Does Lean Improve Labor Standards? Capability Building and Social Performance in the Nike Supply Chain

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Social compliance programs employed by MNEs face significant challenges in enforcing labor standards across global supply chains. We study whether focal firms can improve supplier social performance through capability building that aligns business practices with social compliance goals. We analyze an intervention by Nike Inc. to promote lean manufacturing and high-performance management systems in apparel suppliers across eleven developing countries. Using difference-in-differences estimates from a panel covering over 300 factories from 2009 to 2013, we find that adoption of lean manufacturing produced a 15 percentage point reduction in serious labor violations on average. We also find variation by country; adoption of lean raised labor compliance in Southeast Asia but not in China. Finally, we find no discernible effect of the lean program on health, safety, and environmental compliance. Our results offer the first quantitative evidence for the efficacy of capability building in sustainability strategy.

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1 Introduction

Corporate social performance has become a key goal in strategic management. As activists and the media have grown increasingly adept at pressuring firms surrounding the social impacts of their activities (Porter and Kramer 2006), scholars have linked corporate social performance to a variety of positive outcomes, including improved access to finance (Cheng, Ioannou and Serafeim 2013), the ability to attract talented employees (Turban and Greening 1997; Bhattacharya, Sen and Korschun 2008), increased recommendations from stock analysts (Luo et al. 2013), and improved risk management (Koh, Qian and Wang 2013). Effective social performance strategy is particularly important to firms transacting in global value chains that span jurisdictions with weak regulatory enforcement or high levels of corruption Kytle and Ruggie (2005).

A wide variety of multinational enterprises—including industry leaders in retail (Walmart, Target, Ikea), electronics (Apple, Microsoft, HP), toys (Mattel, Hasbro), soft drinks (Coca Cola), and the ten most valuable global apparel brands[1]—have responded by adopting compliance programs to enforce social performance standards in their global supply chains. The goal of these programs is to improve the social performance of upstream business partners, primarily in developing countries, thereby addressing stakeholder concerns about labor, environmental, and health conditions in globalized production and reducing social and reputational risk for lead firms (Locke 2013). Yet despite widespread adoption of social compliance programs, research has repeatedly shown that they yield only limited improvements in social performance (Barrientos and Smith 2007; Egels-Zandén 2007; Locke and Romis 2007; Locke, Qin and Brause 2007; Lund-Thomsen et al. 2012). Weak social compliance means that core labor, safety, and environmental standards are violated in the production of popular consumer goods, placing employees' health and economic wellbeing at risk. From the managerial perspective, ineffective compliance programs threaten corporate social performance and its associated benefits. The persistence of socially irresponsible practices in the supply chain also expose lead-firms to the risk of negative financial shocks associated with the disclosure of socially harmful corporate behavior (Klassen and McLaughlin 1996; Flammer 2012).

In this paper we examine the idea that a major limitation of most supply chain com-

[1] The top ten global apparel brands ranked by Millward Brown Optimor (2013) are Zara, Nike, H&M, Ralph Lauren, Adidas, Uniqlo, Next, Lululemon, Hugo Boss, and Calvin Klein. Ralph Lauren has not yet issued a corporate sustainability report, but it claims to, "conduct independent audits of our suppliers to evaluate their compliance with our Operating Guidelines." `http://www.ralphlauren.com/transparencyact/index.jsp?ab=footer_CAtransparencyact` (Accessed Nov 19, 2013).

pliance programs is poor integration of social compliance goals with core business practices. Market demands tend to decouple supply chain social compliance activities from other business practices, mirroring pathologies documented in other corporate compliance programs (Weaver, Trevino and Cochran 1999; MacLean and Behnam 2010). To make matters worse, supply chain compliance programs are enforced across the boundaries of firms. Buyers therefore face additional challenges of monitoring and coordinating the activities of independent organizations.

We hypothesize that capability-building interventions that align supplier business practices with social compliance goals will lead to improved social performance in global supply chains. We test this hypothesis with an empirical study of management practices and social compliance in global apparel production, an industry that employs over 25 million in low- to middle-income countries (International Labour Organization 2005). Since 2008, Nike Inc.—an international leader in the design and retail of athletic apparel, footwear, and equipment—has promoted the adoption of lean manufacturing techniques in its apparel supply base. This program transformed management systems in participating suppliers with the goal of improving both operational and social performance. Nike provided extensive training in lean manufacturing to supplier management, encouraged the adoption of these techniques, and verified that supplier production lines met their lean standards. Supplier adoption of this production system required significant changes to the organization of production, the management of data, and the participation of production employees in supplier factories, with emphasis placed on multi-skilled workers who actively participate in production processes.

Drawing on difference-in-difference estimates from panel data of over 300 factories across eleven developing countries between 2009 and 2013, we find that Nike's lean intervention produced a significant improvement in a key aspect of factory social performance: participation in the lean program led to a 15 percentage point reduction in serious labor violations. This finding is robust to alternative specifications, including an examination of pre-trends among the lean-adopters. By contrast, we detect no significant effect of the lean program on health, safety and environmental compliance. We also find heterogeneity in labor improvements by country; while the program significantly raised labor compliance in Southeast Asia, factories in China show no improvement.

Our work contributes to a greater understanding of how MNE strategy affects social outcomes in global markets in three ways. First, we establish a causal link between management strategy and social performance outcomes. While a growing scholarly consensus affirms the importance of corporate social performance, major questions remain about how

to achieve this performance. The problem of social performance is particularly troublesome in global supply chains that link multiple organizations, economies, and political jurisdictions. Our findings represent the first quantitative evidence linking capability building to improved social performance in global production. Capability-building interventions are increasingly promoted by both focal firms and external stakeholders to improve supply chain social compliance (Oxfam 2010; IMPACTT 2011), but empirical evidence on their impact is limited and ambivalent (Locke, Amengual and Mangla 2009; Locke et al. 2007), leading to calls for new empirical work to fill the gap (Lund-Thomsen and Lindgreen 2013). This paper estimates the effects of a large capability-building program across a variety of economic and political contexts. Our use of unit fixed-effects for econometric identification also offers a methodological advance from previous research on social compliance programs, which has relied on cross-sectional analysis (Locke et al. 2007).

