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IRLE WORKING PAPER
#104-18
December 2018

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Cite as: Niklas Lollo and Dara O'Rourke. (2018). "Productivity, Profits, and Pay: A Field Experiment Analyzing the Impacts of Compensation Systems in an Apparel Factory". IRLE Working Paper No. 104-18.
http://irle.berkeley.edu/files/2018/12/Productivity-Profits-and-Pay.pdf

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Productivity, Profits, and Pay: A Field Experiment Analyzing the Impacts of Compensation Systems in an Apparel Factory*

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Abstract

Factory worker pay in global value chains remains a contentious issue. In this paper, we evaluate a two-year field experiment in an apparel factory to analyze altered compensation systems designed to increase worker pay while supporting factory goals around productivity and profitability. Using a quasi-experimental design, with unique data on wages, hours, productivity, quality, and worker engagement, we estimate the impact of three altered compensation systems on pay, productivity, and factory profits. The compensation systems can be described as: 1) an improved productivity-based scheme, 2) a scheme that brings quality and waste reduction into the calculation; and 3) a "target wage" scheme. Overall, the treatments raised wages by 4.2-11.6% and increased productivity by 7-12%-points. Management reported significant financial benefits from the experiment, including increased profits for five of six lines, and avoided costs and productivity losses due to decreased turnover. The factory workers, through focus-group interviews before, during, and after the intervention, reported improved relations with team members and managers. This study demonstrates altered factory compensation can support better factory performance and a better paid workforce, indicating a path towards advanced supply chains with improved wages.

*The authors would like to first thank the workers and managers of the apparel factory that supported this experiment, several key collaborators in the work to increase factory worker pay, engagement, and well-being around the world, including Lea Borkenhagen and Henrietta Lake, and a generous group of reviewers, including Greg Distelhorst, Michael Toffel, Charles Sabel, Richard Locke, Maximilian Auffhammer, and seminar participants at UC Berkeley and Brown University. The authors acknowledge financial support from the Tides Foundation, the Center for Responsible Business at Berkeley-Haas, and UC Berkeley's Institute for Research in Labor Economics. This study has been reviewed by the UC Berkeley Committee for Protection of Human Subjects, Protocol ID 2015-09-7924. Any errors that remain are our own.
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1. Introduction

There are few more contentious, yet poorly studied issues in the global economy than factory worker pay. Activists point to pennies-per-hour wages in factories producing consumer goods as proof of systemic exploitation (Harbour and Woodward 2014, Pollin et al. 2004). Global brands assert that they pay "prevailing wages," that they have limited ability to increase the wages paid by supplier factories, and that they have even less influence over government set minimum wages (Bhagwati 2005). Despite increasing productivity, factory workers have experienced flat or declining real wages around the world (ILO 2014, Lee and Sobeck 2012, Rossi et al. 2014, Selwyn 2016, Vaughan-Whitehead 2014).

This situation has led to over 20 years of non-governmental organizations (NGOs) arguing for the need to pay a "Living Wage." Some parts of the industry have responded that the Living Wage can be difficult to define and is not realistic because it will likely motivate further automation and decreased employment, can undermine government minimum wage setting efforts, and doesn't link improvements in wages to productivity. And both sides disagree on the impacts of "productivity-based" wage schemes (Impactt Limited 2005, Raworth and Kidder 2009).

During this time, there has been surprisingly little empirical research on wage dynamics in emerging markets (Miller 2014), and even less experimental research on how compensation systems might be altered to increase worker pay, while supporting factory imperatives for productivity and profitability (Miller and Williams 2009). With the widespread diffusion of advanced manufacturing and management systems (such as "Lean" production), brands and factories have argued that productivity enhancements, and productivity-based pay systems, are the economically-efficient strategy to raise worker's wages to "fair" levels (Miller and Williams 2009). However, many technologically advanced factories continue to employ traditional compensation systems (Vaughan-Whitehead 2014). Worker incentive systems, it turns out, in most factories around the world, are not aligned with modern management best practices nor worker goals (Adler et al. 2017, Helper et al. 2010).

Management practices focused on increasing productivity are thus often at the center of debates about worker wages and factory profits. Non-governmental organizations (NGOs) and unions argue that productivity-based schemes are used in practice to maintain long work hours (sometimes beyond legal limits) for the sake of maximizing output, but often without actually increasing worker take-home pay (Impactt Limited 2005, Miller and Williams 2009, Raworth and Kidder 2009). Indeed, productivity-based compensation schemes have been linked with workplace stress, accidents, and injuries (Brown and O'Rourke 2007), problems which lead, in turn, to high absenteeism and attrition. Even factories producing for some of the most profitable brands in the world struggle with extremely high turnover rates.

Despite a small number of examples of improvements in worker pay in factories producing for global brands (such as the Alta Gracia factory in the Dominican Republic (Nova and Kline 2013)), there remains a surprising dearth of experimentation in compensation systems or strategies in developing country factories.[§] Owing in part to continued gender wage discrimination (Christian et al. 2013, Collins 2003), wages for most factory workers look today the way they did in 1980 (Vaughan-Whitehead 2014).

This situation raises the practical question of whether compensation and incentive systems could be better aligned with modern production systems and worker goals (Helper et al. 2010, Román 2009). Is there an opportunity for factory management to improve productivity and profitability, enhance worker pay, and create an agile and competitive factory environment (Appelbaum 2001, Becker and Huselid 1998, Blasi et al. 2009, Schuler and Jackson 2014)? Further, could compensation systems be designed to motivate problem solving in a way that is better for workers and factories (Becker and Huselid 1998, Bloom and Van Reenen 2010, 2011, Boselie et al. 2005, Ichniowski and Shaw 2013)?

We sought to engage this heated debate, and to fill an empirical data gap through a field experiment. In this paper, we analyze the impacts of implementing three alternative compensation systems in an operating apparel factory over a two-year period. Through our quasi-experimental intervention, we provide empirical estimates for the size of potential worker and factory gains, while at the same time developing a practical intervention prototype with potential to scale. Before discussing the experiment, we briefly cover theoretical, applied, and context background, drawn from labor economics and human resource management (HRM).

2. Compensation and Human Resource Management

Economic theory posits that firms should pay workers according to their marginal productivity (Billikopf 2008, Lazear 2000, Lazear and Shaw 2007). The "piece rate" system, where workers are paid per piece they produce, is exemplary of this theory. A common implementation of this model has been to pay workers the locally required minimum wage (usually set by the hour or day), and then to override this minimum with the calculated piece rate if workers exceed the output needed to meet the minimum wage.

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

A related implementation adds a production bonus to the minimum wage based on output at the end of a day. These payment schemes are almost always tied back to the concept of Standard Allowable Minutes (SAM), the estimated labor time required to complete a specific product, and a daily output target for that product.

With the onset of Lean manufacturing, the focus of productivity shifted from the individual to teams or modules (Abernathy et al. 1999), and from total output to the continuous flow of high quality, in-demand styles. The piece-rate often traced a similar path, moving from an individual to a "group-based piece rate" or "group rate" (Bloom and Reenen 2011, Helper et al. 2010). Research has shown that group-rate systems can raise productivity in team-based workplaces (Bloom and Reenen 2011, Boning et al. 2007). However, research has also identified problems with group rates. Economists have pointed to possible free-riding, a narrow focus on productivity, and workers withholding effort to avoid employers adjusting the rate downwards (Bloom and Van Reenen 2011). Research concerned with social dynamics has cautioned that group rates can create new forms of peer pressure, stress, and workers "sweating" each other (Billikopf 2008, Helper et al. 2010).

