 2007; Román 2009; Hamilton, Nickerson, and Owan 2003). A better team culture and/or skill and seniority bonuses can help minimize the issue. However, a recent assessment suggests skill and seniority bonuses are uncommon (Vaughan-Whitehead 2014). All told, wage increases should motivate workers to increase productivity if they are currently below their reference wage, trust management that wage gains are permanent, the wage gains are fair given the effort required to obtain them, there are productivity-increasing actions workers have control over, and conflicts from free rider issues are not significant.

4.1.2. Project Summary

In a two-year quasi-experiment in Thailand, we made three specific changes to the operating apparel factory's existing compensation system on eight production lines (that is, six treatment lines, plus two control lines out of 23 total lines). First, an accelerating group-rate wage structure was introduced to the production line. We tested three different versions of this accelerating group-rate (two lines per version; two lines were held as control). The compensation systems can be described as: 1) accelerating group-rate ("Productivity"); 2) accelerating group-rate focused on Productivity with additional Quality and Waste Reduction incentives ("PQWR"); and 3) accelerating group-rate that allowed workers to elect to go home when they reached a pre-specified target wage ("Target wage"). Second, these wage structures were applied to all workers in the relevant production chain (cutters, line managers, supermarket, etc.; see Fig. 1 for more graphic detail), and monthly and yearly bonuses were removed where those had been applied (mostly for lower-level managers). Third, new communication procedures around compensation were introduced via LCD monitors and team meetings.

Employing a difference-in-difference identification strategy with a two-year panel dataset, we find the PQWR and Target Wage treatments increased productivity about 8%-points and 10%-points, respectively, while the Productivity treatment saw no effect. These gains were obtained in the short-term and persisted, ruling out a mere novelty effect. The treatments raised wages between 20 and 46 baht per ten-hour day from a pre-treatment average of approximately 480 baht. These wage increases of between 4.2% and 9.7%, raised wages much closer to the estimated living wage of 606 baht in 2017, and to workers self-reported-preferred wage of 700 baht. Workers, in four sets of focus groups conducted by a third-party, reported increased satisfaction with the new wages, and more satisfaction with management, as a result. Turnover decreased in the PQWR and Target wage treatment groups, and workers stated they more motivated by the increased potential wage, and that it created a starker difference with the "pay for time" option.

Newly motivated workers focused their increased effort on behaviors for which they had the most control. The PQWR and Target wage treatments raised the quality rate by about 1.8%-points, while Productivity had no effect. While stress did not appear to increase, we find worker tardiness decreased. Yet additional productive behaviors which required more effort and stress, such as supporting team members and line balancing, were largely unaffected. This can be explained by the still-present free-rider issues; workers continually noted their frustration with lower-skilled team members. Similarly, line workers lacked the skills and authority to remove some of the more consequential constraints on productivity, such as material and machine downtime. The incentive for those workers who were responsible for those issues was found to be less effective.

For the factory, profits increased as output gains outweighed profit-per-garment losses on five of the six treatment lines. Moreover, the decreased turnover resulted in significant avoided costs.

The clearest testament to the intervention's success is that management expanded parts of the new compensation framework—the accelerating wage structure and production chain alignment—across the entire factory as soon as the quasi-experiment ended.
This research suggests that, even within current factory constraints, important worker wage gains are possible and profitable. Management should consider improving compensation as a means to retain workers and incent better performance. The results should be of interest to industry stakeholders and to scholars of worker compensation regarding the effects of raising wages on firm outcomes. The paper is structured as follows. In Section II, we provide details on the quasi-experiment. Section III covers results and discussion. Section IV concludes.

4.2. Quasi-Experimental Details

4.2.1. Factory Context

In 2015, we partnered with a multinational company and one of the company's strategic suppliers—a manufacturer for the company's more innovative and high-value products—based in Thailand. Of the supplier's facilities, we selected a "cut-and-sew" final-assembly factory for the intervention. The factory workforce was entirely ethnic Thai. The gender balance was typical of apparel manufacturing: about 95% of the sewing line workers, quality control personnel, line managers, and supervisors were female, while all of the mechanics and upper management were men.

The factory had fast-fashion production characteristics: continuously changing product styles, small-batch orders, high-pressure to meet on-time delivery targets, and a competitive price negotiation process. To meet these demands, the factory, over the preceding years, had implemented many features of a modern Lean production system, from the physical factory layout to advanced technology and machinery, all to encourage more efficient production flow.

In addition, between May and November 2015, the factory management had begun to implement new human resource policies, including management training. For workers, there was an emphasis on skills and engagement. First, all sewing line team members and supervisors received five trainings, from technical to interpersonal skills. Second, the management instituted a social dialogue system with worker election of line representatives, training of line representatives on how to hold meetings, elicit input, elevate issues to management, and communicate resolutions (without supervisors present). Third, management trained workers and supervisors in stress management and provided time each morning for a short set of stress management activities. And finally, management supported discrete 5-day, worker-only problem-solving events—"Kaizens"—in which workers would raise issues (perhaps using insights from an internal "engagement and well-being" survey), develop solutions, and then present the ideas to management.

Before the new HR program, worker dissatisfaction was quite high, as measured in an internal engagement and well-being survey. Initial focus groups revealed that line managers were highly dissatisfied as a result of perceived undue pressure from both upper management and sewing line workers, along with unsatisfactory compensation. Sewing line workers, in a separate focus group, expressed frustration with nearly all other workers—quality control personnel, mechanics, and line managers—for lack of support. Along with unsatisfying compensation, these workplace tensions were contributing to turnover rates upwards of 80% per year on some lines.

To understand how these workplace tensions affected productivity, first we need to understand how a garment is produced. Fabric enters the facility and is cut into pieces of a given garment. These pieces are bundled and sent to sewing lines in another part of the factory. Once the garment is assembled and has passed the quality inspection, the garments are tagged, packed, and boxed for shipment. Figure 4-1 presents a basic schematic of the production process for one business unit involving four sewing lines.

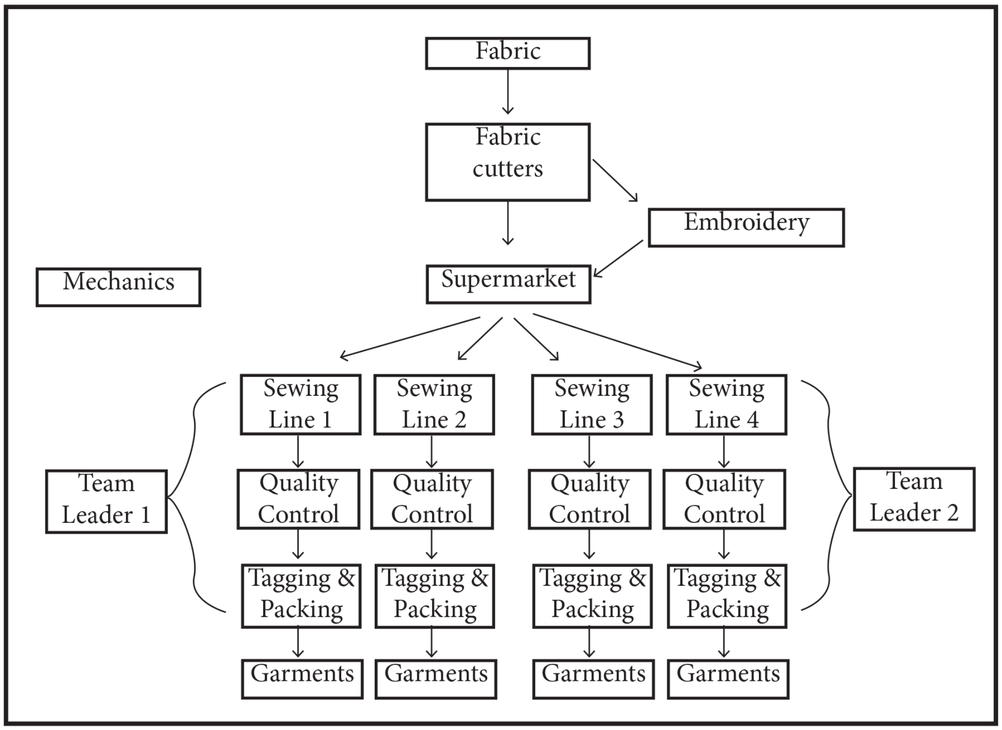

Figure 4-1: The production schematic for one business unit.
In the factory, the fabric cutters, embroidery, and supermarket supply to multiple lines. Each team leader oversees two lines. Mechanics help fix machines anywhere along this process. At the end of each line, there was an LCD screen that displayed information about the target output and current production level.

Production lines are generally assigned the number of workers that match the number of discrete operations a garment requires, typically about 20. These workers form a team and generally stay on their given line. However, workers may be added (from a "relief" team) or removed from lines on any given day as line managers try to balance production as product-styles change during the day, workers are absent, or bottlenecks emerge. How effectively this "line balancing" is performed has large consequences for productivity.

Despite being a central worker concern, wages had not been addressed by factory management within the new HR program. Worker compensation and incentives varied by position. Sewing line workers, whose pre-existing compensation was the starting point for the intervention, received the greater of the minimum wage or a group rate multiplied by total line output.[20] Line managers were paid a monthly salary with uncertain profit-based bonuses. Quality control personnel received the minimum wage plus an incentive for identifying product-defects. Mechanics, whose efforts to fix machines were critical to achieving production flow, were paid through a separate compensation framework. Fabric cutters and workers that transported the garment bundles simply received the minimum wage. There were no seniority or skill-based bonuses in the factory.

Line workers, before the intervention, were making 480 baht for a 10-hour day. This was slightly above the 412.5 baht minimum required by law for ten hours. Though Thailand lacked a Living Wage estimate produced by the ILO-Anker method, the Asia Floor Wage, a second-best option, was estimated in 2015 at 13,359 Baht per month and in 2017 at 15,140 Baht per month.[21] Assuming 25 workdays per month, these figures translate to 534- and 606-baht per day. With consistent year-over-year change, at the onset of the intervention in 2016, the Asia Floor Wage would have been 570 baht per day, leaving a daily wage gap of 90-baht per line-worker. Workers stated in focus groups they that 700 baht per day would be "good". This would mean line workers had a 220-baht daily wage gap.

