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Daily Incentive and Jump-base in a Non-Real-Time Apparel Manufacturing Context

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ABSTRACT

This study summarizes piecework incentive systems and examines two apparel manufacturing factories that used daily incentive calculations at one time and weekly incentive calculations at another. In addition, one factory implemented a multiple base-rate incentive system, often called jump-base. The data shows that, when not controlled, daily incentive can facilitate operators engaging in fraudulent activity such as ticket-holding. With fraud controlled, daily incentive calculation makes little difference in overall pay; therefore, it may have individual level motivational effects by nullifying the effect of averaging one-bad-day into the week. While jump-base may enhance productivity in lower performing operators or modules, one must take great care when designing such systems.

Keywords: incentive, productivity, piece-rate pay, set rates

1. Introduction

Despite the decline of piece-rate pay in developed nations (Hart, 2016), piece-rate pay systems remain predominant in apparel manufacturing factories around the world because it functions well. According to Lazear (2018), "The literature is virtually unequivocal in documenting that for the circumstance where piece-rate pay is well suited, it provides incentives for workers to produce as predicted by standard theory" (p. 198). While the academic literature documents that under the correct circumstances piece-rate incentivizes workers to produce as predicted by standard theory (see Lazear, 2018; Seiler, 1984), the literature also documents that incentive systems are subject to people *gaming the system* (Roy, 1959; see also Kerr, 1975; Paulsen, 2013). Despite over 100 years of use across numerous industries, there are only a few empirical studies (Yetton, 1979) reporting the actual productivity increases, especially in recent years (e.g., Lazear, 2000; Shearer, 2004; Bandiera, Barankay, Rasul, 2007; Paarsch & Shearer, 1999; Haley, 2003; Shi, 2010). While these studies report impressive gains in productivity, they involve work in agriculture, forestry, and replacing windshields, not apparel and they only compare productivity under hour-based pay to piece-rate pay. These studies also do not address the subject of workers' propensity to game the system.

This study uses data from two different natural experiments in apparel manufacturing factories. The first identifies the propensity of workers to game the system using one known method, holding tickets in a non-real-time daily incentive calculation environment and provides an estimate of the cost to the employer. The second identifies the productivity change and associated cost of switching from a single base-rate to a multiple-base rate system, sometimes called step-base or jump-base, in a modular or team production environment.

2. Literature Review

Piece-rate, or piecework, pay is a pay-for-performance system that has a long history, back to antiquity, across many industries (Peach & Wren, 1991). Agricultural industries pay workers by the bushel basket, pound, or another measurement unit for picking crops (Billikopf, 2014). The construction industry also has a long history of piece-rate use (Peach & Wren, 1991), for example, masons receive pay based on the number of bricks or blocks laid. However, piece-rate pay is most associated with manufacturing industries. While there are examples of pay-for-performance in manufacturing in the US and Europe in the 1700s, Frederick Taylor and his contemporaries institutionalized its use starting in the 1880s. In his first paper, *A Piece-Rate System*, presented to the American Society of Mechanical Engineers, Taylor (1895) proposed a system for paying workers based on an individual worker's productivity as opposed to a fixed rate per day or hour based on the position. He based his seminal work, *Scientific Management* (1911), on his experience working in the steel industry beginning in the 1870s. Taylor stated that most workers, intentionally or unintentionally, perform work very inefficiently. He also noted that when workers receive the same pay, they often perform at the rate of the slowest among them and called this soldiering. Taylor, and his contemporaries Frank and Lillian Gilbreth, and Harrington Emerson, emphasized analyzing jobs by breaking them down into tasks and using time and motion studies, which could include motion pictures, to set fair rates (Emerson, 1911; Gilbreth, 1912; Taylor, 1911).

