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Does Lean Capability Building Improve Labor Standards? Evidence from the Nike Supply Chain

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Abstract

This paper offers the first empirical analysis of the introduction of lean manufacturing as a "capability building" strategy for improving labor standards in global supply chains. Buyer interventions to improve supplier management systems have been proposed to augment existing, and widely deemed insufficient, private regulation of labor standards, but these claims have yet to be systematically investigated. We examine Nike Inc.'s multiyear effort to promote lean manufacturing and its associated high-performance work systems in its apparel supply base across eleven developing countries. Adoption of lean manufacturing techniques produces a 15 percentage point reduction in serious labor violations, an effect that is robust to alternative specifications and an examination of pre-trends in the treatment group. Our finding contradicts previous suggestions that pressing suppliers to adopt process improvements has deleterious effects on labor conditions and highlights the importance of relational contracting and commitment-oriented approaches to improving labor standards in the developing world.

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1 Introduction

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. In fact, private regulation has emerged as the dominant approach that global corporations and labor rights non-governmental organizations (NGOs) alike embrace to promote labor standards in global production.

The most 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).

One proposal to augment the traditional compliance model advocates a "commitment-oriented" approach to private regulation of global labor standards (Locke, Amengual and Mangla 2009). Building upon insights from the literature on relational contracting (Baker, Gibbons and Murphy 2002), this approach argues that costly improvements to workplace standards can be incentivized when suppliers trust that their investments will sustain long-term commercial relationships with buyers. This commitment approach to private regulation involves information sharing, joint-problem solving, and buyer investments in supplier management capacities or "capability building." It hypothesizes that the combination of trust, transparency, and improved supplier capabilities can resolve labor standards problems intractable to traditional compliance approaches. Some major lead firms have integrated capability-building into their supply chain regulatory strategies, but the evidence to date is ambivalent about their effects on labor standards (Locke 2013, Ch. 4). Moreover, it remains unclear whether the political economy of today's retail supply chains—shorter lead-times, compressed product cycles, numerous small orders, and constant price pressures (Bruce and Daly 2011)—permit for commitment-oriented relationships to emerge and persist between buyers and suppliers.

We offer the first analysis of a major managerial capability-building program to improve labor standards in a global supply chain. Since 2008, Nike Inc.—an international leader in the design and retail of athletic apparel, footwear, and equipment—has implemented a multi-country program of lean capability building in its apparel supply base. It provided extensive training in lean manufacturing techniques to supplier management, incentivized the adoption of these techniques, and verified that factory production lines met their standards. Drawing upon difference-in-difference estimates from panel data of over 300 factories between 2009 and 2013, we find that lean adoption produced a significant improvement in factory labor compliance. This effect is concentrated in the improvement of core labor standards; participation in the lean program led to a 15 percentage point reduction in serious labor violations. Our result is robust to alternative specifications, including an examination of pre-trends among the lean-adopters. We detect no significant effect of the lean program on health, safety and environmental compliance, and we also find heterogeneity in labor improvements by country. While the lean program significantly raised labor compliance in Southeast Asia, factories in China show no improvement.

By measuring the benefits of lean capability-building, we contribute to the litera-

ture on "second-best institutions" (Rodrik 2008) for regulating global labor in the absence of effective national and international laws. Our finding offers novel evidence on the potential for managerial capability-building, and more broadly for the commitment-oriented approach, to improve private regulation of global supply chains. 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 enforcement-oriented compliance regimes. The apparel supply chain, where contemporary sourcing practices have been argued to be particularly deleterious to labor outcomes (Anner, Bair and Blasi 2012), is a crucial case for understanding the possible benefits of capability-building interventions.

Our findings also speak to the literature on relational contracting and the development of business capabilities in supply chains (Gibbons and Henderson 2012). The study of relational contracting has focused on the need for repeated interactions and reputation to sustain cooperative activities, particularly in weaker institutional settings such as the developing world (McMillan and Woodruff 1999; Banerjee and Duflo 2000). Capability-building interventions involve relational contracting, as both parties undertake investments without explicit guarantees of future business relationships. With the need for buyers to retain flexibility in apparel sourcing, it was unclear whether the repeated interactions and trust in future business needed for such relational contracts could obtain in the contemporary political economy of value chains, where buyers can often easily switch between suppliers (Gereffi and Sturgeon 2005). Prior to this study, examples of successful capability-building were limited to a handful of individual cases (Locke, Amengual and Mangla 2009; Locke et al. 2007). We measure capability-building's effects across eleven countries and dozens of factories, offering more generalizable evidence that substantial investments undertaken by both buyer and supplier can sustain cooperation in building managerial skills and ultimately improving labor conditions. The lean intervention we study offers a concrete operationalization of how to generate "commitment" in buyer-supplier relationships, despite the considerable volatility and uncertainty that characterizes many contemporary global supply chains.