While recent research has shown that Lean can improve factory compliance with wage and hour standards (Distelhorst et al. 2017), factory managers have not transformed compensation systems to motivate new workplace practices. Simply shifting from an individual rate to group rate fails to align fully with, or take advantage of, Lean principles (Helper et al. 2010). Indeed, a ten-country audit by the Fair Labor Association showed 38% of the companies paid workers according to piece-rates, 42% offered workers an output bonus, and only 2% had implemented profit-sharing (Vaughan-Whitehead 2014).

Research from the "High-Performance Work Practices" (HPWP) literature argues that simple group rate systems are unlikely to effectively incentivize workers to achieve Lean goals. The HPWP framework argues that successful companies provide workers with three interlocking criteria: (1) skills to develop and master, (2) meaningful participation opportunities, and (3) compensation that incentivizes core job functions (Appelbaum 2001, Boxall and Macky 2009, Posthuma et al. 2013, Sterling and Boxall 2013). These three distinct analytical categories—skills, engagement, and motivation—are highly-interrelated and often packaged together (Arefin and Raquib 2015, Boxall and Macky 2009, Gittell et al. 2009, Ichniowski and Shaw 2003, Wallner et al. 2012).

First, HPWP theory supports building worker capability through multi-skilling, up-skilling, or otherwise enhancing individual and team skillsets (Sterling and Boxall 2013). This includes training in technical skills, as well as soft skills such as communication with management, collaboration, and problem identification (Bloom and Van Reenen 2011).

Second, HPWP theory encourages firms to leverage those skillsets by engaging workers in meaningful activity (Appelbaum 2001, Arefin and Raquib 2015, Konrad 2006, Maynard et al. 2012, Wallner et al. 2012). By delegating decision-making authority to the appropriate level, increasing teamwork (Birdi et al. 2008, Hamilton et al. 2003), and improving communication channels, management can reduce production inefficiencies, build trust between management and workers, and allow workers to utilize intrinsic motivation. Less intensive forms of engagement include soliciting suggestions, holding team meetings, and creating off-line problem-solving teams (Boning et al. 2007, Jones and Kato 2011).

Third, external motivation, particularly compensation and benefits, remains central to driving workplace change. Workers are more productive when the pay process and schema are transparent, communication with management is open, and pay is connected to the firm's short- and long-term goals (Billikopf 2008, Cohn et al. 2015). In this way, workers are more likely to perceive that their pay—including both wage structures and the payment process—accurately reflects and adequately compensates them for their effort, skills, and contributions (Appelbaum et al. 2001, Cohn et al. 2015, Vaughan-Whitehead 2014).

Of course, HPWP considers it foundational that the workplace management is itself capable, engaged, and motivated. Indeed, research specific to the apparel industry has shown the importance of capable management in driving working condition improvements (Bloom et al. 2013, Distelhorst et al. 2017). Vertical as well as horizontal HPWP implementation is necessary.[**]

The HPWP literature is practically-oriented, and many studies have tried to assess the effectiveness of various interventions and bundles. The majority of HPWP effectiveness studies have focused on the first two analytical categories - employee skill development and engagement - and concluded that HPWP is likely to yield productivity gains (Appelbaum et al. 2001, Bloom and Van Reenen 2011, Jones et al. 2006), and some employee compensation gains.[††] Some studies have indicated that worker engagement and skill development elicit positive wage gains on the order of 5% (Bailey et al. 2001, Handel and Levine 2006, Osterman 2006), while others have concluded these are insufficient for driving and

[**] Unfortunately, the HPWP perspective fails to account for a critical aspect of the factory wage debate: gender (Collins 2003, Esbenshade 2004, Rosen 2002). In apparel production, women constitute a majority of factory workers, yet are often less well-paid, have less opportunity for advancement, and rarely occupy management or high-status positions (Christian et al. 2013).

[††] Process improvements can also represent gains for workers, but we are principally concerned with wages.

maintaining increased wages where labor unions or other political means of sharing the gains are not present (Cappelli and Neumark 2001, Handel and Gittleman 2004, Martinez-Jurado and Moyano-Fuentes 2014, Rossi et al. 2014).

Our goal was to study the effects of altered compensation system onto already-implemented HPWP. As noted, this has historically meant simply applying a group-rate pay, which suffers from several limitations. First, the rate (and the output targets) are rarely transparently set from the worker perspective. In the ten-country audit discussed above, only 48% of workers were given pay slips that included information about hours worked (Vaughan-Whitehead 2014). The lack of social dialogue around wages, let alone bargaining, can feed a sense of mistrust, which in turn leads workers to game piece-rate systems (by reducing productivity fearing that rates will simply be lowered) or become motivationally untethered to the group rate (assuming the wage will remain constant regardless) (Billikopf 2008). Without information and dialogue, even if workers are paid better, they would lack the tools to perceive their wage adequately compensates them for their effort, skills, and contributions.

To understand how this occurs in practice, we need to know the rate adjustment mechanism, which, in apparel manufacturing, is the SAM, or "standard allowable minutes," for a particular garment. Set during brand-factory negotiation, the SAM can be calculated by industrial engineering methods (i.e. time measurements of ideal physical movement) or through statistical measures of past performance of time required to assemble a specific style garment. The SAM is thus a semi-static metric that represents garment output per unit of labor-minutes. While many factories use historical data to set group or individual rates, some factories (including our case study) use the negotiated SAM to set the group rate per garment to achieve a target output. The group rate multiplied with target output might amount to low daily wage, so the basic idea is for workers to try to produce a style faster than the SAM. However, the SAM can also be adjusted downward during the next contract.

From a worker perspective, even garments with the same SAM can vary in difficulty. On new or unfamiliar styles workers may take longer than the SAM, and thus may be incentivized to ignore the output target and focus instead on wages from overtime. Since workers make more with a garment they are "good" at producing, workers are incentivized to dislike style changes and new products or processes, both of which are commonplace in Lean factories.

As the market moves towards increasing product differentiation and just-in-time delivery, factories need to incentivize workers to respond to style changes and emergent problems. Instead, workers continue to be incentivized to focus on maximizing output of garments they are already good at producing. One could imagine altered compensation systems that seek to compensate workers for getting good at style changes, such as a process that starts from the actual (not estimated) time to produce a garment and then incents continuous improvement over time, or that adjusts the SAM over time as workers learn a new style, explicitly incentivizing an efficient "ramping" process to full productivity levels. A "lean-aligned" compensation system might also bring in incentives for improving quality, while reducing waste and solving line-level problems. Instead, with a fixed SAM, workers stay focused on total output, and morale is often lowered when mismatched targets (or entirely unrealistic targets) end up requiring workers to work additional hours of overtime (Chang and Gross 2014).

Overtime thus becomes the default in apparel factories. Workers appear to "want" overtime to maximize take-home pay, even though it often motivates high turnover rates (Ngai 2005). Managers accept overtime as normal business practice, even though it costs them more per labor hour, as it allows them to accommodate variable order sizes, hire fewer full-time workers, flex worker hours during production peaks, and not have to lay off workers during slow periods (Raworth and Kidder 2009, Robertson et al. 2016). Yet both workers and management—if their incentives could be aligned—would benefit from producing the target output of products in less hours.

Our research seeks to engage this debate. We provide empirical estimates of the effect of altered compensation systems on worker wages, hours of work, productivity, and factory profitability. To do so, we analyze panel data and focus group information from a 2015-2017 field experiment in an apparel factory in Thailand.

3. The Experiment

In 2015, we partnered with a multinational company and one of their suppliers based in Thailand. The factory is one of the company's strategic suppliers, regularly entrusted to produce the company's innovative and high-value products due to its strong management capacity and demonstrated production capability. The primarily cut-and-sew factory had a history with pilot projects as management were keen to try new approaches.