Emerson's work cemented the term *efficiency* into the manufacturing and piece-rate pay systems vocabulary. One determines an operator's efficiency by comparing actual units produced to the rate or quota in a specified period as set by engineers. A rate is the time it should take an average experienced worker to complete a job task. In some operations, a worker may complete the task on many units in one minute while other operations may take several minutes, or in some industries even hours, per unit. It is common to express the rate in terms of

Standard Allowed Minutes (SAM) or Standard Allowed Hours (SAH) per unit, dozen, or hundred.

The apparel manufacturing industry implemented the then controversial piece-rate pay system in the early days of the Scientific Management Movement (Emmet, 1917) and it resulted in increases of both pay and productivity (see Seiler, 1984). In an apparel factory, a work-bundle containing parts for a few dozen garments has a sheet with removable tickets attached. Each ticket represents a unique operation and has a SAM or SAH value for each piece multiplied by the number of pieces in the bundle. When the worker completes the bundle, the worker removes the ticket for that operation and attaches it on his or her pay sheet. The employee's earned-hours equal the sum of the SAM values on the tickets. A payroll clerk, or computer system, multiplies the earned-hours by the base-rate and the clock-hours by the minimum wage and the operator receives the higher of the two values. If the pay for earned hours is less than the required minimum wage, *makeup* is the term used to describe the difference paid to reach minimum wage. Some also use the words *top-up* or *top-off* (Grimshaw & Munoz de Bustillo, 2016). Dividing the earned-hours by the clock-hours provides the worker's efficiency. While this is a daily example, as discussed below, most apparel manufacturers have calculated the pay and any makeup on a weekly basis, when allowed by law, to limit the ability of operators' holding-tickets to game the system by earning unjustified makeup one day and payment of the ticket SAM value as earned-hours on another day.

2.1 Setting the Rate

The controversy that arises between workers and employers over piece-rate pay usually revolves around the fairness of the rate (Matthew & Rogers, 1955). The issues and steps taken to resolve disputes described by Emmet (1917) over one-hundred years ago still exist today. Some countries such as Cambodia, Madagascar, and Morocco have adopted specific piece-rate national legislation to protect workers from abusive piece-rate practices (ILO, 2014). A fair rate, or a fair day's work, is one where a properly trained and experienced worker with average skills can achieve the rate consistently. This includes time for breaks to overcome fatigue. In addition, delays such as machine failure or lack of work do not count against the worker's performance. Taylor and his contemporaries promoted the use of time-study where one analyzes the job by studying one or more workers performing the job. Since some workers have greater abilities and manual dexterity than others, it often involves a subjective performance factor, determined by the engineer (Matthew & Rogers, 1955). However, as sociologist Donald Roy (1954) learned from working undercover for a year as a radial-drill operator in a piece-work machine shop, there is also a good deal of collaborative effort to thwart engineers' efforts to set rates by workers running machines at lower speeds and adding in unnecessary movements when being observed during time studies.

The Gilberts used moving picture cameras to build on the time-study methods by breaking down the work into individual motions to analyze the tasks and identify method improvements. This approach evolved into a systematic method, known as a predetermined motion time system (PMTS), for applying times to individual motions and actions named Methods-Time Measurement (MTM) developed by Maynard, Stegemerten, and Schwab (1948). Variations and simplifications of the original MTM resulted in MTM-2, MTM-3, Maynard Operations Sequence Technique (MOST), and MODAPTS. Adaptations of these PMTS for the sewn products industries resulted in General Sewing Data (GSD), MODSEW, and more recently Engineered TruCost and SewEasy GSD among others. Today, firms often use PMTS and time-study in combination to establish and verify piecework rates. However, this has not ended the ongoing conflict between piece-rate workers, time-study engineers, and management over what the true rate should be.

2.2 Piece-Rate and the Motivation to Cheat

Taylor's observation of soldiering behavior is not unique to US culture. Paulsen (2013, 2015) reviews the literature documenting what he calls "*empty labour*" across various nations from the post-industrial revolution through contemporary times. Steven Kerr's (1975) widely cited article entitled *On the Folly of Rewarding A, while hoping for B* points out how incentive systems frequently encourage behavior different from what the creators intended.

