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EFFECTS OF A GROUP PERFORMANCE-BASED INCENTIVE SCHEME ON LABOR PRODUCTIVITY, PRODUCT QUALITY, AND ORGANIZATIONAL PERFORMANCE

by

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DEDICATION

This dissertation is dedicated to:

Lillian Farre

and

Ing. Jose Alberto Saralegui Quijada
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ABSTRACT

This study uses a field method to examine the effects of a group compensation plan on labor productivity, product quality, and organizational performance, in three independent subunits of the same manufacturing plant. More specifically, the study investigates whether the use of two budget-based incentives, a group output-target based scheme and a gain-sharing scheme offered in combination, motivates production teams to improve economic performance in this manufacturing setting. The output-target based scheme is a linear budget-based incentive that rewards individual team performance, providing a cash bonus when quantity meets or exceeds a target and a low (penalty) wage when quantity or product quality falls short of a target. The gain-sharing scheme (also a budget-based scheme) rewards production teams for achieving plant-level quarterly targets for labor productivity and product quality.

After controlling for numerous factors that influence labor productivity and product quality in a multivariate regression model, I find that the combination of incentives schemes is associated with improvements in performance. Labor productivity increases by sixty eight percent and the defects rate decreases by ninety five percent following implementation of the incentive scheme. I also found a reduction in absenteeism and turnover, as well as improvements in the percentage of work orders completed on schedule.

Although I cannot attribute the observed performance improvements to a specific scheme, nor discern whether the improvements are causally linked in some proportion to
greater worker effort, improved peer monitoring, improved team cooperation, or better strategy development (i.e., worker learning); the empirical results of the study suggest that team (and group) performance is enhanced through the use of standard-based incentives contracts. Moreover, the results suggest that both schemes offered jointly with mechanisms to prevent free-riding and promote worker learning (timely performance feedback) create synergies in this particular setting that motivate production teams to improve performance. These findings suggest that this combination is effective in motivating group effort, promoting cooperation, and encouraging peer monitoring within and across production teams. All these factors leading to improvements of the firm’s economic performance.
CHAPTER 1
INTRODUCTION

1.1 OVERVIEW AND PURPOSE OF INVESTIGATION

This study investigates the effects of a group compensation plan on labor productivity, product quality, and manufacturing performance. More specifically, the study employs a field method to consider whether the use of two entirely distinct budget-based compensation schemes, a group output-target incentive and a gain-sharing scheme, offered in combination as part of a group performance-based compensation contract, motivates production teams to improve economic performance in a manufacturing setting. The output-target is a linear budget-based incentive that rewards individual team performance for achieving output and quality targets. The gain-sharing scheme is also a budget-based scheme but rewards production teams' aggregate performance for achieving plant-level quarterly targets on productivity and quality.

When designing team-based rewards systems two germane issues should be reconciled. First, the use of group incentives can result in free-riding, so incentives should mitigate moral hazard (i.e., minimize shirking).\(^1\) Furthermore, group incentives should entice cooperation among team members and across production teams. The

\(^1\) In the context of principal-agent theory, a moral hazard problem arises when an owner (principal) cannot observe the actions (i.e., effort) of work-averse employees (agents), thus the principal designs a compensation contract to reward the agents' performance on imperfect surrogates of behavior (Baiman, 1982). Alternatively, moral hazard refers to the problem of inducing agents to supply proper amounts of productive inputs (labor) when their actions cannot be perfectly observed. Moral hazard may also be referred as ex-post employment contract agent's opportunism in the context of a principal-agent relationship.
theoretical contracting literature suggests that the use of an output-target (or budget) based scheme can mitigate free-riding and improve efficiency in a team production setting (Holmstrom, 1982). The use of budget-based contracts has also been suggested as a remedy for the inherent conflict of interests between firms and employees in an agency relationship (i.e., mitigate agency problems related to adverse selection and moral hazard)² (Baiman, 1982, 1990; Demski and Feltham, 1978). Further, studies in organizational behavior suggest that the use of gain-sharing incentives schemes also alleviates agency problems in multi-agent settings. It is argued that gain-sharing contracts encourage workers to monitor each other’s performance, thus reducing monitoring expenses otherwise incurred by the principal. Internal monitoring both within a work team and between work teams should increase as a result of gain-sharing implementation (Welbourne and Gomez-Mejia, 1995), reducing agency costs and minimizing the residual loss to the firm. Also, the organizational behavior literature suggests that gain-sharing schemes promote team cooperation and enhance firm’s performance (Schuster, 1983; White, 1977).

This research study brings together ideas from economics and psychology as a basis for predicting the effects of a group performance-based incentive scheme intended to achieve enhanced manufacturing performance by means of greater team effort, improved team-cooperation, and mechanisms put in place to facilitate worker learning and to

² As previously defined (refer to footnote 1), moral hazard is an agency problem that arises because the principal (i.e., owners, managers) cannot observed the actions (i.e., effort levels) of agents (workers). Adverse selection is the other class of agency problem that arises when employees have private information (i.e., their skilled level) that is of value to the firm, yet they use this information to increase their welfare at the expense of the firm’s welfare (Baiman, 1982). This problem has also been referred as pre-contract agent’s opportunism or a problem of “hidden information” within the context of agency theory.
encourage peer monitoring across teams. The study does not aim to test the optimality of the incentive scheme or make a direct test of the predictions of agency theory. Instead the focus of the study is to examine whether the group incentive scheme introduced at the research site is associated with improvements in economic performance, making an inference that if improvements in the firm’s performance are realized, then the incentive scheme aids in mitigating agency problems (i.e., free-riding) and in improving efficiency in this team production setting relative to the firm’s previous incentive contract which relied primarily on group piece-rates to motivate team effort. The investigation aims to provide empirical support in addressing the following research questions: (1) Is the group compensation plan associated with improvements in labor productivity and product quality, as well as improvements in material waste, manufacturing cycle time efficiency, worker absenteeism, and turnover? (2) Do improvements in productivity and quality persist over time or do these level-off after the initial stages of the scheme’s implementation period? (3) Is the group incentive plan cost effective?

1.2 INCENTIVE PROBLEMS IN MULTI-AGENT (TEAM) SETTINGS

As changes in technology prompt firms to re-organize their operations to emphasize teamwork rather than individualistic performance, the design of incentive schemes becomes more complex. A well-known economic problem in team production is that

---

1 As firms attempt to integrate advanced manufacturing practices (i.e. TQM, JIT, process re-engineering, TOC, balanced scorecard, flexible manufacturing), they increasingly rely upon production teams or production cells in their work operations. Firms are rediscovering production teams as an effective tool to promote spontaneous cooperation and foster interactive participation throughout their workforce (Banker, Field, Schroeder, Sinha, 1996; Hackman, 1991; Safizadeh, 1991; Young, Fisher, and Lindquist, 1993; Wageman, 1997).
each worker’s contribution to aggregate performance may be costly or impossible to measure (Alchian and Demsetz, 1972; Demski and Sappington, 1984). Assuming that workers are effort-averse, how can firms motivate team members to provide the proper inputs to the team production process? One alternative is the classical arrangement in which the team monitor is the sole residual claimant. However, this approach may be unsatisfactory at the lower levels of a large, decentralized firm. Production supervisors rarely have property rights to the residual produced in their subunit. A second alternative is to reward workers on the basis of their observable input (e.g. pieces rates for component parts). This approach may also be unsatisfactory, because individual incentives are unlikely to induce the necessary degree of cooperation for team effectiveness. A third alternative is the use of group incentives in which each worker shares in the team’s aggregate performance. A potential problem with this approach is free-riding on the inputs of others, absent some intra-team mechanism for disciplining shirkers.

The theoretical contracting literature has devised a number of possible solutions to the team incentive problem such as the use of implicit incentives systems, including mutual monitoring (Arya et al., 1997; Ma et al., 1988; Varian, 1990), peer pressure (Kandel and Lazear, 1992), and peer evaluations (Arya and Glover, 1996a; Ma, 1988). Alternatively, analytical models of agency also propose the use of explicit (performance-contingent) incentives to reduce moral hazard in team-settings. In particular, Holmstrom (1982) proposes the use of a target-based incentive scheme (i.e., a standard or budget-based contract) as an effective solution to the shirking dilemma in team production
settings. The scheme remunerates team members equally if the output target is achieved, otherwise pays a relatively low (penalty) wage when output falls short of a target. This class of incentive contracts satisfies the theoretical conditions to achieve Pareto-optimal effort levels as Nash equilibria, and, as such, should motivate higher individual and collective effort; thus reducing moral hazard problems and restoring economic efficiency in team production-settings. However, this theoretical prediction lacks empirical testing in a natural setting and little is known about the effects of this class of incentive schemes on group productivity. Whether the scheme motivates production teams to exert greater levels of effort remains an open empirical question.

Recall that cooperation is the other underlying issue that should be considered when designing group rewards systems. Group incentives should encourage a high degree of cooperation across production teams. The organizational behavioral literature suggests that gain-sharing plans accomplish the cooperation level that is desired in a team environment and also encourage stronger levels of peer pressure and group monitoring. This argument is based on the premise that by linking financial rewards for workers to the achievement of performance standards of the entire production unit (i.e., plant,

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4 The output-target scheme is analogous to the class of standard or budget-based contracts studied in the incentive-contracting literature in accounting (Demsik and Feltham, 1978). Under budget-based contracts, only group output that meets or exceeds the pre-specified target is rewarded. If the team output is below the target, then workers receive a low (penalty) wage. The discontinuity of the scheme can change the marginal benefit to working. In particular, Holmstrom's model is based on the theoretical framework of agency theory. The model assumes a case of certainty and agents' risk-neutrality. The scheme may also be effective under uncertainty, but its effectiveness will be limited if there are many agents and if the agents are risk-averse. He introduces mutual monitoring as an important instrument to remedy moral hazard (i.e., free-riding) in the case of uncertainty. For an in-depth explanation about the functioning of this compensation scheme in mitigating moral hazard refer to chapter 4 (hypotheses development).