At the start of our study in late 2015, the factory had already implemented both first- and second-generation Lean practices. Having previously invested in first-generation, physical factory and process-improvement-focused Lean technologies, the factory then implemented second-generation Lean practices—management training, multi-skill training, social dialogue, and worker engagement programs—between May and November 2015. All sewing line team members and supervisors received five trainings, including both technical and interpersonal skills. Moreover, the management developed a social dialogue system with: election by workers of line representatives; training of line representatives on how to hold meetings, elicit input from workers, take minutes, elevate issues, and communicate resolutions to the issues; holding morning meetings between workers and line representatives (without supervisors present). Management trained workers and supervisors in stress management and provided time each morning for a short set of stress management activities. They also hosted discrete "Kaizen" 5-day, worker-only problem-solving events in which workers would define the problems to be solved, often using insights from the Engagement and Wellbeing Survey, define how to solve them, and then present their ideas to management. This system, when coupled with Lean problem-solving, was meant to improve communication between workers and management to discuss production issues as well as, among other topics, wages.

Before the second-generation Lean initiatives, worker dissatisfaction was quite high, as measured by an internal "engagement and well-being" survey. In particular, line managers were the most dissatisfied, receiving blame from upper management as well as from team members (sewers), while perceiving their wages to be too low. In our initial focus group discussions, sewing line workers expressed frustration with nearly all other workers: quality control personnel, mechanics, and line managers. These frustrations, in addition to concerns with wages, likely contributed to high worker-turnover rates (upwards of 80% on some lines).

Importantly, the factory had not changed its compensation system to align with its Lean principles, nor were workers incentives aligned. Instead of each worker being paid to meet the factory goals or to facilitate learning or continuous improvement, many low-level workers—including mechanics, fabric cutters, and quality control personnel—were either paid the minimum wage or according to an output-based rate. Line managers were paid a monthly salary, with year-end bonuses. There were no seniority or skill-based bonuses. Worker compensation was particular to each position, which in aggregate, contributed to misaligned incentives for factory goals.

Sewing line workers, the primary focus of our study, received the greater of the minimum wage or a group piece-rate multiplied by total line output, both of which were indexed by style.[‡‡] The wage formula expressed mathematically is:

[‡‡] Over the entirety of the study period, the Thai minimum wage was 300 baht over 8 hours and 1.5 times the hourly rate for overtime. (For reference, the exchange rate between Thai baht and USD was approximately 35 baht to one

$$(1)\ Wage = \text{Max}(Minimum\ wage,\ GroupRate * Output)$$

Both of these wage systems are time-based. The minimum wage plus overtime (OT) system pays workers per hour, with a 50% multiplier for OT. But the group piece-rate system is also essentially a system of "renting" worker minutes. Contract negotiations between brand and factory hinge on the Standard Allowable Minutes (SAM) of labor required to make a garment. The brand estimates SAM for sourcing, cost-accounting, and price-setting. The factory uses SAM to set the output target, breaking down costs into units of Thai baht per minute which are based on expected output per worker. And workers negotiate their effort and eventual wages in respect to the SAM.

Workers can make more if they beat the SAM estimate for the garment consistently throughout the day. Due to learning effects (across the factory), workers become more productive as they produce a given style for a longer period. Wage gains thus are linear. Each additional garment produced above the day's output goal is paid the same. At the same time, workers can also fall below the goal, and be bumped back to the minimum wage plus OT pay. This occurs regularly when new styles arrive, when a more complex style is being produced, or when problems emerge on the line.

3.1. Intervention

Our intervention sought to test solutions to the three problems—incentive misalignment, poor communication, and ineffective incentives—we identified in the factory's compensation system. Because the factory had already implemented engagement and skill-based HPWPs, we wanted to test motivational solutions so as to improve wage and productivity levels to create an enduring and positive wage system.

First, to address the problem of misaligned incentives, we adjusted the compensation systems for all the workers—including line workers, mechanics, fabric cutters, quality control personnel, line managers, and so on—to be aligned on the same formulas. Second, to address the lack of wage transparency and communication, the factory installed LCD screens with detailed daily wage and productivity information for each line in the study. In addition, the management held several discussions and hired a third-party to hold small group discussions to introduce the new wages, answer questions, and receive feedback about the new compensation scheme. This worker feedback was incorporated into the final intervention design. Third, to address the ineffective productivity incentive, we developed three alternative wage schemes

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USD.) Workers typically worked 8 hours on Monday and Saturday, and 11 hours on Tuesday through Friday, for a total of 60 weekly hours, which is the maximum hours under Thai law.

applied to six treatment line production chains (the other two lines were held as control lines).[§§] These alternative wage schemes can be thought of as: 1) an altered productivity-based scheme, 2) an altered productivity scheme that includes quality and waste reduction incentives; and 3) a target-wage scheme.

Each of the new wage schemes took productivity to be the backbone measure. Productivity here is still essentially a measure of labor-time efficiency, defined as the output multiplied by the expected minutes per garment divided by the number of workers, multiplied by the working minutes, expressed as:

$$(2)\ \ Productivity = \frac{Output * \frac{expected\ minutes}{garment}}{\#\ of\ workers * working\ minutes}$$

Using productivity had several advantages: (1) the management was comfortable with and adept at its calculation, (2) workers were familiar with the concept, (3) its value is affected by actions throughout the production chain, and (4) it is a primary factory goal. Though still fundamentally an output-based measure, we hoped to overcome some of the limitations noted above.

For example, instead of hoping supply (output) would match demand (target output) through a static piece-rate, we introduced a dynamic piece-rate to incent continuously increasing productivity. This involved a piece-rate-multiplier that increased as productivity increased. Through analysis of historical data, we conservatively estimated that the breakeven profit point commonly occurred at 85% productivity. Thus, the piece-rate-multiplier schedule began at 90% productivity, at which point the piece-rates for all garments produced that day (even with multiple styles) were multiplied by 1.06. This multiplier increased by 0.06 for every five-percentage-point productivity increment thereafter, with a ceiling at 1.48 for 125% productivity. Taking this multiplier into account, the new formula for worker wage was:

$$(3)\ \ New\ Wage = GroupRate * Output * Multiplier(Productivity)^{***}$$

This new wage, in addition to the alignment and transparency measures, constituted the first treatment, which we called the "Productivity" treatment, and was applied to sewing line workers, team leaders,

[§§] These changes were made in concert, so we did not test individual effects, nor, of course, are the effects independent of the factory's pre-existing HPWPs.
[***] Just as in Equation 1, workers were guaranteed the minimum wage. We omitted this to aid comprehension of the new formula.

supervisors, mechanics, quality control personnel, and cutting room team members. Throughout the intervention workers were always guaranteed to receive the higher of either their traditional compensation package or the new wage.

The second treatment, "Productivity, Quality, and Waste Reduction" (PQWR), used this same new wage calculation, but also sought to bridge the tradeoff between productivity and quality. Since mistakes and inefficiencies can cascade across the production chain, workers at each stage were incentivized to maintain high-quality standards and to identify material utilization improvements. For instance, fabric cutters were given a 10-baht bonus when they identified that a given fabric layout could be remarked to optimize fabric usage. For line workers, there was a 20-baht bonus if the line achieved a 97% quality rate for the day.[†††] The quality rate was defined as:

$$(4)\ \ Quality\ Rate = \frac{\#\ of\ garments\ that\ did\ not\ need\ rework\ nor\ were\ defective}{total\ output}$$

The third treatment, "Target Wage," used the Productivity wage calculation, and sought to test for a wages-versus-hours tradeoff. We hypothesized that workers might elect to leave work early once they achieved a satisfactory wage. Thus, after consulting with workers and the previous wage data, the "Target Wage" treatment was set such that if and when the line reached 500 baht in 8 hours and 650 baht in 10 hours, the line could collectively decide to leave. The Thai minimum wage was 300 baht per day, and during the pre-treatment, lines were making 440-530 baht per day on average during a 10-hour day.