Secondly, this study contributes to a debate about how high-performance work systems in globalized production affect social performance. Various studies have documented the impact of lean and related high performance work systems on worker productivity (MacDuffie 1995; Dunlop and Weil 1996; Ichniowski, Shaw and Prennushi 1997), improved quality (MacDuffie 1995; Bloom et al. 2013), financial performance and profitability (Huselid 1995), and working conditions (Ichniowski et al. 1996). In turn, some research has suggested that pressure in global supply chains to adopt lean manufacturing and other process improvements has actually led to a deterioration of working conditions and labor rights for workers in supply chain factories, as managers lacking the skills and resources to effectively implement these systems shift the costs of flexible production onto the workforce in the form of longer hours and more precarious employment (Dhanarajan 2005; Raworth and Kidder 2009). Our results indicate that high-performance work systems can be meaningfully implemented in the context of global production, and that their adoption can yield benefits for workers, linking economic upgrading to social upgrading in global supply chains (Barrientos, Gereffi and Rossi 2011). Most importantly, because the adoption of high-performance management systems stands to simultaneously benefit the buyer, supplier, and workers, this intervention promises greater sustainability than traditional compliance regimes.

Finally, our findings on capability building suggest a strategy for reconciling tension between the imperatives of supply chain management and social performance. Contemporary sourcing strategies such as competitive costing, reduced lead-times, and smaller order sizes shift risks onto suppliers and their workforces, thereby undermining key goals of social compliance programs (Locke 2013; Dhanarajan 2005; Barrientos 2013; Riisgaard 2009).

The global apparel industry, where contemporary sourcing practices have been argued to be particularly deleterious to labor outcomes (Anner, Bair and Blasi 2012), is a crucial case for addressing the conflict between sourcing strategy and social compliance. A major goal of the Nike lean program was to improve supplier capabilities to deal with sourcing trends toward smaller orders and more rapid turnaround. At the same time, adopting management systems to support these capabilities also led suppliers to improve labor standards compliance. Our findings suggest that modern techniques of supply chain management need not depress workplace conditions when combined with appropriate management systems.

In the following section, we introduce supply chain compliance programs and the challenges of aligning business practice with social performance goals in global production, developing our hypothesis that managerial capability building can align supplier business practices with compliance goals. We proceed to describe Nike's lean intervention in its apparel supply chain and how it changed the management practices of suppliers across eleven emerging economies. We follow by describing our data and strategy for estimating the causal effect of this intervention on social performance. We then present our main finding; lean adoption produced a substantial reduction in serious labor violations. The final section discusses the importance of our findings to the theory and practice of supply chain governance, including our discussion of the program's varying efficacy across different countries.

2 Managing Social Performance in Globalized Production

The demand for systems to manage the social performance of far-flung suppliers is a by-product of the globalization of production. Globalization, with its volatile mix of economic opportunity and social disruption, is shaping the working conditions of the millions of individuals employed in today's global supply chains. The world of global supply chains links thousands of firms, large and small, across multiple political and economic boundaries. The diffusion of global supply chains in an array of different industries-apparel, electronics, footwear, food, toys, and so on-has provided developing countries with much-needed investment, employment, technology, and access to international markets. At the same time, however, the social and environmental consequences of this particular pattern of economic development have provoked significant controversies over the role of global brands and their local suppliers, often seen as exploiting developing countries' low wages and weak social and

environmental regulation to produce low-cost goods at the expense of local workers' welfare. In fact, child labor, hazardous working conditions, excessive working hours, and poor wages plague many workplaces in the developing world, creating scandal and embarrassment for the global companies that source from these factories and farms (Verité 2004; Pruett, Merk and Ascoly 2005; Connor and Dent 2006; Kernaghan 2006).

In the absence of a strong system of global justice (Cohen and Sabel 2006), and given the limited ability (perhaps willingness) of many national governments to enforce their own labor laws, an array of actors—including transnational NGOs (Keck and Sikkink 1998; Seidman 2007), global corporations and industry associations (Haufler 2001; Bartley 2007; O'Rourke 2003; Ruggie 2008; Reich 2007; Vogel 2008), multi-stakeholder initiatives, and even a few developed country governments (Bartley 2007)—began to promote private initiatives aimed at establishing and enforcing labor standards in global supply chains.

The prevalent model of private regulation involves establishing "Codes of Conduct" which are enforced on upstream suppliers through private audits and the threat of withholding orders from noncompliant factories. However, a decade of research has demonstrated the severe limitations of this strategy for enforcing core labor standards. Notwithstanding years of effort and significant investments by global corporations in developing ever more comprehensive monitoring tools, hiring growing numbers of internal compliance specialists, conducting thousands of factory audits, and working with external consultants and NGOs, working conditions and labor rights have improved somewhat among some of their suppliers but have stagnated or even deteriorated in many other supplier factories (Locke 2013). Although the standards embodied in codes of conduct are usually described as minimum requirements for doing business with the lead-firm, in practice many suppliers remained in the supply base after repeatedly failing to meet these standards. Even after years of auditing, many factories continue to remain out of compliance in core labor standards (Barrientos and Smith 2007; Locke et al. 2007; 2012; Locke 2013).

One important critique of these programs is that they have "decoupled" compliance activities from core business practices and thereby limited their impact on improving core labor standards and social performance. When needs for external legitimacy diverge from market demands, firms may design compliance regimes that are not fully integrated with core business processes, a decoupling which has been observed in other corporate ethics regimes (Weaver, Trevino and Cochran 1999). Supply chain compliance programs suffer from decoupling in two important ways. First, within the focal firms overseeing compliance programs, the activity of sourcing is often decoupled from the enforcement of social compliance, re-

sulting in tension between these two functions. It is not uncommon to hear complaints from social compliance managers that their mission is not taken seriously by executives in sourcing (Harney 2008, 213). Second, conscientious buyers have publicly acknowledged that a variety of their own sourcing practices—including the proliferation of styles, last-minute order changes, poor forecasting, and overloading supplier capacity—contribute to the very social performance problems that compliance programs attempt to resolve (Locke 2013; Nike Inc. 2012). For their part, suppliers complain that despite lip-service paid to ethical compliance, sourcing decisions appear to remain guided by traditional business considerations. They offer evidence of buyers' willingness to overlook compliance problems in sourcing destinations that offer superior price, quality, or turnaround (Ruwanpura and Wrigley 2011). This decoupling of sourcing and compliance practices obviously limits the efficacy of social compliance programs.

The misalignment of compliance goals and sourcing practice is not universal in global sourcing. Some firms have made significant efforts to integrate supply chain compliance with core business activities. Nike uses a public Manufacturing Index that equally weights quality, delivery, cost, and sustainability to guide sourcing decisions (Nike 2012). However, enforcing social compliance in global supply chains faces the additional challenges of structural decoupling. The economic and managerial boundaries between firms mean that supplier management practices cannot be changed by buyer fiat. Whereas firms can internally change how managers are reviewed and promoted, they cannot ordinarily exercise such control over suppliers' management systems. Therefore, even when internal decoupling is mitigated by better alignment of sourcing practices with compliance goals, the boundaries between buyers and suppliers further limit efforts to institutionalize social responsibility in the supply chain.

