

ORIGINAL RESEARCH

Pay Matters: The Piece Rate and Health in the Developing World



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Abstract

BACKGROUND Piece rate pay remains a common form of compensation in developing-world industries. While the piece rate may boost productivity, it has been shown to have unintended consequences for occupational safety and health, including increased accident and injury risk.

OBJECTIVES This paper explores the relationship between worker pay and physical and emotional health, and questions the modern day business case for piece rate pay in the developing world.

METHODS The relationship between piece rate and self-reported measures of physical and emotional health is estimated using a large survey of garment workers in 109 Vietnamese factories between 2010 and 2014. A random effects logit model controls for factory and year, predicting worker health as a function of pay type, demographics, and factory characteristics.

FINDINGS Workers paid by the piece report worse physical and emotional health than workers paid by the hour (OR = 1.38-1.81). Wage incentives provide the most consistently significant evidence of all demographic and factory-level variables, including the factory's own performance on occupational safety and health compliance measures.

CONCLUSIONS These results highlight the importance of how workers are paid to understanding the variability in worker health outcomes. More research is needed to better understand the business case supporting the continued use of piece rate pay in the developing world.

KEY WORDS emotional health, occupational health, performance pay, physical health, piece rate, wages
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“Workmen...when they are liberally paid by the piece, are very apt to overwork themselves, and to ruin their health and constitution in a few years.” (Adam Smith, 1776).¹

INTRODUCTION

Performance-based pay systems such as the piece rate are frequently used to encourage workers to be more productive on the job. Piece rate pay rewards speed and intensity at the expense of health-promoting behaviors such as machine safety

maintenance, work breaks, and medical visits.² It has been associated with increased job injury and accident risks,³ and negative effects on worker physical and emotional well-being.⁴⁻⁹

Modern manufacturing in the developed world has gradually moved away from the piece rate. In the US manufacturing industry, piece rate pay has gone from being the dominant form of compensation a century ago to less than 5% in 2003.¹⁰ Despite being on the decline in comparatively wealthy countries, the piece rate is still common among low-wage industries in the developing world. It

continues to represent an important pay mechanism in industries where output is easily measurable, such as agriculture (by the bushel) or apparel (by the garment). The presence of exploitative wages further complicates the role of the piece rate in the developing world, since the piece rate incentive may be needed to balance out the loss of intrinsic motivation to work for extremely low wages.¹¹ For this reason, the ill effects of piece rate pay and worker health outcomes remain a relevant and timely question for much of the world's lowest-paid workers.

This paper explores the relationship between piece rate and a range of self-reported physical and emotional health symptoms among a large cohort of garment workers across 109 factories in Vietnam between 2010 and 2014. This work represents an important contribution to the literature, adding to the small but convincing body of evidence highlighting the negative health effects of piece rate pay. This paper further explores the policy implications of piece rate pay in the developing world, and suggests important areas of future research.

Vietnamese Apparel. The apparel industry represents the largest formal business sector in Vietnam, employing over 2.5 million people. Vietnam is also a sizeable player in the global apparel market, with exports valued at over \$17 billion per year (15% of the country's total exports); Vietnam is the fifth largest supplier of apparel worldwide, and the second largest supplier to the US market.¹² In regard to the health of the Vietnamese workforce, workers and employers pay into a series of mandatory nationalized insurance programs, including health, social, and unemployment. Health insurance coverage is mandated for workers in the formal sector and paid for through payroll deductions that represent a percentage of worker salary.¹³ Under the labor code, employers are responsible for providing worker compensation for injuries and illnesses suffered by their employees on the job, including medical treatment and paid leave during recovery. Employers are also required to provide routine medical treatment and care to all employees on an annual basis.¹⁴

In response to growing international concern over working conditions in the global apparel sector, a program known as Better Work was founded in 2007 as a joint initiative of the International Finance Corporation and the International Labour Organization. Better Work provides monitoring and assistance on compliance with international and national labor laws in participating countries, and has been operating in Vietnam since 2009. As part of their effort to improve working conditions in the

global apparel industry, Better Work publicly reports factory-level compliance statistics with national and international labor laws on an annual or bi-annual basis for those factories participating in the program.

MATERIALS AND METHODS

A list of the relevant questions from these Better Work worker surveys is provided in [Supplementary Table 1](#). The collected data include information on worker demographic characteristics, factory operations, and worker compensation, which is further broken down by production quota and piece rate pay. The survey protocol for collecting these data was approved by the Tufts University Institutional Review Board.

More specifically, workers at 109 factories were surveyed between 2010 and 2014, with a target sample of 30 workers per factory per year. However, not all factories were available during all years, resulting in an unbalanced panel of data across factories. Despite the original intent of the study design to resurvey the same workers every year, turnover was a major challenge and it is unclear from the available data whether a worker represents a repeated observation.

As noted previously, Better Work monitors and reports working conditions in the participating apparel factories. More specifically, they assess compliance with eight broad 'compliance clusters,' one of which is occupational safety and health (OSH).¹² The OSH cluster is further broken down into a series of 'compliance points,' each dealing with a separate OSH-related concern in the factories. Compliance (or non-compliance) with any of these OSH points are determined by a series of onsite checks conducted by Better Work staff. The checklist of questions related to OSH in the sub-set of factories with matching worker survey data is provided in [Supplementary Table 2](#). These factory-level compliance data were matched by year and factory to the worker surveys to assess the extent to which compliance with national and international labor laws at the factory level impact self-reported health outcomes at the worker level. Various specifications of this relationship were tested, including performance on the individual compliance points, such as ergonomic stressors and the availability of worker protective equipment, as well as based on a composite index of average non-compliance across all the checklist questions.