4.2.2. Quasi-Experimental Design

We evaluated three compensation system treatments with eight sewing lines—six treatment lines and two control lines—out of 23 lines in the factory. Data collection began one year prior to the intervention and continued for one year following the intervention (from January 1, 2015 until January 15, 2017) to control for seasonality of order volume and holidays. The primary data is daily human resource and productivity data for each of the eight sewing lines. Each observation represents one line-day. Factory management also provided demographic information and monthly turnover data, while a third-party conducted four sets of focus groups with workers before, during, and after the intervention. Informed consent was obtained verbally by workers and managers for the general study as well as specifically for those workers who participated in focus groups. This study, including verbal consent,[22] was approved by the UC Berkeley Committee for Protection of Human Subjects, Protocol ID 2015-09-7924.

We employed a quasi-experimental design. The lines were not randomly selected; the company and factory management selected what they considered to be four average pairs of lines. Since the line manager is critical for performance (Huo and Boxall 2017), and line managers oversaw two lines each, line-pairs were evaluated against one another. Using data from the prior year

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[20] Over the entirety of the study period, the Thai minimum wage was 300 baht over 8 hours and 1.5 times the hourly rate for overtime. For reference, the exchange rate between Thai baht and USD was approximately 35 baht to one USD. Workers typically worked 8 hours on Monday and Saturday, and 11 hours on Tuesday through Friday, for a total of 60 weekly hours, which is the maximum hours allowed under Thai law.

[21] **https://asia.floorwage.org/what**. Accessed July 8th, 2019.

[22] Verbal consent without record was deemed acceptable according to UCB IRB reasoning: "The research presents no more than minimal risk of harm to subjects AND involves no procedures for which written consent is normally required outside of the research context."

(2014-2015), the company and factory management tried to control for line-level variables they thought would influence the study: productivity, number of workers, worker skill, location in the factory, the physical line shape, and line manager capability. Workers were not able to self-select onto or off of lines that received a treatment. The other 15 lines in the factory were not monitored during our intervention, but were likely aware of the intervention and present a possible source of bias.

The intervention aimed to increase wages through an accelerating group rate (Sliwka and Werner 2016). The control group continued to be compensated as had been previously done: they received the greater of the minimum wage or a group rate multiplied by total line output. For the treatment, however, the group rate would increase as certain productivity targets were reached. Productivity, a measure of labor-time efficiency, can be expressed as:

$$(1) \qquad Productivity = \frac{Output * \frac{SAM}{garment}}{\#\ of\ workers * working\ minutes}$$

Through analysis of historical data, we conservatively estimated a breakeven-point for the factory at 85% productivity. So, at 90% productivity, the group-rate for all garments produced that day (even on days with multiple styles) was multiplied by 1.06. This multiplier increased by 0.06 for every five-percentage-point productivity increment thereafter, with a ceiling at 1.48 for 125% productivity. This new wage structure constituted the first treatment, which was called "Productivity", and served as the base for the other two treatments. According to the new incentive structure, all eight lines would have received some extra incentive 60% of the days during the pre-treatment period.

The second treatment, "Productivity, Quality, and Waste Reduction" (PQWR), used this same new wage calculation, but sought to anticipate and avoid a tradeoff between productivity and quality. Since inefficiencies can cascade across the production chain, workers at each stage were incented to maintain high-quality standards and to reduce material waste. For instance, fabric cutters received a 10-baht bonus when they identified that a fabric layout could be remarked to optimize fabric usage. For sewing line workers, there was a 20-baht bonus if the line achieved a 97% quality rate for the day. The quality rate is the number of garments that did not need re-work nor were defective divided by the total output.

The third treatment, "Target wage," used the same new wage calculation as the Productivity treatment, but if the line reached a given target wage, then they could elect to go home for the day. After consulting with management and workers and analyzing the previous wage data, the target wage was set at 500 baht in 8 hours and 650 baht in 10 hours. This target wage effectively aimed to codify the reference wage.

Each treatment also received several complementary measures: incentive alignment and better wage communication. These changes were made in concert with the compensation formula change, so we did not test individual effects, nor, of course, are the effects independent of the factory's pre-existing HR practices. First, all workers along the production process—sewing line workers, team leaders, supervisors, mechanics, quality control personnel, and cutting room team members associated with two of the treatment lines—would be compensated according to the line's productivity. Workers associated with multiple lines, like team leaders and fabric cutters, were compensated based on an average of associated lines. For all workers, the new wage was either an upgrade in pay or maintained pay at a similar level. Workers were guaranteed to not be lower than they would have been under the old system. Biweekly paychecks showed workers their wage alongside what they would have received under the previous compensation system (for positions without profit-sharing bonuses).

Second, the factory reconfigured pre-existing LCD screens with more detailed hourly wage, target output, hourly rates of productivity, and expected wage information for each treatment line. Workers were also trained to interpret the reconfigured LCD screens, in order to help workers to make informed, real-time decisions about their effort based on expected wages. Through focus groups, workers recommended and it was adopted that the LCD screens would display the number of garments needed to reach the next incentive bracket, rather than show a percentage measure of productivity.

In the focus groups conducted by a third-party consultant, workers were introduced to the new wages. Worker feedback from these focus groups informed the final wage targets, productivity levels, and quality bonuses. Workers also asked for mid-level management to personally explain the new wage system to all workers in the treatment. This request was granted.

4.2.3. Empirical Strategy

Establishing causality with a quasi-experimental design presents challenges (Lonati et al. 2018). To estimate the treatment effect, we use the difference-in-difference strategy with an ordinary least squares (OLS) regression model with fixed effects. We bolster this analysis with turnover data and focus groups.

In each of four focus group sessions—one before the treatment, two during, and one after the intervention—a trained, local facilitator separately queried line members, line managers, quality control personnel, higher-level managers, and mechanics. The consultant worked with factory mid-level management to select workers. Focus groups included a few team members from each treatment group, as well as control lines. The resulting documents were analyzed thematically, looking for patterns and deviations from the different focus group members. The focus groups provided important information about worker perception of wages and about team dynamics across treatments and over time.

The primary line-level productivity and wage dataset contains 4372 observations with full and consistent data (i.e., no outliers or missing data). One observation entails one line-day, with data on productivity, output, number of workers, style ID, and so on. Observations are at the line-level, not worker-level. The observations that are missing (about 200 line-days were missing data on either the dependent or independent variables) do not disproportionately fall on any one line or treatment group. Table 1 below shows descriptive statistics of the key variables. The Appendix A contains summary statistics grouped by treatment (Tables 7-1 to 7-4).

Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Productivity (%)	4,372	98.09	34.94	2	74	123	178
Hourly Wage (THB)	4,372	50.46	10.87	37.50	42.61	56.88	111.49
Working Hours	4,372	9.97	1.46	8	8	11	12
Overtime (0,1)	4,372	0.52	0.50	0	0	1	1
Number of Workers	4,372	20.02	1.87	9	19	21	28
SAM (min/garment)	4,372	22.66	6.25	0.00	19.86	26.35	78.00
Lead Time (days)	4,372	6.61	7.24	1	2	9	57
Style Familiarity (style-days/line)	4,372	54.18	47.91	1	17	81	179
Tardiness (min)	4,372	4.96	19.76	0	0	4	725
Unplanned Absenteeism (%)	4,372	1.77	3.68	0	0	4.2	77

Table 4-1: Descriptive statistics of all variables over the full period (January 2015-January 2017).

The general regression model specification is:

$$(2) \qquad y_{it} = \alpha_{it} + \beta_{it}X_{it} + \delta_{it}W_{it} + \gamma_{it}Z_{it} + \varepsilon_{it}$$

Where y_{it} is the outcome variable, indexed by line (i) and time (t); X_{it} is the treatment dummy variable (0,1); W_{it} is a vector of covariates; Z_{it} is a vector of fixed effects; and, ε_{it} is the error term, and is assumed $\text{E}[\varepsilon_{it}|X, W, Z] = 0$.

The treatment variable, X_it, can be decomposed into its interaction terms:

$$(3) \qquad X_{it} = phase_{it} * treat_{it}$$

Where, $phase_{it}$ is a (0,1) dummy for the intervention period, with a value of one during the intervention, and $treat_{it}$ is a (0,1) dummy variable for treatment, with a value of one if a line received a treatment. Our coefficient of interest in Equation 2, β_{it}, therefore, captures the mean difference between treatment and control groups, controlling for any pre-treatment differences by group.

A difference-in-difference strategy depends on the parallel trends assumption (Lonati et al. 2018). Despite non-random line selection, the parallel trends assumption was not violated in all cases when controls (line, style, and number of workers) are included. The parallel trend assumption did not hold for a simple time trend, likely due to strong seasonality and differences in style consistency (in Appendix A, see Table 7-5 for the results from the two-tailed t-test; see Figure 7-1 for a plot of the time trend using regression residuals).

Using a January 2016 snapshot of demographic data, we did not find significant differences in worker age or length of employment. There were some gender composition differences between the lines (see Tables 7-6 to 7-8 in Appendix A). And, when comparing line manager characteristics—years at the facility, years as a manager, and number of trainings—the only significant difference was that the PQWR treatment manager had less management experience (as shown in Table 7-9). We believe the comparison is still valid, but the point estimates may not be precise.

We estimate treatment effects on productivity, wages, tardiness, quality rate, and factory profit-per-garment. The covariates, whose inclusion vary across regression model specification, include number of workers, work hours, a binary variable for overtime, the number of consecutive days a style has been in production on the line, the expected standard allowable minutes (SAM) to produce the garment, total tardiness in minutes, and unplanned absenteeism. We tested various functional forms for these covariates. The fixed effects, included in each model specification, were garment style, date, and line. Style captures major differences between the 170 styles not accounted for by SAM. Date controls for any temporal variations such as temperature (Somanathan et al. 2014), type of garments, and number of orders. Line captures unobservable differences across lines that may cause different outcomes such as the team culture.

We corrected for standard errors using the Newey-West variance estimator (Newey and West 1987). When clustering standard errors at the line level, the general statistical story remained consistent, however the Newey-West method resulted in a better distribution between fitted values and residuals. For more information on data analysis, see the Appendix A. The regression tables were generated using the "Stargazer" package in R (Hlavac 2015).