Capability building for social compliance aims to address these challenges by promoting new management systems in suppliers that better align with compliance goals. The immediate goal of these programs is not to monitor and enforce socially responsible performance outcomes, but rather to change day-to-day managerial practice in suppliers in ways that support improved social performance. Capability building for social performance has been pursued across a variety of industries and specific goals (Locke 2013), but claims of impact have yet to be subjected to quantitative hypothesis testing. The following section describes Nike's lean capability building initiative and the opportunity it provided to test whether such interventions can actually improve social performance in global production.

3 Lean Capability Building in the Nike Supply Chain

Facing systemic challenges in both workplace conditions and product quality in the late 1990s, Nike began a search for management and production interventions for its supplier base.[2] Toyota's lean production system was selected for emulation, and a Toyota consultant was hired to adapt lean concepts to footwear manufacturing. By working with its contract manufacturers in Vietnam, Nike developed applications of lean production concepts to footwear manufacturing. In 2002, Nike secured commitments from long-term manufacturing partners in footwear to implement the lean management and production system it had developed, and a dedicated Vietnam training center was established in 2004 to train both factory managers and Nike staff. By May 2011, 80% of Nike's footwear manufacturers had committed to adopting the system and begun to transform their production processes.

Lean concepts have been widely applied in management practice and studied in scholarship without a clear consensus on the definition of lean production (Shah and Ward 2007). We characterize the Nike production system as "lean" by reference to common goals and features in lean systems described by key works in the literature. The features of the Nike system included identifying the core value stream and orienting production around this concept; balancing production processes using takt time; eliminating waste through the reduction of inventory buffers and works-in-progress; increasing operator participation in quality control and problem-solving for continuous improvement; and improving operational stability with 5S, standardized work, and visual management techniques (Womack and Jones 1996; MacDuffie 1995; Shah and Ward 2003).

Nike claims that its lean intervention in footwear increased productivity, reduced defect rates, and shortened lead times and the introduction of new models[3] (Nike Inc. 2012). If these managerial practices were so beneficial to productivity and quality, why did manufacturers require outside intervention to adopt lean manufacturing? The adoption of high-performance management systems can be hindered by institutional conformity, asymmetries between visible costs and hard-to-measure benefits, and pre-existing assumptions about human behavior (Pfeffer 2007). In addition to these organizational constraints, implementing high-performance management systems also requires information that may not be easily accessible to factory management in developing countries (Bloom et al. 2013). It is therefore

[2]The following description of Nike's lean capability building program is based on repeated interviews with eight senior managers at Nike, as well as internal documents provided by management and a field visit to the NOS training center in Vietnam in 2007.

[3]Available online at: `http://www.nikeresponsibility.com/report/content/chapter/manufacturing#infographic105` Accessed October 2, 2013.

unsurprising that implementing high-performance management systems in emerging-market manufacturers would require external motivation and training.

The perceived success of the footwear program led Nike to expand the lean program to its apparel supply chain. The global apparel industry is an important site of research for improving supply chain social performance. It employs tens of millions of workers in the developing world (International Labour Organization 2005) and represents an important industry for gaining entry to global production networks and creating opportunities for industrial upgrading (Gereffi 1999). As of August 2013, Nike directly contracted with 449 apparel makers across 39 countries, with over 370,000 employees.[4]

The initial wave of lean-adopters came from Nike's Apparel Manufacturing Leadership Forum (MLF), a group of strategic manufacturing partners with long-term relationships to Nike.[5] Senior management from MLF suppliers were initially brought to the footwear training center in Vietnam and introduced to the Nike lean production system. All participants accepted Nike's offer to receive training and implement the system in their own plants. In general, the factories receiving the intervention were larger plants with preexisting sourcing relationships to Nike and stronger capabilities. These selection criteria are one reason why cross-sectional comparisons of outcomes do not produce valid estimates of the program's effects; previous research on working conditions among Nike's suppliers found that strategic partners were more likely to have higher compliance scores (Locke et al. 2007). We discuss our empirical strategy for dealing with this selection bias in the following section.

In 2007, the first wave of apparel suppliers committed to the Nike lean program and began meeting to discuss lean concepts and receive limited training. The full training curriculum was offered starting in 2009 at the newly-opened Nike Apparel Innovation and Training Center (AITC) in Sri Lanka. The program sought to create "agents of change" to oversee the lean transformation of participating apparel factories. The training program works on a self-funding model that involves significant commitment from participating plants; factories send managers to the Sri Lanka training center for eight weeks and pay tuition to cover program costs.[6] The training center sits on the property of a dedicated apparel plant, so trainees could both observe and practice what they learn in a lean manufacturing environment. After completing the program, trainees worked with a Nike manager to develop

[4] `http://nikeinc.com/pages/manufacturing-map`

[5] Subsequent waves of lean-adopters were not necessarily members of the MLF; they were nominated by Nike Apparel Liaison Office Directors.

[6] The AITC lean training program lasts twelve weeks, but managers return to their home factories for the middle four weeks to work on assignments.

a "proliferation" strategy for their home factories. They would begin with a pilot line and a particular element of the transformation and implement each element until the change was considered stable.

After suppliers complete the initial transformation of production lines, Nike personnel visit the plant to observe progress and certify that the lines possess the core elements of lean production, as defined by Nike. These minimum definitions cover eight key features, summarized in Table 1. The line must connect or link at least one process to the core value stream; control inventory via flow racks, kanbans, and pull systems; utilize an Andon system to signal problems in the line; track appropriate metrics for safety, quality, delivery, and cost; use in-station quality inspection; utilize standardized work; show evidence of 5S and visual management; and manage the core value stream as a single entity rather than individual processes. In addition to these specific criteria, Nike personnel also look for understanding of these processes and the use of takt time and cycle time in the organization of production.

The lean transformation had important consequences for management techniques. Managers undertook a major physical and visual reorganization of production. Variability in production processes, previously managed through maintaining large work-in-progress inventories, was instead to be managed by improved balancing of process cycles and utilizing pull-based systems to move inventory through the value stream. Whereas supervisors previously managed distinct production processes, supervisors of lean certified lines took responsibility for all connected processes. Managers also collected a variety of new performance metrics and communicated performance with easy-to-read visual signals.