Analytical Approach. A logit model was used to predict worker physical and emotional health

symptoms, adjusted with a random effects intercept to control for factory-level differences and year-specific dummy variables. More specifically, the xtlogit command in STATA 14 (College Station, TX) was used to estimate the following equation:

$$I_{it} = \alpha_0 + \beta x_{it} + \delta W_{it} + \phi \text{PayType} + \sigma_i + \kappa_t + \varepsilon_{it},$$

where i and t index factories and years, I is the presence of a physical or emotional health symptom, X is a vector of worker demographic characteristics, W is a vector of factory characteristics including OSH compliance, PayType is the existence of performance-based pay (in this case, piece rate or quota), σ is the random factory effect, and κ

represents year-specific dummy variables. The logit model coefficients and P values are reported for all variables, as well as the conditional odds ratios for PayType . Specifically for the PayType variable, quota represents a binary response to the survey question, denoting whether the worker faces a weekly or daily production quota (No = 0, Yes = 1). The piece-rate survey question distinguishes between workers that are paid entirely by the piece and those that receive some combination of piece rate and hourly pay. For this reason, piece rate is specified as three categorical variables (Hourly Pay = 0, Partial Piece Rate [1-99%] = 1, All Piece Rate = 2). Since it is not possible to discern repeated observations of workers over time in this sample, a separate specification of annual logit

Table 1. Summary Statistics

| | Obs | Variable | Mean | Median | SD |
|--|------|---|-------------------------------------|-----------|-----------|
| Worker Self-Reported Physical Health | | | | | |
| Fatigue | 5822 | 0 = Never, 1 = Otherwise | 30.2% | | |
| Headache | 5823 | 0 = Never, 1 = Otherwise | 58.3% | | |
| Stomach | 5820 | 0 = Never, 1 = Otherwise | 27.0 % | | |
| Dizzy | 5822 | 0 = Never, 1 = Otherwise | 35.5% | | |
| Backache | 5820 | 0 = Never, 1 = Otherwise | 36.9% | | |
| Thirst | 5822 | 0 = Never, 1 = Otherwise | 14.1% | | |
| Hunger | 5821 | 0 = Never, 1 = Otherwise | 10.7% | | |
| Worker Self-Reported Emotional Health | | | | | |
| Sad | 5818 | 0 = Not at All, 1 = Otherwise | 23.9% | | |
| Crying | 5820 | 0 = Not at All, 1 = Otherwise | 15.4% | | |
| Hopeless | 5820 | 0 = Not at All, 1 = Otherwise | 10.8% | | |
| Restless | 5820 | 0 = Not at All, 1 = Otherwise | 9.2% | | |
| Fearful | 5819 | 0 = Not at All, 1 = Otherwise | 10.0% | | |
| Incentive Pay Type | | | | | |
| Quota | 5758 | 0 = No, 1 = Yes | 36.7% | | |
| Piece rate | 5687 | 0 = By the hour, 1 = Partial piece rate (1%-99%), 2 = All piece rate | 0 = 72.0% 1 = 8.1% 2 = 20.0% | | |
| Worker and Factory Variables | | | | | |
| Sex | 5823 | 0 = Male, 1 = Female | 81.4% | | |
| Age | 5819 | Continuous | 31.58 | 30.0 | 7.18 |
| Education | 5882 | 1 = Primary school or lower 2 = Lower secondary school 3 = Upper secondary school or higher | 1 = 12.4% 2 = 58.7% 3 = 28.9% | | |
| Marital status | 5823 | 0 = Not Married, 1 = Married | 58.0% | | |
| Sewer | 5816 | 0 = No, 1 = Yes | 49.9% | | |
| Tenure | 5821 | 0 = No, 1 = Yes | 78.7% | | |
| Hours worked | 5621 | Continuous | 90.13 | 94.17 | 25.57 |
| Usual pay | 5669 | Continuous | 3,511,652 | 3,500,000 | 3,217,357 |
| Current employees | 5030 | Continuous | 1544.59 | 984 | 1577.24 |
| Injury treatment | 5808 | 0 = No, 1 = Yes | 2.1% | | |
| Illness treatment | 5808 | 0 = No, 1 = Yes | 25.0% | | |
| OSH compliance | 6514 | 1 = Noncompliant, 0 = Otherwise | 0.14 | 0.13 | 0.09 |

Obs, number of observations; OSH, occupational safety and health; SD, standard deviation.

regressions are presented, as each worker can be observed at most once a year.

RESULTS

Table 1 summarizes the survey data, including self-reported physical and emotional health, demographic characteristics, and factory-level data and compensation information. The most commonly reported physical health ailments were headaches (58.3%), followed by backaches (36.9%) and dizziness (35.5%), while the lowest reported symptoms were thirst (14.1%) and hunger (10.7%). With respect to the emotional health indicators, feeling sad (23.9%) and crying (15.4%) were most commonly reported, while feeling restless (9.2%) was the lowest. Nearly 37% of surveyed workers reported that they faced a production quota (either daily or weekly), while 28% reported being paid at least in part by the piece (alternately, 72% of the sample represented hourly wage workers). The demographic data suggest a dominantly female workforce in their early thirties, working in a factory with on average 5000 other

workers. Over half of the population was married and educated through lower secondary school. Approximately half of the sample did sewing work, and most had worked at their present factory for at least a year. The Vietnamese garment workers in this sample worked an average of 90 hours per week, earning the equivalent of \$156 US per month or 40 cents an hour. Two percent of workers were reportedly treated at a medical facility for injuries in the past year, while a quarter had been treated for illnesses. The composite OSH compliance index shows a relatively high degree of compliance with OSH standards within the subset of factories with worker survey data, with an average of 14% noncompliance. Additional specifications also explore whether specific compliance points, such as those focused on ergonomic stressors and the availability of worker protective equipment, impact self-reported worker health outcomes.