4.3. Results & Discussion

This section proceeds as follows. First, we determine if and by how much the treatment influenced productivity, the central measure of treatment success. We then look for evidence that the treatment had its intended effects: that wage increases, and other treatment features, occurred. By examining if and how workers perceived the wage increases, we explore mechanisms for changes in productivity. Then we look at how worker behavior changed, by examining turnover, absenteeism, tardiness, quality, teamwork, and effort. Finally, we assess the intervention's effects on firm outcomes including profitability.

4.3.1. Impact on Productivity

Across six OLS specifications presented in Table 4-2, we find the PQWR and Target wage treatments had positive, significant effects on productivity—10%-points and 8%-points, respectively. Both point estimates increase by about 4%-points when the covariates are removed. We do not find a significant effect for the Productivity treatment. When examining Figure 4-2, which shows the actual change in productivity between the two periods, we see that only one line in the Productivity treatment appears to be unsuccessful, a discrepancy we explore in detail during our investigation of mechanisms.

	Dependent variable:					
	Productivity (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	-2.128	-1.767	-1.861	-2.827	-3.886	-3.692
	(3.805)	(3.841)	(3.289)	(3.429)	(3.497)	(3.518)
PQWR treatment	12.075**	12.231**	9.353*	8.611*	8.276*	8.178*
	(5.177)	(5.178)	(4.924)	(4.940)	(4.941)	(4.959)
Target wage treatment	13.985***	14.100***	11.696**	10.313**	9.745**	10.240**
	(4.493)	(4.502)	(4.589)	(4.480)	(4.420)	(4.382)
Overtime		3.897**	3.975**	4.049**	4.099**	7.590*
		(1.884)	(1.836)	(1.848)	(1.856)	(4.143)
Familiarity			0.118***	0.120***	0.118***	0.114***
			(0.025)	(0.025)	(0.024)	(0.025)
Number of line workers				38.888	43.541	41.722
				(39.509)	(39.319)	(39.544)
Square of Number of line workers				-53.458*	-49.571	-48.214
				(31.837)	(31.817)	(31.639)
Cube of Number of line workers				-80.781***	-75.140***	-74.497***
				(23.358)	(24.083)	(23.657)
SAM					1.287**	1.290**
					(0.504)	(0.510)
Work hours						-1.352
						(1.268)
Style - consecutive days in production						0.122
						(0.121)
Tardiness (minutes)						-0.015
						(0.020)
Unplanned absenteeism (%)						-0.023
						(0.143)
Observations	4,372	4,372	4,372	4,372	4,372	4,372
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 4-2: OLS regressions with productivity as the dependent variable.
Fixed effects for each specification are date, style, and line.

There is a strong non-linear relationship between work hours and productivity. We would expect effort and productivity to linearly decrease with work hours, however there is no evidence for this effect. Instead, productivity increases significantly with overtime, which may be a result of workers applying greater effort when they can receive higher wages. As we would expect, familiarity is a driver of increased productivity as workers become more adept at making a particular style. In the focus groups, workers consistently said that "longer orders" were better for productivity. Interestingly, SAM has a strong, positive relationship to productivity, which may be a feature of higher SAMs having more leniency baked in (or are harder to project), or that workers are more familiar generally with higher SAMs and this result is capturing that effect. We expect it to be the latter, considering a majority of SAMs were within the 25-40 minute range. Specification 6 includes two endogenous variables—tardiness and unplanned absenteeism—so the estimates are likely biased and any interpretation of that specification's results should be cautious.

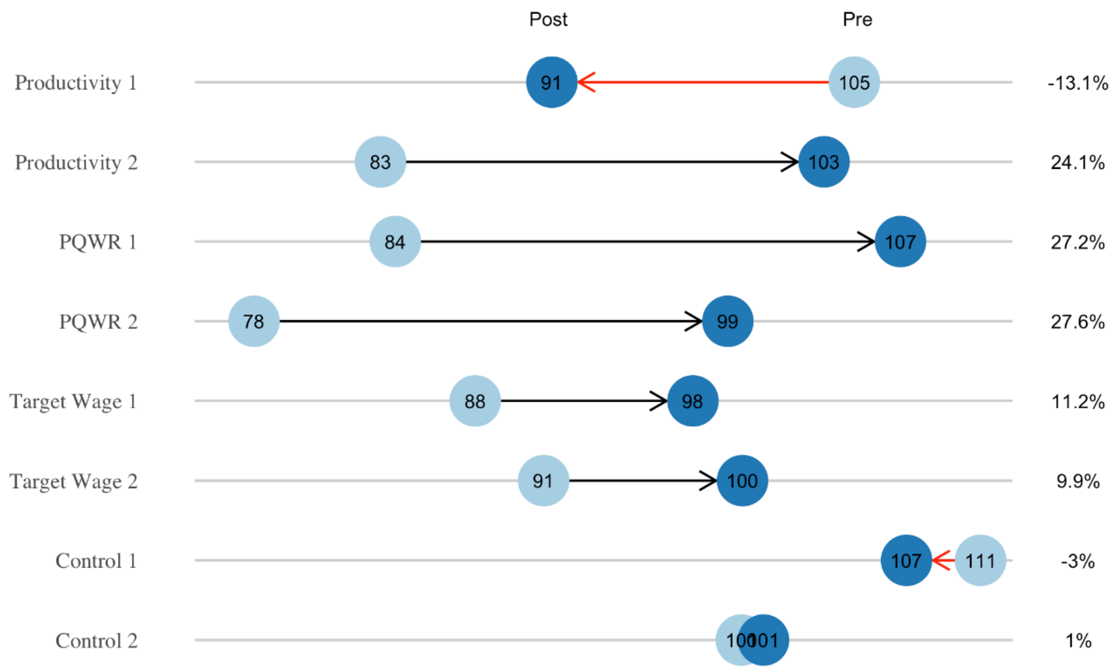

Figure 4-2: Change in daily productivity between pre-treatment and post-treatment periods for each line.
The percentage-points gained or lost is presented on the right-hand side. "1" and "2" denote the line.

4.3.2. Wages & Behavior

Our primary hypothesis was that an increase in wages would yield an increase in productivity. Yet if workers had previously been producing with maximum effort and efficiency, a wage increase would not induce any productivity increase. Moreover, if wages already equaled the reference wage, we might expect a rate increase to yield a decrease in productivity while wages stayed consistent.

As with productivity, we find positive and significant treatment effects on hourly wages, as shown in Table 4-3 below. For the Productivity treatment, despite no corresponding increase in productivity, hourly wages still increased by about two baht. For the other two treatments, their productivity increase, coupled with the accelerating group rate, raised hourly wages between 3.7 and 4.6 baht per hour. So, on an average ten-hour day, the treatment raised wages between 20 and 46 baht, amounting to a 4.2% and 9.7% average wage increase over the pre-treatment period.

	Dependent variable:					
	Hourly wage (baht)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	2.202^{*}	2.597^{**}	2.562^{**}	2.246^{**}	2.115^{*}	2.120^{*}
	(1.281)	(1.298)	(1.078)	(1.083)	(1.095)	(1.095)
PQWR treatment	4.986^{***}	5.158^{***}	4.067^{***}	3.831^{***}	3.790^{***}	3.739^{***}
	(1.490)	(1.489)	(1.425)	(1.407)	(1.402)	(1.402)
Target wage treatment	5.845^{***}	5.971^{***}	5.059^{***}	4.619^{**}	4.549^{**}	4.600^{**}
	(1.874)	(1.867)	(1.880)	(1.842)	(1.830)	(1.824)
Overtime		4.272^{***}	4.301^{***}	4.322^{***}	4.328^{***}	3.021^{**}
		(0.675)	(0.654)	(0.655)	(0.656)	(1.265)
Familiarity			0.045^{***}	0.045^{***}	0.045^{***}	0.044^{***}
			(0.008)	(0.008)	(0.008)	(0.008)
Number of line workers				15.069	15.645	16.048
				(12.589)	(12.525)	(12.741)
Square of Number of line workers				-18.452^{*}	-17.971^{*}	-18.057^{*}
				(9.817)	(9.663)	(9.639)
Cube of Number of line workers				-21.799^{***}	-21.101^{***}	-21.315^{***}
				(7.398)	(7.244)	(7.260)
Work hours					0.159^{**}	0.155^{**}
					(0.065)	(0.066)
SAM						0.505
						(0.406)
Style - consecutive days in production						0.021
						(0.034)
Tardiness (minutes)						-0.008
						(0.007)
Unplanned absenteeism (%)						0.038
						(0.032)
Observations	4,372	4,372	4,372	4,372	4,372	4,372
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 4-3: OLS regressions with hourly wage as the dependent variable.
Fixed effects for each specification (1-6) are date, style, and line.

Because the Productivity group received higher wages but did not see corresponding productivity gains, it would suggest there are certain conditions necessary for wage gains to be effective motivators. To understand these, we need to examine if and how the other treatment groups were motivated, so we may compare with the Productivity group. To understand motivation, we evaluate how workers perceived the wage increases (via the compensation changes) as well as other facets of the treatment: transparency, communication, and wage alignment. Then we examine what behavior changes workers made in order to increase productivity. Through this examination of motivation, we can determine what barriers or blockages the Productivity treatment group faced.

Worker perception of wages

We assume that workers were not able to precisely parse changes in wages due to the treatment versus changes due to other causes, such as longer orders, more familiar styles, and so forth. The direct juxtaposition of new and old compensation on each biweekly paycheck increased the likelihood that workers attributed most wage increases to the treatment. This supposition is supported by evidence from the focus groups that workers did attribute their wage increases to the treatment. Figure 4-3 shows the total hourly wage change.