Noteworthy to this study, Roy (1954) describes how the piece-rate workforce held the belief that, "You can't 'make out' if you do things the way management wants them done….You've got to figure the angles" (p. 257). He then describes several situations where piece-rate employees on the shop floor collaborated within and between groups and departments to "cheat" (p. 256) the system to attain their production quotas. Some collaborators, such as inspectors and time-checkers, were managerial extensions to ensure compliance with the rules. Concisely, one measures the earned-hours against the clock-hours accumulated while working *on-production* or *on-standard* to determine the production bonus, which is the amount above the minimum wage that the operator receives based on productivity. Time spent on set-up, waiting on a machine repairs, in department meetings, etcetera, are *off-standard* or *clocked-out* of production time. Firms pay off-standard time, depending on the reason and company policy, at minimum wage or an employee's average on-standard wage. Therefore, appearing as off-standard while producing products would provide a significant boost to earnings because it would double-compensate the time.

From years spent implementing and supporting software systems that monitored production and generated payroll across dozens of apparel manufacturing plants owned by different firms, the first author of this study recalls numerous situations similar to those described by Roy (1954). They ranged from ticket-holding, to supervisor collusion in off-standard time schemes and even administrative employees printing tickets for nonexistent work and selling them to employees. All authors recall situations where rates were too beneficial to operators, sometimes referred to as *loose rates*, and operators colluded by not turning in bundle-tickets because, while doing so would significantly increase pay, it would also alert managers to the faulty rate. This would cause engineers to lower the rate, which would require operators to work harder to achieve 100%. This anecdotal evidence is relevant not only because it underlines the propensity to cheat in piece-rate environments, but also because it shows that, as Roy (1954) suggests, employees figure out the system and the angles necessary to gain financial advantage. The data from Factory A provides empirical evidence of the frequency of such activity and the need for effective controls through shop floor supervision procedures and software systems.

2.3 Variety in Piece-Rate formulas

Although not covered in the extant academic literature, one debate in the apparel industry piece-rate discussion revolves around calculating the minimum makeup and production incentive on a daily versus weekly basis. In some factories, a collective bargaining agreement with unionized employees dictates daily calculation. On its face, this appears to be a minor issue; however, in practice daily calculation facilitates operators being able to hold bundle tickets from one day to turn them in on another day. In the most simplistic piece-rate system that has a guaranteed minimum wage and only one base-rate, this occurs with operators performing around the point where they are only earning minimum wage or slightly higher. Not submitting all of one's tickets on one or more days allows one to earn the minimum makeup on those days and then earn the production value of the tickets on the days when one submits the held tickets. This was a greater problem in the days before computerized systems with barcoded bundle tickets, but it remains an issue. Given that most apparel operators will have multiple sheets filled with dozens of bundle tickets on any given day, in the times before unique barcoded tickets on each bundle it was difficult to identify this behavior. An operator's performance varies from day to day for a variety of reasons. Therefore, it is burdensome for payroll clerks to detect fraudulent versus valid daily fluctuations from intent to game the system. However, if an operator routinely attempted to hold tickets in one week and submit them in another week to game the system, payroll clerks could easily identify the large oscillation in weekly pay.

In non-real-time shop floor information systems, the barcode is an operation or sequence number plus a unique serialized number for each bundle. The operator pulls off the barcoded ticket for the operation performed and sticks it on the pay sheet. Scanning tickets into the system allows pay calculation and production tracking through the line. In theory, implementing a computer system using unique barcoded tickets on each bundle would enable management to thwart ticket-holding behavior in a non-real-time environment. However, despite most systems having reports available to alert for tickets scanned out of sequence, in practice it has not been a complete success. Without engaging in a detailed explanation, it is administratively cumbersome and time-consuming to make these features function smoothly. For example, before scanning the tickets, payroll clerks must order operators' bundle ticket sheets from first operation to last. In addition, there are numerous situations, such as machine breakdown and line balancing needs, which result in some operations occurring out of order, sometimes days later. It is easier to control this in a modular or team environment because all or most sewing operations are on one ticket. Therefore, there are fewer sheets to scan and follow up on when an issue such as a questionable sequence of operations arises.