These new management techniques might improve social performance through several mechanisms. One key problem in global supply chains is excessive overtime among production employees, which is exacerbated when suppliers rush orders to meet short delivery times or changing buyer demands (Locke, Amengual and Mangla 2009). By reducing time between the arrival of raw materials and the shipping of a finished product ("dock-to-dock"), lean management techniques provide producers with greater leeway to ship orders on schedule, reducing the need to keep lines running in overtime. Lean production lines also require operators to undertake a greater array of responsibilities in the production process. They are responsible for cleaning and arranging their workstations according to the 5S demands. The functioning of pull systems requires that employees use kanbans to signal the start and stop of production processes. Operators are trained to incorporate quality inspection into their work, with the concept of not accepting, making, or passing on defects. They also signal problems to supervisors and other workers via an Andon system. These are signifi-

Table 1: Minimum Definitions for the Nike Lean Production System

1. Connect or link at least one process to the core value stream.	Prior to lean, almost all apparel factories had physically disconnected sewing, ironing, and packing, with high inventory buffers between each process. Connecting processes to the core value stream (sewing, in apparel factories) means physically moving operators and machines into the line, with process cycle time balanced to the line takt time. In practice, most apparel factories chose to connect ironing and packing at the end of each sewing line.
2. Control inventory via flow racks, kanbans, and pull systems	Flow racks allow for easy retrieval of inventory on a first-in-first-out basis; kanbans are cards used to signal the start and end of production. Both tools support pull systems, which drive production by demand at the end of the process and reduce waste by eliminating inventory that would ordinarily build up in the value stream to absorb variability in production processes.
3. Utilize an Andon system to signal problems in the line	The Andon system allows production team members to quickly signal production problems to the entire team. Suppliers must adopt a visual system (e.g. colored flag, card, or digital signboard) to signal problems, such as production defects, machine malfunctions, or an operator's need for relief. Depending on the problem, activating the Andon may temporarily stop production while the problem is addressed.
4. Track appropriate metrics for safety, quality, delivery, and cost	The minimum definition requires collection of these key performance indicators. Suppliers are expected to use these measures to track their performance and drive improvements in the value stream.
5. Use in-station quality inspection	The concept of not accepting, making, or passing on a defect is introduced to the line. Operators are asked to self-inspect their own output rather than depend on end-of-line inspection.
6. Utilize standard work in the core value stream.	Standardized work involves specifying standards for the rate of production (takt time), required inventory, and sequence of operator actions. These are written on worksheets located at each work station.
7. Show evidence of 5S and visual management.	5S (Sorting, Setting, Shining, Standardizing, and Sustaining) ensures operational stability by eliminating waste from the work environment. Sorting removes non-essential tools and materials from the workspace. Setting arranges the workers, parts, and materials to minimize waste as value-added tasks are performed. Shining maintains the cleanliness of the workstation and its usability to subsequent operators. The final two Ss refer to the institutionalization of these practices. Visual management techniques include signs, shadow boards, tape to mark walkways and production areas, and colors to indicate performance.
8. Manage the core value stream as a single entity rather than individual processes.	Prior to lean adoption, each production process was managed by separate supervisors. Once ironing and packing are connected to the end of sewing lines, a single supervisor would be responsible for all processes in that line and the final output.

Notes. Nike personnel certify lean lines by examining supplier adoption of these eight practices.

cant departures from traditional sewing and ironing and therefore require training workers to shoulder new responsibilities. In these ways, many non-sewing (non-ironing) activities of workers become integral components of the production system; they are multi-skilled partners in sustaining the lean production system.

Increased reliance on a multi-skilled workforce provide a second potential mechanism for upward pressure on labor standards. Workers can assume greater responsibilities only when trained to work in the lean system. Bringing new workers into this system requires significant investments of managerial time and attention to train and coach these workers. This raises the already significant challenge of high rates of worker turnover. Managers may attempt to buy worker loyalty by improving various conditions of employment in ways that address major problems of social compliance: underpayment of wages, industrial hygiene problems, and inferior conditions in dormitories and cafeterias.

Nike anticipated an improvement in social performance associated with the "culture of empowerment" embedded in their lean production system. However, other scholars have contended that applying these systems to global supply chains has had deleterious consequences for labor standards in the developing world. In 2003-2004, Oxfam International coordinated a research project on the supply chain practices of 20 companies spanning 15 countries. The project included thousands of interviews with factory and farm workers, managers, government officials, union and NGO representatives, trading agents, importers, and staff from various major brands and large retailers. The study concluded that: "...current sourcing strategies designed to meet 'just-in-time' delivery (premised on flexibility and fast turnaround), combined with the lowering of unit costs, are significantly contributing to the use of exploitative employment practices by suppliers" (Dhanarajan 2005, p. 531).

According to the authors of this study, lean production is "mimicked" rather than genuinely practiced when suppliers do not possess the managerial and technical tools to cope with the demands by global brands and large retailers for shorter production lead times, greater number of products and styles, and ever-lower unit prices. They conclude that, "As a result, it is most definitely the workers at the labor-intensive stage of production who are getting leaned on" (Raworth and Kidder 2009, 170). A subsequent study by the Clean Clothes Campaign of 30 plants located in Sri Lanka, Bangladesh, India, and Thailand, producing garments for several large retailers (Wal-Mart, Carrefour, and Tesco, among others) also found that demands by these global buyers for quick turnaround and lower unit costs were undermining the ability of their suppliers to respect their codes of conduct (Clean Clothes Campaign 2008). While capability-building has been proposed as a technique to

relieve these pressures, the evidence to date is mixed and inconclusive. The following section measures the impact of Nike's lean intervention on social performance in developing-world apparel factories.

4 Data and Empirical Strategy

Measuring workplace social performance is challenging even in advanced economies (Weil 2008). Upstream firms in today's global supply chains are predominantly located in emerging economies, where workplace inspectorates may be understaffed, lack critical technology for managing data, or both (International Labour Organization 2011). We address these challenges by measuring social performance with audits imposed by a single focal firm, permitting repeated observations of developing-country workplaces that would otherwise be difficult for researchers to access. Social compliance audits also utilize common inspection procedures and workplace standards to characterize outcomes in suppliers across a diverse array of countries, allowing us to examine the generality of this intervention's effects across several countries.

Nike evaluates factory compliance with standards in labor, health, and environmental performance using periodic factory audits.[7] Supplier factories are audited for social compliance every 12 to 18 months, according to a schedule that takes into account their previous compliance ratings and levels of factory risk. One-third to one-half of these audits are conducted by Nike compliance personnel, a team of roughly 70 employees, with the remaining audits performed by approved third-party auditors (Nike Inc. 2012, 42).