5 It should be noted that the effects of standard-based incentives contracts on individual productivity has been studied in experimental studies (Chow, 1983; Chow et al., 1988; Waller and Chow, 1985) and field-studies (Merchant and Manzoni, 1989) in the accounting literature.
division), workers (and production teams) would be motivated to ratchet-up their effort levels, cooperate within each other, and monitor each other’s behavior to assure that workers are attaining the goals of the work group, in order to realize higher rewards (Schuster, 1983; White, 1977; Welbourne and Gomez-Mejia, 1995; Welbourne, Balkin, and Gomez-Mejia, 1995).

This investigation attempts to provide empirical support to all of the above conjectures by testing whether the combination of a group output-target and a gainsharing scheme is associated with improvements in manufacturing performance.

1.3 RESEARCH SETTING AND METHODS SUMMARY

The investigation takes place in a manufacturing facility. This firm restructuring its compensation plan to introduce both incentives (the output-target scheme and the gain-sharing schemes) to replace group piece-rates and an individual attendance bonus. The output-target scheme is a linear-standard (or budget) based incentive that includes a bonus when production quantity reaches (or exceeds) a set target, and a penalty when production quality falls short of a target. The gain-sharing scheme, also a standard-based scheme, rewards production teams for meeting quarterly plant goals on productivity and quality.

To assess the incentive scheme’s impact on the firm’s performance, and to provide support for the various hypotheses, I use an interrupted longitudinal time-series design. I control for general and firm-specific factors influencing productivity and quality using a series of multivariate regression models to isolate the performance impact of the
incentive scheme. I analyze changes in performance of the three production subunits that comprise the research setting (i.e., manufacturing plant), following the implementation of the group incentive plan.

1.4 SUMMARY OF RESEARCH FINDINGS

Econometric analysis using pooled and cross-sectional time-series data for the three production subunits provides empirical support for the various hypotheses. These results indicate that manufacturing performance improves following the introduction of the group compensation plan, suggesting that team performance is enhanced through the use of an output-target and a gain-sharing scheme.

Specifically, plant-wide average labor productivity increased by 68% and the finished goods defects rate decreased by 95% following the introduction of the group incentive plan. Improvements in productivity and quality are also observed uniformly across the three production subunits. Furthermore, productivity and quality gains persist over time, indicating that the results are not potentially driven by a Hawthorne (or placebo) effect. Additionally, the plant experienced an average reduction in material waste of 44%, and a modest improvement of 7% in the rate of production work orders completed on schedule (on-time delivery), following the implementation of the incentive scheme. While neither the output-target scheme nor the gain-sharing scheme rewards production teams for achieving performance improvements in these metrics, the statistical analyses suggest that these gains are driven in part by the improvements in labor productivity.
Additionally, tests to assess the impact of the scheme on non-economic aspects of performance reveal a reduction in the rates of worker absenteeism and turnover for the plant. Absenteeism and turnover decreased by an average of 47% and 67% respectively, following the introduction of the incentives.

While I cannot attribute the observed improvements in performance to a specific incentive scheme, I am also unable to ascertain whether the improvements are driven by increased effort, improved peer monitoring, a framing-effect (i.e., whether the incentive is interpreted as a gain or as a loss by production workers), the attraction of more productive or skilled workers (i.e., a selection effect), greater team-cooperation, or improved worker learning (through the mechanisms put in place by management to facilitate learning and strategy development). The results suggest that team performance is enhanced through the use of standard-based incentives and provide (indirect) support for the theoretical conjecture that the use of an output-target based scheme aids in promoting efficiency in team settings by motivating effort and reducing moral hazard (Holmstrom, 1982). Further, the results also provide indirect support of how the use of gain-sharing incentives contracts may also be an effective incentive mechanism to encourage peer monitoring within and between work teams thus reducing monitoring costs for the principal (Welbourne and Gomez-Mejia, 1995; Welbourne, Balkin, and Gomez-Mejia, 1995), as well as in enhancing participation and cooperation across
production teams (Gomez-Mejia and Balkin, 1992; Schuster, 1983). All these factors leading to improvements of the firm’s economic performance.

Results from the various statistical tests performed to measure the cost effectiveness of the group incentive scheme suggest that while total labor production costs (direct labor costs plus the incentives) have increased after the implementation of both incentives, the effects of labor costs after adjusting for fluctuations in production volume are mixed. For instance, the direct labor cost per standard hour of output decreases after the scheme’s implementation, but direct labor cost per unit of output rises after implementation; thus providing mixed evidence of whether the scheme is cost effective. Finally, there is no significant difference in the amount of compensation that each worker earned before and after implementation.

1.5 IMPORTANCE OF RESEARCH ISSUE TO PRACTICE

The design of effective rewards systems is of special importance for firms as they attempt to improve their contracting relationship with workers. The use of group incentives schemes (i.e., employee stock ownership plans, gain-sharing and profit sharing), are on the rise and firms are searching for effective pay systems to motivate workers to raise productivity in a team environment (Blinder, 1990, 1999).

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6 It is impossible to directly test whether the output-target scheme mitigates free riding in a team setting as proposed by the analytical literature. Furthermore, it is impossible to specifically identify whether improvements in performance were caused by greater collective effort, greater peer monitoring, or improved cooperation across production teams. I use longitudinal data ex-post the fact, and, more importantly, all of these factors are latent (unobservable) variable constructs for which no empirical measures exist. Several surrogate measures of performance (i.e., productivity, quality, etc.) are used as proxies for the latent constructs. Instead, the results suggest (through indirect evidence) that if manufacturing performance improves ex-post, then the group incentive schemes motivate production teams to enhance team performance by means of the latent constructs describe above.
However, in spite of the popularity and importance of group incentives, the design of group-based rewards continues to be problematic for many firms as they face the challenge of finding the best way to measure and reward performance in a team-based environment. There is little guidance available to firms regarding the development of group-based incentives (DeMatteo et al., 1998). For instance, the popular business press reports anecdotal evidence of firms that experienced a significant drop in labor productivity and output after switching from output-based individual incentives (i.e., piece-rates) to group performance-based incentives (Fortune 1994, The WSJ, May 20, 1998, The NY Times, October 13, 1994).^7

Hence, while I do not test whether the implemented incentive scheme is optimal, the empirical findings should assist firms as they seek guidance in the design of effective group reward systems especially for those firms planning to adopt standard-based incentives systems in their compensation plans. The results shown here support the conjecture that budget-based schemes, when used in team-settings, may be effective in motivating team effort when implemented in combination with mechanisms to provide teams' performance feedback with frequency in order to encourage mutual monitoring and to facilitate worker learning. Thus, these findings have implications for the design of group rewards systems.

^7 Specifically, Levi Corp. changed its compensation system by switching from individual piece-rates to group piece-rates. Anecdotal evidence at this firm suggests a significant drop in worker productivity and output and a rise in labor costs after switching to group piece-rates. Moreover, descriptive evidence from these firms reveals lower compensation among the top performers under the individual performance-based incentives, and greater compensation for low performers after they were remunerated based on the group’s output. This same effect was documented in a field study that measures the effects of a change in compensation plan from an individual performance-based incentive to a group-based performance incentive (Hansen, 1997).
1.6 CONTRIBUTION TO ACCOUNTING RESEARCH

This study contributes to the accounting literature in several ways. While the incentive contracting literature has devoted significant effort in examining the effects of performance-based incentives on individual productivity (Banker et al. 1996, 2001; Chow, 1983, Chow et al. 1988; Waller and Chow, 1985), accounting studies examining the impact of group-based incentives on group productivity and performance have been scant and limited to a few experimental studies (Young et al., 1993; Drake et al., 1998, Towry, 2001). The effects of group-based incentives on group performance and productivity represents a largely unexplored area of research in the incentive-contracting literature in accounting (Sprinkle, 2003; Young and Lewis, 1995). This study contributes to the relatively undeveloped literature examining the effects of incentives in team settings. The study also contributes to the stream of research that examines how the use of budget-based compensation contracts, containing an explicit link between pay and performance aid in reducing agency problems (Bailey et al. 1998; Chow, 1983; Waller and Chow, 1985). In addition, prior research examining the effects of performance-contingent incentives on worker productivity has been conducted in contrived settings under imperfect conditions with strict assumptions (i.e., subjects perform a simple one dimensional task in a single period), thus limiting the ability to draw strong conclusions about the effects of incentives on performance. Furthermore, these studies have produced mixed results (Bonner et al. 2002). Accordingly, this study contributes to the limited body of research that has examined the multi-period impact of performance-based monetary incentives on worker productivity in field settings (Banker et al. 1996, 2001).
Also, prior research has examined the effects of incentives in isolation, but never in combination. It is common practice for firms to design compensation plans as a combination of incentive schemes. However little is known about how incentive contracts offered in combination affect worker effort and productivity (Bonner and Sprinkle, 2002). Thus, the study makes a positive contribution here. Finally, recent developments in accounting research call for greater integration of psychology and economics concepts to provide insights into accounting issues (Haynes and Kachelmeier, 1998; Waller, 1995). This research brings ideas from economics (i.e., agency theory) and psychology (i.e., prospect theory) to develop theoretical predictions of the effects of the group incentive scheme on the firm's (team) performance.