To increase transparency and communication directly applicable to the compensation system, workers were consulted about the wage scheme and their feedback informed the various targets and levels. Once treatments were finalized, both management and a third-party consultant trained workers to understand the new wage system, and assured them wages would not be lower than they would have been under the old system.[‡‡‡] Workers were also trained to interpret the new LCD screens at the end of the line, which displayed target output, hourly rates of production, the current and next two productivity levels, and each

[†††] Initially, workers had five baht deducted if quality rate went below 95% and received a 10 baht increase above 99%. In June of 2016, the factory removed the deduction and set the positive incentive at 97% quality rate. While not ideal, this shows that worker feedback was taken seriously; workers did not like the deduction.
[‡‡‡] The factory continued to calculate the old wage and showed workers both calculations on each paycheck.

level's expected wage.[§§§] This information allowed workers to compare in real-time their performance with the expected wages as well as make informed decisions about pacing.

4. Experimental Design

We employed a quasi-experimental design to evaluate the three treatments with eight sewing lines—six treatment lines and two control lines—out of 23 lines in the factory. The experiment lasted two years, with 12 months pre-intervention[****] and 12 months post-intervention to control for seasonality of order volume and worker turnover (due to holidays). The primary data comes from management-provided daily human resource and productivity data for each of the eight sewing lines from January 1, 2015 until January 15, 2017.[††††] Factory management also provided demographic information and monthly turnover data, while a third-party conducted four focus group discussions with several sets of workers before, during, and after the intervention.

The lines were not randomly selected; the company and factory management selected what they considered to be four average pairs of lines (out of eleven possible) when implementing the second-generation lean practices. Since the line manager is critical for performance (Adhvaryu et al. 2016, Bloom et al. 2013, Huo and Boxall 2017), and line managers oversaw two lines each, line pairs were evaluated against one another. Using data from the prior year (2014-2015), the company and factory management tried to control for line-level variables they thought would influence the study: productivity, number of workers, worker skill, location in the factory, the physical line shape, and line manager capability. Workers were not able to self-select onto or off of lines that received a treatment.

Despite non-random line selection, the parallel trends assumption is satisfied in all cases when controls (month and consecutive days in production for one style) are included. The parallel trend assumption did not hold for a simple time trend, likely due to strong seasonality and differences in style consistency (in Appendix, see Table A1 for the results from the two-tailed t-test).

Moreover, using a January 2016 snapshot of demographic data, we did not find significant differences in worker age or length of employment. The workforce was entirely ethnic Thai and about 95% of the sewing line workers, quality control personnel, line managers, and supervisors were female (while all the

[§§§] Other lines in the factory also had LCD screens, but those screens did not convey the same, and as detailed, information, nor were they visible to all the workers on each line.
[****] The second-generation lean practices were only in place for eight of the twelve pre-intervention months.
[††††] The Productivity and Lean treatments began on December 15, 2015, while Target Wage began on January 15, 2016.

mechanics were men). While some lines lacked male workers, the amount of men on the other lines was sufficiently small (n < 5) that we did not expect much difference. Finally, when comparing line manager characteristics—years at the facility, years as a manager, and number of trainings—the only significant difference was that the PQWR treatment manager had much less management experience.

Although this was not a randomized control trial, there is statistical justification for evaluating the treatments using a quasi-experimental approach.

5. Methods

We employ a difference-in-difference model to compare cross-sectional groups. To estimate the effect of the treatments, we compare the change in outcome for the treated group, considering the control group's change, while controlling for other variables. We have good coverage for our primary dataset. There are ~4600 observations with full and consistent data (i.e., no outliers or missing data). The observations that are missing (about 200 line-days were missing data on either the dependent or independent variables) do not disproportionately fall on any one line or treatment group. We bolster this analysis with turnover data, a profitability model, and the focus group discussion data. Table 1 below shows descriptive statistics of the key variables.

Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Hourly Wage (THB)	4,960	50.34	12.57	0.00	42.61	57.53	129.56
Productivity (%)	4,593	93.38	37.28	0.00	69.00	121.00	160.00
Daily Output	4,608	541.40	243.83	0.00	378.00	702.00	2,652.00
No. of workers	4,964	19.71	4.27	0.00	19.00	21.00	200.00
Daily workhours	4,961	9.93	1.48	8.00	8.00	11.00	13.00
Overtime (0,1)	4,968	0.50	0.50	0.00	0.00	1.00	1.00
Unplanned Absenteeism (%)	4,962	2.04	19.72	0.00	0.00	4.17	1,364.00
Total Tardiness (minutes)	4,970	4.88	19.66	0.00	0.00	4.00	725.00
Style - consecutive days in production	4,869	6.77	7.47	1.00	2.00	9.00	57.00
SAM (minutes)	4,827	22.98	8.94	0.00	20.58	26.35	451.00

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

5.1. Regression Model

We use an ordinary least squares (OLS) regression model with fixed effects. We estimate the treatment effect through the difference-in-difference estimator. This means we subtract the longitudinal change (i.e., post-treatment minus pre-treatment) of the control group from the longitudinal change of the treated group. This technique accounts for the counterfactual assumption that, under like conditions, the control and treatment groups would have changed similarly.[‡‡‡‡]

We estimate the treatment effects on wages, productivity, and factory profit-per-garment. In order to control for other independent variables that might also drive outcome differences, we include covariates and fixed effects. The covariates vary in each model specification, while the fixed effects do not. The covariates include number of workers, work hours, a binary variable for overtime, the number of consecutive days a style has been in production on the line, the expected standard allowable minutes (SAM) to produce the garment, total tardiness in minutes, and unplanned absenteeism. The fixed effects include garment style, date, month, day of week, and line.

The general model specification is:

$$(5)\ y_{it} = \alpha_{it} + \beta_{it}X_{it} + \delta_{it}Y_{it} + \delta_{it}Z_{it} + \varepsilon_{it}$$

‡‡‡‡ This counterfactual assumption is why we needed to establish similarity across groups in the previous section.

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

The treatment variable can be decomposed into its interaction terms:

$$(6)\ \ X_{itj} = phase_{it} * treat_{itj}$$

Where, $phase_{it}$ is a dummy for the treatment phase, taking on the value of one after the treatment was applied, and $treat_{itj}$ is a dummy variable for treatment and is also indexed by treatment, with a value of one if a line received a treatment. Our coefficient of interest in Equation 5, β_{it}, therefore, captures the mean difference between treatment and control groups, controlling for any pre-treatment differences by group.

5.2. Covariates

Below we discuss each covariate and the rationale for its inclusion in one or more of the model specifications.

Unplanned absenteeism Lean apparel factories generally allocate workers to lines to meet the number of operations a shirt requires, typically on average 20 operations. However, this is not a one-to-one allocation; two workers might be assigned to a difficult operation, while one will be assigned to a quicker and easier operation. The impact of this "line balancing" on outcomes is known: Factory management estimated one fewer worker than planned decreased productivity by 1%. Two fewer workers reduced productivity by 5%, and four or more absent workers reduced productivity by 15%. As a result, the factory created a "relief" team of workers whose job is to fill absences or line gaps. We do not observe relief team use, so we include both number of workers—which takes relief members into account—and unplanned absenteeism. Thus, unplanned absenteeism, when used with number of workers, tries to capture relief team effects, including any skill differences.