Nike divides its factory compliance program into two topic areas monitored through two different factory audits: health, safety and environment (HSE) and labor. These audits score factory compliance on a four-point scale: A (4) to D (1). Factories that achieve A scores demonstrate no serious violations of the standards. A major distinction is between factories that score B or higher and those scoring C or worse. Factories scoring a B are mostly compliant, with minor violations such as isolated instances of excess overtime. In contrast, factories scoring a C or below may fail to provide basic terms of employment, employ child labor, pay less than the legal minimum wage, or have serious health and safety system failures. Nike characterizes a noncompliance rating of C to be "serious" and D to be

[7]The "Nike Inc. Code Leadership Standards" are available from: `http://www.nikeresponsibility.com/report/uploads/files/NIKE_INC_Code_Leadership_Standards.pdf`

"critical."[8]

We built a panel dataset of factory compliance ratings over time. These data consist of factory audit results from FY2009 to the first half of FY2014. (The Nike fiscal year starts in June and ends in May.) As the lean-adopting factories are all apparel manufacturers, our sample includes only apparel factories in the same 11 countries as the lean adopters. A summary of the dataset is presented in Table 2. Roughly half the factories are located in China, and one-third are in Southeast Asia. Factories with serious or critical compliance violations (C or D grades) comprise over one-third of our labor panel and one-half of our HSE panel.

Factories that adopted lean production techniques exhibit better labor and HSE compliance than non-adopters. In labor audits, lean-adopters have a mean score of 3.1, compared to 2.6 among non-adopters (pval <.00). For HSE, they average a 2.8 compared to a 2.3 among non-adopters (pval <.00).[9] This lends initial support to the idea that lean production is associated with better social compliance. However, this type of cross-sectional comparison is a poor attempt at causal inference, raising serious concerns about endogeneity and omitted variable bias. The initial participants in the lean program were key manufacturing partners; they enjoyed longer-term business relationships with Nike. They were in many ways different from the factories that did not participate in the lean program, raising concerns that lean-adopters would have enjoyed better workplace conditions anyway.

We utilize the panel data structure and the gradual introduction of lean manufacturing across the supply base to address these concerns. Table 3 describes the progress of lean adoption in the factory panels. While no factory used lean at the beginning of the sample period in FY09, about 20% of factories had implemented lean at the end of our sample period in FY14. This progressive proliferation of lean manufacturing allows us to control for both time-invariant factors associated with each factory and time-varying compliance shocks to the entire pool of factories. We estimate lean's effect on social compliance using a standard fixed effects regression:

$$Y_{it} = \eta_i + \delta_t + \alpha \, \text{Lean}_{it} + \varepsilon_{it} \tag{1}$$

[8]Compliance letter grade criteria are available at: `http://www.nikeresponsibility.com/report/uploads/files/LetterGradeCriteria.pdf`

[9]Nike compliance grades run on a four-point scale from D (1) to A (4). We examine compliance scores for apparel factories in Asia, Europe, the Middle East, and Africa as of FY14 Q1. For labor compliance, we have audit data for 71 lean-adopters and 572 non-adopters. In HSE compliance, we observe 71 adopters and 490 non-adopters. P-values reported from a two-sided t-tests.

Table 2: Factory compliance panel summary

	Labor sample	HSE sample
Countries	11	11
Factories	300	332
Audits	884	986
Observations	2,600	2,317
Compliance scores		
A	16%	1%
B	47%	46%
C	24%	50%
D	13%	3%
Observations by country		
China	47%	45%
Thailand	11%	10%
Indonesia	8%	7%
India	7%	6%
Malaysia	7%	7%
Sri Lanka	7%	6%
Vietnam	6%	10%
Turkey	3%	4%
Bangladesh	3%	2%
Egypt	1%	1%
Cambodia	.3%	2%

Notes. Summary statistics for the factory compliance panels. Our panels include only factories with at least two audits over the time period, and because Nike uses separate labor and health, safety, and environment (HSE) audits, the samples for labor and HSE are not completely identical. When facilities are not audited in a given time period, we impute compliance scores from the most recent audit. The larger number of imputed values for labor compliance results from the larger number of labor scores available early in the panel. 279 factories are common to both samples.

In this equation, Y_{it} is the compliance score on a four-point scale from A (4) to D (1), η_i is a factory fixed-effect that controls for time-invariant unobserved confounders, δ_t is a half-year fixed effect to control for common shocks across the pool of factories, Lean_{it} is our measure of lean adoption, and ε_{it} is an error term with $E[\varepsilon|\eta, \delta, \text{Lean}] = 0$. The parameter of interest is α, the effect of adopting lean production techniques on compliance scores. Under the assumption of parallel trends in the treatment and control groups, the average treatment effect on the treated (ATET) is identified by within-factory change in compliance scores among factories that adopt lean production. This strategy improves upon cross-sectional comparisons by eliminating concerns about time invariant and slow-changing differences between lean adopters and non-adopters, such as factory location, product focus, business culture, size, ownership, and pre-lean levels of managerial competence. All estimations cluster standard errors at the factory level to account for potential serial correlation and heteroscedasticity.

Table 3: Lean adoption in the compliance panel

	Labor sample		HSE sample	
Year	Factories	%	Factories	%
FY09	0	0%	0	0%
FY10	12	4%	12	4%
FY11	27	9%	27	8%
FY12	53	18%	56	17%
FY13	60	20%	64	19%
FY14	64	21%	68	20%

Notes. Displays the count of lean-adopting factories and their share of all factories at the start of each fiscal year.

For robustness we utilize two measures of lean adoption at the factory level. The first—lean adoption—is a binary indicator of whether a factory has *any* certified lean production lines at the start of a given time period. The certification of production lines represents the major qualitative shift toward new management systems; it is the result of months of manager training, numerous changes to production processes, and re-training of involved workers. Our second measure captures the intensity of the lean treatment by measuring the share of total production lines certified to Nike's minimum lean standard; it varies continuously from 0 to 1. Because we use lean certification by Nike staff to measure the intervention, our treatment variables are likely somewhat lagged. By the time that production lines are

certified by Nike personnel, supplier factories have already undergone an extended process of training and production line modifications. Nonetheless, lean certification provides a useful metric as it is measured against a uniform standard by Nike lean staff. Neither our lean measures nor our social compliance scores rely upon factory self-reporting, which may be subject to biases motivated by self-interest.

5 Results

Table 4 presents the main results of our estimation using two measures of lean adoption. Models (1) and (3) use the binary indicator which is coded as one if the factory has any lean-certified production lines and zero otherwise. Models (2) and (4) use the continuous measure of lean adoption: the percentage of lean-certified production lines in a plant. In both specifications, lean adoption has a positive effect on labor compliance. The adoption of any lean lines results in an improvement of roughly 1/3 of a letter-grade. Going from zero lean lines to a 100% lean factory is associated with an improvement of half a letter grade. However, we find no effect of lean adoption on HSE compliance; the coefficients are positive but small and statistically insignificant.