Multiple base-rate systems increase the financial benefit of holding tickets. After Frederick Taylor presented his paper in 1895, many manufacturers across the US were interested in implementing the system. Several expert consultants rose to the occasion, each with his own branded enhancements to Taylor's system (Peach & Wren, 1991; Sharma, 1997). Examples include the Dwight Merrick Differential Piece-Rate, the Harrington Emerson Efficiency Bonus Plan, and Henry Gantt's Task and Bonus Plan where workers receive a significant increase for reaching higher levels of efficiency. One should note that they developed these systems before minimum wage laws existed in the US and today there is near universal application of minimum wages around the world (Grimshaw & Munoz de Bustillo, 2016). Most of these systems were some version of multiple base-rate systems, similar to Factory B in this study, that pay earned-hours at progressively higher base-rates depending on productivity.

The following example demonstrates how ticket-holding benefits the employee financially in a multiple base-rate system. If a worker is 1% to 84.9% efficient, the pay for all earned-hours is at a base-rate of $9, from 85% to 99.9% the pay for all earned-hours is at a base-rate of $10, and at 100% and above the pay for all earned-hours is at a base-rate of $11. The reasoning is that this provides additional motivation for workers to exert the effort to reach the next level of efficiency because it will cause a significant jump in pay. Many refer to this system as a jump-base or step-base system. In the example given, a moving from 84% to 85% would amount to about $7.50 or 11% jump in pay for the day. However, especially if the incentive calculation is daily, a jump-base system also motivates ticket-holding behavior. For example, an operator that consistently performs at 83% would benefit by just turning in enough tickets to be about 70% on three days of the week and then turn in the held tickets in on the other days for payment of the held back earned-hours at the rate of $10 or $11 instead of $9. In this simplified example, an operator could increase his or her pay by 3% to 5% with no additional effort exerted to create more production for the week.

3. Research Methodology

The proprietary data sets used in this study came from somewhat natural experiments where the authors did not set the parameters but were observers during and/or after the fact. Factory A implemented a quasi-manual piece rate payroll information system in a new Central American factory because the information system used by the parent company in the US was not in Spanish and was not compatible with country's overtime rules that were daily, as opposed to weekly, and varied depending on the time of day and day of the week. We call it quasi-manual because the bundle tickets had no unique identifying number, just style, cut, operation, and SAM value; therefore, the system provided no tracking information, but the payroll clerk entered the manually summed values into a computer program for payroll calculation. Although intended as a temporary solution, the system ran for almost three years before implementation of a barcoded bundle-ticket system from an outside supplier. When operating the new barcoded system and the old system in parallel, a discrepancy in individual operator pay uncovered that the old system had been calculating minimum wage makeup and production incentive on a daily rather than weekly basis. This was not what upper management intended because they knew of the potential of holding-tickets to increase pay. The error occurred because the programmer of the quasi-manual system, not familiar with piecework pay systems, had written a simple program with the focus being on facilitating the payroll clerks' tasks, especially in addressing the complex overtime calculations.

Factory A used the traditional progressive bundle system where individual employees performed one or two tasks and received pay based on his or her individual performance. The payroll clerks manually summed the SAM value of the tickets on an operator's sheet and entered them for that day of the week along with the on-standard and off-standard times. Upon closing the screen for that operator, the program calculated the operator's on-standard and off-standard pay for that day using the required overtime rules and saved the data to the operator's file. The weekly payroll calculation was then just summing the previously calculated values for each day of the week. This method calculated minimum wage makeup and production bonus per day instead of per week. The correct method for weekly calculation is not calculating pay every day but instead summing all SAM values for the week along with on-standard and off-standard clock-hours for the week and then calculating the production pay and comparing it to the minimum wage required for the entire week. As a result, the Factory A dataset allowed us to investigate the frequency of ticket-holding behavior and estimate the potential benefit to the operator and loss to the employer from this method of gaming the system.