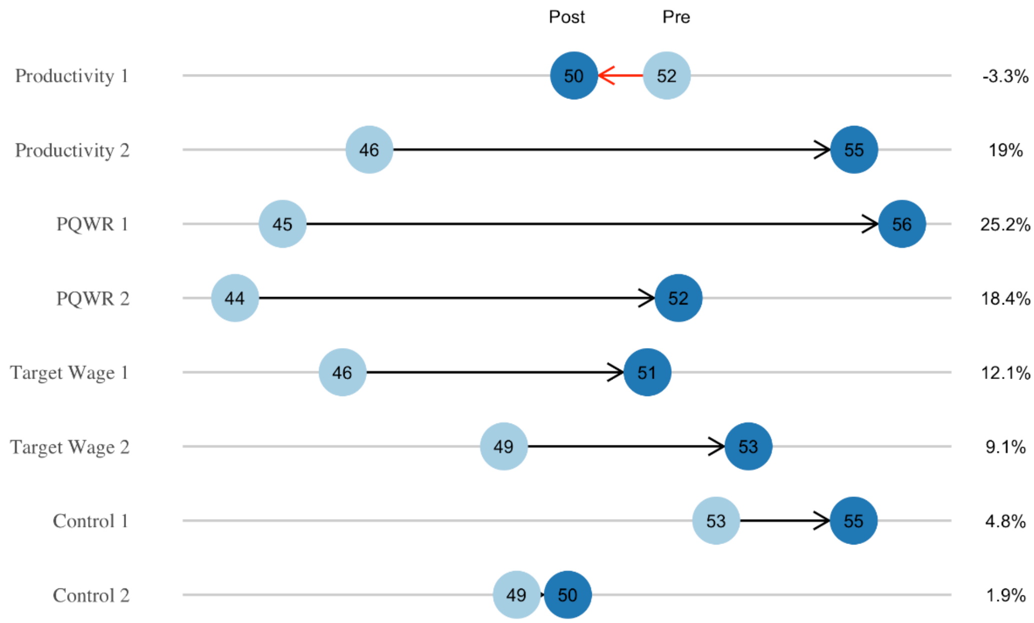

Figure 4-3: Change in average hourly wage between pre-treatment and post-treatment periods for each line.
The right-hand side shows percentage change. "1" and "2" denote the line.

In the first focus group, many sewing line workers said it would be "fair" to be paid 500 baht in 8 hours, but that it would be "good" if they received 700 baht for the whole workday. We might suggest the "good" level is analogous to a living wage, though we did not try to precisely measure this figure. For comparison, the Asian Floor Wage was estimated at 570 baht in 2016 and 606 baht in 2017. The treatment did raise average wages above the "fair" level (albeit not within 8 hours), but not above the "good" level. As a result, we should expect continued dissatisfaction with wages even as the wage increases were highly welcomed. Indeed, most workers who received the treatment, even the Productivity group, spoke positively about their new wages, though that they would still like to earn more.

And yet, in the second focus group, a worker from Productivity line 1 did say: "I thought that I could have earned more than this". Workers on that line were apparently earning only half the incentive earned by Productivity line 2. Interestingly, in the third and fourth focus groups, this discrepancy did not resurface outwardly. This might result from workers growing accustomed to new wage potentials, and perhaps the effort required to overcome their particular barriers was not worth the potential gain in income, or perhaps they felt it was out of their control.

The case of the Target wage treatment is instructive in this regard, since the target wage could be compared conceptually with a reference wage. If the Target wage group reached their reference wage and were presented with the opportunity to go home, then we might expect them to elect to do so at least some of the time (Fehr and Goette 2007). Indeed, before the intervention, workers reported a desire to work fewer days and shorter hours (although not at the expense of wages). Referencing OLS specification 6 in Table 4-3, the Target wage treatment shows a larger hourly wage increase (4.6 baht) than the PQWR (3.7 baht) and Productivity (2.1 baht) treatments. This increase, while larger, raised Target wage's average wage to comparable levels with the other treatment groups, yet neither line in the Target wage group ever opted to go home early. Assuming reasonably homogenous wage preferences, the Target wage group's decisions should be representative of other factory workers.

We might expect this outcome. The first target wage, 500 baht in eight hours, while "fair", is significantly below what workers believe is "good" for a workday. The second target, 650 baht in ten hours, is perhaps more salient, but workers would want that wage on average. Because an equivalently satisfying wage is not guaranteed each day, workers seek to maximize earnings on days of high-earning potential, instead of taking off early. As it stood, workers were still motivated by long days with higher earning potential, a sentiment noted in the focus groups, despite a desire to spend more time with family and friends. This relationship can be seen in the data by looking at the non-linear working hour effect represented by overtime: for both productivity and wages, overtime is positive and significant.

Worker perception of other treatment features

Before looking at changes in worker behavior, we need to understand the effect of the other treatment features. One major feature of the treatment was the communication and transparency measures. Overall, workers reported a similar level of understanding as with the pre-treatment compensation system: the incentive was difficult to calculate while working, but they understood the mechanics. Similarly, the updated LCD monitors were better than before, but still limited. For instance, the information—such as expected wage—was occasionally wrong, especially when the number of workers on the line fluctuated during the day. This frustrated workers and made them somewhat distrustful of the monitors. They preferred to consult a sheet posted on a board at the end of the line or to confer with fellow workers. Yet, later on, management added a red/green color-coding on the monitor to readily display if a target was met and how many garments it would require to meet the next target. Workers were encouraged by this easy-to-understand display. It is unlikely that these aspects of transparency provided much additional benefit, though they did not detract from the treatment either.

The communication procedures could also support another effect: simply being observed can affect changes in behavior. The Hawthorne Effect, as it is known, would require workers to know they are being observed, and perceive that observation as significant to their aims as to elicit a change in behavior (Bandiera, Barankay, and Rasul 2011). The evidence here is mixed. First, the effect on productivity from the treatment is immediate and persists (see Tables 7-10 to 7-13 in Appendix A for short- and medium-term regression summaries). We might expect the Hawthorne Effect to diminish once the honeymoon period had ended, yet workers did consistently note in focus groups that they knew they were under observation. However, this feeling of being observed had multiple effects on their motivation. First, workers initially expressed distrust of management. They believed if they worked harder, management would raise the goals and reduce the incentive. Second, workers in later focus groups reported feeling increasingly positive feelings towards management. They felt like management cared, which made them want to work harder out of a sense of reciprocity. Third, workers acknowledged that their colleagues in the factory likely would be envious of the treatment, so they encouraged the factory to provide it to all workers as soon as possible.

Finally, the treatment aligned incentives for workers along the production chain—from cutters and mechanics, to sewers, quality inspectors, and team leaders. We see limited evidence that the incentive induced significant changes for several of these worker-groups. For instance, cutters were still dissatisfied with their wages. Further, their physical disconnection from the lines meant they were unaware about the line's production (and thus their wage) throughout the day. The relief team, instead of being more motivated and/or supported, reported feeling extra pressure from the line they supported and would be blamed for production issues. Moreover, the line workers reported that there was still the same level of issues with materials and machines. This suggests that the workers responsible had not changed their behavior significantly. Overall, certain physical and workplace features limited the effectiveness of the incentive alignment.

Worker Behavior Changes

Workers are able to control their effort in the form of work-rate, time spent working, quality of work, and type of work, including supporting their team members. Workers can also stay at the job or quit. It appears that the increased wages and attention from management were motivating. However, it is not obvious which behavior changes led to the increase in productivity.

<u>No evidence for a higher work-rate</u>

We do not find evidence for significant change in work-rate. Workers across all groups did not report working any faster. Some, in focus groups, did say their colleagues appeared to be less "lazy" and "tried harder", but none mentioned anything about speed. We might expect stress to increase with work-rate, but in focus groups, workers did not note any significant change in their stress levels, either positively or negatively due to the intervention.

<u>Some evidence for more time spent working</u>

If workers show up for work, do so on time, and take fewer breaks, their productivity, all else equal, should increase. We find some evidence that workers reduced their tardiness due to the treatment. Table 7-14 in Appendix A shows a significant decrease in tardiness for the PQWR treatment group due to the treatment. Workers reported that fellow workers were less tardy, and that their colleagues took fewer and/or shorter breaks (though we do not have data on breaks). Many workers did report that they were more likely to show up to work because of the potential to earn more. As one worker reported: "Team is… on time and willing to work overtime and help each other because they know that the more they work, the more they earn. And if they simply take leave, they might, sometimes, miss 700 baht in a day" (Focus group, 9/1/16). We do not find any evidence for changes in absenteeism. This may be due to the fact that day-to-day absences are likely driven by contingencies, such as a sick child or personal illness.

<u>Substantial evidence for greater attention to quality</u>

There is substantial evidence that workers increased their attention to detail. Quality issues can significantly hamper productivity, and are frustrating and aggravating for all workers. To reduce the number of defects, aside from skill enhancements, workers consult with quality inspectors to better understand quality standards and they can take care that each garment meets the quality standard. In the focus groups, workers noted they took both these actions. And in the data, we see that the quality rate increased significantly. For both the PQWR and Target wage treatments, we find significant, positive increases of about 1.8%-points in the quality rate, as shown in Table 4-4. The Productivity treatment, however, saw no effect.

	Dependent variable:					
	Quality Rate (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	0.797	0.808	0.800	0.745	0.838	0.867
	(0.515)	(0.519)	(0.541)	(0.549)	(0.561)	(0.562)
PQWR treatment	1.814***	1.820***	1.707***	1.653***	1.676***	1.665***
	(0.533)	(0.538)	(0.551)	(0.545)	(0.550)	(0.554)
Target wage treatment	1.816***	1.820***	1.716***	1.638***	1.686***	1.768***
	(0.451)	(0.451)	(0.480)	(0.487)	(0.495)	(0.477)
Overtime		0.125	0.127	0.125	0.120	0.289
		(0.275)	(0.276)	(0.280)	(0.281)	(0.455)
Familiarity			0.005**	0.005**	0.005**	0.004**
			(0.002)	(0.002)	(0.002)	(0.002)
Number of line workers				1.127	0.684	0.346
				(3.988)	(4.045)	(4.059)
Square of Number of line workers				-4.889**	-5.274**	-5.073**
				(2.399)	(2.445)	(2.472)
Cube of Number of line workers				-3.856	-4.370*	-4.190*
				(2.345)	(2.383)	(2.372)
SAM					-0.105**	-0.104*
					(0.053)	(0.054)
Work hours						-0.066
						(0.127)
Style - consecutive days in production						0.019
						(0.015)
Tardiness (minutes)						-0.003*
						(0.002)
Unplanned absenteeism (%)						-0.007
						(0.015)
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 4-4: OLS regressions with quality rate as the dependent variable.
Fixed effects for each specification are date, style, and line.

Similarly, when the quality rate is included as a covariate in the regressions on productivity, as seen in Table 7-15 in Appendix A, the treatment effect is greatly diminished. This suggests that changes in the quality rate account for a large portion of the behavior change induced by the treatment. This makes sense that workers would adjust their quality rate: it is largely under their control and provides a high productivity return on effort. Indeed, they are already producing a fairly high quality.