This research also contributes to the management literature on high-performance work systems. 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). Yet other 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). We show 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).

In the following section we discuss private regulation of global supply chains, its pathologies, and "capability building" as a solution to them. We next introduce Nike's lean intervention in its apparel supply chain and describe how it sought to change the management practices of its suppliers. We then present our strategy for estimating the impact of this intervention on workplace conditions and our main finding: lean adoption produced a substantial reduction in serious labor violations. In the final section, we discuss the importance of our findings to the theory and practice of supply chain governance, including a discussion of variation in the program's efficacy across different countries.

2 Private regulation and Capability Building in Global Supply Chains

Private regulation has become an ubiquitous institution for managing labor standards in global production. In response to scandals surrounding harsh working conditions in global supply chains, high-visibility buyers (or lead-firms) developed systems of private regulation that converged around a common model. The compliance model of private regulation first establishes standards for workplace practices for firms in the supply chain, embodied in a "Code of Conduct." These codes are ordinarily a blend of internationally recognized core labor standards and local laws of the countries where factories are located. They typically cover labor practices such as wages and benefits, health and safety conditions like industrial hygiene, emergency preparedness, and ergonomics, and environmental compliance. In the traditional compliance model, these codes would be enforced through periodic audits that measure conformance to these standards, under the threat that lead-firms would drop orders from persistently noncompliant factories.

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. Empirical research has shown that 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). The limitations of these private regulatory regimes include unrealistic expectations surrounding the power of lead-firms, the quality of information their auditors can gather, and the role of incentives (as opposed to improved capabilities) in changing supplier behavior (Locke, Amengual and Mangla 2009)).

One response to these criticisms has been the use of "capability building" as a strategy to augment the efficacy of private regulation. The capability-building approach argues that certain problems in labor standards result from limitations in managerial capabilities. For example, excessive overtime may be improved by effective systems for monitoring worker hours, more efficient line changes, or improved management of orders to avoid overloading factory capacity. While it is clear that capability building (and private regulation more generally) does not offer a replacement for collective labor rights and enforcement of law by individual nation-states, the conjecture held that management interventions—particularly the introduction of lean manufacturing and its associated high-performance work systems—could improve upon the documented pathologies of compliance-oriented private regulation. Lean manufacturing, when combined with high performance work systems, are known to benefit firm productivity, quality, profitability, and working conditions. Early case studies suggested that this form of capability building could indeed provide simultaneous benefits to buyers, suppliers, and workers (Locke et al. 2007).

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, 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 improve private regulation of global supply chains, the evidence to date is mixed and inconclusive. In the following section we describe the multinational capability-building program that we study and how it contributes novel evidence to the debate.

3 Lean manufacturing in Nike apparel

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.[1] 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 its own version of the lean production system, referred to internally as NOS. In 2002, Nike secured commitments from its long-term manufacturing partners in footwear to implement this management and production system, 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. Nike claims that these interventions have increased productivity, reduced defect rates, and shortened lead times and the introduction of new models.[2]

If these managerial practices were so beneficial to productivity and quality, why did apparel manufacturers require outside intervention to adopt lean manufacturing? Previous research has shown that the adoption of high-performance management systems can be

[1]This description of Nike's lean intervention 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.

[2]Nike Inc. FY10/11 Corporate Responsibility Report. `http://www.nikeresponsibility.com/report/content/chapter/manufacturing#infographic105` Accessed October 2, 2013.