Tardiness Tardiness occurs when a worker is late to the line but is not absent for the day. Since the worker may ultimately show up, the use of a relief team member is less likely especially for brief tardiness. However, production bottlenecks can accumulate quickly, so we expect worker tardiness to negatively impact productivity even though tardiness averaged less than twenty minutes per day. Thus, we aim to capture the effect of a slow or unbalanced start.

Work hours & Overtime In our focus group discussions, workers reported more energy on eleven-hour days (Tuesday-Friday) because of the possibility for greater total wages. This leads to the counterintuitive idea that workers are more productive on long days, which is not supported by research (Shepard and Clifton 2000).[§§§§] We expect productivity to weakly decrease with work hours. If workers are able to be more productive on long days, this may provide evidence for workers intentionally modifying their productivity to maximize wages during overtime as discussed in section 2. We test for a nonlinear effect by including a dummy variable for overtime.

Style consistency We expect that as workers become familiar with a style, productivity should increase. Styles may last on a line for multiple days. We do not have visibility into within-day style changes, so we assume one style each day. From this, we calculated how many consecutive days a particular style stayed on a line. A more thorough analysis would utilize data we do not have: output by style, productivity rates by style, style by hour, or rework of an old style on a line already producing a new style, etc.

Standard Allowable Minutes (SAM) We are uncertain of the effect of SAM on productivity. On one hand, the target takes SAM into account, so there should be no productivity effect. However, a very high SAM indicates an outlier style, and we suspect productivity may drop due to unfamiliarity, and more coordination between sewers. During the experiment, management tried to maintain SAM between fifteen and thirty minutes. Yet, there are outlier SAMs of fewer than five minutes (e.g., repacking) and greater than forty (e.g., a jacket).

Fixed Effects Style, date, day of week, month, and line fixed effects were included in each model specification. We include style ID to capture major differences between the 170 styles not accounted for by SAM. Date controls for any temporal variations such as temperature, type of garments, and number of orders.[*****] "Line" captures unobservable differences across lines that may cause different outcomes such as the team culture. Day of week captures any regular weekly cycle, while month captures annual seasonal trends.

[§§§§] We had hoped to analyze hourly data on productivity to measure variations across the hours of a day. However, the factory management was unable to implement this data collection system in time. We believe this is a promising area for future research.

[*****] Temperature in particular has been shown to have an effect on factory labor productivity (Somanathan et al. 2014).

There are several covariates for which we do not have data that may be important to precisely estimate treatment effects. This presents an endogeneity issue, meaning our treatment effect estimate is unlikely to be consistent. Our most problematic omission is downtime, the length of time a line has stopped producing during normal working hours. The dataset contains downtime data based on the type—machine, material, personnel, or quality—for the pre-treatment period, but we were unable to acquire it for the post-treatment period. We ran multiple exploratory regressions over the pre-treatment period in order to at least sign the bias. Using productivity and hourly wage as our dependent variables, total downtime was significant at the 10% level with a value of -0.029. The number of occurrences where this would affect productivity more than 1%-point was 674 instances and more than 5%-points was 42 instances of 2058 total observations. The effect on hourly wage was negligible and not significant. When explored by type of downtime, only material-induced downtime (i.e. the line had not received fabric to sew) was significant (at the 1% level), and the number of instances it reduced productivity more than 1%-point was 173 instances and more than 5%-points was 61 times of 1867 total observations.

This obviously has a significant effect on productivity. In order to sign our bias, we assume downtime is not correlated with the other covariates. Given that, because the covariances between the treatments and downtime are likely to be negative, the bias is likely to have a negative effect on our treatment estimates. In theory, the treatment should incentivize the type of behavior (e.g. local problem-solving) that minimizes downtime.

Moreover, there were a number of outliers in the data. In the outcomes of interest, these outliers are potentially the result of measurement error. To minimize the effect, we created minima and maxima values based on a feasibility assessment and checked for abnormal changes using sensitivity analyses. For productivity, we decided the maximum possible value was 160%, a generous estimate, which resulted in ~400 missing observations. The overall statistical story was not affected when we ran the specified regressions with productivity maxima of 140%, 180% and 200%. In addition, we performed a check using SAM, output, number of workers, and some other data to calculate daily productivity and compared it with the given productivity. We expected some divergence between these figures because of the data granularity, but there were no abnormal or asymmetric deviations. For wage, we limited the minimum wage to 300 baht which is the minimum wage in Thailand. We limited the maximum wage to 900 baht, a fairly-conservative level. Sensitivity analyses at 800 baht and 1000 baht did not alter the overall analysis.

6. Results

Across five OLS specifications, we find positive and significant treatment effects on wages, as the three treatments increased hourly wages two to five Thai baht per hour, or 4.2 to 11.6%. On productivity, the PQWR and Target Wage treatments had positive, significant effects—12%-points and 7%-points, respectively—however, we do not find the Productivity treatment had a significant effect (which we determine is driven largely driven by one line's poor performance). The three treatments decreased per-garment profit by about three baht. However, we find overall profit increased for the factory, as productivity gains swamped per-garment losses. This positive financial result is further reinforced by decreases in employee turnover and increases in quality rate.

6.1. Wages

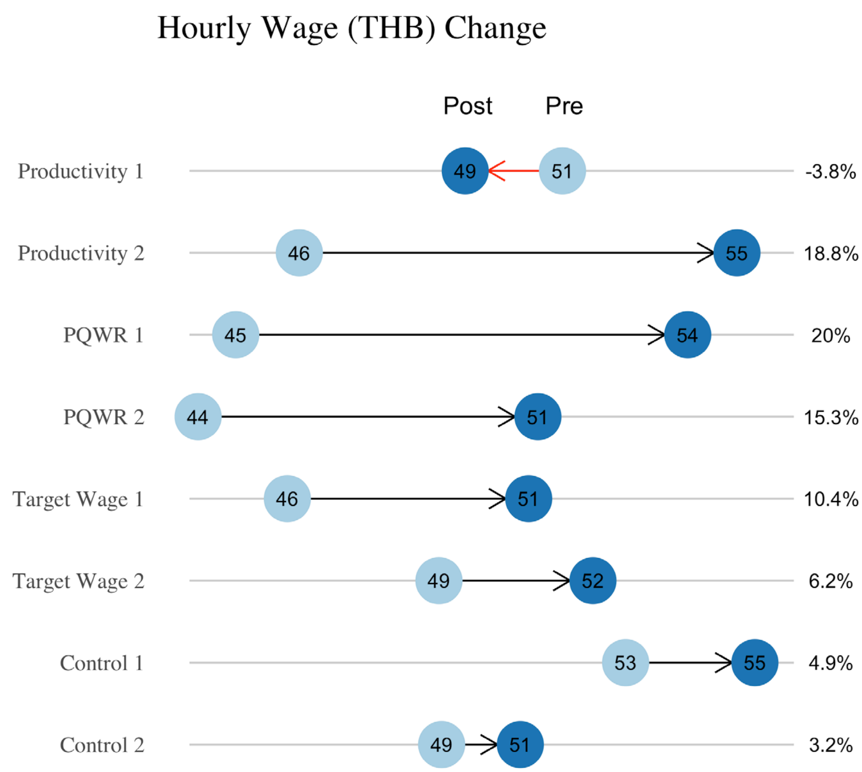

Figure 1*: Change in average hourly wage between pre-treatment and post-treatment periods for each line. The percentage gained or lost is presented on the right-hand side. This shows raw hourly wage change and is not a reflection of the treatment effect. That is shown in the regression table below.*