Physical Health. Table 2 describes the results of the analyses linking physical health to piece rate pay, while similar estimates for quotas are presented in Supplementary Table 3. The presence of wage

Table 2. Worker Self-Reported Physical Health by Piece Rate

| | Fatigue | Headache | Stomach | Dizzy | Backache | Thirst | Hunger |
|--|----------------------|----------------------|----------------------------------|----------------------|----------------------|----------------------|----------------------|
| Hourly pay (reference group) | | | | | | | |
| Partial piece rate | 0.39* | 0.55* | 0.32 [†] | 0.43* | 0.45* | 0.59* | 0.60* |
| All piece rate | 0.05 | -0.07 | -0.10 | 0.13 | 0.03 | -0.05 | 0.01 |
| Sex | 0.55* | 0.81* | 0.15 | 0.91* | 0.03 | -0.01 | 0.05 |
| Age | -0.01 | -0.001 | 0.0001 | -0.01 [†] | 0.01 | 0.01 | -0.03* |
| Education 2 | -0.10 | 0.03 | -0.05 | 0.05 | 0.13 | -0.11 | -0.35 [†] |
| Education 3 | 0.14 | 0.25 [†] | 0.09 | 0.18 | 0.40* | -0.09 | -0.07 |
| Marital status | -0.10 | -0.19* | -0.16 [†] | -0.04 | -0.02 | -0.37* | -0.14 |
| Sewer | -0.06 | -0.03 | 0.02 | -0.04 | 0.16 [†] | -0.001 | -0.08 |
| Tenure | 0.02 | 0.05 | 0.15 | 0.08 | 0.20 [†] | 0.07 | 0.09 |
| Hours worked | -0.002 | -0.001 | -0.001 | -0.003 [†] | -0.004* | -0.003 [‡] | -0.01* |
| Usual pay | 6.53e-09 | 5.38e-09 | 2.67e-08 [†] | 1.94e-08 | 1.64e-09 | 6.62e-09 | 5.18e-09 |
| Current employees | 0.0001 [†] | 0.0001 | 0.00002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 [‡] |
| Injury treatment | 0.278 | 0.42 [†] | 0.51 [†] | 0.19 | 0.65* | 0.51 [†] | 0.58* |
| Illness treatment | 0.65* | 0.53* | 0.36* | 0.38* | 0.36* | 0.03 | 0.34* |
| OSH compliance | -0.08 | 0.03 | -0.03 | -0.04 | 0.50 | -0.95 | 1.07 |
| Constant | -1.19* | -0.26 | -1.37* | -0.89* | -1.21* | -1.10* | -0.53 |
| # Obs | 4611 | 4611 | 4611 | 4611 | 4610 | 4611 | 4610 |
| # Factories | 109 | 109 | 109 | 109 | 109 | 109 | 109 |
| Estimated odds ratio | | | | | | | |
| Partial piece rate | 1.47 (1.14-1.90)* | 1.73 (1.33-2.26)* | 1.38 (1.08-1.78) [†] | 1.54 (1.20-1.98)* | 1.57 (1.23-2.00)* | 1.80 (1.34-2.42)* | 1.81 (1.31-2.50)* |
| All piece rate | 1.05 (0.85-1.30) | 0.93 (0.77-1.13) | 0.91 (0.74-1.11) | 1.14 (0.93-1.39) | 1.03 (0.85-1.25) | 0.95 (0.73-1.25) | 1.01 (0.75-1.38) |
| All random effects logit models control for year and factory. Abbreviations as in Table 1. | | | | | | | |
| * P < 0.01. | | | | | | | |
| † P < 0.05. | | | | | | | |
| ‡ P < 0.10. | | | | | | | |

incentives was consistently and significantly associated with an increase in self-reported physical health symptoms. In other words, workers paid under a quota or piece rate system were more likely to report poor health than workers paid by the hour. With respect to the piece rate, workers under a partial piece rate system appear to be worse off than those working either 100% hourly wages or 100% by the piece. The conditional odds of a partial piece rate worker self-reporting physical symptoms were between 1.38 and 1.81 times that of workers under set hourly wages. The results are similar for workers under a production quota, with increased conditional odds of reporting physical health symptoms between 1.43 and 1.98 times the hourly-wage worker.

With respect to the other variables in the model, being older and married were associated with better self-reported health, while being female increased the likelihood of reporting poor physical health symptoms. A greater number of hours worked was significantly associated with better physical health, possibly due to a healthy worker effect. Not surprisingly, visiting a health facility for injury or illness

was significantly associated with increased self-reporting of poor physical health. Factory compliance with existing occupational safety and health regulations was not a statistically significant predictor of self-reported physical health symptoms, nor were specifications testing compliance separately by compliance point. The results of the alternative specifications by year (Supplementary Table 4) showed similar trends across the physical health indicators. However, the reduced sample sizes and lack of substantial variability within a given year for some of the categorical variables made interpreting the separate annual regressions problematic, with comparatively large confidence intervals and less statistically significant effects for the wage variables. Despite these data issues, the presence of a production quota remained statistically significant in over 70% of the annual regressions, with odds ratios ranging from 1.40 to 2.69. The trends were similar for the partial piece rate although notably less statistically significant (only 40%), with odds ratios ranging from 1.65 to 4.18 compared to hourly workers.