An alternative explanation is that because the quality inspector is now incented by productivity, the inspector might lower (nearly undetectably) quality standards. In the short term and with a weaker buyer-supplier relationship, this would be difficult to rule out. However, the buyer-supplier relationship is strong, so it is unlikely that poor quality garments would have gone unnoticed for a full year.

Minimal evidence for taking on additional responsibility

In addition to improving the quality of their work, workers may also take on extra responsibility, such as supporting team members, fixing machines, and so forth, to support productivity. We find minimal evidence that this took place. Line managers reported that workers displayed more problem-solving initiative. But in the larger picture, workers were still highly aggravated by the free rider issue endemic to group rates and teamwork. Nearly all workers advocated for some skill or seniority wage bonuses to account for these effects. While workers supported their fellow workers at times, there was still animosity that prevented more widespread collaboration. Moreover, workers were constrained by hierarchical management and a lack of skills to perform other tasks that needed to be done. The other major enablers of productivity were related to line balancing, materials, and machines. The team leader controls line balancing, and while workers reportedly offered to help given they had intimate knowledge of their colleagues' abilities, they were largely ignored. Similarly, workers were frustrated by inadequate material supply, and they offered numerous suggestions to alleviate problems, but did not affect change on a consistent basis. And finally, workers were still largely reliant on mechanics for major machine fixes, which caused major problems particularly when mechanics left during overtime.

Significant evidence for reduced turnover

We find significant evidence for reduced turnover. Many workers noted that the factory had a reputation for paying higher wages than comparable jobs, and that the wage intervention only bolstered the factory's position. Turnover data for the two periods is shown in Table 4-5 below.

Average Monthly Turnover(%)

Line	2015	2016
Productivity 1	6.21	6.7
Productivity 2	3.91	4.04
PQWR 1	1.93	1.98
PQWR 2	6.71	4.93
Target Wage 1	2.72	1.9
Target Wage 2	3.12	0.79
Control 1	1.14	1.72
Control 2	2.71	5.28

Table 4-5: Average monthly turnover per year per line.

The turnover rate is the number of workers who left divided by the number of workers who were on the line at the beginning of the month. This does not track individual workers, so it may be the newest workers who are leaving each month. A rate just above 5% indicates that about one worker left per month. "1" and "2" denote the line.

Reduced turnover benefits productivity due to skill and experience benefits. Workers at the factory are more likely to be more skilled than those who might be hired. Retained workers can also build on their skills to become more multi-skilled; this generates large benefits for line-balancing. Retained workers also gain tacit knowledge about the factory, machines, colleagues, material, and so forth, that can benefit productivity.

Lessons

The workers appeared to know how to increase their productivity. They routinely made suggestions to support production flow, from adding workers, to helping materials delivery, to improving line balancing, to improving the mechanic response-time. Since line workers were not able to control those facets of production, they increased effort where it would yield the highest benefit: attention to quality and tardiness. Of course, the Productivity treatment group did not increase their quality, nor their productivity. As shown in Tables 7-16 to 7-18 of the Appendix A, the Productivity treatment group's productivity significantly decreased when compared to the other treatment groups, while its wages neither increased nor decreased.

A major difference that may have caused this discrepancy between Productivity and the other treatment groups was line-level turnover. The Productivity lines had persistently higher turnover. We do not have individual-level data to examine, but we speculate that higher turnover lowered the average skill and experience level of the line, depressing wage potentials, and reducing the incentive for those workers to put in extra effort where they could: by increasing quality.

Overall, most workers were motivated by the potential for increased wages from an accelerating group rate as well as increased engagement and sense of fair compensation. Workers focused their increased effort on reducing quality defects and tardiness, two behaviors which individual workers largely control. Additional productivity-increasing behaviors were constrained by skill, position, and conflicts arising from free riders.

4.3.3. Impact on Profit

We next examine the compensation system effect on factory profit. The increased productivity does not guarantee increased profit, as workers receive a higher share of the per-garment value, on average. Because we lack pre-treatment data on prices, we estimated the profit-per-garment decrease through a cross-sectional OLS over the post-treatment period (see Table 7-19 in the Appendix A). Though our estimates may suffer from omitted variable bias due to uncontrolled-for intangible differences between lines, we are reasonably confident in the results, because there is a fairly mechanistic story. Per-garment profits decreased by about three baht for each line.

We then constructed a simple profit assessment from mean changes in output and profit per-garment. While mostly illustrative, it demonstrates that productivity gains did overcome losses in per-garment profit, yielding a higher total profit. Table 4-6 shows that five out of the six treatment lines realized increases.

Profit Assessment

	Productivity 1	Productivity 2	PQWR 1	PQWR 2	Target Wage 1	Target Wage 2	Control 1	Control 2
Pre-Treatment Output per Day	603	508	463	390	504	476	667	655
Post-Treatment Output per Day	446	602	535	474	571	579	543	563
Pre-Treatment Profit per Garment	29	48	54	54	52	62	61	39
Post-Treatment Profit per Garment	25	45	51	51	49	59	61	39
Pre-Treatment Profit per Day	17388	24375	25156	21232	26266	29655	40872	25517
Post-Treatment Profit per Day	11468	26504	26722	25063	27254	35638	33336	22846
Profit per Day Change	-5920	2129	1566	3831	988	5982	-7536	-2671

Table 4-6: A simple profit assessment.

Uses average output and OLS-derived profit-per-garment to derive an estimate for the change in total profit between the two periods. "1" and "2" denote the line.

In addition, there are significant costs from employee turnover, management expenses, and capital investments. We rule out any effect of capital investments since any changes that happened were exogenously driven. And management expenses are relatively small compared to employee turnover costs, especially when spillover effects are considered. Employee turnover generates large costs for hiring and training, as well as lost productivity when a line has reduced numbers of workers. Given the decreases in turnover, the factory likely benefitted from the intervention. As evidence, the factory management proliferated the intervention across the factory's 23 lines once the intervention ended.

4.4. Summary

There remain significant tensions between workers, factory management, and brands regarding wages. Even as worker productivity has increased, the financial gains have not been shared with workers. When workers realize they are not receiving financial benefits from increased effort, problem solving, or skills development, they are likely to lose motivation and/or quit (Blasi et al. 2009).

Skilled, engaged, and motivated workers are critical to respond to industry demands for agile production, mass customization, and even new forms of automation. This research provides evidence that paying workers more, delivered through a more transparent, fair, and Lean-aligned compensation system, can be a vehicle to raise worker satisfaction, reduce turnover, and increase productivity and profits.

This early work points to the need for additional research. A randomized control trial across more factories would yield greater insights for how new compensation systems respond under different conditions. Moreover, future research could examine worker responses to different levels of compensation and versions of compensation—including skill-based, seniority-based, and quality-based measures. Applying these lessons across factories and industries will require improved factory management, more sophisticated human resources data management, careful efforts to align factory goals with incentives, and improved communication and transparency.

This research suggests that, even with current factory margins and market conditions, important wage gains are possible and profitable. And yet, other efforts are still needed to progress to living wages. Brand sourcing practices—with respect to delivery times, quality requirements, and styles—need to be examined and improved to support worker wage increases (Miller and Hohenegger 2017; H. Park and Dickson 2008). Unions need to be supported to negotiate and protect wage gains, and to ratchet up working conditions over time (Esbenshade 2004; Fung, O'Rourke, and Sabel 2001). Domestic regulators need to more consistently and strongly enforce existing labor law (Bartley 2018). And as ILO's Better Work program has demonstrated, governments should support economic and social upgrading with innovative policies, such as, in this case, more strategic compensation and upskilling programs (Gereffi and Lee 2016; D. Brown et al. 2016).

5. Conclusion

Private, networked, data-centric governance (PNDG) is not a monolithic structure. It is a trend emerging from many competing actors, beliefs, discourses, capacities, and actions. Broadly, it represents a turn inside-out from previously existing non-state market driven governance (NSMD) led by non-industry private actors. Instead of NGOs controlling the information and generating market incentives, corporations, whether to forestall onerous regulation, pursue a vision of Industry 4.0, or find competitive advantage through marketing themselves as sustainable, have become the rule makers, rather than rule takers (Büthe and Mattli 2011; Bartley 2018).

PNDG has emerged from and alongside previous regimes in part because it offers unique advantages to the system, and importantly, to firms. Perhaps due to the shift in the Overton Window[23], firms have acknowledged they need to act on sustainability concerns. Many firms are moving towards faster, efficient, and interoperable supply networks with an emphasis on digital integration and automation (Lasi et al. 2014; Rüßmann et al. 2015). Firms are able to implement digitization and data collection in the pursuit of sustainability and thus merge two aims (Kiron and Unruh 2018).

Given corporations' power within production networks, they can gain access to more and more detailed levels of data at consistent rates. Though this process is not perfect (Locke 2013; Bartley 2018), NGOs have failed for years to gain access to sufficient data, keep it updated, and deliver it to consumers in order to generate the market transparency mechanisms needed to drive innovation (Bullock 2017). PNDG holds the promise of being able to supply credible and industry-comparable data to consumers to generate market transparency and incentives.

This data can not only be leveraged for transparency and accountability, but also for firm innovation. With the data close to the point of implementation, firms may be able to find inefficiencies and problems and remedy them faster. Their power within production networks means these solutions can be shared and deployed widely. By competing for market advantage, there could develop industry-wide experimentation as well as natural diffusion and scaling of ideas through shared supply networks. The strengths of PNDG, in short, concern the "inside" portions of the "inside-out" turn.

Meanwhile, the "outside" is underdeveloped. PNDG has underdelivered on both consumer transparency and stakeholder accountability measures (S. Park and Kramarz 2019). Without transparency, there are few incentives for significant innovation or improvements. And there are not many incentives for comprehensive transparency. For many firms, incremental progress that staves off the worst regulation and market shaming is the ideal path. Better than comparable, comprehensive, comprehensible information then, is a muddled information-space with disparate claims of sustainability from competing certifications and initiatives. Governments, NGOs, workers, and other stakeholders do not have access to even aggregated sources of data.

[23] https://www.mackinac.org/OvertonWindow. Accessed July 26th, 2020.

The key to strengthening PNDG is by focusing on its “outside”. First, brands, and retailers need to be committed to market and stakeholder transparency. Platforms can facilitate this process by providing information and developing algorithms to match buyers, suppliers, and consumers. Governments can provide oversight of standards and data dissemination.