Factory B used the same barcoded-bundle-ticket system from its beginning. This factory used a group or modular manufacturing system where teams of eight employees formed a group assigned to twelve to fourteen machines. The number of completed garments produced out of the module determined the earned-hours. An individual member received the production pay in proportion to the number of on-standard hours the individual contributed to the group during the week. Factory B had operated using a traditional incentive system where minimum wage is at about 70% of the base-rate paid for earned-hours and minimum wage makeup is on a weekly basis. Management changed to calculating minimum wage makeup and piece-rate bonus daily instead of weekly. In addition, they implemented multiple earned-hour base-rates that increase in steps as efficiency increases, often referred to as step-base or jump-base piece-rate systems where all SAMs earned for the day are multiplied by the higher rate if the operator reaches the next efficiency tier. Because the incentive system in both factories set minimum wage at 70% of the base rate, we standardized our calculations for this paper on $7 and $10, and adjusted for Factory B's jump-base accordingly, instead of using local currency units.

3.1 Factory A

The research objective with Factory A data was to determine the actual frequency of ticket-holding behavior in an environment where management took no efforts to prevent it. This proved more challenging than first assumed due to the way the quasi-manual system stored the data. As a result, we ended up taking a sampling approach. In a traditional piece-rate system with a single base-rate, one games the system by holding tickets on one or more days so that earned-hours are sufficiently below the minimum wage breakpoint to earn minimum wage makeup pay. Operators then turn in the held tickets on other days for payment of those earned hours at the base-rate. This behavior will only occur in operators performing around the minimum wage breakpoint, in this case 70% efficiency, because daily oscillation between 90% or 100% and 50% would be detectable by supervisors and the makeup pay benefit would be a smaller portion of gross earnings. Given that employers usually terminate operators who cannot consistently perform in the 80% to 100%+ range, ticket holders are usually new employees or existing employees transitioning to a new job task or during style changes. Training programs base pay on a training or retraining curve that adjusts efficiency required to earn incentive down and gradually raises it over several weeks. Because not all operators hold tickets on Monday and Tuesday and turn them in on Thursday and Friday, it is difficult to identify ticket holding patterns in the combined data of numerous individuals. Also, because it is an up-or-out system where employers terminate those who do not progress along the training curve in a set period of time, tracking the same individuals over months is not possible because they either advance beyond the point where ticket holding is beneficial while not being obviously detectable or they are no longer employed.

After a variety of mathematical approaches, we found that a bar graph was the easiest way to identify ticket-holding behavior. Factory A had over 500 piece-rate employees, which resulted in over 25,000 operator-weeks of pay data per year. Therefore, we first selected only the data where an operator earned at least one day of makeup pay in a given week. We then drew a random sample of one-week of pay data for 20 operators from each month of the last twelve months (n = 240) that the quasi-manual system operated. We chose a sampling approach because the process was time consuming. Most operators with makeup were on a training or retraining curve and the data structure of the quasi-manual system required us to make several manual adjustments. We had to identify the particular curve and the amount of adjustment for that particular week on the curve and then normalize it so that the information viewed was on the same scale for all observations. We then ran the observations through a program we developed to display the bar graph and allow us to tag those with clear indications of ticket holding behavior. A review of tagged observations found that observations with clear indications of ticket holding behavior had two or three days of makeup pay. To determine that, we took the additional step of viewing the data for the week prior and after the sample observation week for those that had one, four or five days of makeup pay in the sample observation. Based on the extended analysis, we found that those with four or five days of makeup pay were consistently operating at or below the normalized minimum wage breakpoint. We could not make a firm conclusion for those with only one day of makeup pay. About 25% of the 38 operators with only one day of makeup pay, from our sample of 240, were not on a training curve and appeared to have had just one-bad-day with the remaining days being in the same range as the prior and proceeding week. This is not consistent with chronic ticket holding behavior. Those on training curves with only one day of makeup were usually near the end of the training curve period where they were graduating to consistently performing well above the minimum makeup breakpoint. Given these findings, we focused on the operators having two or three days of makeup pay during a week. Starting with a larger random sample of one-week of data from 240 operators and eliminating operator-weeks with absences or excessive overtime, or excessive off-standard time, we drew a sample of one-week of data from 40 different operators with two or three days of makeup pay to evaluate the frequency and cost of ticket holding behavior. The awareness of ticket holding behavior and the bundle tracking tools in the new barcoded system allowed management to focus on reducing the behavior; however, based on management's comments, attempts persisted for several months. We drew a similar sample of one-week of data from 40 operators with two to three days of makeup pay about six months after the new system implementation to evaluate the variance in the before and after samples. Finally, we did a same-group pre-post comparison by identifying three weeks of data from the same 40 operators, before and after, to see if daily versus weekly incentive calculation made any significant difference in weekly performance by comparing the means of on-standard efficiency. In all cases, we selected weeks with minimal overtime where the operator worked every day and only used data from Monday through Friday since any Saturday work was overtime. We observed that Saturday performance, when it occurred, was usually lower than performance during the week. The operators in the same-group pre-post analysis had over one year in the factory and averaged between 90% and 100% efficiency.