Table 3. Worker Self-Reported Emotional Health by Piece Rate

| | Sad | Crying | Hopeless | Restless | Fearful |
|--|----------------------|----------------------|----------------------------------|----------------------------------|---------------------|
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 0.33* | 0.33* | 0.45 [†] | 0.21 | 0.04 |
| All piece rate | -0.14 | -0.09 | -0.22 | -0.35 [‡] | -0.22 |
| Sex | 0.37 [†] | 1.78 [†] | 0.25 [‡] | 0.36* | 0.44 [†] |
| Age | -0.01 | -0.04 [†] | -0.01 | 0.01 | -0.01 |
| Education 2 | -0.09 | 0.01 | -0.29 [‡] | -0.20 | -0.22 |
| Education 3 | 0.26* | 0.32* | 0.08 | 0.24 | 0.22 |
| Marital status | -0.17 | -0.14 | -0.52 [†] | -0.37 [†] | -0.22 [†] |
| Sewer | -0.07 | -0.11 | -0.25 [†] | -0.13 | -0.11 |
| Tenure | -0.20* | 0.05 | -0.12 | -0.10 | 0.06 |
| Hours worked | -0.001 | -0.002 | -0.001 | -0.0001 | 0.0005 |
| Usual pay | 1.92e-08 | 5.61e-09 | -8.83e-09 | 8.00e-09 | 9.64e-10 |
| Current employees | 0.0001 [†] | 0.0001 [‡] | 0.0001 | 0.0001 | 0.00004 |
| Injury treatment | 0.25 | 0.32 | 0.24 | 0.65* | 0.50 [†] |
| Illness treatment | 0.27 [†] | 0.14 | 0.06 | 0.04 | 0.05 |
| OSH compliance | 0.78 | 0.31 | 0.65 | 1.41 | 0.26 |
| Constant | -1.61 [†] | -2.16 [†] | -1.44 [†] | -2.82 [†] | -2.10 [†] |
| # Obs | 4,609 | 4,610 | 4,610 | 4,610 | 4,610 |
| # Factories | 109 | 109 | 109 | 109 | 109 |
| Estimated odds ratio | | | | | |
| Partial piece rate | 1.39 (1.06-1.82)* | 1.39 (1.02-1.89)* | 1.56 (1.11-2.19) [†] | 1.23 (0.85-1.77) | 1.04 (0.72-1.52) |
| All piece rate | 0.87 (0.69-1.11) | 0.92 (0.70-1.20) | 0.81 (0.58-1.13) | 0.71 (0.50-1.01) [‡] | 0.80 (0.57-1.13) |
| All random effects logit models control for year and factory. Abbreviations as in Table 1. | | | | | |
| * $P < 0.05$. | | | | | |
| † $P < 0.01$. | | | | | |
| ‡ $P < 0.10$. | | | | | |

Emotional Health. Table 3 describes the results of analyses linking emotional health to piece rate pay, with quota results presented separately in Supplementary Table 5. Similar to the results for physical health, the presence of wage incentives was associated with lower self-reported emotional health compared to workers paid by the hour. Additionally, workers compensated under partial piece rate systems again appeared to be worse off than workers on either hourly wages or all piece rate systems. The conditional odds of a partial piece rate worker self-reporting emotional symptoms were between 1.39 and 1.56 times that of workers under set hourly wages. The results are similar for workers under a production quota, with increased conditional odds of reporting emotional health symptoms between 1.43 and 1.98 times the hourly-wage worker.

Older married workers were associated with better self-reported emotional health, while being female was predictive of elevated emotional health symptoms. Although the number of hours worked was no longer significant, greater tenure on the job was suggestive of better reported emotional health, again potentially indicative of a healthy worker effect. Sewers (compared to other job groups) reported fewer emotional health symptoms, while the size of the factory and recent visits to medical facilities for illnesses and injuries were related to a worsening of reported emotional health symptoms. Again, factory compliance with existing occupational safety and health regulations was not statistically significant at conventional levels, nor were specifications testing compliance separately by compliance point. Similar to the data issues described in the previous section, the logit results by year (Supplementary Table 6) provided generally confirmatory evidence to support a relationship between wage structure and emotional health despite fewer statistically significant effects overall. Where statistically significant relationships were detectable, the odds ratios ranged from 1.80 to 2.46 for partial pay by the piece and 1.78 to 3.56 for quota.

DISCUSSION

The results suggest that wage incentives such as quota and piece rate pay impact a worker's sense of their own physical and emotional health. In other words, workers paid by the piece or subject to a production quota report worse physical and emotional health than workers paid by the hour. Wage incentives provide the most consistently significant evidence of all the demographic and factory-level variables in these models, including the factory's own

performance on occupational safety and health compliance measures. Interestingly, the driving force behind the piece rate is not a full piece rate system; rather, it is those that pay some combination of by the piece and hourly. It is possible that increased wage uncertainty related to partial pay systems is driving this relationship, although the specific mechanism behind such an effect is unclear. One possible explanation is that a partial piece rate system sets the stage for other health-compromising conditions in these factories, such as worker abuse. Previous research has linked sexual harassment to the piece rate, suggesting that supervisors responsible for output reporting may extract some portion of the production bonus or piece rate incentive from workers in the form of sexual favors.^{15,16} A partial piece rate system may inadvertently provide additional leverage for supervisors to extract such favors, which may ultimately impact worker health outcomes. Understanding the role of various intensities of the piece rate system on worker health is an important area of future research.