Table 4: Effects of lean adoption on compliance scores

	Labor		HSE	
Mean score (No lean)	2.59		2.36	
Model	(1)	(2)	(3)	(4)
Lean adoption	.29**		.13	
	(.11)		(.08)	
% lean lines		.52**		.12
		(.15)		(.11)
Factory FEs	✓	✓	✓	✓
Half Year FEs	✓	✓	✓	✓
Factories	300	300	332	332
Total obs	2,600	2,600	2,317	2,317

** p<0.01, * p<0.05

Notes. OLS panel fixed effects regression from FY2009 H1 to FY2014 H1. Regression coefficients shown with robust standard errors clustered by factory in parentheses. The outcomes are factory compliance grades on a four-point scale (A=4, B=3, C=2, D=1) for labor and health, safety, and environment (HSE). The two codings of the independent variable are any lean adoption (1 if the factory has adopted any lean lines, 0 otherwise) and percentage of lean lines (count of lean lines / total lines in factory).

5.1 Robustness Checks

We provide several robustness checks to scrutinize the causal interpretation of our results. One potential concern with the previous analysis is the validity of the parallel trends assumption, which implies that average outcomes for lean adopters and non-adopters follow parallel trends in the absence of the program. To examine this concern we can check if lean adopters and non-adopters followed similar trends prior to the participation in the lean program. To this end we estimate a dynamic panel model that uses an indicator to capture the "switch" from the last time period of no lean lines to the first time period with any lean lines, as well as leads and lags of this indicator:

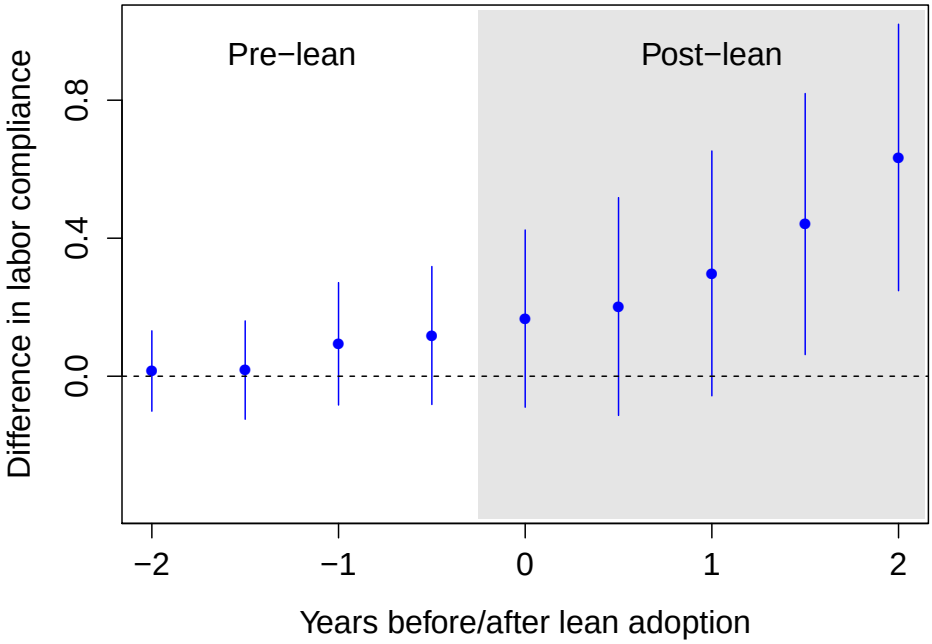
$$Y_{it} = \eta_i + \delta_t + \sum_{a=-4}^{4} \beta_a leanswitch_{i(t-a)} + \varepsilon_{it} \tag{2}$$

Our fixed-effects remain the same as the ordinary panel model. The explanatory variable $leanswitch_{it}$ is a binary indicator that takes the value 1 only if factory i certifies its first lean production line in period t. The four leads and lags of this indicator take the value 1 only when factory i certifies its first lean line in the time period $(t - a)$. The result is a model with nine explanatory variables corresponding to the switching period, four leads, and four lags. By estimating coefficients for these leads and lags (β_a), this specification allows us to inspect differences between lean-adopting plants and non-adopters both before and after they certify their first lean lines. If unmodeled differences between groups threaten the causal interpretation of our fixed effects model, we may observe differences in labor compliance between adopters and non-adopters prior to the introduction of lean manufacturing. Apart from providing a check of the parallel trends assumption, the dynamic panel model also has the advantage that it allows for the effect of the program to vary over time.

Figure 1 plots the estimated coefficients for these indicators, including 95% confidence intervals, highlighting the periods before and after lean adoption. This estimation provides evidence that the lean manufacturing program caused improved compliance in the lean-adopting group. We detect no significant placebo effects in the two years prior to lean adoption, which suggests that unmodeled differences between adopters and non-adopters did not significantly affect labor compliance and therefore the parallel trends assumption seems plausible. We also detect over time variation in the effect of the program. The improvement in labor compliance grows consistently in the years following lean adoption, reaching a statistically significant level 18 months after adoption. By two years after adoption, lean plants

are estimated to score 0.63 letter grades higher on their labor audits than non-adopters.

Figure 1: Dynamic effect of lean adoption on labor compliance



Notes. Estimated effect of lean production on labor compliance for halves prior to (white area) and after (gray) the adoption of lean; 0 marks the first period in which the factory had any lean lines on the first day of the half. Displays point estimates with 95% confidence intervals (using robust standard errors clustered by factory) from dynamic panel regression using four leads and four lags of lean adoption. Results based on 300 factories and 2,600 factory-half observations. Regression results are available in the appendix, Table A1.

A second concern with the previous tests is that we treated the four letters grades as a continuous variable. In Table 5 we relax this linearity assumption and replicate the analysis with binary transformations of the compliance scores. The first transformation codes A or B as 1, and C or D as 0. The second transformation codes only A as 1, and all other scores as 0. Again, we find a significant positive effect of lean adoption on labor compliance, present in both transformations of the dependent variable. These specifications also highlight that the weak effect on HSE compliance is primarily in moving factories up to a B score.

The effects observed in the first two columns of Table 5 are particularly important. As noted above, the gap between B scores and C scores captures major differences in labor standards. Factories scoring a C or lower in labor compliance may have serious violations including underage labor, failure to pay minimum wage, and systematically excessive work hours. We estimate in column (1) that lean adoption reduces the probability of receiving a

C grade or worse from 40% to 25%.