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 (Bloom et al. 2013). It is therefore 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, which consists of hundreds of factories across dozens of countries.[3] The initial wave of lean-adopters came from Nike's Apparel Management Leadership Forum (MLF), a group of strategic manufacturing partners with long-term relationships to Nike and large capacity. Senior management from MLF suppliers were brought to the footwear training center in Vietnam and introduced to the Nike lean production system. All invitees accepted Nike's offer to receive training and implement the system in their own plants. Subsequent waves of lean-adopters were not members of the MLF, but rather nominated by Nike sourcing managers. 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, Qin and Brause 2007). We discuss our empirical strategy for dealing with this selection bias in the following section.

The first wave of suppliers committed to implementing the Nike lean program and began meeting as a group to discuss lean concepts in 2007. After joining the program, managers received extended training on the use of Nike's lean system in apparel manufacturing. In 2009, Nike opened the Apparel Innovation and Training Center in Sri Lanka with the goal of creating "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 stay at the Sri Lanka training center for a twelve-week program and pay tuition to cover program costs. 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 a "proliferation" strategy for their home

[3]As of August 2013, Nike directly contracted with 449 apparel makers across 39 countries, with over 370,000 employees. `http://nikeinc.com/pages/manufacturing-map`

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.

In order to meet Nike's minimum definition of lean, a production line must possess eight key features. 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. We adopt this as our definition of a "lean" production line for this study. Once the supplier believed that production lines met these criteria, Nike personnel would visit the plant to certify which lines satisfied the minimum standard for lean production.

In addition to improving factory performance in quality, flexibility, and cost, this program was expected to improve labor conditions through a "culture of empowerment."[4] The features of lean production described above require multiskilled workers and increased communication among employees on the production line. Previous research suggests that training workers to participate in high-performance work systems produces benefits in labor conditions, as factory management has increased incentive to respect labor standards and production workers feel more empowered to defend their own rights (Locke et al. 2007). The Nike lean program offers a novel opportunity to test this claim in a large number of factories across several developing countries.

An important concern arises when attempting to estimate the causal effect of this program on factory working conditions: selection bias. As noted above, the initial participants in the lean program were key manufacturing partners; they enjoyed longer-term relationships and more stable orders from 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 discuss our strategy for addressing this selection bias in the following section.

4 Data and empirical strategy

To estimate the effect of Nike's lean program on workplace conditions, we first built a panel dataset of factory compliance ratings over time. These data consist of factory audit results

[4]Nike Corporate Responsibility Report, FY05-06, `http://www.nikebiz.com/crreport/content/workers-and-factories/3-9-1-our-approach.php?cat=hr`

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 1. Roughly half the factories are located in China, and one-third are in Southeast Asia.

Table 1: 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	0.3%	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.

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 "critical."[5] Factories deemed to have serious violations comprise over one-third of our labor panel and one-half of our HSE panel.

Factories that adopt 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).[6] This lends initial support to the idea that lean production is associated with better social compliance. However, this type of cross-sectional comparison raises serious concerns about endogeneity and omitted variable bias. Factories that pursue lean adoption may differ from non-adopters in ways that affect their labor and safety standards.

We utilize the panel data structure and the gradual introduction of lean manufacturing across the supply base to address these concerns. Table 2 describes the progress of lean adoption in the factory panels. The 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:

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

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

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

[6]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-test.

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 serial correlation and heteroscedasticity.

Table 2: 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.

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 3 presents the main results of our estimation using two measures of lean adoption. Models (1) and (3) use a binary indicator which takes one if the factory has any lean-certified production lines and zero otherwise. Models (2) and (4) use a 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 3: Effects of lean adoption on compliance scores

	Labor		HSE	
Model	(1)	(2)	(3)	(4)
Mean score (No lean)	2.59	2.59	2.38	2.38
SD	.90	.90	.56	.56
Lean adoption	.29**		.13	
	(.11)		(.08)	
% lean lines		.52**		.12
		(.15)		(.11)
Factory FEs	✓	✓	✓	✓
Half 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).