Overall, the connection between piece rate and worker health makes intuitive sense, as financial incentives that speed the pace of work may also result in less worker investment in safety precautions, particularly those that slow the pace of work. Research suggests that the piece rate leads workers to shirk on health-promoting activities such as machine safety maintenance, work breaks, and medical visits that would otherwise reduce job injury and accident risks.² Subsequent studies have shown an elevated accident and injury risk of piece rate pay in a number of industries,¹⁷⁻¹⁹ and cross-industry analyses in Europe²⁰ and the United States²¹ provide additional support for the negative effect of piece rate on occupational health. Increased medical symptoms have also been observed among piece rate workers, including lower levels of self-reported health,⁴ body mass index,⁵ absenteeism,⁶ higher levels of depression and somatic complaints,⁷ elevated heart rate,⁸ and medication usage.⁹

Understanding the Business Case for Piece Rate Pay. While the piece rate is generally understood as an effective means of boosting worker performance,²²⁻²⁵ the effect on profits (which balance both revenues and costs) is less straightforward.^{26,27} Recent evidence suggests that gains in productivity may be offset by maladaptive worker behaviors (including those detrimental to health) that ultimately increase operating costs and lower profits.²¹ Based on the existing research, it is unclear whether there remains a modern-day business case

for piece rate pay in occupationally hazardous industries. This is particularly true in the developing world, where a culture of abuse can notably lessen a worker's sense of control over their own output, which could weaken or even reverse the standard productivity boost observed under a piece rate system.²⁴ Research conducted in a US shoe-manufacturing plant described a positive shift in profits after moving from piece rate to hourly pay, despite a decline in worker productivity.²⁷ There are no similar studies of the effect of removing the piece rate in developing-world low-wage sectors, although the underlying rationale to support such a shift may be stronger. Understanding the business case for piece rate pay in the developing world represents an important area of future research.

Complicating this question is the fact that the scope of piece rate pay in the developing world is largely unknown, and there is limited data available to explore this issue on a global scale. However, information on pay structure for sewers in a sample of Better Work countries (Table 4) suggests that the impact of piece rate may be country-specific, from a majority of sewers paid by the piece in Haiti and Nicaragua to a majority of sewers paid by the hour in Indonesia and Jordan. The underlying reasons for the cross-country differences in the structure of sewer pay is unclear, and understanding these differences may provide important insight into improving working conditions globally in this sector.

Limitations. Although the dataset represents a rich source of worker-level information, covering more than 5000 workers at 109 Vietnamese garment factories during a five-year period, it was impossible to control for potential bias related to repeat surveys of workers in the full model. While the annual regressions singled out repeat workers and provided additional supportive evidence of a relationship between wage and worker health, small sample data issues resulted in less statistically significant trends once these effects were isolated by year. Also, although information was available on compliance with occupational standards as well as worker-

Table 4. Compensation Systems for Sewers in Better Work Garment Factories

| | Haiti | Indonesia | Jordan | Nicaragua |
|-----------------------------|-------|-----------|--------|-----------|
| Hourly pay | 10.0% | 72.3% | 71.7% | 30.7% |
| Partial piece rate (1%-99%) | 16.5% | 25.9% | 28.3% | 44.8% |
| All piece rate | 73.5% | 1.8% | 0% | 24.5% |

reported medical visits for illness and injury, the survey did not collect systematic and detailed information on accidents and injuries within the factories. These data would have been useful to better understand the mechanism behind which performance-based pay impacts worker physical and emotional health outcomes.

CONCLUSION

This paper provides evidence linking performance-based pay to worker health effects, specifically self-reported measures of physical and emotional health. How workers were paid represented the most consistently significant predictor of worker health among all the demographic and factory-level variables in the model, including the factory's own performance on occupational safety and health standards. Future research is needed to explore the underlying mechanism involved in promoting ill health, particularly those related to partial piece rate systems. An important challenge remains to identify whether there is a modern-day business case to support piece rate pay in developing-world industries such as the garment sector.

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| Supplementary Table 1. Description of Survey Questions | |
|--|---|
| Survey Question | |
| Worker Self-Reported Physical Health* | |
| Fatigue | How often do you experience severe fatigue? |
| Headache | How often do you experience severe headache? |
| Stomach | How often do you experience severe stomach pain? |
| Dizzy | How often do you experience severe dizziness? |
| Backache | How often do you experience severe backache or muscle ache? |
| Thirst | How often do you experience severe thirst? |
| Hunger | How often do you experience severe hunger? |
| Worker Self-Reported Emotional Health† | |
| Sad | During the past month, including today, how much have you been bothered or troubled by feeling sad? |
| Crying | During the past month, including today, how much have you been bothered or troubled by crying easily? |
| Hopeless | During the past month, including today, how much have you been bothered or troubled by feeling hopeless about the future? |
| Restless | During the past month, including today, how much have you been bothered or troubled by feeling restless or unable to sit still? |
| Fearful | During the past month, including today, how much have you been bothered or troubled by feeling fearful? |
| Performance-Based Pay | |
| Piece rate | How is your pay determined? |
| Quota | Does your supervisor set a production target or quota for you? |
| Worker and Factory Variables | |
| Sex | What is your gender? |
| Age | What year were you born? |
| Education | What is your highest level of education? |
| Marital status | What is your current marital status? |
| Sewer | What is your job in the factory? Sewer? |
| Tenure | Have you been in this position for more than 1 year? |
| Hours worked | Total number of hours worked in a week |
| Monthly pay | In Vietnamese Dong, monthly estimates calculated based on reported typical paycheck |
| Current employees | Estimate of the current number of employees at the factory |
| Injury treatment | Have you visited a health facility in the past year for treatment of injury? |
| Illness treatment | Have you visited a health facility in the past year for treatment of illness? |
| OSH compliance | Average performance on all compliance questions related to occupational safety and health |
| OSH, occupational safety and health. | |
| * Responses specified as binary (0 = Never, 1 = Otherwise). | |
| † Responses specified as binary (0 = Not at All, 1 = Otherwise). | |