3.2 Factory B

The research objective with Factory B was to determine if multiple base rate, jump-base, pay systems result in productivity increases. One of management's motivations behind changing to a jump-base system with daily incentive calculation was to increase productivity and pay to combat turnover in lower performing modules. Being aware that the jump-base system combined with daily incentive calculation provided increased motivation to hold tickets, management took numerous fraud prevention steps to identify and thwart ticket holding and other system gaming behavior. Despite numerous attempts in the first few months, the fraud preventions steps proved effective; therefore, Factory B data did not provide much insight into ticket holding.

For this analysis, we reviewed the data for the entire factory for eight months starting three months after the change and identified evidence of positive production increases. However, because of the variation caused by weeks with excessive overtime and employee turnover, the differences were not statistically significant. This is not surprising given that the greater the variation, the further apart the means have to reach statistical significance. As noted by Borino (2018), wage and hour data in the garment industry exhibit substantial noise and have very large standard deviations, which limit the ability to draw robust conclusions. Therefore, we identified five modules with the least employee turnover in each of three production ranges so we could have, as close as possible, a same-group pre-post comparison. We then identified nine weeks, before and after the change, with minimal overtime and off-standard time and performed a t-test for difference in mean efficiency using only on-standard time during the normal Monday to Friday workweek

4. RESULTS

Ticket holding behavior in Factory A was rampant before implementing a barcoded bundle ticket system. It is surprising it persisted for so long; however, corporate management was not aware of the programming error and local management in the new factory did not know to guard against ticket holding behavior. We found that 85% of operators with two or three day of makeup pay during the week exhibited clear ticket-holding behavior with efficiency on makeup days being on average 29% below his or her efficiency on non-makeup days. Based on review of weeks before and after the sample week, these operators obviously replicated the behavior over multiple weeks. The difference between makeup and non-makeup days for those deemed not exhibiting ticket-holding behavior was only about 5%. We also found that the low-performing operators with two to three days of makeup but not exhibiting ticket-holding usually had less than four weeks working in the factory and likely not yet enlightened to the financial advantage. Overall, the fraud facilitated by the unchecked daily calculation of makeup cost the factory 6.94% more in fraudulent payments than if the calculation was weekly. For individual operators the range of increase for a week was between 3.27% to 10.24%. An indication that cheating does pay.