1.7 SUMMARY OF THE FOLLOWING CHAPTERS

In chapter two, I present a summary of the extant literature on agency theory and incentive contracting. I continue with a summary of the use of workgroups and group incentives. The chapter concludes with a summary of experimental studies in accounting, examining the effects of group-based incentives on group productivity. Chapter three describes the research setting. It presents a time-chronology of the implementation of the group incentive scheme, depicts the structure of the output-target scheme and gain-sharing schemes, and describes formal mechanisms put in place by management to reinforce the effectiveness of the group compensation plan. Hypotheses are developed in chapter four. Chapter five describes the empirical methodology and data used. Chapter six presents results of all statistical tests. Chapter seven concludes the paper with a
summary of the underlying findings, the study limitations, and a discussion for future research.
2.1 AGENCY THEORY FRAMEWORK

In the framework of agency theory, a principal (owner) hires an agent (worker) to perform some service or task on behalf of the principal (Eisenhardt, 1985; Jensen and Meckling, 1976).¹ It is assumed that the agent is risk and effort averse, and acts opportunistically. The principal is risk-neutral and delegates decision making authority to the agent. An agency problem arises because the agent may not always act in the best interest of the principal. The principal (owner) wishes to maximize firm value whereas workers (agents) maximize their own utility. The divergence of interests across the parties gives rise to agency costs for the principal (a residual loss to the firm).²

There are two types of agency problems: moral hazard and adverse selection. Moral hazard (hidden action) arises when the principal cannot perfectly observe the actions of agents; and adverse selection (hidden information) results from information asymmetry, that is private information of the agent’s intentions or skill level that is unavailable to the principal. To mitigate dysfunctional behavior by the agent and minimize agency costs (prevent a loss in efficiency or a reduction in firm value) the

¹ Classical writings on the agency relationship include the works of Alchian and Demsetz, 1972; Baiman, 1982; Fama, 1980; Fama and Jensen, 1983; Eisenhardt, 1985; Holstrom, 1979; Jensen and Meckling, 1976; and Ross, 1972.
² Agency costs include: (1) monitoring costs – costs incurred by the principal in an effort to limit the opportunistic (discretionary) behavior of the agent. (2) Bonding costs – incurred by the agent to guarantee the principal that the agent is not performing outside the boundaries intended by the agent. (3) Residual losses – loss in efficiency caused by the inability of the principal to monitor the agent’s actions in order to guarantee full compliance.
principal relies on active monitoring (direct supervision), enacting budget controls, or designs incentives systems. This investigation focuses on the design of effective incentive systems to alleviate problems of moral hazard in a multi-agent production setting, where the problem arises of inducing agents to supply the proper amounts of productive inputs (labor).

### 2.2 Incentive Alignment to Reduce Agency Costs

Agency models suggest that the principal could improve his/her contracting relationship by designing incentives systems. In other words, because full observation of actions is either impossible or too costly, the principal could rely on optimal risk-sharing by designing incentive systems that induce appropriate behaviors by the agent (Holmstrom, 1979). Hence, the principal may rely on explicit (monetary) incentives to mitigate problems of moral hazard and adverse selection in the agency relation.

The incentive contracting literature in accounting has examined the use of incentive alignment (explicit incentive systems) to resolve the inherent conflict of interests across the parties. For instance, experimental studies have found that the use of budget-based schemes induces individuals to reveal private information about their skill-levels, reducing hidden information problems [adverse selection] (Chow 1983; Shields and Waller, 1988; Waller and Chow, 1985), as well as problems of moral hazard (Bailey et al., 1998; Chow, 1983; Sprinkle, 2000).
2.3 PERFORMANCE-BASED INCENTIVES AND MORAL HAZARD

One of the underlying assumptions of principal-agent theory is that individuals respond favorably to economic incentives that reward performance (Prendergast, 1999). Analytical models of agency suggest that by relating pay to performance, individuals would be more motivated to exert greater levels of effort to improve performance. This prediction is based on the underlying assumption that workers will trade-off disutility of higher effort for higher expected rewards. Workers would be motivated not only to exert greater levels of effort by linking pay to performance, but also to learn more productive ways to perform their tasks.

The incentive-contracting literature in accounting has found empirical support for the predictions of agency models. Experimental studies (Chow, 1983; Sprinkle, 2000) and field studies (Banker, Lee, Potter, 1996; Banker et al. 2001) have found that individuals respond favorably to the use of performance-based incentives. Monetary performance (contingent) incentives motivate individuals to improve their productivity and task performance; thus, helping to mitigate problems of moral hazard.

While the use of performance-based incentives may resolve agency problems of moral hazard by rewarding individual performance, the use of performance-based incentives in team production settings could produce an opposite outcome, and instead,

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3. From an agency theory perspective, performance-based incentives increase an organization's overall productivity not only by motivating individuals to increase or to better allocate their effort levels (effort effect), but also by attracting and retaining more productive or skilled individuals for the task at hand (selection effect).

4. The evidence of the effects of performance-based incentives on performance in experimental studies is mixed. Monetary incentives oftentimes did not lead to improvements in individual performance in experimental studies (Bonner, Hastie, Sprinkle, and Young, 2000; Bonner and Sprinkle 2002; Jenkins, Mitra, Gupta, and Shaw, 1998).
performance-based incentives could exacerbate moral hazard given the free-riding dilemma that exists in group settings. Tying workers’ compensation to group performance could provide workers with an incentive to shirk because the benefits of increased effort are shared with co-workers (Demski and Sappington, 1984; Holmstrom, 1982; Ma 1988; Mookherjee, 1984; Prendergast, 1999).

2.4 The Use of Teams in the Workplace and Group-Based Incentives

The use of teams (or production workgroups) is becoming commonplace among firms (manufacturing plants). While the use of teams has been in existence for over fifty years in the U.S., only in the last decade has this practice resurged among firms. Firms are rediscovering multiple benefits for the use of teams, including greater participation and cooperation, increased information-sharing, and increased attention to process improvements, and greater satisfaction in the workforce (Safizadeh, 1991).^5

The central tenet of team benefit is that greater worker involvement and participation generates ideas that are geared toward process innovations and problem solving, leading to improvements in productivity, quality, and organizational performance (Banker, Field, Schroeder, Sinha, 1996).

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^5 Research studies examining the potential benefits and merits of production workgroups, their dynamics and effectiveness, have been extensive and have expanded over fifty years in industrial psychology (Marks et al., 1986), organizational behavior (Banker et al., 1996; Trist and Bamforth, 1951; Wall et al., 1986), and operations management (Gersick, 1988; Griffin, 1988; Safizadeh, 1991; Susman, 1970).
Moreover, organizing operations with production workgroups has also been influenced by recent advancements in manufacturing technology which have created reciprocal interdependencies across production tasks.  

Additionally, the rapid proliferation of advanced manufacturing innovations (e.g., total quality management, just-in-time, process re-engineering, theory of constraints, flexible manufacturing) has demanded radical changes in job design and organization of the workforce into functional teams. With these innovations, the need arises for extensive worker participation, so companies are rediscovering workgroups as an effective mechanism to foster interactive participation throughout their workforce (Young, Fisher, and Lindquist, 1993; Wageman, 1995).

As the use of teams has proliferated, so has the use of group-based incentives (i.e., group piece-rates, profit sharing and gain-sharing plans) [Blinder, 1990, 1999]. However, despite of their popularity, the design of group-based incentives continues to be problematic for many firms (DeMatteo et al., 1998). The design of group rewards systems becomes more complex in a team-production environment because the incentives need to promote cooperation and motivate proper amounts of team effort (i.e., minimize free-riding).

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6 The total quality management (TQM) literature has developed various theories that explain how participation in work teams leads to improvements in performance. The TQM literature suggests that participation in teams (i.e., quality circles) improves quality and productivity through greater cooperation and greater idea generation, which improve productivity and quality. A competing theory suggests that teamwork leads to favorable individual outcomes that improve job satisfaction, motivation, and task performance – all leading to productivity improvements. For a detailed explanation of these theories, refer to the work of Mohrman and Novelli, 1985.
2.5 RESEARCH ON GROUP-BASED INCENTIVES

While research about group-based rewards has proliferated in the psychology and organizational behavior and management literatures for several decades (DeMatteo et al., 1998; Miller and Hamblin, 1969; Goldman et al., 1977; London and Oldham, 1977; Schuster, 1983; Tjosvold, 1984; Wageman 1995; Wageman and Baker, 1997), empirical studies in accounting examining the effects of group incentives on team productivity and performance have been scant and limited to a few experimental studies. In the words of Young (1995), "group incentives-based contracts and their effect on performance represent a largely unexplored area of research in the incentive contracting literature."