Beyond transparency, there needs to be greater integration with government actors, NGOs, worker unions, and other stakeholders. The myth of private governance carries with it an image of “empty” local governing contexts (Bartley 2018). In fact, private action is always entangled with local regulatory and political environments (Toffel, Short, and Ouellet 2015). Local regulatory enforcement when paired with corporate governance can be more effective (Amengual 2010; Bartley 2018). Moreover, domestic governments can delegate limited authority (Abbott et al. 2016; Green 2014) or provide funding to private initiatives (Overdevest and Zeitlin 2014).

Further, independent initiatives and indicators like Science-Based Targets[24] or the Sustainable Development Goals are critical for setting independent, rigorous standards. The model of global experimentalist governance put forth by (De Búrca, Keohane, and Sabel 2014) may be an effective accountability framework to follow. Global experimentalism advocates for a structured approach with oversight and scaling of local innovation experiments. These oversight mechanisms need to be paired with credible and strong enforcement. Enforcement of rules could perhaps be provided through transnational labor unions and collective bargaining agreements (Evans 2014), sustainability clauses within trade agreements (Gallagher 2009), redress mechanisms (Ruggie 2013), or government standards and enforcement (D. Brown et al. 2016).

Moreover, it is consequential who generates the data to make the market mechanisms function. Within collection of data lies the power. Power determines what data gets collected, on whom, when, how, where, and why. Power determines what actions are taken with and based on that data, and if it gets shared. Data analytics enable organizations to “see” and control at a distance (Porter 1996; Broome and Quirk 2015). Power shapes and biases how processes are perceived. In a low-trust environment, data has a unique ability to generate trust, thus making it much more powerful (Porter 1996). (This may not hold without shared epistemological frameworks and within fragmented information ecosystems (boyd 2019).) Data can swamp other types of information, thus privileging certain voices and perspectives. As data-centric operations continue to be constructed, scaled, and made more efficient, democratic participation (including the ability to challenge, downscale, or block development) becomes ever more essential (Anner and Hossain 2014; O’Neil 2016; Noble 2018; Eubanks 2018). Open-source initiatives like the Open Apparel Registry, or third-party initiatives like IPE[25], Provenance, and worker SMS transparency programs[26], can create credible data not owned by corporations. More can be done to make room for perspectives of the global south, workers, and marginalized peoples.

As data becomes central to governance, there needs to be robust privacy and power-conscious reforms in the collection and use of data. Sustainability is a broad concept that has the potential

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24 https://sciencebasedtargets.org/. Accessed February 2020.

25 http://wwwen.ipe.org.cn/. Accessed February 2020.

26 https://ulula.com/ulula-cleans-up-supply-chains-with-human-rights-transparency/. Accessed February 2020.

for intimate intrusion and control, so demands for information need to be tempered by sensitivity to privacy and vulnerability (Eubanks 2018), or perhaps an eye towards liberation not control (Benjamin 2016). Similarly, attention needs to be paid to the scale, auditability, and potential for impact of automated processes and algorithms based on data (O'Neil 2016).

And finally, there needs to be a greater commitment to impact, even in the face of inconvenient facts. There is low-hanging fruit: brands could drop their worst supplier factories and source from better performers found through existing databases like the Higg Index. But impacts need to be measured against independent standards. A worker wage increase is not the same as achieving International Labor Organization standards for a living wage.

And yet, the elephant in the room is that economic growth and profits might be at odds with meaningful progress (Putt Del Pino et al. 2017; Parrique et al. 2019). For instance, if consumption fell drastically (as it has due to the COVID-19 crisis) and consumers transitioned to reducing, reusing, upcycling, and repairing, it would likely have devastating near-term effects on employment in global supply chains, as well as generate an economic recession. Networked relationships mean that consumers and markets cannot be depended on to drive sustainability equitably.

As well, there is a critical need to maintain the links between environmental and social sustainability (Salleh 2016; Agyeman 2014; Martínez-Alier 2012). It may well be that social reforms are more likely to yield environmental improvements than the reverse. If we truly care about environmental action, we may need social justice or structural reforms, if not first, then at the same time.

Private, networked, data-centric governance holds a lot of promise. Yet we cannot permit ourselves to be dazzled by data and technology into complacency. If PNDG is truly an inside-out turn of NSMD, then there needs to be much more focus on the "out". With greater attention to transparency, accountability, and inclusion, as well as data-conscious protections and reforms, there is a chance for broad sustainability transformation across the industry. The proof is in the pudding, however, so sustainability and justice need to be privileged above economic growth and profits. The more inclusion of diverse perspectives and silenced voices is likely to lead to faster, bigger, and more comprehensive and tolerable solutions. Corporations will not complete the inside-out turn themselves.

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7. Appendix A: Supporting Information for Chapter Four

Data Analysis

There are several covariates for which we do not have data that may be important to precisely estimate treatment effects. The most problematic omission is downtime, the length of time a line has stopped producing during normal working hours. The dataset contains downtime data based on the type—machine, material, personnel, or quality—for the pre-treatment period, but we were unable to acquire it for the post-treatment period. We ran multiple exploratory regressions over the pre-treatment period in order to understand how downtime would likely impact wages and productivity. We found no significant relationship between wage and any form of downtime. With productivity, however, total downtime was significant at the 10% level with an estimate of -0.025. The number of occurrences where this would affect productivity more than 1%-point was 708 and more than 5%-points was 33 instances of 2020 total observations. When explored by type of downtime, material-induced downtime (e.g., the line did not have fabric to sew) was significant at the 1% level with an estimate of -0.17. The number of instances where it reduced productivity more than 1%-point was 192 and more than 5%-points was 65 times out of 2020 total observations. The other types of downtime were not significant nor particularly large estimates.

In addition, the data contained a number of outliers, potentially the result of measurement error. Some values were obviously faulty, such as a value of unplanned absenteeism over 1000%. These instances were excluded from the dataset. We also flagged and removed instances which were highly implausible, such as where productivity was very high (greater than 150%) while the incentive was very low (less than 50 baht), or when productivity was very low (less than 55%) while the incentive was non-zero.

Other filtering decisions involved judgement and sensitivity analysis. For instance, we excluded observations where wages were recorded as less than minimum wage, number of workers was equal to zero or greater than 34, and productivity equal to zero or greater than 4 standard deviations from the mean (leaving a maximum of 178%). The overall statistical story was not affected when we ran the specified regressions with productivity maxima of 140%, 160%, 180%, and 200%, or three standard deviations and five standard deviations. In addition, we found no abnormal or asymmetric deviations when comparing the reported productivity with a productivity calculated using the SAM, output, number of workers, and other data.

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Productivity (%)	1,100	96.98	35.87	2	70	123	177
Hourly Wage (THB)	1,097	50.94	11.18	37.5	42.61	58.12	93.32
Working Hours	1,097	9.92	1.48	8	8	11	12
Overtime (0,1)	1,100	0.49	0.5	0	0	1	1
Number of Workers	1,100	19.34	1.75	11	18	20	28
SAM (min/garment)	1,099	21.99	8.07	1.84	17.11	26.35	56.92

Lead Time (days)	1,096	6.56	7.92	1	2	8	57
Style Familiarity (style-days/line)	1,100	59.07	57.75	1	16	75	179
Tardiness (min)	1,094	5.87	25.57	0	0	5	725
Unplanned Absenteeism (%)	1,100	2.16	3.55	0	0	4.5	30

Table 7-1: Summary statistics for all variables included in regressions of Productivity Treatment Group.

Statistic	**N**	**Mean**	**St. Dev.**	**Min**	**Pctl(25)**	**Pctl(75)**	**Max**
Productivity (%)	1,084	93.35	35.01	2	68	118	178
Hourly Wage (THB)	1,084	49.31	11.17	37.5	42.61	55.06	93.35
Working Hours	1,084	10.03	1.47	8	8	11	12
Overtime (0,1)	1,084	0.53	0.5	0	0	1	1
Number of Workers	1,084	19.2	1.77	10	18	21	28
SAM (min/garment)	1,084	24.11	4.2	1.84	21.51	26.35	41.25
Lead Time (days)	1,082	8.06	8.15	1	2	12	43
Style Familiarity (style-days/line)	1,084	54.51	40.93	1	17	99	124
Tardiness (min)	1,083	4.34	13.75	0	0	4	302
Unplanned Absenteeism (%)	1,084	1.8	3.41	0	0	4.51	39.47

Table 7-2: Summary statistics for all variables included in regressions of PQWR Treatment Group.

Statistic	**N**	**Mean**	**St. Dev.**	**Min**	**Pctl(25)**	**Pctl(75)**	**Max**
Productivity (%)	1,147	95.46	35.26	2	72	120	178
Hourly Wage (THB)	1,146	49.85	11.3	37.5	42.61	55.37	111.49
Working Hours	1,146	9.95	1.44	8	8	11	12

Overtime (0,1)	1,147	0.52	0.5	0	0	1	1
Number of Workers	1,147	20.44	1.4	14	20	21	27
SAM (min/garment)	1,147	21.83	3.86	1.62	20.66	23.02	38.03
Lead Time (days)	1,143	6.11	6.42	1	2	8	34
Style Familiarity (style-days/line)	1,147	43.42	39.91	1	17	50	141
Tardiness (min)	1,147	4.17	12.8	0	0	4	247
Unplanned Absenteeism (%)	1,147	1.34	3.61	0	0	0	77

Table 7-3: Summary statistics for all variables included in regressions of Target Wage Treatment Group.

Statistic	**N**	**Mean**	**St. Dev.**	**Min**	**Pctl(25)**	**Pctl(75)**	**Max**
Productivity (%)	1,099	106.5	9 32.69	3	86	128	174
Hourly Wage (THB)	1,098	51.8	9.69	37.5	0 42.61	58.12	99.1
Working Hours	1,098	9.97	1.46	8	8	11	12
Overtime (0,1)	1,099	0.53	0.5	0	0	1	1
Number of Workers	1,099	21.16	1.93	9	20	22	28
SAM (min/garment)	1,080	22.87	7.62	0	18.91	26.35	78
Lead Time (days)	1,083	5.94	6.13	1	2	8	34
Style Familiarity (style-days/line)	1,099	59.83	49.42	1	16	96	154
Tardiness (min)	1,099	5.39	23.38	0	0	3	274
Unplanned Absenteeism (%)	1,099	1.74	4.02	0	0	2.3	75

Table 7-4: Summary statistics for all variables included in regressions of Control Group.