	Dependent variable:					
	Hourly wage (baht)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	2.545**	2.946***	2.952***	2.949***	2.930***	2.931***
	(1.127)	(1.144)	(1.140)	(1.141)	(1.119)	(1.119)
PQWR treatment	3.341**	3.521**	3.525**	3.523**	3.442**	3.448**
	(1.375)	(1.380)	(1.378)	(1.378)	(1.380)	(1.379)
Target wage treatment	5.081***	5.208***	5.222***	5.219***	5.406***	5.409***
	(1.705)	(1.704)	(1.695)	(1.695)	(1.688)	(1.687)
Work hours		0.305	0.304	0.304	0.299	0.301
		(0.380)	(0.380)	(0.380)	(0.377)	(0.378)
Overtime		3.327***	3.322***	3.322***	3.308***	3.304***
		(1.181)	(1.182)	(1.182)	(1.177)	(1.178)
Number of line workers			-0.013	-0.013	-0.014	-0.014
			(0.062)	(0.062)	(0.061)	(0.061)
SAM				0.003	0.004	0.004
				(0.011)	(0.011)	(0.011)
Style - consecutive days in production					0.050	0.050
					(0.031)	(0.031)
Tardiness (minutes)						-0.003
						(0.010)
Unplanned absenteeism (%)						0.001
						(0.002)
Observations	4,271	4,271	4,271	4,271	4,271	4,271
R^2	0.010	0.027	0.027	0.027	0.028	0.028
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 2 OLS regressions with hourly wage as the dependent variable. Fixed effects for each specification (1-6) are date, style, and line. The point estimates represent a change in daily wage due to each independent variable. (Hlavac 2015, Newey and West 1987)

Table 2 shows the impact on hourly wages are positive for all of the treatment effects, and the point estimates are robust to the inclusion of covariates. The Target Wage treatment, significant at the 1% level in each specification, has larger effects (1.7 to 2.5 baht more) than the PQWR and Productivity treatments, respectively. Of course, because in overtime the base wage increases, it appears to have a significant and positive effect on hourly wages, while hours worked has no effect. Number of line workers is significant at the 5% level, indicating more line workers helps boost wages. SAM has a significant effect at the 1% level, and style consistency is positive and significant at the 5% level. Tardiness and unplanned absenteeism are both insignificant and negligible in magnitude, indicating no effect.

6.2. Productivity

	Dependent variable:					
	Productivity (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	-2.830	-2.442	-2.259	-2.199	-2.104	-2.064
	(4.716)	(4.735)	(4.720)	(4.720)	(4.758)	(4.739)
PQWR treatment	12.122**	12.304**	12.473**	12.555**	12.283**	12.346**
	(6.005)	(6.022)	(6.007)	(6.021)	(6.036)	(6.013)
Target wage treatment	7.138*	7.231*	7.655*	7.730*	8.403**	8.437**
	(4.154)	(4.167)	(4.155)	(4.167)	(4.162)	(4.143)
Work hours		-1.329	-1.359	-1.362	-1.313	-1.277
		(1.350)	(1.349)	(1.350)	(1.348)	(1.355)
Overtime		7.316*	7.168*	7.175*	6.939	6.872
		(4.351)	(4.354)	(4.353)	(4.366)	(4.387)
Number of line workers			-0.380**	-0.382**	-0.384**	-0.385**
			(0.184)	(0.182)	(0.181)	(0.180)
SAM				-0.078	-0.075	-0.075
				(0.134)	(0.134)	(0.134)
Style - consecutive days in production					0.170	0.169
					(0.138)	(0.138)
Tardiness (minutes)						-0.028
						(0.047)
Unplanned absenteeism (%)						0.007
						(0.008)
Observations	4,114	4,114	4,114	4,114	4,114	4,114
R^2	0.006	0.007	0.009	0.009	0.010	0.011
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table 3 OLS regressions with productivity as the dependent variable. Fixed effects for each specification are date, style, and line. (Hlavac 2015, Newey and West 1987)

With productivity (%) as the dependent variable, the PQWR and Target Wage treatments show large positive effects, with significance at the 5% and 10% level, respectively. The Target Wage point estimate changes just over 1%-point when the covariates are included compared to no covariates. The Productivity treatment shows no effect. Work hours did not have an effect on productivity, though overtime showed a consistently large and positive effect (significant in 3 of 5 specifications), suggesting that workers increased effort on days with overtime. The number of line workers is significant at the 5% level suggesting that as number of workers increases, productivity decreases. This may point to the complexity in a style with more steps or the complexity in managing a larger team. Surprisingly, the SAM is insignificant and negligible. Once more, tardiness and unplanned absenteeism are both insignificant and negligible in magnitude, which may indicate the line manager effectively utilized relief team members. Unfortunately, we do not have the relief team data to evaluate this proposition.

6.3. Factory Profits

A critical question of course is the tradeoff between reducing per-garment profits for the factory (because workers are receiving a higher share of the value) versus the increase in overall productivity this motivates. To assess this tradeoff, we constructed a simple profit model using pre- and post-treatment output and profit-per-garment. Because we lacked pre-treatment data on prices, we ran a cross-sectional OLS for the post-treatment period to determine the change in profit-per-garment attributed to the treatments (for results see Table A2 in the Appendix).[†††††]

In order to generate the pre-treatment profit-per-garment, we subtracted the profit-per-garment estimate from Table A3's regression specification (6) to a line-specific average post-treatment profit-per-garment. We assumed the control group's profit-per-garment remained constant.

Profit Assessment

	Productivity 1	Productivity 2	PQWR 1	PQWR 2	Target Wage 1	Target Wage 2	Control 1	Control 2
Pre-Treatment Output per Day	599	505	458	388	501	475	661	612
Post-Treatment Output per Day	440	597	535	475	580	575	553	574
Pre-Treatment Profit per Garment	28	49	56	55	54	61	62	40
Post-Treatment Profit per Garment	26	47	52	52	51	59	62	40
Pre-Treatment Profit per Day	16869	24858	25404	21406	26990	29166	40674	24692
Post-Treatment Profit per Day	14938	28949	28069	25481	29834	35967	36729	24210
Profit per Day Change	-1931	4092	2665	4075	2844	6802	-3944	-482

Table 4 A simple productivity model using average output and profit per garment to derive an estimate of total profit and change between the periods.

Table 4 shows that five out of the six treatment lines realized an increase in overall profit. Both control lines saw a reduction in total profit due to decreases in output (we kept the per-garment-profit fixed). Productivity 1 experienced a large decrease in profit driven by decreases in output and profit-per-garment. Because Productivity 1's total profit in the pre-treatment period is likely biased downward by the lack of pre-treatment profit-per-garment data, the overall negative decrease is likely larger.

Importantly, we also find the treatment had a significant, positive effect on the quality rate of the PQWR (+1.86%-points) and Target Wage (+1.61%-points) treatments (see Table A3 in Appendix). This is significant because quality rate and other metrics can be ignored when focusing solely on productivity (Bloom and Van Reenen 2011).

[†††††] Though our estimates may suffer from omitted variable bias due to uncontrolled-for intangible differences between lines, we are reasonably confident in this result, because there is a fairly mechanistic story behind the estimates. It is entirely reasonable to expect increased worker incentives to cause a decrease in the profit-per-garment.

This simple analysis, of course, does not tell the full story of factory profit. Significant additional costs and benefits are driven by employee turnover, management expenses, and capital investments. We rule out any effect of capital investments since any changes that happened were exogenously driven. Management expenses are relatively small compared to employee turnover costs, especially when spillover effects are considered. Employee turnover generates large costs for hiring and training, as well as lost productivity when a line has reduced numbers of workers. Turnover data for the two periods is shown in Table 5.