Robustness checks

To scrutinize the causal interpretation of our results, we also estimate a dynamic panel model that uses an indicator to capture the "switch" from the last time period of no lean lines to

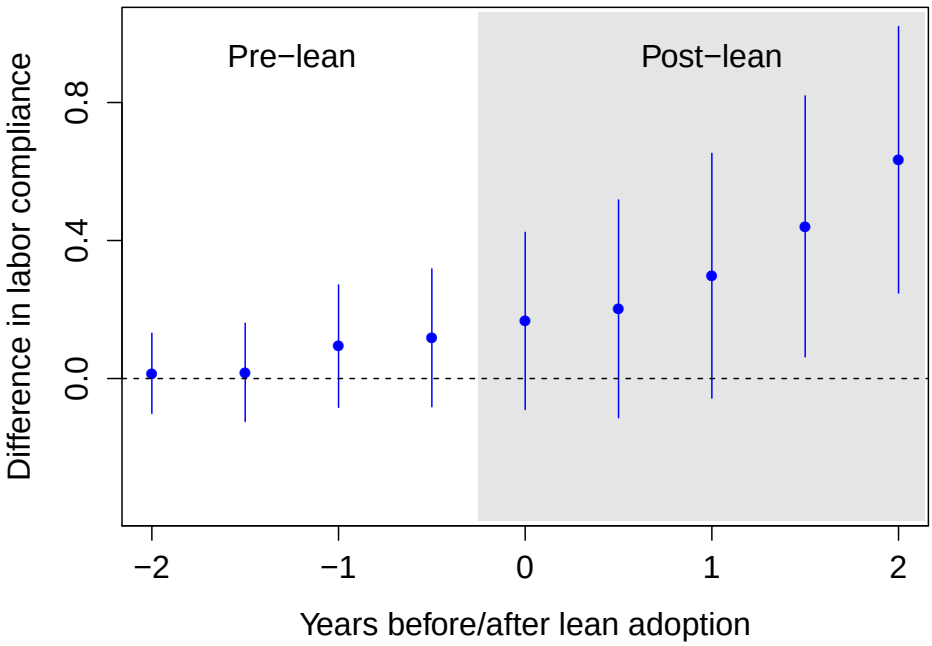
the first time period with any lean lines, as well as leads and lags of this indicator:

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

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.

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. 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.

We relax assumptions about the distribution of the dependent variables and present estimations with binary transformations of compliance scores (Table 4). 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 estimate 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. We do not report estimates for the final cutpoint of ABC=1, D=0, as no treatments were statistically significant at the .05 level.

The effects observed in the first two columns of Table 4 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 4: Binary transformations of dependent variables

DV	Labor				HSE			
Cutpoint	AB|CD		A|BCD		AB|CD		A|BCD	
Mean (No lean)	.60	.60	.13	.13	.41	.41	.004	.004
SD	.49	.49	.34	.34	.49	.49	.06	.06
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

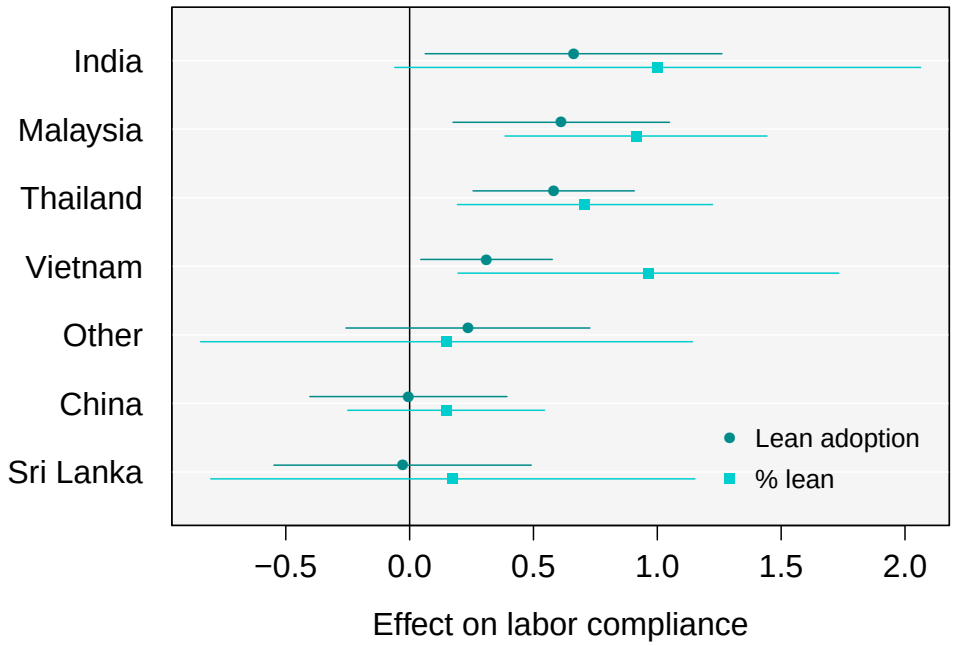
Notes. OLS panel fixed effects regression from FY2009 H1 to FY2014 H1 (11 periods). Regression coefficients shown with robust standard errors clustered by factory in parentheses. The outcomes are binary transformations of factory compliance scores for labor and health, safety, and environment (HSE). 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).