The first empirical evidence of the effects of incentives on group performance in the accounting literature is the seminal work of Young, Fisher, and Lewis (1993). Based on the theoretical framework of Deutsch's theory of competition and cooperation in small groups (Deutsch, 1949), this study examined the effects of intragroup (and intergroup) cooperation and competition on group performance in an experimental setting. Young et al. (1993) hypothesized that cooperative groups would outperform noncooperative groups. Group rewards were designed either to encourage intra and intergroup cooperation or to induce intergroup competition. However, contrary to their prediction, group rewards that were intended to foster group cooperation did not lead to greater group productivity and performance. In subsequent experimental work, Drake, Haka and

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7 Deutsch's theory of competition and cooperation in small groups suggests that when rewards (outcomes) contingent on group performance are distributed to group members equally (i.e., cooperatively), each group member has an incentive to work cooperatively. Conversely, when outcomes are distributed to group members based on individual effort (competitively), each member has an incentive to excel beyond the level of performance of fellow group members to obtain a larger share of the competitively distributed reward.
Ravenscroft (1998) examined the effects of group rewards on group innovation and group productivity. They also found mixed evidence of the effects of cooperative rewards on group productivity. They concluded that a combination of cooperative and competitive group rewards leads to greater group productivity and innovation.

However, only recently has incentive contracting research in accounting tested the predictions of analytical models about the effectiveness of various incentives schemes in mitigating moral hazard problems in team production settings. Sprinkle, Fisher, and Peffer (2003) examined the effects of piece-rates versus budget-based contracts on group productivity in an experimental setting as suggested by the analytical contracting literature (Demski and Feltham, 1978). Sprinkle et al. (2003) found that budget-based contracts outperformed group piece-rates. Budget-based contracts led to higher group effort (less free-riding), higher group performance, and less decay in long run performance. Additionally, Towry (2001) examined the effectiveness of two implicit incentives systems (vertical versus horizontal) that rely on mutual monitoring in mitigating free-riding in a team-setting. She found that the effectiveness of each system depended on the level of team identity.8

In spite these advancements; there is no empirical evidence in the accounting literature examining the effects of group incentives in a natural setting. This may be the first empirical study in the incentive contracting literature in accounting that documents the performance impact of group incentives in a real production setting.

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8 Both of these incentives systems rely on mutual monitoring. The vertical incentive system reports observations of co-workers’ efforts to management, as opposed to the horizontal system in which team members control the actions of each other and can punish shirkers. These findings suggest that the use of horizontal incentive systems becomes more effective in the presence of a strong team identity, as opposed to the effectiveness of the vertical system which is degraded by strong team identity.
CHAPTER THREE

RESEARCH SETTING

The research site for this study is a manufacturing facility operated by a division of a Fortune Five-Hundred company. The facility assembles a large assortment of metal locks and employs production workgroups (or teams) in its manufacturing processes. Because there is a high degree of interdependence across the various production tasks and the plant uses a sequential production process it is difficult to measure individual contributions to output. Therefore, at the inception of operations the management of this facility decided to design its rewards systems as a combination of individual and group-based incentives.

Management restructured its compensation plan to improve organizational performance. Management expected a combination of a group output–target scheme and a gain–sharing scheme to motivate production workgroups to exert greater levels of effort, instill greater cooperation within and across production cells, and to minimize the levels of free-riding within each production cell. Thus, management anticipated that these adjustments in its compensation plan would lead to overall improvements in economic performance.

The rest of this chapter is organized as follows. I first describe the plant’s parent company and its various business segments. I then describe the research site, its production technology, the structure of the old and new compensation plans, and the formal mechanisms that reinforce the new incentives schemes.
3.1 OVERVIEW OF THE COMPANY AND ITS BUSINESS SEGMENTS

The research site is owned and operated by a highly diversified business conglomerate, comprised of various business segments that manufacture and market a wide range of consumer products. The company is a publicly traded U.S. company with operations in several countries. It is organized into four divisions: home and hardware products, office products, spirits and wine, and sporting goods. In 2002, the company had sales of $5.68 billion dollars and maintained a leadership position in several of its core businesses.

The home and hardware products division is the company’s main revenue generator, accounting for approximately 45% of total company sales. This division manufactures and markets a wide array of home and consumer products, such as kitchen and bath cabinets, water faucets, tools boxes, and security metal locks.

The research site belongs to the security locks segment of the division. Founded in 1921, the security locks segment has become the world’s largest manufacturer and marketer of security locks and has maintained its leadership position for over eighty years. The security locks segment maintains manufacturing operations in several foreign locations and operates sales, distribution, and administrative functions in the U.S..

3.2 OVERVIEW OF THE RESEARCH SITE

The study setting is one of the manufacturing plants of the security locks segment. The facility manufactures a large assortment of security, combination, and locker locks in three manufacturing subunits that operate on the premises of the facility. The plant is
located in Mexico where it has been in operations since April of 1998. Prior to the
initiation of operations at this location, the company had maintained manufacturing
operations at several facilities within the U.S.; however, the dynamics of a global
economy and competitive pressures to reduce labor costs forced the company to relocate
its U.S. manufacturing operations to Nogales, Mexico, an industrial city along the U.S.—
Mexican border.

The facility is part of the maquiladora (in-bond) industry of Mexico and operates
under the guidelines and statutes that regulate this industry.\(^1\) The firm exports, from the
U.S. into Mexico, duty free raw materials and components for use in the assembly of its
products (locks). After assembly, the final product is sent back to a U.S. distribution
center and the product is distributed to various customers in the U.S., Canada, Mexico,
and South America. In a relatively short time span, the facility has become the largest
producer of security locks for the company, accounting for over 65% of total output and
generating over $300 million dollars in annual revenue. The remaining 35% of the
company’s production needs is outsourced to various smaller manufacturing facilities
scattered throughout Asia.

Each of the three manufacturing subunits operates as an independent production
center, assembling a wide array of lock models that are manufactured for three specific
markets. The retail (or make-to-stock) unit manufactures a large volume of metal

\(^1\) Under the general guidelines of the maquiladora production program, formally known as the Border
Industrialization Program (BIP), the Mexican government permits foreign firms to establish manufacturing
operations in Mexico, and to temporarily import duty free raw materials, components and supplies, and
machinery and replacement parts needed for assembly of goods. These firms pay duties after completion of
their products and resulting export to the respective firm country of origin (in this case, to the U.S.). Tariffs
are only applied to the value-added of the finished product; that is, the labor and overhead costs that were
incurred in Mexico.
padlocks for distribution to national chain stores, primarily supplying the consumer market. The institutional (locker-lock) unit assembles locker and combination locks for institutional customers, such as schools, the military, and sports facilities. The commercial (or make-to-order) unit assembles a large variety of lock models for distribution to industrial customers; these locks are generally built according to customer specifications.

Each unit maintains independent production operations and has its own functional area of production, process engineering, quality control, master scheduling and planning. A central staff provides support in the functions of finance, human resources, logistics, and materials. The commercial unit is the largest of the three units followed by the retail and institutional units.

At full capacity, the facility is capable of manufacturing 160,000 locks, 2,000 production work orders, and 1,600 different models of locks (SKU's) daily. The plant currently consists of fifty-one production (workgroups) cells and employs an average workforce of 875 direct, indirect, and administrative employees.

3.3 PRODUCTION TECHNOLOGY

The production technology is predominantly labor-intensive with a high degree of production flexibility; a large number of heterogeneous locks can be produced in a single production cell. While the three units share similar production technologies, the large

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2 While the research's site production technology may be classified as labor-intensive, some of its production processes are capital-intensive. For instance, several lock models are engraved using automated laser technology. Furthermore, production tasks such as key cutting and packaging are performed with
heterogeneity of lock models creates some divergence in the degree of manufacturing complexity across the units. For instance, the commercial unit exhibits a higher degree of complexity in its assembly process relative to the make-to-stock and locker lock units which assemble a larger homogeneity of locks with simpler assembly processes. Moreover, the large heterogeneity of lock models in the commercial unit requires constant machinery changeovers and adjustments in the assembly process, introducing additional operational complexities not present in the other units.

Although a large diversity of lock models are manufactured, numerous locks share many of the same components or use similar manufacturing designs. This simple production strategy adopted by the plant, coupled with its flexible manufacturing capability, has allowed the facility to achieve remarkable growth and manufacturing efficiency in a relatively short time span.

3.4 Cellular Team-Based Manufacturing Process

The production tasks required for assembly of a lock are performed by workgroups (teams) composed of eight to fifteen members. The various production tasks are highly integrated and the assembly process for each cell is sequential, therefore each production task is dependent on the previous task. A given assembly process is completed in its entirety within a single production cell, eliminating the need to transfer subassemblies.

automated machinery. The production technology is a combination of labor and capital-intensive, however, most of the assembly operations are predominantly labor-intensive.

For instance, the commercial and retail units share many of the same components across the various models of locks, such as key cylinders and lock bodies. This has allowed the facility to mass-produce these two sub-assemblies in a central workstation and then transfer the components to the respective production cells so these can be used in the assembly of any of the lock models manufactured by these units.
across the various production cells. Refer to figure 2 for an illustration of the structure of a production cell.

Management decided to adopt a cellular manufacturing system from the beginning of operations at this facility. Their rationale coincided with the need to establish effective communication between workers given that production tasks were highly dependent. When there exists reciprocal interdependences in the production process, as is the case of the site’s manufacturing process, workers must constantly communicate with each other to prevent defects from flowing across the various assembly tasks. Management believed that implementation of a cellular system at the facility would facilitate a timely exchange of information between workers and would also allow workers to provide feedback to each other during the assembly process.

Management thought that a cellular manufacturing design would offer advantages as opposed to a linear (conventional) manufacturing design. This belief coincides with research suggesting that production processes embedding high dependencies among tasks are more effective using teams rather than assembly line approaches (Hemmer, 1995).