Yearly Turnover (%)

Line	2015	2016	Difference
Productivity 1	73	71	-2
Productivity 2	49	24	-25
PQWR 1	24	24	0
PQWR 2	84	46	-38
Target Wage 1	33	18	-15
Target Wage 2	38	9	-29
Control 1	14	17	3
Control 2	32	59	27

Table 5 Turnover rates per year per line. The bottom two rows are the control group. Turnover rate is generated by total number of workers left during year divided by average number of workers on first day of month during the year.

Productivity 1, with a persistently high turnover rate, once again has the worst outcome of the treatment lines. There is almost certainly a correlation between its poor productivity and turnover rate. All of the other treatment lines either reduced their turnover rate or remained constant at lower levels. Conversely, the control lines both experienced an increase in turnover rate, although Control 1 continued to have a low turnover rate and the increase was minimal.

6.4. Focus Group Findings

In each of four focus group sessions—one before the treatment, two during, and one post-treatment—a trained, local facilitator separately queried line members, line managers, quality control personnel, higher-level managers, and mechanics. These focus groups provided important visibility into team dynamics across treatments and over time.

In the final focus group, after the treatment, line workers in the five successful treatment lines reported improved communications among line workers and with line managers. Line managers, in turn, reported line workers displayed more problem-solving initiative. Workers reported they felt more valued by management, felt listened to by team leaders, and perceived fellow workers as more supportive. While most workers reported positive feelings about the increased wages, line managers, in particular, reported feeling highly motivated by the wage increases and decreased financial stress. The fabric cutters were the only workers still dissatisfied. The cutters cited unmet income expectations as well as team friction due to unequal incentives for all close team members.

Workers were more ambivalent towards other aspects of the quasi-experimental design. For instance, line workers were encouraged by the more-informative LCD screens, however most reported a continued inability to calculate the incentive while they were working. Line workers reported better communications with mechanics and line managers, whereas previously poor interactions were a major reported cause of stress prior to the experiment. Nonetheless, workers reported that their jobs were still too stressful. However, our focus group data indicates this stress is of a traditional form, that is, of work in an apparel factory, rather than from a new source of peer or management pressure.

Less ambivalently, workers on Productivity 1 voiced a negative experience. Productivity 1 workers reported discontent with each other for lack of skills, with the team leader for poor communication, and with management for not assuring an adequate flow of quality material. These problems fed into a dysfunctional team dynamic, and workers perceived a general lack of accountability to show up to work on-time or at all, and to support one another. Even while Productivity 1's wage potentials increased (for the same output), workers claimed the financial incentive to show up did not outweigh the guaranteed sick-leave wage (300 baht), and 71% of the line quit during the year. This negative outcome is informative. Poor teamwork lowered productivity, which lowered wage potential, incentivizing marginal increases in absenteeism, decreasing productivity and, in turn, further worsening morale.

7. Impacts on the Factory and Workers

This research suggests that in factories operating with High Performance Work Practices, improved compensation systems can unlock further gains in productivity, wages, and profits. The treatments raised wages between 20 and 55 Thai baht per day from a pre-treatment average of approximately 475 baht per day. Workers thus received a wage increase between 4.2% and 11.6%. The treatment also increased productivity 12%-points and 7%-points for the PQWR and Target Wage treatments, respectively, and outputs gains outweighed profit-per-garment losses on five of the six treatment lines. Importantly, these productivity gains did not come at the cost of quality, as the quality increased by 1.8%-points and 1.6%-points for the PQWR and Target Wage treatments, respectively. In all, management reported significant financial benefits from the experiment, including avoided productivity losses due to decreased turnover. The clearest testament to this outcome is the fact that management expanded parts of the new compensation framework—the wage multiplier and production chain alignment—across the entire factory as soon as the experiment was completed.

The results also suggest the three categories of HPWP—skills, engagement, and motivation—reinforce one another. Communications and transparency about compensation help unlock motivation. In the clearest example, workers, through the LCD screens, were able to match motivation to performance.

The poor outcomes reported in the Productivity 1 line appear to be driven by the flip side of engagement and motivation, that is dysfunctional team dynamics (Gittell et al. 2009). Beset by in-fighting and high-turnover, the improved compensation system was not enough to overcome the line's existing problems. In fact, the treatment may have exacerbated the poor dynamics as the line performed poorly relative to the other treatment lines and workers blamed one another.

The results suggest that factory management may benefit in both the short- and long-term from creating a more engaged and transparent workplace (Barrientos et al. 2011) coupled with improved compensation systems. Many workers reported feeling motivated because they believed management "cared" more under the new systems. Improved communications and management-worker relations, combined with increased wages appeared to alleviate previous points of conflict (Bloom et al. 2013). Again, this points to the synergistic potential when management combines initiatives to increase engagement, incentives, and skills.

One management skill which we believe may be foundational to future efforts in this area is improved data collection and analysis. Managers will need to develop the human resource tools, Lean metrics, and business management processes to ensure consistent orders coming into the factory, materials going to the lines, skills on the lines, and appropriate compensation structures to motivate continuous improvements.

7.1. Impacts on Work Hours

As noted, the Target Wage treatment aimed to engage the wages versus hours tradeoff. And while the target wage of 500 baht in 8 hours was occasionally met, neither treatment line ever opted to go home early. In focus groups, workers reported it was more important to bring home additional wages than take time off. When given a hypothetical scenario, almost all workers preferred the ability to earn as much as possible each day, rather than receive a flat wage with the same mean as the variable-wage choice. For workers, it was rational to take advantage of the wage multiplier to maximize that day's earnings, when tomorrow's rates were not guaranteed to be as high. Workers showed that they preferred a high daily wage to smooth out variability. They also reported that the Target Wage rate was set too low. When the hypothetical flat wage was raised to 700 baht, some workers reported they would prefer the flat rate.

At the same time, workers reported a desire to work fewer days and shorter hours. However, they explained that this was actually not practical. A number of workers explained that they had secondary jobs, such as running a small shop or selling items to other workers, on top of the 60-hour factory week. In addition to needing the money, if the workers left early, they would face the sometimes-difficult task of rearranging rides, alerting family members, and coordinating plans.

Turnover and absenteeism are important proxies for worker satisfaction. The observed decrease in turnover, we infer, was likely driven by increased wages compared to alternative jobs. The factory became a better option than it previously was. However, there was no change to unplanned absenteeism. This is because day-to-day tardiness and absences are likely driven by contingencies, such as a sick child or personal illness.

7.2. Labor Concerns

While the High Performance Work Practice framework is promising, there remain significant tensions between workers, factory management, and brands (Boxall 2014). When it comes to wages, the distribution of productivity gains is highly contentious. Historically, even as worker productivity has increased, the financial gains have not been shared with workers (Berg et al. 2004). When workers realize they are not receiving financial benefits from increased effort, problem solving, or skills development, they are likely to lose motivation or depart the factory entirely. Transparency, communication, incentive alignment, and increased wages are all critical to responding to this tension.

To a skeptic, this intervention may be perceived as just another form of "sweating" workers, as wages are still tied to productivity increases. However, this experiment sought to give workers a clearer view into the connections between productivity and wages, and to connect incentives to engagement and skill-building. Moreover, this intervention provides some clues for the next generation of manufacturing. Agile production, mass customization, and even many forms of automation will require skilled, engaged, and motivated workers. A number of analysts have argued that with increased capital investments in factories, workers (that remain) will become even more valuable. Upgrading compensation and incentive systems may be a critical building block for this transition. Moving away from a strictly transactional "piece rate" relationship with workers may support both long-term goals and short-term gains (Boxall and Purcell 2011).