To confirm that the barcoded system combined with ticket-holding prevention steps on the shop floor resulted in change, we drew a similar sample from the new system data six months after implementation and performed Levene's test for equal variances between data from the old and new system for operators that could benefit from ticket-holding. The reasoning being that if operators had learned that ticket holding does not result in higher pay, then they would not hold tickets and this would cause less day-to-day variance. We could reject the null hypothesis of equal variances ($p < 0.001$). This indicates that the barcoded bundle-ticket information system combined with managerial vigilance was effective in reducing piece-rate fraud as indicated by a reduction in daily efficiency variance. Results from comparing weekly efficiency (SAMs for the week divided by on-standard clock minutes for the week) for our sample of 40 experienced operators under daily and weekly incentive calculation showed that performance was only 0.06% (SE = 0.44) higher under daily incentive. However, it was not statistically significant $t(119) = 0.132$, $p = 0.895$ with a low effect size $r = 0.10$.

A broad analysis of the on-standard post-change efficiency in Factory B showed a small, less than 0.5%, but not statistically significant overall improvement in on-standard efficiency. Given the previously mentioned large weekly variation, particularly in weeks with high levels of overtime when on-standard efficiency dropped, the lack of significance is not surprising. However, even small increases in both on-standard and global efficiency in a large factory can be financially significant and we found a breakdown of modules by performance ranges was more informative. One of the main motivations of the change was increasing pay to improve retention in low-performing modules. The data indicates that modules performing in the 75%-90% range before the change increased on-standard efficiency on average by 3.56 percentage points (SE=0.44), it was statistically significant $t(224) = 8.074$, $p < 0.001$and it did represent a medium size effect of $r = 0.47$. The wage increase over the old single base rate system was 2.88%. The results for the higher efficiency modules were less convincing and more costly. The increase in efficiency for modules in the 90%-105% range was on average only 0.67 percentage points (SE = 0.59) and not statistically significant $t(224) = 1.138$, $p = 0.256$) with a low effect of $r = 0.08$; however, the wage increase was 11.56% on average. The change in efficiency for modules performing over 105% was negative by a minuscule amount at -0.02 percentage points ($SE = 0.02$) and not statistically significant $t(224) = 1.40$, $p = 0.162$ with a low effect of $r = 0.09$. The wage increase was a similar 11.54%. Table 1 provides the jump-base rates used in Factory B.

Table 1. Factory B Jump-Base Rates

Efficiency	Base Rate
0%-84.9%	$10.00
85%-89.9%	$10.25
90%-94.9%	$10.50
95%-99.9%	$10.75
100%-104.9%	$11.00
> 105%	$11.25

Factory B management also changed from weekly to daily incentive calculation with the stated intention of eliminating the demotivating effect of averaging one-bad-day into the remaining days of the week. This study did not investigate the actual motivational effect on groups or individuals; however, we recalculated based on weekly incentive and the data provided some interesting results. Keeping in mind that the jump-base system would create an environment for greater pay differences between weekly and daily incentive calculation, we found only small positive differences, 0.28% on average with a range of -0.05% to 3.4%, in the daily calculations for lower performing modules. However, for higher performing modules there was a miniscule difference in pay and in several individual weeks it was actually negative. This was puzzling at first glance. However, high performing modules have relatively consistent performance. Where one lower day in daily jump-base calculation lowers pay significantly for that day, when averaged over the week, the better days keep the rate in the higher jump-base range. This accounts for why high performing groups saw slightly lower pay under the jump-base system when the calculation is daily instead of weekly.

5. Conclusions

The data in this study provides empirical evidence that, just as Roy (1959) suggested, workers figure out the angles. In Factory A, the vast majority of workers that ticket-holding would benefit, were doing it and those not holding tickets were new hires that arguably lacked indoctrination. During the jump-base implementation, Factory B also encountered numerous ticket-holding attempts and working-off-the-clock schemes. Working-off-the-clock includes working during lunch or breaks and doing actual production work while being clocked-off for things like machine repair or meetings. Some may view an operator's decision to work during a break or lunch to earn more money as being an individual choice; however, besides being a way to game-the-system in a jump-base environment, it is illegal to work off-the-clock in most jurisdictions because of minimum wage laws and it violates most, if not all, vendor compliance standards. Working on production while clocked-off for machine repair or another purpose is fraud and usually occurs when the reason ends but the operator does not clock back on-standard. The result is increasing earned-hours that will increase on-standard pay while concurrently being compensated off-standard time.