Moreover, the facility operates under an innovative total quality management (TQM) philosophy that requires its workforce to interact and participate at all levels of the organization. Management thought that a team-based approach would merge well with a TQM philosophy. The benefits of functional teams used with innovative practices are also promoted by numerous academics and practitioners. For instance, as firms attempt to integrate innovative practices (i.e., TQM, JIT, process re-engineering, TOC, balanced scorecard, flexible manufacturing), they increasingly rely upon production
teams in their work operations. Firms are rediscovering production teams as an effective tool to promote spontaneous cooperation and foster interactive participation throughout their workforce (Banker et al., 1996; Hackman, 1991; Safizadeh, 1991; Young, Fisher, and Lindquist, 1993; Wageman, 1997).4

Furthermore, assembling a large heterogeneity of lock models and numerous production work orders in the same production cell requires a high degree of coordination on the part of workers to execute machinery set ups. In the opinion of management, production teams would facilitate coordination across workers to execute machinery changeovers.

In general, the manufacture of a laminated lock requires between eight and fifteen various assembly operations. The exact number of operations varies according to the number of functions and features of the lock. Except for generic operations, such as the assembly of a cylinder and the design of the lock key, all the assembly operations are performed within the same production cell. The following diagram depicts the assembly operations that are required for assembly of a laminated lock.5

4 Empirical studies suggest that the dynamics of teams are such that members tend to interact extensively in carrying out task operations and produce results through a highly collaborative process. Moreover, the information to solve problems during the production process flows more effectively in the presence of production teams (Safizadeh, 1991; Weinberger, 1988).

5 This diagram represents, on average, the number of functions that are required to assemble a laminated lock. However, the number of assembly operations and degree of complexity vary with the model of lock. For instance, the assembly process for a combination (or locker) lock varies substantially from the process described above. Moreover, some of the more complex locks (i.e., make-to-order) require up to 15 different operations for assembly as opposed to the eight operations in the diagram.
3.5 INCENTIVES UNDER THE OLD COMPENSATION PLAN

In team production settings, output reflects the collective efforts of multiple workers, making it difficult to link financial incentives to individual performance (Blinder, 1999; Demski and Sappington, 1984; Holmstrom, 1982; Prendergast, 1999). Management recognized its inability to reward individual performance in a team-production setting, so worker compensation was structured as a combination of individual and group-based incentives.

Individual rewards consisted of a daily flat wage of 70, 80, 91, or 101 Mexican pesos on average per worker, depending on the worker’s seniority and his/her level of
certification to perform multiple tasks. This represents approximately $7, $8, $9, and $10 U.S. dollars respectively based on the current exchange rate. In addition to the daily wage, there was a weekly attendance and punctuality monetary incentive. Each worker was entitled to earn a cash bonus of 115 pesos per week, about 23 pesos a day, for attending work and being on time during the whole week. Missing a day or being late on two occasions within a week, precluded workers from receiving this monetary bonus. This incentive aimed at minimizing worker absenteeism.

Furthermore, as part of the compensation plan, there were several non-monetary individual incentives to retain employees. For instance, workers receive free transportation to the facility, subsidized meals, full access to the on-site day care facility, on-site medical consultations, and tuition reimbursements. Also, on-site assistance is provided for various legal issues such as divorce, alimony, and application for U.S. tourist visas, and free advice is provided with respect to housing (i.e., how to qualify for government subsidized housing). While these sort of non-monetary incentives are

6 A Worker’s degree of certification is based on the number of assembly operations that each employee is able to execute; the fixed wage is proportional to the employee’s level of certification. There are three certification levels and workers should successful pass an examination at each level, encompassing various operations on the production floor. When employees become certified at the third level, they receive the title of a ‘universal operator’ and the worker is entitled to receive the highest level of fixed pay, 101 pesos, irrespective of the worker level of seniority.

7 Under Mexican labor law, employees are paid a fixed salary per day as opposed to an hourly rate. The four levels of flat wages are based on workers’ seniority and these are in excess of the minimum wage required by Mexican law, which at the present time is approximately 47 pesos per day. It is uncommon for firms operating in this geographic region to pay a minimum wage. The wages paid by the firm are in line with the industry average within the geographic region where this plant operates. Furthermore, the daily flat wage has been relatively constant throughout the study period (January 2000-August 2002). There have been two minor increases in the minimum wage in the country, and the flat wage in the factory has increased on the same proportion.

8 High rates of labor turnover and absenteeism are two serious problems facing the maquiladora (in-bond) industry in Mexico (Schwartz, 1987; Sklair, 1989; The Wall Street Journal, 2001). Hence, the large majority of these firms rely on this sort of monetary incentives to alleviate absenteeism among the workforce.
uncommon in other industries in Mexico, they are quite common among maquiladora firms. Typically these non-monetary incentives are offered to alleviate worker turnover.

As part of the group-incentives, the plant offered a piece-rates scheme in which worker compensation was tied to the team’s output. The bonus was dependent on a team’s daily performance and the reward was shared equally across team members. Instead of linking pay to units of output, the scheme paid an average piece-rate factor for each standard hour of output. With slight variation, the scheme may be classified as a performance-based incentive similar to the class of individual piece-rate schemes which have been studied by the incentive-contracting literature in economics and accounting (Demski and Feltham, 1978; Lazear, 1986; Prendergast, 1999), and that are predominantly used by firms in various industries (Blinder, 1990; Petersen, 1992; U.S. Department of Labor Statistics, 2003). On average, workers earned between 20 and 40 pesos per day under the group piece-rates scheme.

Performance-based contracts are used extensively among firms in the maquiladora industry. Management’s decision to offer this performance-based incentive as part of the compensation plan was influenced by the prevalence of similar incentives used by other firms.

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9 Standard hours of output equal the number of locks produced in a given day times the standard labor time required to manufacture each of those locks. Management decided to use standard hours of output instead of actual units (locks) in the incentive formula for simplicity purposes given the high degree of heterogeneity and complexity of products.

10 A worker’s daily payoff under the group piece-rates scheme is equal to 1/n, where 1 is the total reward based on a team’s daily production output (based on the standard hours of actual output) and n equals the number of members on the team. The average of 20 to 40 pesos was computed using payroll data. This figure was corroborated with payroll personnel and management. However, the figure should be interpreted with caution because some workers could have been earning more than this range. For instance, management pointed out that workers from more dynamic teams could exceed the 40 pesos regularly.
manufacturing firms in the same geographic location; so management aimed at aligning worker compensation with their counterparts.\footnote{In the maquiladora industry, the use of performance-based incentives as part of workers’ compensation plans are customary and are greatly used by firms. Based on my personal experiences within this industry, a large majority of firms employ either piece-rates or standard-based incentives, paying a cash bonus when the worker reaches a pre-specified production quota. Overwhelmingly, these sort of incentives are linked to individual performance.}

The compensation contract comprising the fixed-wage and the incentives described above was in effect from April 1998 through March 2000. On average, total daily compensation (in pesos) for a production worker under this contract was as follows.\footnote{I am using an average fixed-wage of 90 pesos; however as previously indicated, there are four different fixed-wage categories ranging from 70 pesos to 101 pesos. The attendance bonus is the same for all workers and it is proportionate to the number of working days during the week. I used an approximate average of 22 working days in a month to estimate the daily piece-rate bonus.}

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<td>Fixed-wage</td>
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<td>Group-piece rates</td>
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<td>Total compensation (in pesos)</td>
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Also, refer to appendix A for a numerical example comparing average employee compensation under the old and new compensation plans. Appendix B contains a mathematical and graphical representation of the various schemes in place: group piece-rates, output-target, and gain-sharing schemes.

### 3.6 Incentives under the New Compensation Plan

In April 2000, management decided to restructure its compensation plan. The group piece-rates scheme was replaced with a group output-target in April 2000. The individual attendance bonus was replaced by a gain-sharing scheme that linked compensation to plant-level performance in July 2000.
The consensus among management and production supervisors was that piece-rates were only partially effective at motivating higher collective effort and easing production free-riding across production cells. Furthermore, management wanted to promote more cooperation and motivate information sharing across production cells aimed at improving the production process and product quality. They felt that the attendance bonus was not providing any motivation on the part of workers to improve performance; thus they attempted to improve the contractual relationship and risk-sharing position with workers by implementing the gain-sharing plan.13

While there were production cells that responded favorably to the piece-rates incentives, employees in other cells were not as economically motivated to improve performance. Among production cells with more senior workers, piece-rates were quite effective and workers responded favorably to the piece-rates incentives. This was reflected in constant improvements in labor productivity across these cells. In part, these teams were more cohesive and had established a close relationship across members (i.e., strong team identity). It was easier for these groups to cooperate and coordinate efforts during production and to agree to work with greater intensity to increase their monetary compensation. This level of cooperation and coordination was difficult to achieve uniformly across those production cells that experienced high turnover and that were constantly receiving new workers; free-riding was more prevalent among these teams.

13 The attendance bonus was equivalent to a fixed-wage contract in the sense that it imposes zero risk on the part of workers (Demski and Feltham, 1978). Indeed, workers only needed to show up for work and arrive on time to be entitled to receive this monetary bonus. Management aimed at imposing more risk on workers but they also attempted to keep part of the features of the attendance bonus in the gain-sharing scheme. Therefore, under the guidelines of the gain-sharing scheme, employees were required to maintain a minimum threshold of absents during the quarter to be entitled to receive the bonus.
Furthermore, management realized that piece-rates incentives were causing quality problems. Because piece-rates incentives reward output, production cells tend to focus on raising output at the expense of product quality. For instance, the average monthly defects rate on final products was around 12,000 parts per million in the months prior to the adoption of the output-target scheme. Therefore, management aimed at making production teams more accountable for quality.