Supplementary Table 2. Data Collection and Reporting on Occupational Safety and Health at Subset of Factories with Worker Survey Data

| Compliance Points in OSH Cluster | % Noncompliance in Sample | Checklist Questions for Compliance Points |
|--|---------------------------|---|
| Chemicals and hazardous substances | 38% | -Does the employer provide adequate washing facilities and cleansing materials in the event of exposure to hazardous chemicals? |
| Health services and first aid | 19% | -Do female workers receive periodical gynecology health checks every 6 months? -Does the employer adequately protect pregnant or nursing workers against safety and health risks? -Does the employer comply with the law on HIV/AIDS Prevention and Control? -Does the workplace have sufficient onsite medical facilities and staff? -Has the employer ensured that there are a sufficient number of readily accessible first aid boxes/supplies in the workplace? |
| Management systems | 40% | -Does the employer conduct risk assessment? -Does the employer develop an OSH plan annually? -Does the employer develop the Document on Working Conditions and Environment? -Does the employer regularly inspect and maintain machines, equipment, buildings and stores? -Does the factory have an approved OSH feasibility study? -Has the employer performed an assessment of general occupational safety and health issues in the factory? |
| Welfare facilities | 36% | -Does the employer keep food samples for 24 hours? -Does the workplace have adequate accessible toilets? -Is the workplace clean and tidy? -Does the workplace have other legally required facilities? |
| Worker accommodation | <1% | -Does worker accommodation comply with legal minimum space requirements? -Does the accommodation provide each worker with at least 75 liters of safe water per day? -Does worker accommodation have adequate toilets, showers, sewage, and garbage disposal systems? -Is the accommodation adequately protected against heat, cold, or dampness? -Has the accommodation been built with noise-proof materials? -Is the accommodation adequately ventilated? -Does the accommodation have adequate cooking and storage facilities? -Does the accommodation have lighting of at least 50 lux? -Does the accommodation offer workers adequate privacy? -Is the accommodation protected against disease-carrying animals or insects? |
| Worker protection | 13% | -Are materials, tools, switches, and controls within easy reach of workers? -Are standing workers properly accommodated? -Are there appropriate safety warnings posted in the workplace? -Are there sufficient measures in place to avoid heavy lifting by workers? -Are workers effectively trained to use machines and equipment safely? -Do workers have suitable chairs? -Does the employer force workers to continue working when they have refused to work due to clear imminent and serious danger to their life or health? |
| Work environment | 8% | -Is the temperature in the workplace acceptable? -Is the workplace adequately lit? -Is the workplace adequately ventilated? |
| Average noncompliance across all questions | 14% | |

AIDS, acquired immune deficiency syndrome; HIV, human immunodeficiency virus; OSH, occupational safety and health.

| Supplement Table 3. Worker Self-Reported Physical Health by Quota | | | | | | | |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | Fatigue | Headache | Stomach | Dizzy | Backache | Thirst | Hunger |
| Quota | 0.37* | 0.35* | 0.36* | 0.43* | 0.55* | 0.41* | 0.68* |
| Sex | 0.51* | 0.78* | 0.13 | 0.90* | 0.01 | −0.03 | 0.01 |
| Age | −0.01 | −0.001 | −0.0003 | −0.01† | 0.01 | 0.01 | −0.03* |
| Education 2 | −0.09 | 0.03 | −0.05 | 0.06 | 0.12 | −0.12 | −0.35† |
| Education 3 | 0.11 | 0.23† | 0.05 | 0.16 | 0.35* | −0.13 | −0.14 |
| Marital status | −0.08 | −0.19* | −0.16† | −0.05 | 0.01 | −0.37* | −0.11 |
| Sewer | −0.11 | −0.06 | −0.04 | −0.10 | 0.08 | −0.06 | −0.17 |
| Tenure | 0.01 | 0.03 | 0.15 | 0.09 | 0.21† | 0.07 | 0.09 |
| Hours worked | −0.002‡ | −0.001 | −0.001 | −0.003‡ | −0.004* | −0.003‡ | −0.01* |
| Usual pay | 5.46e-09 | 5.48e-09 | 2.17e-08‡ | 1.55e-08 | −4.43e-09 | 5.59e-09 | −3.69e-09 |
| Current employees | 0.0001‡ | 0.0001 | 0.00002 | 0.0001 | 0.00004 | 0.0001 | 0.0001 |
| Injury treatment | 0.28 | 0.41‡ | 0.53† | 0.26 | 0.66* | 0.52‡ | 0.51‡ |
| Illness treatment | 0.61* | 0.50‡* | 0.36* | 0.35* | 0.34* | −0.01 | 0.32* |
| OSH compliance | −0.07 | −0.09 | 0.13 | −0.07 | 0.46 | −0.96 | 1.01 |
| Constant | −1.20* | −0.21 | −1.47* | −0.92* | −1.24* | −1.15† | −0.67 |
| # Obs | 4,670 | 4,670 | 4,670 | 4,670 | 4,670 | 4,670 | 4,669 |
| # Factories | 109 | 109 | 109 | 109 | 109 | 109 | 109 |
| Estimated odds ratio | | | | | | | |
| Quota | 1.44 | 1.43 | 1.43 | 1.54 | 1.73 | 1.51 | 1.98 |
| | (1.25-1.66)* | (1.24-1.63)† | (1.24-1.65)* | (1.34-1.76)† | (1.51-1.98)* | (1.26-1.80)* | (1.62-2.42)* |
| All random effects logit models control for year and factory. Obs, number of observations; OSH, occupational safety and health. | | | | | | | |
| * $P < 0.01$. | | | | | | | |
| † $P < 0.05$. | | | | | | | |
| ‡ $P < 0.10$. | | | | | | | |