Table 5: Binary transformations of dependent variables

DV	Labor				HSE			
Mean (No lean)	.61		.14		.40		.004	
Cutpoint	AB|CD		A|BCD		AB|CD		A|BCD	
Lean adoption	.15*		.07		.13*		.01	
	(.06)		(.05)		(.06)		(.01)	
% lean lines		.26*		.20**		.14		.01
		(.11)		(.07)		(.10)		(.01)
Factory FEs	✓	✓	✓	✓	✓	✓	✓	✓
Half FEs	✓	✓	✓	✓	✓	✓	✓	✓
Factories	300	300	300	300	332	332	332	332
Total obs.	2,600	2,600	2,600	2,600	2,317	2,317	2,317	2,317

** p<0.01, * p<0.05

Notes. OLS panel fixed effects regression from FY2009 H1 to FY2014 H1 (11 periods). Regression coefficients shown with robust standard errors clustered by factory in parentheses. The outcomes are binary transformations of factory compliance scores for labor and health, safety, and environment (HSE). The first transformation codes factories achieving an "A" or "B" rating as 1, and 0 otherwise. The second transformation codes factories receiving only an "A" rating as 1, and 0 otherwise. The two codings of the independent variable are lean adoption (1 if the factory has adopted any lean lines, 0 otherwise) and percentage of lean lines (count of lean lines / total lines in factory).

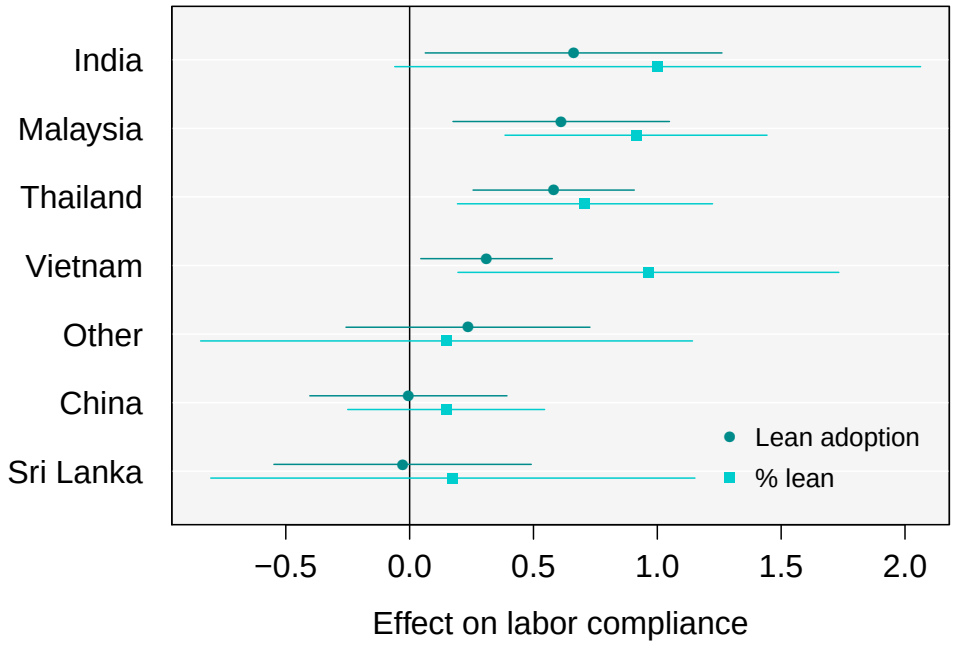
5.2 Heterogeneous Effects

Finally, we run a specification of the panel model that allows us to examine the effect of lean in different countries. We interact the lean measures with country indicators to estimate country-specific treatment effects. The seven countries that occupy at least 5% of the sample each have their own indicators, and the remaining four countries are pooled into a residual category: Bangladesh, Cambodia, Egypt, and Turkey.

The results are plotted in Figure 2, and illustrate significant heterogeneity in the treatment effect. In India, Malaysia, and Thailand, any lean adoption is associated with over half a letter-grade improvement in labor compliance. The effect in Vietnam is smaller but statistically significant. However, in China, Sri Lanka, and our pool of other countries, lean-adopters do not improve significantly. F-tests reject the hypotheses that the treatment effect for China is identical to those of Thailand (pval $<$ .02) or Malaysia (pval $<$ .04). While lean adoption appears to have a large effect on labor standards in several key apparel-

exporting countries, we detect no effect on factories in China, where nearly half of our sample is located.

Figure 2: Country-specific treatment effects



Notes. Figure displays point estimates with 95% confidence intervals (using robust standard errors clustered by factory) from fixed effects model interacting country indicators with treatment variables. The two codings of the independent variable are lean adoption (1 if the factory has adopted any lean lines, 0 otherwise) and percentage of lean lines (count of lean lines / total lines in factory). Countries pooled in the "other" indicator are Bangladesh, Cambodia, Egypt, and Turkey. Results based on 300 factories and 2,600 factory-half observations. Regression results are available in the appendix, Table A2.

6 Discussion

This research builds on literatures in corporate social responsibility strategy and value chain governance to shed light on the social consequences of management strategy. Based on a five-year analysis of a management intervention in the global apparel industry, we find that capability building in suppliers can result in improved social performance. Specifically, we find that the adoption of management systems to support lean manufacturing produced a large improvement in labor standards performance in several developing countries. Particularly important is the reduction in core labor rights violations; lean adoption is estimated to

reduce the prevalence of "serious" and "critical" labor violations by fifteen percentage points. While this finding should not obviate concerns about labor standards in global production, it does provide the first quantitative evidence for the benefits of widely promoted capability building interventions in remediating harsh working conditions in global supply chains.

Our findings on the efficacy of lean capability building are not unqualified. We do not find that the intervention improved factory compliance with health, safety, and environment (HSE) audits, but we also do not find that it made compliance worse in this domain. Insofar as HSE noncompliance results from problems with the factories' physical infrastructure (ventilation, emergency exits, etc.) or regulatory compliance (proper licensing of hazardous substance facilities, environmental permitting, etc.), this finding of no effect is unsurprising. Nike's lean intervention was primarily targeted at investments in managerial capabilities, process improvements, and worker skills. Therefore, we might expect to see improvements in the "softer" aspects of HSE, such as ergonomics, use of personal protective equipment, and industrial hygiene. This may explain the imprecisely- estimated positive effect of lean we estimate for HSE scores. Unfortunately, Nike compliance data do not allow us to offer more precise estimates of this effect nor a detailed breakdown of the sources of HSE noncompliance.

We also detect no effect for the lean intervention in Sri Lanka, China, and our pool of residual countries. It is perhaps unsurprising to find little improvement in Sri Lanka, a country known for high levels of factory social compliance (Ruwanpura and Wrigley 2011). Among factories in Sri Lanka, 85% of non-lean observations exhibited a labor compliance rating of B or higher, with 31% receiving A ratings. The same cannot be said for China, where just 58% of non-lean observations received a B or higher and only 7% received an A grade. China's labor compliance grades are comparable to factories in India (51% B or higher, 7% As), where factories exhibited significant improvement.