Of course, these findings do not negate the importance of additional, external efforts to improve working conditions and wages. For instance, investigative journalism and consumer campaigns can contribute to exposing problems and improving conditions (O'Rourke 2005). There is also a critical role for freedom of association, collective bargaining, and labor unions to negotiate and protect wage gains, and to ratchet up conditions over time (Esbenshade 2004, Fung et al. 2001). The social dialogue system perhaps provides a step in such a direction. We also believe there is a central role for governments to support more strategic compensation and upskilling programs (Gereffi and Lee 2016).

7.3. Research Limitations & Future Research

A two-year field intervention in a dynamic operating business environment presents inherent challenges. In particular, it is always difficult to study a moving object. A Randomized Control Trial design would have improved our precision and causal claims. However, this would have required factory management to refrain from making critical decisions for two years, which is not practical.

More specifically, we originally set out to include a profit-sharing scheme and a guaranteed wage target system. However, neither was possible to test in a pure sense. Future research should consider these types of compensation systems as alternatives to productivity-based compensation system. In addition, future research in other, more gender-diverse locations should consider the role of gender more explicitly (Barrientos 2013, Christian et al. 2013, Collins 2003).

This research highlights the need to better specify the conditions under which interventions can be effective. One could test our belief that the intervention relies on a pre-existing, second-generation Lean program. Moreover, one could assess what level of brand support is necessary. However, it may be that some brand sourcing practices—with respect to delivery times, quality requirements, and styles—play critical roles in supporting or undermining improved wages. Finally, future research should examine factories with greater levels of automation and product diversity.

8. Conclusions

The most common systems of pay in the apparel industry, which represent very simple versions of output-based or time-based compensation, are not aligned with Lean principles, not transparent to workers, and do not share gains equitably with workers. These systems are likely holding back both productivity and profits. This research provides empirical evidence that altered compensation systems can be a vehicle to simultaneously increase productivity, profits, and wages. When compensation systems are aligned with advanced Lean principles, transparent to workers, and deployed in a way that engages workers in decision-making, problem-solving, and supported by social dialogue systems, altered compensation can produce conditions that support higher worker pay and more profitable factory operations. Carefully designed compensation that incents continuous productivity improvements and that shares these gains more equitably, may provide a pathway to move from output-based, towards strategic approaches to compensation that pay the worker for their contribution to the business, while also making progress towards wage levels that are sufficient for workers and their families to live on with some discretionary income.

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Applying these lessons across factories and industries will require improved factory management, more sophisticated human resources management data, careful efforts to align factory goals with incentives, and improved communication and transparency. For wage gains to stick, and to improve over time, workers will need to participate fully in creating and benefiting from these gains. This research identifies a pathway for increasing factory productivity to better achieve the goals of factory managers, brands, and workers.

Appendix

Parallel Trends Assessment

Dependent Variable	Treatment Group	Simple Time Trend P-value	Time Trend w/ Controls P-value
	Productivity	0.27	1
Productivity (%)	PQWR	0	1
	Target Wage	0	1
	Productivity	1	1
Hourly Wage (THB)	PQWR	0	1
	Target Wage	0	1

P-values for parallel trends assessment over the pre-treatment period. Results from a two-tailed t-test. Values below 0.1 show a statistically significant difference between the treatment and control group.

***Table A1**: Results from two-tailed t-test. Comparison of simple time trend and time trend with controls for month and consecutive days in production for one style. The first column shows a failure of the simple time trend test. However, when seasonality and disparities in lead time are accounted for, the parallel trends assumption is satisfied.*

	Dependent variable:					
	Factory Profit per Garment (baht)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	-3.037***	-3.108***	-2.841***	-2.656***	-2.607***	-2.638***
	(0.705)	(0.742)	(0.802)	(0.791)	(0.768)	(0.775)
PQWR treatment	-4.129***	-4.163***	-3.674***	-3.552***	-3.493***	-3.451***
	(0.663)	(0.679)	(0.778)	(0.815)	(0.811)	(0.811)
Target wage treatment	-2.721***	-2.757***	-2.788***	-2.628***	-2.699***	-2.678***
	(0.512)	(0.526)	(0.494)	(0.485)	(0.490)	(0.489)
Work hours		-0.029	-0.038	-0.062	-0.036	-0.048
		(0.314)	(0.312)	(0.318)	(0.315)	(0.318)
Overtime		-0.469	-0.426	-0.369	-0.404	-0.424
		(0.912)	(0.908)	(0.934)	(0.931)	(0.925)
Number of line workers			0.202**	0.197**	0.201**	0.223**
			(0.095)	(0.097)	(0.098)	(0.096)
SAM				-0.842***	-0.844***	-0.843***
				(0.052)	(0.052)	(0.051)
Style - consecutive days on line					-0.036	-0.036
					(0.022)	(0.022)
Tardiness (minutes)						0.009
						(0.006)
Unplanned absenteeism (%)						0.062*
						(0.034)
Observations	1,825	1,825	1,825	1,825	1,825	1,825
R^2	0.047	0.048	0.051	0.118	0.119	0.120
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table A2: OLS regression output table of profit per garment on a similar set of covariates to Tables 8 and 9. The data only covers the post-treatment period however, so the comparison is to the control group. (Hlavac 2015, Newey and West 1987)

In Table A2, we first note there are only 1,692 observations, because we only have the necessary data to calculate profit-per-garment for the post-treatment period.[‡‡‡‡‡] Thus, these are results for a cross-sectional OLS, not a difference-in-difference model. The treatment effect is the difference between treatment groups in the post-treatment period. The key takeaway is average profit-per-garment decreased by three to four baht.

	Dependent variable:					
	Quality Rate (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity treatment	0.828	0.856	0.860	0.865	0.850	0.853
	(0.621)	(0.623)	(0.627)	(0.627)	(0.633)	(0.633)
PQWR treatment	1.864^{***}	1.882^{***}	1.879^{***}	1.882^{***}	1.852^{***}	1.858^{***}
	(0.577)	(0.582)	(0.582)	(0.583)	(0.585)	(0.584)
Target wage treatment	1.610^{***}	1.614^{***}	1.621^{***}	1.625^{***}	1.700^{***}	1.705^{***}
	(0.471)	(0.470)	(0.479)	(0.479)	(0.469)	(0.468)
Work hours		-0.056	-0.056	-0.056	-0.061	-0.058
		(0.125)	(0.125)	(0.125)	(0.127)	(0.128)
Overtime		0.413	0.412	0.412	0.419	0.415
		(0.434)	(0.437)	(0.437)	(0.440)	(0.440)
Number of line workers			-0.010	-0.011	-0.012	-0.013
			(0.048)	(0.048)	(0.049)	(0.049)
SAM				-0.004	-0.004	-0.004
				(0.006)	(0.006)	(0.006)
Style - consecutive days on line					0.020	0.020
					(0.016)	(0.016)
Tardiness (minutes)						-0.003
						(0.003)
Unplanned absenteeism (%)						0.001
						(0.001)
Observations	4,102	4,102	4,102	4,102	4,102	4,102
R^2	0.007	0.007	0.007	0.007	0.009	0.009
Note:	*p<0.1; **p<0.05; ***p<0.01					
	Standard errors corrected for serial correlation using Newey-West variance estimator.					

Table A3*:* OLS regressions with quality rate as the dependent variable. Fixed effects for each specification are date, style, and line. (Hlavac 2015, Newey and West 1987)

[‡‡‡‡‡] This is due to a change in factory data collection in part driven by this experiment. We also note that line was dropped as a fixed effect because of collinearity.

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