From the standpoint of the vice president of manufacturing operations, management's rationale in replacing the group piece-rates incentives with the group output-target scheme was to minimize free-riding, enhance labor productivity, and improve product quality, as suggested by the following remark:

"We replaced our group piece-rates compensation plan with a group output-target scheme with the objective of minimizing [free-riding] across production cells and to reduce our quality defects. We expect the new scheme to encourage more cooperation among cell members and to exercise pressure among each other to reach the specified output and quality targets."

Furthermore, management replaced its attendance bonus with a gain-sharing scheme on July 2000 to foster cooperation and information sharing between production cells and to improve efficiency in the manufacturing process. Management felt that the attendance bonus did not provide incentives to improve performance, so they instituted a pay-for-performance incentive that rewards employees for achieving plant-level performance targets for labor productivity and product quality. A more detailed description of the structure of the gain-sharing scheme follows, but this statement from the plant manager illustrates the intended purpose of adopting the gain-sharing plan:
"The gain-sharing plan was instituted with the objective of fostering cooperation and to promote information-sharing across production cells to find ways to improve the production process, improve quality, and to reduce material waste."

More importantly, management expected the schemes to complement each other in terms of motivating and coordinating greater levels of effort and cooperation within and across production cells. Management thought that the combination would create synergies (i.e., greater effort and greater worker involvement) across production cells to enhance organizational performance.

In the next section, the structure of the output-target scheme and gain-sharing plan is discussed. Refer to figure 1 for a chronology of the implementation dates of the incentives schemes as well as for the dates of adoption of salient manufacturing innovations that could have an effect on the site’s performance.

1. Output-Target Scheme (Linear Budget-Based Scheme)

The group output-target scheme, which is analogous to the class of budget-based contracts (quota schemes) that have been proposed in the analytical contracting literature, links employee compensation to achieving budgets (or standards) containing explicit production, revenue, and cost goals (Demski and Feltham, 1978; Holmstrom, 1982).

In general, budget-based contracts reward individuals (agents) with higher income if a budget is attained, or offer a lower income usually in the form of a fixed-wage when the pre-specified budget-level or standard targets are not achieved (Demski and Feltham, 1978). Budget-based contracts are routinely used in practice to reward individual performance (Blinder, 1999; Henderson, 2000; Sprinkle et al., 2003).
At this research site, the output-target scheme provides a daily fixed bonus of 30 pesos to each member of a team when the production team reaches a daily output quota. However, a penalty is incurred when a team fails to maintain quality standards. Production teams also need to maintain a minimum threshold of quality defects rate (a quality quota) to attain the bonus. If a particular team meets or exceeds the output standard for the day, but fails to maintain the minimum threshold of quality rejects, then the entire team loses the bonus.¹⁴

Moreover, the output-target scheme adopted by the research site has a piece-rate component that takes effect after a team reaches the specified output target for the day. Once the target is achieved, the scheme begins to pay additional compensation for every unit of output that is produced above the daily output-target.¹⁵ The rewards function becomes linear and continuous with output after reaching the output target, making the scheme a combination of a budget-based and linear (piece-rate) contract. This combination of incentives has been labeled as a budget-linear incentive scheme in the incentive-contracting literature in accounting (Sprinkle, Peffer, and Fisher, 2003).

2. **Gain-sharing Scheme**

The gain-sharing scheme may also be classified as a budget-based (quota) incentive scheme similar in some respects to the output-target scheme. Nevertheless, while both schemes contain a performance-contingent incentive that links compensation to meeting

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¹⁴ The quality guidelines include a maximum threshold of three finished goods rejects during an intermediate quality audit or one reject during a final inspection audit that takes place before the product is shipped to a distribution center. Exceeding either threshold automatically eliminates the output-based bonus. All production teams are subject to the same quality guidelines.

¹⁵ The piece-rate factor is analogous to the group piece-rate scheme used at the site prior to the implementation of the production-target scheme. The incentive is tied to the number of additional standard hours of output produced above the daily production quota instead of the actual units of output.
explicit performance goals (e.g., output and quality goals for the output-target scheme, and labor productivity and quality goals for the gain-sharing scheme), the gain-sharing scheme varies from the output-target in two respects. First, the scheme ties the financial incentive to achieving plant-level rather than team performance targets (goals). Secondly, the scheme remunerates employees for achieving any one of three specific performance targets (i.e., budget levels) for productivity and quality, varying in degree of difficulty as opposed to achieving a single performance target. Hence, the gain-sharing scheme’s reward function is a combination of continuous and step (not strictly linear) reward function.

The gain-sharing scheme is structured so that production cells in each manufacturing unit coordinate their efforts to achieve pre-specified quarterly plant-level targets in labor productivity and product quality. The reward increases as the performance targets become more difficult, making the scheme’s reward function a step (not strictly linear) reward function. Specifically, workers receive a cash award of six, eight, or ten percent of their average quarterly compensation depending on the achievement of performance targets.

The productivity and quality targets are set endogenously based on the plant’s quarterly performance. Depending on the unit’s performance, both targets are adjusted (usually ratcheted-up) before the commencement of each quarter. For instance, if improvements are needed in labor productivity, the target is raised relative to quality. If either quality or productivity has improved significantly during the respective quarter, management ratchets-up both outcome targets in the same proportion.

Management may also adjust the reward weights depending on where the performance improvements are most needed. Both performance metrics may carry equal weight or the
weights may be adjusted during each quarter. The various targets for labor productivity and quality (defects rate), and the respective reward weights carried throughout the study period, are reported in figure 3.

Management rationale in adopting the gain-sharing scheme was to foster cooperation and information sharing between production cells in an effort to improve efficiency in the manufacturing process. Management expects groups to communicate with each other about ways to remove bottlenecks in their respective production cells and provide suggestions for identifying quality problems during production; thus allowing teams members to identify and remove flawed units from production runs before these reach an external quality inspection workstation.

To facilitate learning (i.e., strategy development) and to reinforce communication across production cells, performance feedback is provided frequently. For instance, management tracks labor productivity, quality (defects rates), material spoilage, percentage of orders completed on-time, turnover, and absenteeism for each of its fifty-one production cells and for the plant as a whole.\textsuperscript{16}

Management aimed to accomplish two objectives by providing performance feedback to production cells. First, this information allows low performing teams to identify specific cells that have significant improvements in performance. Low and high performing cells can then exchange information to assist the lagging cells. Management acknowledged that it is not uncommon for a particular cell, upon discovering a method to speed-up production or

\textsuperscript{16} Performance feedback is reported either on a daily or weekly basis depending on the performance metric being reported. For example, plant-level performance metrics are reported on a weekly basis. Feedback on labor productivity, defects rate, and material waste for each production cell is reported daily.
identify a defective component, to either inform its production supervisor, or to advise the rest of the production groups within the same manufacturing unit of the discovery. Similarly, production workgroups meet informally on a daily basis to discuss ways to improve performance. These meetings are particularly important if a production unit is not meeting the plan's productivity and quality targets.

Secondly, management also expected that providing team performance and variance feedback would facilitate learning. Receiving feedback on past performance allows cells to assess their progress and learn from the past to improve future performance.\(^{17}\)

### 3.7 MECHANISM TO REINFORCE THE EFFECTIVENESS OF THE OUTPUT-TARGET SCHEME

To reinforce the effectiveness of the output-target scheme, management incorporated a mechanism to report each production team's performance that was unavailable under the piece-rates contract.\(^ {18}\) Each production team is provided with feedback of their actual performance relative to the daily standard at various points in time during each day. In a blackboard adjacent to each production cell, production supervisors report the output target and the number of locks that each team has completed every two hours. Having access to this information, team members can assess whether they need to coordinate greater levels of effort to either reach or exceed the day's output target, depending on the team's current level of performance.

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\(^{17}\) Experimental studies in accounting have found that performance feedback promotes and enhances the rate of learning (Sprinkle, 2000; Bonner and Sprinkle, 2002), and receiving budget and variance feedback appears to enhance learning and improve decision performance (Ghosh, 1997; Mock, 1973). Furthermore, effort directed toward strategy development (i.e., learning) could enhance future performance because it creates greater knowledge for workers to improve a production task (Bonner and Sprinkle, 2002; Sprinkle, 2000, 2003).

\(^{18}\) This performance feedback mechanism is different from the one used in the gain-sharing scheme that was mentioned earlier.
Furthermore, performance feedback allows team members to assess in an indirect way whether shirking is taking place in their respective cells. Simply put, performance feedback provides a benchmark to compare current to past performance to judge whether the team is working with the same level intensity as in prior periods. For instance, suppose that a particular production cell reaches its output and quality targets on a regular basis and neither target is ratcheted-up or changed in subsequent periods. If on a given day, this team significantly trails the output target, absence exogenous or extraordinary circumstances in the assembly process (e.g., material shortages, bottlenecks, etc.), this would be an indication that the team's collective effort levels are not as intense as in previous periods, signaling some level of shirking occurring at the cell.

Therefore, teams are provided with a direct measure to investigate whether all members are managing the required effort to reach the output quota; and to identify possible shirking among their peers.

The following diagram depicts the form in which performance feedback is reported to production cells. The information was replicated from the actual blackboard adjacent to a production cell. Each figure represents the number of units (locks) either completed or budgeted. On this particular day, the output-target for the cell is for 6,800 locks. The standard is divided into five different output levels spread out in time-intervals of two hours.
### 3.8 MECHANISM TO GET RID-OFF OF SHIRKERS

To reinforce the effectiveness of both incentive schemes, management instituted a formal mechanism to remove shirkers or low performers from production cells. Team members could request the transfer of fellow members who perform poorly or constantly shirk. These workers are either given a written warning by the respective production supervisor or immediately transferred to another team. If performance does not improve with a reasonable time frame, usually a month, then the worker is laid-off.