Supplement Table 4. Reported Odds Ratios for Annual Regressions—Physical Health

| | Fatigue | Headache | Stomach | Dizzy | Backache | Thirst | Hunger |
|--|-----------------------|-----------------------|----------------------|-----------------------|----------------------|----------------------|----------------------|
| 2010 (Obs = 1062) | | | | | | | |
| Hourly pay (Reference group) | | | | | | | |
| Partial piece rate | 1.38 (0.87- 2.18) | 2.10 (1.23-3.59)* | 1.10 (0.69-1.77) | 1.73 (1.10-2.72)† | 1.48 (0.95-2.30)‡ | 1.48 (0.91-2.41) | 1.24 (0.71-2.18) |
| All piece rate | 0.97 (0.69-1.36) | 0.83 (0.60-1.13) | 0.76 (0.54-1.08) | 1.15 (0.84-1.57) | 0.72 (0.53-0.99)† | 0.75 (0.51-1.11) | 0.75 (0.47-1.19) |
| Quota | 1.84 (1.39-2.43)* | 1.50 (1.13-1.99)† | 1.56 (1.17-2.08)* | 2.03 (1.55-2.67)* | 2.58 (1.98-3.38)* | 1.68 (1.23-2.29)* | 2.49 (1.74-3.55)* |
| 2011 (Obs = 1023) | | | | | | | |
| Hourly pay (Reference group) | | | | | | | |
| Partial piece rate | 2.14 (1.35-3.40)* | 2.52 (1.43-4.45)* | 1.43 (0.89-2.30) | 1.65 (1.04-2.63)† | 1.88 (1.19-2.97)* | 1.24 (0.69-2.22) | 1.73 (0.95-3.15)‡ |
| All piece rate | 0.82 (0.55-1.24) | 0.72 (0.49-1.06)‡ | 0.96 (0.62-1.46) | 0.87 (0.58-1.30) | 0.90 (0.60-1.35) | 1.16 (0.69-1.94) | 0.70 (0.36-1.34) |
| Quota | 1.23 (0.93-1.61) | 1.52 (1.13-2.02)* | 1.04 (0.79-1.80) | 1.40 (1.06-1.38)† | 1.55 (1.18-2.04)* | 1.17 (0.81-1.69) | 1.32 (0.89-1.95) |
| 2012 (Obs = 1025) | | | | | | | |
| Hourly pay (Reference group) | | | | | | | |
| Partial piece rate | 1.37 (0.83-2.25) | 1.73 (1.06-2.84)† | 2.04 (1.25-3.33)* | 1.71 (1.07-2.75)† | 1.82 (1.13-2.92)† | 2.44 (1.38-4.30)* | 1.75 (0.89-3.41) |
| All piece rate | 0.98 (0.71-1.36) | 0.96 (0.72-1.29) | 1.05 (0.75-1.48) | 0.96 (0.70-1.32) | 0.92 (0.68-1.25) | 0.75 (0.47-1.21) | 1.00 (0.60-1.68) |
| Quota | 1.62 (1.21-2.16)* | 1.56 (1.19-2.05)* | 1.75 (1.30-2.36)* | 1.55 (1.18-2.05)* | 1.25 (0.95-1.64) | 2.69 (1.83-3.96)* | 2.20 (1.42-3.40)* |
| 2013 (Obs = 1263) | | | | | | | |
| Hourly pay (Reference group) | | | | | | | |
| Partial piece rate | 1.13 (0.65-1.96) | 1.20 (0.72-2.02) | 1.42 (0.84-2.41) | 1.05 (0.62-1.78) | 1.36 (0.82-2.24) | 1.86 (0.97-3.57)‡ | 2.20 (1.12-4.33)† |
| All piece rate | 0.93 (0.65-1.96) | 0.91 (0.67-1.24) | 0.99 (0.70-1.40) | 0.92 (0.66-1.29) | 1.20 (0.88-1.63) | 0.65 (0.37-1.15) | 0.82 (0.46-1.48) |
| Quota | 1.29 (0.98-1.70)‡ | 1.52 (1.19-1.95)* | 1.58 (1.20-2.08)* | 1.45 (1.12-1.89)* | 1.75 (1.36-2.24)* | 1.36 (0.92-2.00) | 1.89 (1.24-2.88)* |
| 2014 (Obs = 296) | | | | | | | |
| Hourly pay (Reference group) | | | | | | | |
| Partial piece rate | 3.16 (0.85-11.74)‡ | 3.83 (1.00-14.83)† | 1.23 (0.35-4.35) | 4.18 (1.28-13.62)† | 1.41 (0.46-4.33) | 2.91 (0.48-17.67) | 5.08 (0.57-45.27) |
| All piece rate | 1.05 (0.40-2.71) | 0.76 (0.40-1.44) | 0.36 (0.14-0.90)† | 0.75 (0.37-1.55) | 0.89 (0.45-1.76) | 1.83 (0.46-7.34) | 0.73 (0.07-8.19) |
| Quota | 2.27 (1.10-4.70)† | 1.06 (0.63-1.78) | 1.95 (1.04-3.67)† | 1.89 (1.09-3.30)† | 2.54 (1.47-4.39)* | 0.92 (0.33-2.56) | 3.36 (0.69-16.31) |
| Abbreviation as in Supplementary Table 3 . | | | | | | | |
| * $P < 0.01$ | | | | | | | |
| † $P < 0.05$ | | | | | | | |
| ‡ $P < 0.10$ | | | | | | | |