Dependent Variable	**Treatment Group**	**Simple Time Trend P-value**	**Time Trend w/ Controls P-value**
Productivity (%)	Productivity	0	0.62

	PQWR	0	0.11
	Target Wage	0	0.31
Hourly Wage (THB)	Productivity	0	0.6
	PQWR	0	0.12
	Target Wage	0	0.14

Table 7-5: Results from two-tailed t-test.
Comparison of simple time trend and time trend with controls for line, style, and number of workers. The first test shows a violation of the parallel trends assumption, however, the parallel trends assumption is not violated in the specification including controls.

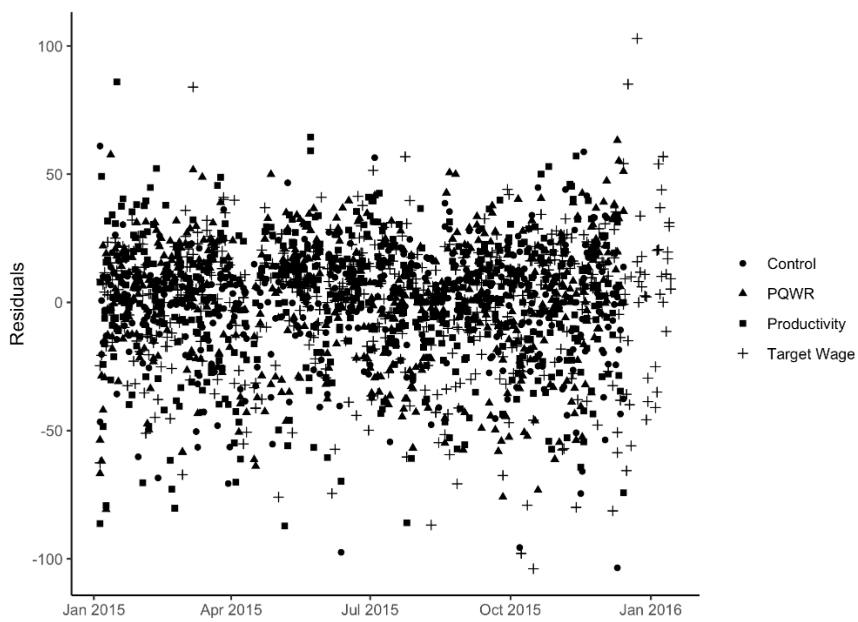

Figure 7-1: Time Trend Plot.
Compare residuals of parallel trends regression with controls for line, style, and number of workers. No heterogeneity found in residuals. Target Wage residuals continue until mid-January 2016, because the Target Wage intervention did not start until that time.

Statistic	N	Mean	St. Dev.	Min	Max
Productivity 1	20	36	6.7	23	52
Productivity 2	17	35.5	8.5	19	44
PQWR 1	19	34.8	8.1	24	49
PQWR 2	19	35.7	5.9	24	46
Target Wage 1	20	38	7.3	24	52

Target Wage 2	21	39.5	8	23	52
Control 1	21	34.8	7.7	21	52
Control 2	19	36.7	8.8	23	52

Table 7-6: Comparison by age (years) across lines in January 2016.
These line compositions changed over the course of the two-year period.

Statistic	N	Mean	St. Dev.	Min	Max
Productivity 1	19	6.41	6.22	0.01	18.03
Productivity 2	20	2.92	2.77	0.07	9.11
PQWR 1	21	7.42	4.67	0.03	18
PQWR 2	21	5.67	5.7	0.03	18.02
Target Wage 1	17	3.81	4.73	0.01	14.04
Target Wage 2	18	6.27	5.65	0.01	14.03
Control 1	19	4.36	4.26	0.01	12.02
Control 2	20	5.44	4.21	0.04	18

Table 7-7: Comparison by length of employment (years) across lines in January 2016.
These line compositions changed over the course of the two-year period.

Line	Men	Women
Productivity 1	0	19
Productivity 2	0	19
PQWR 1	6	14
PQWR 2	1	16
Target Wage 1	0	20
Target Wage 2	1	20
Control 1	4	17
Control 2	0	19

Table 7-8: Comparison by sex across lines in January 2016.
These line compositions changed over the course of the two-year period.

Treatment Group	Years at Facility	Years as Manager	No. of Trainings
Productivity	19	19	6
PQWR	13	2	6
Target Wage	16	11	7
Control	18	10	6

Table 7-9: Line manager characteristics in January 2016.
Line managers did not change throughout the two-year period.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	6.49	6.423	6.851	6.453	6.021	6.307
	(5.506)	(5.511)	(5.053)	(5.133)	(5.211)	(5.252)
PQWR treatment	12.846*	12.913**	11.675*	12.028*	11.957*	11.966*
	(6.624)	(6.588)	(6.387)	(6.394)	(6.378)	(6.811)
Target wage treatment	25.276***	25.239***	20.000**	19.824**	19.661**	19.450**
	(8.849)	(8.879)	(8.272)	(8.659)	(8.743)	(8.424)
Overtime		2.57	3.007	3.224	3.232	-5.552
		(2.383)	(2.231)	(2.270)	(2.277)	(7.986)
Familiarity			0.178***	0.177***	0.176***	0.167***
			(0.029)	(0.030)	(0.030)	(0.030)
Number of line workers				22.028	20.494	22.414
				(26.569)	(26.544)	(25.594)
Square of Number of line workers				-15.328	-16.998	-19.778
				(33.418)	(33.418)	(32.560)
Cube of Number of line workers				-61.194**	-60.880**	-53.447*
				(30.192)	(30.107)	(28.206)

SAM					0.847	0.864
					(0.622)	(0.648)
Work hours						3.019
						(2.638)
Style - consecutive days in production						0.241
						(0.153)
Tardiness (minutes)						0.048
						(0.041)
Total absenteeism (%)						0.035
						(0.121)
Observations	2,237	2,237	2,237	2,237	2,237	2,237
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-10: Shortest-term OLS regression with productivity as the dependent variable.
Short-term regression considers data until February 1st, 2016. Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	0.081	0.079	-1.403	-2.095	-1.57	-0.996
	(5.727)	(5.729)	(6.165)	(6.253)	(5.760)	(5.794)
PQWR treatment	19.013***	19.060***	15.026***	15.192***	15.265***	15.759***
	(6.339)	(6.331)	(5.701)	(5.713)	(5.649)	(5.819)
Target wage treatment	22.912***	22.917***	14.040***	13.819***	14.279***	15.906***
	(5.850)	(5.839)	(5.042)	(5.055)	(4.986)	(4.950)
Overtime		2.746	3.255	3.463	3.472	-4.884
		(2.437)	(2.274)	(2.322)	(2.327)	(6.736)

Familiarity			0.172^{***}	0.171^{***}	0.170^{***}	0.161^{***}
			(0.027)	(0.027)	(0.027)	(0.028)
Number of line workers				15.8	14.876	18.022
				(27.933)	(27.657)	(27.319)
Square of Number of line workers				-15.341	-17.304	-18.246
				(34.921)	(34.959)	(34.933)
Cube of Number of line workers				-65.561^{**}	-65.515^{**}	-61.962^{**}
				(28.963)	(28.922)	(28.758)
SAM					1.156	1.179
					(0.735)	(0.766)
Work hours						2.877
						(2.152)
Style - consecutive days in production						0.270^{*}
						(0.153)
Tardiness (minutes)						0.002
						(0.017)
Total absenteeism (%)						0.064
						(0.114)
Observations	2,414	2,414	2,414	2,414	2,414	2,414
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-11: Second shortest-term OLS regression with productivity as the dependent variable.

Short-term regression considers data until March 1st, 2016. Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	-5.777	-5.767	-6.676	-7.159	-7.226	-5.907

	(4.926)	(4.926)	(4.594)	(4.728)	(4.644)	(4.723)
PQWR treatment	14.662**	14.677**	9.771*	9.739*	9.827*	10.251*
	(6.437)	(6.434)	(5.649)	(5.695)	(5.698)	(5.879)
Target wage treatment	12.891**	12.897**	5.648	5.415	5.686	8.009
	(6.323)	(6.316)	(5.239)	(5.244)	(5.331)	(5.517)
Overtime		1.852	2.352	2.41	2.414	-1.436
		(2.358)	(2.190)	(2.213)	(2.236)	(5.370)
Familiarity			0.178***	0.178***	0.174***	0.162***
			(0.026)	(0.026)	(0.026)	(0.027)
Number of line workers				24.227	22.118	21.092
				(30.013)	(29.632)	(29.513)
Square of Number of line workers				-25.34	-28.812	-29.31
				(33.544)	(33.328)	(32.704)
Cube of Number of line workers				-20.844	-21.338	-20.452
				(34.924)	(34.568)	(33.854)
SAM					1.388**	1.417*
					(0.698)	(0.728)
Work hours						1.256
						(1.662)
Style - consecutive days in production						0.352**
						(0.147)
Tardiness (minutes)						0.007
						(0.023)
Unplanned absenteeism (%)						-0.078
						(0.160)
Observations	2,932	2,932	2,932	2,932	2,932	2,932

Note:	*p<0.1; **p<0.05; ***p<0.01			
	Standard errors corrected for serial correlation using Newey-West variance estimator.			