This mechanism is intended to reinforce the effectiveness of the group output-target scheme by creating *peer pressure* across team members. Several interviews with production workers confirm that peer pressure has become a norm across teams. This behavior was not as prevalent under the old compensation plan. While piece-rates created some friction between potential shirkers and high performers, shirking was not formally disciplined in the firm, thus peer pressure was ineffective. In the words of a production worker:
"...If a member of a production cell is not pulling his weight to meet the daily output quota, we demand extra effort or otherwise we report his behavior with the production supervisor. If he persists [shirking], we request his dismissal from the team."

Most production workers agree with the assessment that this particular mechanism has effectively created greater pressure across workers and has reduced shirking within cells.
CHAPTER FOUR

HYPOTHESES DEVELOPMENT

When individual contribution to output cannot be easily observed or one can only observe the output of the workgroup, the design of incentives to motivate workers to maximize firm value becomes more complex. As previously indicated, a well-known economic problem in team production is that each worker’s contribution to aggregate performance may be costly, or impossible to measure (Alchian and Demsetz, 1972). Hence, tying individual compensation to the group’s performance may provide each team member with an incentive to shirk (Holmstrom, 1982; Ma, 1988; Prendergast, 1999). Hence, the design of effective incentives systems represents a challenge for firms because incentives should ease moral hazard (i.e., free-riding) and also motivate the desired degree of cooperation in a team environment.

Group piece-rates contracts are suggested in the compensation literature as incentive alignment systems to ease moral hazard in multi-agent settings and to motivate workers to improve performance in team production settings (Blinder, 1990; Miller and Hamblin, 1963; Petersen, 1992). Indeed, piece-rates contracts are a popular remuneration contract among firms using group-based rewards (Blinder, 1990, 1999).

However, in spite their popularity, group piece-rates may not effectively mitigate free-riding problems in team settings. While piece-rates reward all positive levels of a group outcome, the scheme may also provide incentives for workers to shirk. The fact that all workers benefit from the effort of fellow co-workers, members of a production
workgroup may not be as economically motivated to increase effort if increases in effort are reflected by increased pay only on the order of \(1/n\) (\(n = \text{group size}\)). All workers share in the benefit created from the extra effort of a particular worker. Additionally, the fact that piece-rates schemes are continuous and linear might exacerbate shirking, because the marginal benefit of an extra unit of effort is constant, thus, making it difficult to motivate a typical worker to exert greater levels of effort. Unless the marginal benefit of an extra unit of effort exceeds the marginal cost of working, the individual incentive to expend more effort under group piece-rates is minimal. Hence, piece-rates in multi-agent settings may lead to Pareto inferior outcomes (Nalbantian and Schotter, 1997).

4.1 OUTPUT-TARGET SCHEME

The theoretical incentive-contracting literature suggests that the use of an output-target scheme (or target-rate scheme) should be an effective solution to the shirking dilemma in team production settings (Holmstrom, 1982). Analogous to the class of budget-based contracts proposed in the incentive contracting literature in accounting (Demski and Feltham, 1978), the scheme rewards group performance only if the group’s output meets or exceeds a target. If the group’s output target is achieved, then all workers share in the output generated (more likely a bonus). However, if the team falls short of the target, each worker receives a low (penalty) wage. Holmstrom demonstrates that, in a team-setting, the sharing of total output among team members will result in shirking. Incorporating the threat of a \(team\)-imposed penalty for output below a target (i.e., the team shares less than 100% of output) would not yield an improvement, because
team members would simply ignore the penalty ex-post. In contrast, incorporating a principal-imposed penalty (i.e., a low wage) for output below a target provides a sufficient solution to the team incentive problem. Hence, the principal (owner) is needed to enforce the penalty and finance the bonus.

The rationale for believing that this class of incentive contract would motivate greater levels of effort from workers (less free-riding), lies in the discontinuity in pay that exists under the contract, which can change the marginal benefit stemming from an extra unit of effort across workers. For example, assuming that individuals are economically rational, if a particular production team member knows that the team’s target, and larger paycheck, could be ensured through the ‘extra effort’ of that member (as opposed to not reaching the quota and pay being low), then this worker is economically motivated to work harder and to expend the ‘extra effort’ needed to reach the output target. In this instance, the incremental benefit from working strictly exceeds the incremental cost of an extra unit of effort. Working rather than shirking should be a dominant strategy that leads to individual and collective rationality (a Nash equilibrium solution) under this type of incentive contract. The analytical contracting literature has demonstrated that this contract yields Pareto Optimal Nash equilibria (Holmstrom, 1982). Refer to appendix C for a mathematical demonstration.

Recall that the research site adopted an output-target scheme to replace piece-rates of its compensation plan restructuring. Based on the theoretical predictions described above, I expect the output-target scheme to motivate greater levels of effort across production cells and lead to a rise in productivity following the adoption of the incentive.
Furthermore, recall that the scheme’s reward is also linked to maintaining a minimum threshold of finished goods defects (i.e., a quality quota). Thus, we should expect greater efforts toward product quality enhancement; the implementation of the output-target scheme should also lead to improvements in quality (a reduction in defects rate) for the factory.

The above prediction is also supported by empirical evidence from experimental studies in economics (Nalbantian and Schotter, 1997), and most recently in managerial accounting (Fisher, Peffer, and Sprinkle, 2003), which have found that output-target (especially linear-budget) based contracts outperform group piece-rate contracts in group-settings. Budget-based contracts lead to higher group output (less free-riding), and higher group performance relative to group piece-rates (Sprinkle et al., 2003). Similarly, research in sociology has also provided empirical support of the superiority of output-target schemes relative to piece-rates in easing free-riding in group settings (Petersen, 1992).¹

In addition, an output-target (budget) based scheme may motivate greater effort levels across workers because it creates a strong framing effect. Workers may perceive the scheme either as a bonus (gain) when a team reaches the output target, or they may perceive it as a penalty (loss) when the output falls short of the target. Prospect theory

¹ This study examines productivity across firms that use group piece-rates relative to a sample of firms that use a group production-target scheme. While the study does not make a direct test of free riding, the empirical evidence provides some indication that the free-riding problem is less exacerbated for firms using group production-target schemes relative to group piece-rates schemes. Group production-target schemes lead to higher effort levels (as indicated by higher wages), which lead to higher output relative to group piece-rates. However, the author lacked performance data across the two samples of firms and assumed that wages were a function of productivity in these firms. He hypothesized that group target-rate workers earned more on the average than group piece-rate workers because piece-rates are subject to free-rider problems.
(Tversky and Kahneman, 1979) suggests that individuals think about financial outcomes in terms of gains or losses vis-à-vis a reference point rather than as the wealth positions proposed in economic theory. For example, the exact same choice (i.e., bonus) presented or “framed” (whether in terms of gains or losses) in different ways could elicit different decisions or outcomes.\footnote{Prospect theory hypothesizes that people think in terms of gains and losses as opposed to states of wealth, as predicted by expected utility theory. A generalization of expected utility theory in economics, prospect theory suggests that individuals discriminate sharply between gains and losses (Kahneman and Tversky, 1979).}

The scheme could potentially create a framing effect that induces team members to coordinate efforts (i.e., increase effort intensity) and exert peer pressure to avoid losses (i.e., not earning the bonus) when failing to reach the output quota. Under piece-rates schemes team members do not necessarily perceive a sense of financial penalty or loss of potential income when output falls short of management’s target, because each team member is guaranteed a bonus as long as there are positive levels of output. The reward is continuous and each worker receives an equal share of the reward irrespective of his or her contribution (effort) to the group’s output.

Experimental research in management accounting provides empirical evidence that individuals are more likely to accept incentive contracts described as bonuses rather than identical contracts described as penalties. The language differences in the compensation contract also affects what individuals learn from experience, so their relative preference for bonus over penalty contracts can increase with experience (Luft, 1994). This finding provides some support for the conjecture presented above, which suggests that the duality that exists in the incentive contract might induce workers to expend ‘extra effort’ to reach
the output targets to avoid being ‘penalized.’ In this study, when asked how they felt when their cells (i.e., teams) failed to achieve output or quality quotas, production line workers responded overwhelmingly that they felt as though they were being penalized when they failed to achieve the output targets. A sense of penalty was felt particularly keenly among workers who consistently received bonuses.

Another important feature that should bring about performance improvements is the mechanism that was instituted by management to allow performance feedback reporting to each production cell. Recall that each production cell receives feedback at various times throughout the day. With access to this information, team members can assess and regulate their own effort levels. For example, they may decide to coordinate greater levels of effort within their team so that the day’s output target may be reached or exceeded. Additionally, performance feedback should facilitate learning across workers in the same production cell (Bonner and Sprinkle, 2002; Sprinkle 2000).

Furthermore, providing performance feedback to each production cell allows team members to assess in an indirect way whether shirking is taking place. As previously indicated in chapter 3, performance feedback provides a benchmark to compare current to past performance to judge whether the team is working with the same level intensity as in prior periods. Therefore, teams are provided with a direct measure to investigate whether all members are managing the required effort to reach the output quota; and to identify possible shirking among their peers. Under group piece-rates, even if performance feedback is provided in an attempt to detect possible shirking, the intended purpose may not be as successful as desired because the scheme rewards all positive levels of output.
The absence of a target makes it difficult to define appropriate output levels; and, hence, the task of assessing the effect of shirking on the team's reward, is problematical. In summary, I expect the performance feedback mechanism to enhance learning across workers, and aid in reducing the levels of shirking (free-riding) across production cells.