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 "other" 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 ($F(1, 299) = 5.44$, $Pr(>F) = .02$) or Malaysia ($F(1, 299) = 4.45$, $Pr(>F) = .04$). 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

We find that the Nike lean program induced improvements in labor compliance, an effect that is robust to alternative specifications and an examination of pre-treatment trends. This is the first systematic appraisal of capability building to improve labor conditions in global production, which despite widespread use by global brands has yet to be subjected to empirical analysis. 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 4. While this should not eliminate concern about labor standards in global supply chains, our finding offers novel support for the efficacy of management interventions in reducing harsh working conditions.

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. 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 the mainland China factories that comprise nearly half our sample. One clue is the lower intensity of lean adoption in Chinese plants. 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. Previous research also indicates that local management culture and host country legal institutions interact with private regulation to produce divergent outcomes (Locke et al. 2007; 2012). This may help to explain the absence of an effect observed in China. Low rates of lean adoption in China could reflect lower levels of managerial commitment to the lean transformation or even 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 requires 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 may actually be 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 switching costs associated with terminating business relationships with noncompliant suppliers. The supplier has to 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.

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 maintain and cultivate new management institutions. We show that workers can also benefit from capability building, indicating that it benefits all three key stakeholders in the debate over working conditions in global supply chains. 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.[7]

[7]Interviews with Nike senior management confirm that this systems-based approach to improving workplace standards is an area of strategic focus moving forward. Nike also implements a Human Resource Management program that is intended to complement and support lean manufacturing through investments in both workers (developing a skilled, stable, and engaged workforce) and factory leadership (changing mindsets surrounding the value of the workforce to business success).

References

Anner, Mark, Jennifer Bair and Jeremy Blasi. 2012. "Buyer Power, Pricing Practices, and Labor Outcomes in Global Supply Chains." *Institutions Program Working Paper Series, University of Colorado at Boulder* .

Baker, George, Robert Gibbons and Kevin J Murphy. 2002. "Relational Contracts and the Theory of the Firm." *The Quarterly Journal of Economics* 117(1):39–84.

Banerjee, Abhijit V and Esther Duflo. 2000. "Reputation effects and the limits of contracting: A study of the Indian software industry." *The Quarterly Journal of Economics* 115(3):989–1017.

Barrientos, S. and S. Smith. 2007. "Do workers benefit from ethical trade? Assessing codes of labour practice in global production systems." *Third World Quarterly* 28(4):713–729.

Barrientos, Stephanie, Gary Gereffi and Arianna Rossi. 2011. "Economic and social upgrading in global production networks: A new paradigm for a changing world." *International Labour Review* 150(3-4):319–340.

Bartley, Tim. 2007. "Institutional Emergence in an Era of Globalization: The Rise of Transnational Private Regulation of Labor and Environmental Conditions1." *American Journal of Sociology* 113(2):297–351.

Bloom, Nicholas, Benn Eifert, Aprajit Mahajan, David McKenzie and John Roberts. 2013. "Does management matter? Evidence from India." *The Quarterly Journal of Economics* 128(1):1–51.

Bruce, Margaret and Lucy Daly. 2011. "Adding value: challenges for UK apparel supply chain management–a review." *Production Planning & Control* 22(3):210–220.

Clean Clothes Campaign. 2008. *Cashing In: Giant Retailers, Purchasing Practices, and Working Conditions in the Garment Industry.*

Cohen, J. and C. Sabel. 2006. "Extra rempublicam nulla justitia?" *Philosophy & Public Affairs* 34(2):147–175.

Connor, T. and K. Dent. 2006. "Offside! Labour rights and Sportswear Production in Asia." .

Dhanarajan, Sumi. 2005. "Managing ethical standards: when rhetoric meets reality." *Development in Practice* 15(3-4):529–538.