Table 7-12: Short-term OLS regression with productivity as the dependent variable.
Short-term regression considers data until May 1st, 2016. Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	-1.017	-0.686	-2.831	-4.397	-5.246	-5.089
	(4.020)	(4.075)	(3.507)	(3.597)	(3.648)	(3.670)
PQWR treatment	13.608***	13.781***	9.946**	9.617**	9.260*	9.227*
	(4.854)	(4.850)	(4.617)	(4.722)	(4.725)	(4.782)
Target wage treatment	20.407***	20.422***	16.338***	15.495***	14.810**	16.143***
	(5.823)	(5.825)	(6.071)	(5.933)	(5.900)	(5.925)
Overtime		5.583**	5.653***	5.761***	5.811***	8.209*
		(2.252)	(2.134)	(2.160)	(2.173)	(4.329)
Familiarity			0.133***	0.134***	0.132***	0.123***
			(0.028)	(0.028)	(0.028)	(0.029)
Number of line workers				61.484	67.001*	66.771*
				(40.769)	(40.355)	(40.363)
Square of Number of line workers				-38.123	-32.994	-30.425
				(34.881)	(34.461)	(34.149)
Cube of Number of line workers				-58.875*	-50.439	-50.294
				(31.656)	(31.541)	(31.274)
SAM					1.311**	1.315**
					(0.600)	(0.615)
Work hours						-0.923

						(1.324)
Style - consecutive days in production						0.259**
						(0.118)
Tardiness (minutes)						0.006
						(0.022)
Unplanned absenteeism (%)						-0.027
						(0.159)
Observations	3,544	3,544	3,544	3,544	3,544	3,544
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-13: Medium-term OLS regressions with productivity as the dependent variable.
Medium-term regression considers data until September 1st, 2016. Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Tardiness (minutes)					
	1	2	3	4	5	6
Productivity treatment	2.617	2.757	2.8	3.034	3.09	2.939
	3.037	3.044	2.967	3.033	3.057	3.024
PQWR treatment	-5.213**	-5.145**	-4.578**	-4.734**	-4.720**	-4.714**
	2.253	2.246	2.088	2.071	2.074	2.076
Target wage treatment	-3.237	-3.19	-2.669	-2.546	-2.517	-2.756
	2.103	2.1	1.929	1.916	1.918	1.941
Overtime		1.467*	1.456*	1.399	1.395	-2.04
		0.867	0.868	0.871	0.87	1.373
Familiarity			-0.025*	-0.025*	-0.024*	-0.024*
			0.013	0.013	0.013	0.013
Number of line workers				-37.442*	-37.706*	-33.039
				22.575	22.59	23.064
Square of Number of line workers				1.803	1.573	0.482
				26.011	25.995	26.069
Cube of Number of line workers				-15.099	-15.406	-16.226

				25.35	25.339	25.022
SAM					-0.063	-0.06
					0.063	0.063
Work hours						1.313**
						0.526
Style - consecutive days in production						-0.027
						0.03
Total absenteeism (%)						0.080***
						0.022
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-14: OLS regressions with tardiness as the dependent variable.
Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	-2.004	-1.687	-1.905	-3.326	-5.391	-5.31
	(3.902)	(3.943)	(3.330)	(3.217)	(3.371)	(3.376)
PQWR treatment	12.393**	12.549**	9.697*	6.497	5.567	5.585
	(5.304)	(5.312)	(5.023)	(4.724)	(4.715)	(4.721)
Target wage treatment	13.695***	13.801***	11.177**	8.012*	6.2	6.642
	(4.701)	(4.711)	(4.724)	(4.566)	(4.429)	(4.423)
Overtime		3.327*	3.380**	3.171**	3.266**	3.559
		(1.746)	(1.707)	(1.569)	(1.564)	(3.304)
Familiarity			0.124***	0.114***	0.114***	0.111***
			(0.024)	(0.023)	(0.023)	(0.023)
Quality Rate				1.855***	1.881***	1.876***
				(0.318)	(0.326)	(0.325)

Tardiness (minutes)				-0.008	-0.008	-0.008
				(0.020)	(0.019)	(0.019)
Total absenteeism (%)				-0.045	-0.032	-0.033
				(0.034)	(0.031)	(0.031)
Number of line workers					25.922	25.486
					(31.855)	(31.686)
Square of Number of line workers					-32.185	-31.401
					(29.789)	(29.730)
Cube of Number of line workers					-66.837***	-65.963***
					(24.207)	(23.944)
SAM					1.419***	1.420***
					(0.445)	(0.450)
Work hours						-0.124
						(1.086)
Style - consecutive days in production						0.097
						(0.110)
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-15: OLS regressions including demeaned quality rate with productivity as the dependent variable.

Fixed effects for each specification are date, style, and line. The treatment effect disappears once quality is accounted for in the regression, which suggests that changes in the quality rate account for a large portion of the behavior change induced by the treatment.

	Dependent variable:					
	Productivity (%)					
	1	2	3	4	5	6
Productivity treatment	-9.117**	-8.889**	-7.519**	-7.704**	-8.696***	-8.657***
	(3.630)	(3.668)	(3.052)	(3.063)	(3.109)	(3.113)

Overtime		3.062*	3.180*	2.823*	2.923*	3.472
		(1.746)	(1.698)	(1.568)	(1.568)	(3.297)
Familiarity			0.134***	0.125***	0.122***	0.120***
			(0.024)	(0.023)	(0.023)	(0.023)
Quality Rate				1.868***	1.903***	1.899***
				(0.324)	(0.333)	(0.332)
Turnover				57.486	51.537	50.18
				(37.205)	(36.917)	(37.095)
Square Turnover				-41.297	-35.688	-34.99
				(31.123)	(31.258)	(31.534)
Cube Turnover				-34.403	-35.05	-34.763
				(28.332)	(28.447)	(28.525)
Number of line workers				27.861	32.924	30.677
				(33.009)	(32.525)	(32.516)
Square of Number of line workers				-41.599	-35.93	-35.216
				(29.190)	(29.299)	(29.309)
Cube of Number of line workers				-81.934***	-74.081***	-73.528***
				(22.319)	(23.001)	(22.802)
SAM					1.413***	1.414***
					(0.449)	(0.452)
Work hours						-0.21
						(1.074)
Style - consecutive days in production						0.063
						(0.111)
Tardiness (minutes)						-0.009
						(0.019)

Total absenteeism (%)						-0.031
						(0.031)
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-16: Productivity-treatment-only OLS regressions with productivity as the dependent variable.

Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Quality Rate (%)					
	1	2	3	4	5	6
Productivity treatment	-0.189	-0.182	-0.115	-0.14	-0.079	0.243
	(0.425)	(0.427)	(0.431)	(0.443)	(0.449)	(0.434)
Overtime		0.087	0.093	0.086	0.269	0.125
		(0.277)	(0.277)	(0.279)	(0.452)	(0.419)
Familiarity			0.007***	0.007***	0.006***	0.002
			(0.002)	(0.002)	(0.002)	(0.002)
Turnover				0.14	0.291	-1.487
				(5.851)	(5.873)	(5.120)
Square Turnover				-1.706	-1.853	-0.566
				(4.694)	(4.770)	(4.152)
Cube Turnover				-3.387	-3.308	-1.844
				(4.357)	(4.359)	(3.812)
Number of line workers				1.513	1.148	-0.247
				(4.198)	(4.300)	(4.038)
Square of Number of line workers				-6.003**	-6.286**	-4.631
				(2.820)	(2.977)	(2.868)
Cube of Number of line workers				-5.151**	-5.618**	-2.739

				(2.433)	(2.553)	(2.578)
SAM					-0.099*	-0.142***
					(0.055)	(0.046)
Work hours					-0.074	-0.058
					(0.126)	(0.119)
Style - consecutive days in production					0.014	0.011
					(0.016)	(0.015)
Tardiness (minutes)						-0.003*
						(0.002)
Total absenteeism (%)						-0.001
						(0.003)
Productivity (%)						0.034***
						(0.005)
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-17: Productivity-treatment-only OLS regressions with quality rate as the dependent variable.
Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Hourly wage (baht)					
	1	2	3	4	5	6
Productivity treatment	-0.643	-0.343	0.172	0.03	-0.12	-0.085
	(1.208)	(1.235)	(0.981)	(0.993)	(1.002)	(1.005)
Overtime		4.040***	4.085***	4.084***	4.095***	1.926*
		(0.689)	(0.663)	(0.646)	(0.647)	(1.131)
Familiarity			0.050***	0.048***	0.048***	0.047***

			(0.008)	(0.008)	(0.008)	(0.008)
Quality Rate (%)				0.331^{***}	0.336^{***}	0.335^{***}
				(0.074)	(0.075)	(0.075)
Number of line workers				16.964	17.814	16.938
				(12.790)	(12.652)	(12.844)
Square of Number of line workers				-16.135	-15.248	-15.233
				(11.597)	(11.264)	(11.222)
Cube of Number of line workers				-24.168^{***}	-22.992^{***}	-22.785^{***}
				(8.617)	(8.224)	(8.204)
Work hours					0.218^{***}	0.217^{***}
					(0.071)	(0.072)
SAM						0.835^{**}
						(0.366)
Style - consecutive days in production						0.01
						(0.035)
Tardiness (minutes)						-0.009
						(0.006)
Unplanned absenteeism (%)						-0.005
						(0.010)
Observations	4,191	4,191	4,191	4,191	4,191	4,191
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-18: Productivity-treatment-only OLS regressions with hourly wage as the dependent variable.

Fixed effects for each specification are date, style, and line.

	Dependent variable:					
	Factory Profit per Garment (baht)					
	1	2	3	4	5	6

Productivity treatment	-3.448***	-3.519***	-3.520***	-3.374***	-3.422***	-3.432***
	(0.922)	(0.969)	(0.959)	(1.000)	(0.990)	(0.990)
PQWR treatment	-3.497***	-3.533***	-3.492***	-3.204***	-3.476***	-3.408***
	(0.814)	(0.838)	(0.806)	(0.895)	(0.906)	(0.907)
Target wage treatment	-3.015***	-3.049***	-3.120***	-3.114***	-3.170***	-3.177***
	(0.762)	(0.779)	(0.841)	(0.803)	(0.799)	(0.799)
Overtime		-0.518	-0.514	-0.484	-0.531	-0.596
		(0.533)	(0.529)	(0.528)	(0.541)	(0.994)
Familiarity			-0.003	-0.003	-0.003	-0.003
			(0.008)	(0.008)	(0.009)	(0.009)
Number of line workers				8.139	3.853	4.817
				(6.361)	(6.634)	(6.805)
Square of Number of line workers				7.693***	7.756***	7.346***
				(2.418)	(2.629)	(2.578)
Cube of Number of line workers				4.952	5.753*	5.455
				(3.523)	(3.371)	(3.444)
SAM					-1.064***	-1.058***
					(0.128)	(0.129)
Work hours						0.016
						(0.339)
Style - consecutive days in production						-0.017
						(0.024)
Tardiness (minutes)						0.012*
						(0.006)
Unplanned absenteeism (%)						0.047
						(0.040)

Observations	1,692	1,692	1,692	1,692	1,692	1,692
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 7-19: OLS regressions on profit-per-garment.
This is not a DID identification strategy, because the data only covers the post-treatment period, thus we only have 1,692 observations. We also note that line was dropped as a fixed effect because of collinearity. The treatment effect is a cross-sectional comparison between the treatment group and control group in the post-treatment period.