| Supplement Table 5. Worker Self-Reported Emotional Health by Quota | | | | | |
|---|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| | Sad | Crying | Hopeless | Restless | Fearful |
| Quota | 0.27 [*] | 0.16 [†] | 0.36 [*] | 0.37 [*] | 0.21 [†] |
| Sex | 0.41 [*] | 1.79 [*] | 0.22 | 0.39 [‡] | 0.48 [*] |
| Age | −0.01 | −0.04 [*] | −0.01 | 0.01 | −0.01 |
| Education 2 | −0.10 | 0.01 | −0.29 [‡] | −0.20 | −0.22 |
| Education 3 | 0.23 [†] | 0.30 [†] | 0.06 | 0.22 | 0.22 |
| Marital status | −0.17 [‡] | −0.13 | −0.48 [*] | −0.36 [*] | −0.22 [†] |
| Sewer | −0.12 | −0.13 | −0.32 [*] | −0.21 [†] | −0.20 [†] |
| Tenure | −0.19 [‡] | 0.07 | −0.13 | −0.10 | 0.03 |
| Hours worked | −0.002 | −0.002 | −0.001 | 8.81e-06 | 0.001 |
| Usual pay | 1.72e-08 | 7.74e-09 | −1.35e-08 | 1.94e-09 | −5.56e-09 |
| Current employees | 0.0002 [*] | 0.0001 [†] | 0.0001 | 0.0001 | 0.00004 |
| Injury treatment | 0.26 | 0.30 | 0.18 | 0.57 [†] | 0.41 |
| Illness treatment | 0.25 [*] | 0.15 | 0.05 | 0.02 | 0.03 |
| OSH compliance | 0.99 | 0.50 | 0.59 | 1.74 [†] | 0.33 |
| Constant | −1.73 [*] | −2.32 [*] | −1.48 [*] | −3.10 [*] | −2.21 [*] |
| # Obs | 4,667 | 4,668 | 4,668 | 4,668 | 4,668 |
| # Factories | 109 | 109 | 109 | 109 | 109 |
| Estimated odds ratio | | | | | |
| Quota | 1.31 (1.13-1.53) [*] | 1.17 (0.98-1.40) [†] | 1.43 (1.16-1.76) [*] | 1.45 (1.17-1.81) [*] | 1.24 (1.00-1.53) [†] |

All random effects logit models control for year and factory. Abbreviations as in [Supplementary Table 3](#).
^{*} $P < 0.01$.
[†] $P < 0.10$.
[‡] $P < 0.05$.

Supplement Table 6. Reported Odds Ratios for Annual Regressions—Emotional Health

| | Sad | Crying | Hopeless | Restless | Fearful |
|--|----------------------|----------------------|----------------------|----------------------|----------------------|
| 2010 (Obs = 1060) | | | | | |
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 2.46 (1.56-3.89)* | 2.18 (1.29-3.67)* | 2.28 (1.37-3.79)* | 1.80 (1.01-3.22)† | 1.40 (0.79-2.49) |
| All piece rate | 0.62 (0.42-0.92)† | 0.89 (0.57-1.41) | 0.52 (0.31-0.86)† | 0.72 (0.43-1.22) | 0.68 (0.42-1.12) |
| Quota | 2.50 (1.85-3.38)* | 2.43 (1.71-3.46)* | 2.47 (1.74-3.52)* | 3.56 (2.37-5.32)* | 2.19 (1.51-3.17)† |
| 2011 (Obs = 1004) | | | | | |
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 1.38 (0.86-2.22) | 1.17 (0.69-2.00) | 1.78 (0.97-3.30)‡ | 1.57 (0.84-2.93) | 1.59 (0.85-2.97) |
| All piece rate | 0.48 (0.29-0.80)† | 0.49 (0.27-0.87)† | 0.24 (0.09-0.69)* | 0.78 (0.41-1.50) | 0.66 (0.33-1.33) |
| Quota | 1.78 (1.33-2.39)* | 1.34 (0.96-1.86)‡ | 1.10 (0.72-1.68) | 0.96 (0.64-1.44) | 0.87 (0.57-1.34) |
| 2012 (Obs = 1015) | | | | | |
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 1.10 (0.64-1.89) | 1.56 (0.85-2.89) | 0.97 (0.46-2.05) | 0.54 (0.20-1.42) | 1.17 (0.55-2.53) |
| All piece rate | 0.83 (0.58-1.19) | 0.97 (0.62-1.51) | 0.71 (0.42-1.20) | 0.52 (0.29-0.96)† | 1.00 (0.59-1.70) |
| Quota | 1.13 (0.83-1.55) | 1.31 (0.90-1.92) | 1.84 (1.18-2.86)* | 2.01 (1.24-3.25)* | 2.04 (1.29-3.22)* |
| 2013 (Obs = 1253) | | | | | |
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 1.42 (0.81-2.48) | 1.04 (0.52-2.11) | 0.57 (0.20-1.66) | 1.14 (0.47-2.82) | 0.39 (0.12-1.30) |
| All piece rate | 1.22 (0.84-1.76) | 0.93 (0.57-1.51) | 0.83 (0.46-1.53) | 0.37 (0.16-0.89)† | 0.36 (0.17-0.78)* |
| Quota | 0.88 (0.65-1.19) | 0.69 (0.48-1.01)‡ | 0.75 (0.47-1.21) | 0.64 (0.38-1.10) | 0.79 (0.50-1.27) |
| 2014 (Obs = 292) | | | | | |
| Hourly pay (Reference group) | | | | | |
| Partial piece rate | 1.11 (0.27-4.52) | 0.84 (0.11-6.28) | 1.81 (0.39-8.34) | 2.38 (0.60-9.45) | 1.09 (0.19-6.40) |
| All piece rate | 0.20 (0.06-0.72)† | 1.06 (0.36-3.12) | 0.30 (0.06-1.51) | 0.30 (0.06-1.41) | 0.34 (0.07-1.76) |
| Quota | 0.83 (0.42-1.65) | 0.82 (0.37-1.84) | 1.72 (0.70-4.23) | 0.88 (0.38-2.04) | 0.70 (0.27-1.80) |
| Abbreviation as in Supplementary Table 3 . | | | | | |
| * $P < 0.01$ | | | | | |
| † $P < 0.05$ | | | | | |
| ‡ $P < 0.10$ | | | | | |