Most noteworthy in both cases is how effective computer information system (CIS) tools combined with shop floor managerial controls can reduce or eliminate fraud in piece-rate pay systems. While CIS tools in a non-real-time environment are effective if used, resolution of issues usually requires time consuming back-tracing. Therefore, effective shop floor prevention methods with CIS tools as a backup are more time efficient. Expecting fraud issues upon daily jump-base implementation, Factory B thwarted multiple fraud attempts. Marking bundle tickets with a different colored marker each day as someone delivered them to the modules proved an effective deterrent to ticket-holding. It would be normal for a few tickets with Monday's color to appear on Tuesday's sheet, but if they showed up on other days of the week, it would alert floor supervisors before getting to the payroll clerks. Because operators could place tickets from the same day of a previous week, since they have the same marker color, on a subsequent week sheet, management utilized CIS bundle-out-of-sequence reports to monitor for this possibility. Factory B also placed timecard holders at each module, instead of the traditional location by the time clock, so that managers and supervisors could easily do random checks throughout the day for people clocked-out but actually working.

The results from Factory B's jump-base data highlight why implementation of any incentive system requires careful pre-launch analysis. While the jump-base system appeared to provide at least some increase in productivity for lower performing modules that aligned with a corresponding increase in pay, in practice the system provided a significant pay increase to high performing modules with little to no increase in productivity. Once employees receive an increase in pay, it is very difficult to reverse it without affecting morale. We know that management adjusted the jump-base rates as currency devaluation and associated government minimum wage changes dictated wage adjustments; however, it took well over a year to better align the upper level jump-base rate tiers with the observed productivity wage increases. Our interpretation is that the larger effect seen in lower performing modules is because those teams have more unnecessary motions and time-wasting behaviors, such as chatting, that they can eliminate to reach the next rate level. Modules already performing near or above the 100% level have little room for efficiency improvement if the firm sets the rates correctly.

Based on the data from Factory B, our assessment is that jump-base systems show promise for motivating those on the lower range of the performance spectrum. However, we acknowledge that a single factory example does not provide broad generalizations. To be most effective, the temporal proximity of the reward to the effort provided by daily incentive calculation seems prudent. In our recalculation comparison of daily versus weekly incentive calculation in both factories, we saw very little difference in pay in the aggregate data between daily and weekly calculation of incentive. Given that we saw evidence that lower performing individuals and modules occasionally experienced that one-bad-day phenomena that some argue the daily incentive calculation diminishes, if proper controls are in place daily calculation may provide some motivation that offsets that one bad day. We did not see that higher performing operators and modules experienced many one-bad-days, and as a result, the daily versus weekly calculation made virtually no difference for them and sometimes even resulted in a slightly negative earnings outcome. However, management must be more vigilant when using daily incentive calculation because the smaller fluctuations are more difficult to detect and small daily fraud can add up to significant costs for the factory.

This study demonstrated the value of the use of well-designed CIS systems using barcoded tickets over quasi-manual systems that do not track individual bundles. We have pointed out that both factories were not using real-time shop floor data collection because real-time collection would eliminate ticket-holding and some other fraudulent practices. This is because in the real-time environment there is no ticket to hold. Each bundle has only one barcoded ticket that operator's scan at the point where work is done and the ticket stays with the bundle. In addition, if a station is scanning tickets, the worker or workers are at the station working so the system monitors actual working time. Real-time systems have been available in the apparel manufacturing industry since the late 1980s; however, implementation has not been widespread due to the initial and ongoing costs involved. The advances in wireless device technology and the reduction in the cost of wireless networks and portable devices should significantly alter the potential real-time payback calculation. This is especially true in factories using modules because there is only one collection device per module instead of one per operator. We are not aware of any independent, peer-reviewed study, old or recent, evaluating the cost-benefit of real-time systems in apparel manufacturing. This would be an interesting area for future research.

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