One clue to the absence of an effect in China is the lower intensity of lean adoption. By the start of FY14, all twelve Thai lean-adopters, nine of ten in Malaysia, and all three in India had certified more than 33% of their production lines to meet Nike's minimum definition. In contrast, six of the sixteen lean-adopters in China had less than 33% lean lines. If the effects of lean are associated with a certain threshold level of adoption, then perhaps these factories in China have not yet reached that level. Low rates of lean adoption in China could reflect lower levels of managerial commitment to the lean transformation. It is also possible that the particular way lean is being implemented among Nike's China-based suppliers may privilege certain features of the program (e.g. reduction of inventory)

over other elements of the lean training program (e.g. empowerment of shop floor workers). Adjudicating between these interpretations presents opportunities for additional research.

The positive effects on compliance we detect may have traveled through three causal pathways linking Nike's lean program to improved labor conditions. The first is through general improvement in managerial skill and sophistication at supplier factories. The lean trainings and engagement with Nike manufacturing specialists demanded detailed data-gathering and the use of this information to modify production practices. To the extent that labor violations result from shortcomings in these core management skills-such as difficulties forecasting production, poor record-keeping for employee work-hours, and generally haphazard problem solving on factory floors-the lean intervention may have improved compliance scores simply by upgrading overall management quality in suppliers.

Secondly, the adoption of lean production practices necessarily involves new investments in worker skills and knowledge. Lean manufacturing systems depend upon active involvement from operators, who are called upon to perform varied tasks, identify quality issues in the production process, and communicate their observations to management and other workers. This investment in human resources raises the costs of worker turnover, already a major management concern in many developing country export manufacturers. Supplier management may attempt to reduce turnover through an improvement in worker wages and workplace conditions. In fact, changing managerial mindsets surrounding the value of the manufacturing workforce was a stated goal of the Nike program. Increasing management's incentive to retain skilled workers offers a second causal pathway between the adoption of high-performance work systems and improved labor standards.

Finally, capability building may improve labor standards by sustaining higher levels of trust and relational contracting in the buyer-supplier relationship. A common complaint from developing world suppliers involves a perceived lack of commitment from the buyers who demand improvements in factory labor conditions. Buyers may tell suppliers that they care about labor standards, but their sourcing behavior occasionally speaks otherwise, reflecting a willingness to buy from whichever suppliers can meet their quality and delivery needs at lowest cost. In this account, suppliers' belief that their relationships to buyers are fragile and short-lived reduces incentives to invest in social compliance. While participation in the Nike lean program did not offer any guarantees surrounding future orders, the high degree of engagement with Nike may have offered a stronger, more credible signal of Nike's commitment to a future business relationship. Capability-building may have increased trust that supplier investments to comply with the Nike code of conduct would not go to waste.

Which of these causal mechanisms are at work is the focus of our future research. However, it is clear that capability-building differs in fundamental ways from the traditional compliance approach to regulating labor in supply chains. The traditional approach motivates improved workplace conditions through the threat of external sanction applied by buyers. Buyers mandate that suppliers meet their code of conduct demands in order to do business. For this system to work, the buyer has to be indefinitely willing to bear the costs of adequately financing an auditing team to monitor compliance as well as switch- ing costs associated with terminating business relationships with noncompliant suppliers. The supplier must believe that investments in improved conditions are more valuable than losing the buyer's business. However, the last decade of research has taught us that buyers continue business relationships even under conditions of sustained noncompliance, and suppliers may opt to invest in the appearance of compliance, through double-bookkeeping and coaching employee responses to auditors' questions, rather than meaningful workplace improvements. Even when traditional compliance regimes function as designed, the buyer must continuously apply these pressures, with their associated costs for all parties, to sustain improved workplace conditions.

Our findings have significant implications for management practice in contemporary supply chains. Capability building diverges from traditional compliance models in its attempt to create value for both the buyer and supplier, such that both parties have incentive to main- tain and cultivate new management institutions. By demonstrating that workers can also benefit from certain forms of capability building, we identify an opportunity to create "shared value" in supply chains (Porter and Kramer 2011). If buyers, supplier management, and the production workforce simultaneously derive benefit from this kind of intervention, capability building may represent a form of self-enforcing institutional change in the campaign to improve working conditions in globalized production.

Appendix: Supplementary tables

Table A1: Dynamic panel estimates of the effect of lean adoption on labor compliance

Model	(1)
$leanswitch_{t+4}$	.0151
	(.0594)
$leanswitch_{t+3}$	.0178
	(.0727)
$leanswitch_{t+2}$	.0939
	(.0905)
$leanswitch_{t+1}$	.118
	(.102)
$leanswitch_{t}$	.167
	(.131)
$leanswitch_{t-1}$	.202
	(.161)
$leanswitch_{t-2}$	.298
	(.181)
$leanswitch_{t-3}$	.441*
	(.193)
$leanswitch_{t-4}$	.634**
	(.197)
Factory FEs	✓
Half FEs	✓
Factories	300
Total Obs.	2,600
** p<0.01, * p<0.05	

Notes. OLS dynamic panel fixed effects regression from FY2009 H1 to FY2014 H1. Regression coefficients shown with robust standard errors clustered by factory in parentheses. The outcomes are factory labor compliance grades on a four-point scale (A=4, B=3, C=2, D=1). The binary indicator $leanswitch_t$ takes the value 1 only in the first period after lean adoption. The leads and lags of this indicator allow us to examine differences between the treatment and control groups prior to $(t+a)$ and after $(t-a)$ lean adoption. The results are plotted in Figure 1.

Table A2: Country-specific effects of lean on labor compliance

	(1)	(2)
Lean adoption		
× China	-.005	
	(.202)	
× Thailand	.582**	
	(.165)	
× Vietnam	.310*	
	(.135)	
× Sri Lanka	-.028	
	(.264)	
× Malaysia	.612**	
	(.222)	
× India	.662*	
	(.305)	
× Other	.236	
	(.250)	
Percent lean lines		
× China		.148
		(.202)
× Thailand		.708**
		(.262)
× Vietnam		.964*
		(.391)
× Sri Lanka		.174
		(.497)
× Malaysia		.914**
		(.269)
× India		1.002
		(.539)
× Other		.149
		(.505)
Factory FEs	✓	✓
Half FEs	✓	✓
Factories	300	300
Total obs.	2,600	2,600

** p<0.01, * p<0.05

Notes. OLS panel fixed effects regression from FY2009 H1 to FY2014 H1. Regression coefficients shown with robust standard errors clustered by factory in parentheses. The outcomes are factory labor compliance grades on a four-point scale (A=4, B=3, C=2, D=1). The two codings of our lean measure have been interacted with country-indicators to estimate treatment effects within each country that represents at least 5% of our sample. Bangladesh, Cambodia, Egypt, and Turkey make up the residual "other" category. Results are plotted in Figure 2.

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