Dunlop, John T and David Weil. 1996. "Diffusion and performance of modular production in the US apparel industry." *Industrial Relations: A Journal of Economy and Society* 35(3):334–355.

Gereffi, G., Humphrey J. and T. Sturgeon. 2005. "The governance of global value chains." *Review of international political economy* pp. 78–104.

Gibbons, Robert and Rebecca Henderson. 2012. "Relational contracts and organizational capabilities." *Organization Science* 23(5):1350–1364.

Haufler, V. 2001. *A public role for the private sector: industry self-regulation in a global economy*. Carnegie Endowment.

Huselid, Mark A. 1995. "The impact of human resource management practices on turnover, productivity, and corporate financial performance." *Academy of management journal* 38(3):635–672.

Ichniowski, C., K. Shaw and G. Prennushi. 1997. "The Effects of Human Resource Management Practices on Productivity: A Study of Steel Finishing Lines." *The American Economic Review* pp. 291–313.

Ichniowski, Casey, Thomas A Kochan, David Levine, Craig Olson and George Strauss. 1996. "What works at work: overview and assessment." *Industrial Relations: A Journal of Economy and Society* 35(3):299–333.

Keck, Margaret E and Kathryn Sikkink. 1998. *Activists beyond borders: Advocacy networks in international politics*. Cambridge Univ Press.

Kernaghan, C. 2006. *US Jordan Free Trade Agreement Descends Into Human Trafficking and Involuntary Servitude*. New York: The National Labor Committee.

Locke, R., M. Amengual and A. Mangla. 2009. "Virtue out of Necessity? Compliance, Commitment, and the Improvement of Labor Conditions in Global Supply Chains." *Politics & Society* 37(3):319.

Locke, R., T. Kochan, M. Romis and F. Qin. 2007. "Beyond corporate codes of conduct: Work organization and labour standards at Nike's suppliers." *Int'l Lab. Rev.* 146:21.

Locke, Richard, Greg Distelhorst, Timea Pal and Hiram Samel. 2012. "Production goes global, standards stay local: Private labor regulation in the global electronics industry." *MIT Political Science Department Research Paper* .

Locke, Richard M. 2013. *The Promise and Limits of Private Power: Promoting Labor Standards in a Global Economy*. Cambridge University Press.

Locke, R.M., F. Qin and A. Brause. 2007. "Does monitoring improve labor standards? Lessons from Nike." *Industrial and Labor Relations Review* 61(1):3–31.

MacDuffie, J.P. 1995. "Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry." *Industrial and Labor Relations Review* pp. 197–221.

McMillan, John and Christopher Woodruff. 1999. "Interfirm relationships and informal credit in Vietnam." *The Quarterly Journal of Economics* 114(4):1285–1320.

O'Rourke, Dara. 2003. "Outsourcing regulation: Analyzing nongovernmental systems of labor standards and monitoring." *Policy Studies Journal* 31(1):1–29.

Pfeffer, Jeffrey. 2007. "Human resources from an organizational behavior perspective: Some paradoxes explained." *The Journal of Economic Perspectives* 21(4):115–134.

Pruett, D., J. Merk and N. Ascoly. 2005. *Looking for a quick fix: How weak social auditing is keeping workers in sweatshops*. Clean Clothes Campaign.

Raworth, Kate and Thalia Kidder. 2009. Mimicking 'lean' in global value chains: It's the workers who get leaned on. In *Frontiers of Commodity Chain Research*, ed. Jennifer Bair. Stanford University Press.

Reich, R.B. 2007. *Supercapitalism: The Transformation of Business, Democracy and Everyday Life*.

Rodrik, Dani. 2008. "Second-Best Institutions." *The American Economic Review* 98(2):100–104.

Ruggie, J. 2008. Taking embedded liberalism global: The corporate connection. In *Embedding global markets: An enduring challenge*, ed. J. Ruggie. Ashgate Publishing Group pp. 231–238.

Seidman, G. 2007. *Beyond the boycott: labor rights, human rights, and transnational activism*. Russell Sage Foundation Publications.

Verité. 2004. *Excessive Overtime in Chinese Supplier Factories: Causes, Impacts, and Recommendations for Action*. Amherst, MA: Verité Research Paper.

Vogel, D. 2008. "Private global business regulation." *Annual Review Political Science* 11:261–282.

Appendix

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

	(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.