Given all of the conjectures described above, I expect the output-target scheme to outperform the piece-rate scheme in terms of motivating production teams to improve performance. Hence, labor productivity and product quality should improve after the introduction of the output-target scheme.

4.2 Gain-sharing Scheme

Recall that the gain-sharing scheme was introduced with the intent of inducing cooperation within and across production workgroups, as well as a way to encourage information sharing across cells to improve the manufacturing process. The gain-sharing scheme was not independent of the output-target scheme. Rather, the schemes were seen as complements, and introduced almost simultaneously to create synergies across the schemes. The intended goal was to motivate production teams to improve performance through greater effort, improved cooperation, and learning.

While gain-sharing plans are "custom designed" for each firm, a common feature of gain-sharing schemes is that they feature aggregate pay-for-performance incentives,
which link workers’ bonuses to improvements in performance of an entire functional unit (e.g., plant, division, firm).\(^3\)

Gain-sharing schemes distribute the responsibility for organizational improvements among all workers. Just as workers must ratchet-up their effort to realize higher rewards, heightened employee involvement and cooperation must be achieved if the desired rewards are to be realized. Hence, participative decision-making across the workforce is a vital driver of performance stemming from gain-sharing (Bullock and Lawler, 1984; Schuster, 1983; Welbourne and Gomez Mejia, 1995). While the monetary reward might motivate team members to increase their effort levels to achieve the plan’s goals, gain-sharing plans also motivate workers to develop solutions for performance problems. Thus, workers share information so that inefficiencies in the production process (e.g., bottlenecks, spoilage) are identified and corrected. Empirical research on the effects of gain-sharing document a positive impact on labor productivity, quality, and reductions in costs caused by greater levels of effort and worker participation (Rosenberg and Rosenstein, 1984; Schuster, 1983, 1984).

Gain-sharing incentives can also be analyzed in terms of an agency relationship. Specifically, it can be argued that improvements in performance (such as labor productivity) may not only be realized via greater levels of effort and cooperation caused

\(^3\) Gain-sharing plans have been in existence for several decades in the U.S. The first gain-sharing plan, the Scanlon plan, was instituted during the 1930’s. These schemes have been exhaustively examined in industrial sociology, industrial engineering and organizational behavior research. However, empirical studies have documented their effectiveness only recently (Rosenberg and Rosenstein, 1984; Schuster, 1983). Even as the gain-sharing concept embraces numerous types of plans (i.e., Scanlon, Rucker, and Improshare), its basic principle and common features are the same across the various types of gain-sharing plans. That is, the bonus component is designed to reward cooperation and to create a unified interest group working toward common goals. For detailed reviews of research on gain-sharing plans (primarily on the Scanlon plan) see the work of Welbourne and Gomez-Mejia, 1995; Bullock and Lawler, 1984; and Geare, 1976.
by the incentive, but, also, gain-sharing schemes could raise the levels of monitoring across workers reducing free-riding problems. Mutual monitoring under gain-sharing should result from the interdependence between agents (workers) who anticipate a financial incentive based on group outcomes. The hierarchical system of control (e.g., direct supervision from the principal), is replaced by collective monitoring under this incentive mechanism. This is accomplished by shifting the risk equally among all agents. In the words of Welbourne, Balkin, and Gomez-Mejia (1995), "because of their common interests, agents have a stake in the contributions of their peers and as a consequence, they engage in monitoring those whom they are cooperatively linked." Furthermore, this role of mutual monitoring as a control mechanism in a multi-agent relationship is also emphasized by Fama and Jensen (1983) and by Kandel and Lazear (1992). In the words of Fama and Jensen, "when agents interact to produce outputs they acquired low cost information about colleagues, information not available to higher-level agents. Mutual monitoring systems tap this information for use in the control process." Empirical evidence from an organizational behavior field study provides support that gain-sharing increases peer monitoring across workers under certain conditions (Welbourne et al., 1995).  

The gain-sharing scheme employed at the research site was tailored specifically to encourage workgroups to discover ways of improving labor productivity and quality. The primary aim was to improve plant performance through greater levels of worker

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4 The level of monitoring increased under certain conditions. In particular, workers monitored their peers more closely if they were asked to actively participate in the gain-sharing program. It should be noted that increased levels of mutual monitoring did not occur across all groups participating in this study.
participation, cooperation, and involvement across production cells to achieve performance targets in two performance outcomes: productivity and defects rate.

To reinforce the degree of participation across production cells, management provides a performance feedback procedure. With this feedback procedure, each production group is made aware of its own performance, the performances of the other workgroups, and the performance of the manufacturing unit as a whole. Feedback on labor productivity, quality (defects rates), material spoilage, percentage of orders completed on-time, turnover, and absenteeism is provided on a weekly basis for the fifty-one production cells and for the plant as a whole. Performance and variance feedback enhances the rate of learning and facilitates strategy development across workers (Sprinkle, 2000, 2003).

In addition to facilitating the rate of learning across production cells, performance feedback could also serve as a powerful mechanism to exert peer pressure across groups. This information could help assess whether workgroups are working with similar intensity to achieve the performance targets for the unit. Top performer groups could exert pressure on slackers, reducing the level of free-riding across production cells.

4.3 Hypotheses

The combination of the output-target and the gain-sharing scheme should create synergies that motivate production teams to improve performance. Enhancement of performance could be realized through greater levels of team effort, improved team-cooperation, greater mutual monitoring, and by mechanisms to facilitate worker learning
and reduce shirking across production teams. All these factors should lead to improvements in economic performance. Hence, I hypothesize:

**H1:** The implementation of the group performance-based incentive scheme (the output-target scheme and gain-sharing schemes) leads to improvements in labor productivity and product quality.

Furthermore, across time, the mechanisms put in place by management to facilitate learning and strategy development should motivate production teams to learn new ways of improving the manufacturing process and their respective production tasks. Workers should devote part of their efforts to discover ways to improve productivity and quality. If this knowledge is shared across all workers, productivity gains and quality improvements should continue gradually after the implementation of the group incentive plan. The following hypothesis is presented:

**H2:** Productivity and quality gains continue and persist over time after the implementation of the group performance-based incentive scheme.

Additionally, the organizational behavioral literature suggests that gain-sharing compensation plans transform a workforce, wherein workers begin to interface with the whole organization and build a broader understanding of the firm's goals. This ultimately leads to greater organizational commitment and improves workers' morale (Bullock and Lawler, 1984; Geary 1976). Longitudinal field studies have shown that greater organizational commitment from employees leads to improvement of non-economic aspects of firms' performance as well. For instance, Schuster (1983, 1984) found a reduction in voluntary turnover, absenteeism, and grievances after the implementation of a gain-sharing plan. Also, recall that the gain-sharing scheme
replaced an individual attendance bonus. However, to participate in the gain-sharing plan, workers are required to maintain a minimum threshold of absents during the quarter (to be entitled to receive the bonus). Worker absenteeism should also be curtailed by greater peer pressure within each worker production cell. Based on qualitative evidence gathered from various interviews, the levels of absenteeism began to decrease after the adoption of the output-target scheme (refer to figure 6). Workers who witnessed the implementation of the target scheme admitted that peer pressure to prevent absents dramatically increased after the adoption of the scheme because a missed workday usually caused the whole team to forfeit the bonus. Therefore, I expect the levels of absenteeism to decrease following the adoption of the incentive scheme as well. Finally, the mechanisms put in place to facilitate learning across production cells (i.e., learning new ways of improving the manufacturing process) and the improvements in labor productivity, should lead to improvements in manufacturing efficiency. Hence, I expect a reduction in material waste and an increase in the number of production work orders completed and delivered on schedule. In consideration of the above arguments, I offer the following hypothesis:

*H3: The implementation of the group-performance based incentive scheme (the output-target scheme and gain-sharing schemes) leads to a reduction in the rates of absenteeism, turnover, and material waste, as well as an increase in the work order completion rate.*
CHAPTER FIVE

RESEARCH METHODOLOGY

5.1 Data

The firm provided ample and unrestricted access to compensation, financial, and performance data to conduct this investigation. I spent several months at the research site assembling a panel of accounting, performance, and operations data from the three production subunits located at the plant. Even though quantitative data from the firm’s records were readily available in electronic form, the data set was compiled by hand-collecting information contained in numerous company archives. This process was necessary because the firm utilizes three different unlinked software systems in addition to various spreadsheets, which were used to track performance of several metrics. It was impossible to automatically merge pre-existing electronic data files.

Data to calculate the various proxies of labor productivity, production output, and production costs were gathered from accounting records. Employee compensation and incentives data were obtained from payroll records. Data regarding employee headcount, rates of absenteeism, turnover, and hours of training were gathered from human resources. Data regarding defects rate, material waste, and production orders completion rate were gathered from appropriate production subunits. Finally, data regarding

1 While the research site provided access to all sources of production, compensation, financial, and general operations data to conduct this investigation, as is characteristic of most field studies, there were data limitations. For instance, records of daily, weekly, and monthly performance data were available from August 1998, and thereafter, but the sample was truncated and had several missing time-series observations from August through December 1999. Moreover, most data pertaining to control variables were available by month. Monthly data, and in some cases, weekly data of most variables of interest were complete and fully available from January 2000, and thereafter by production subunit and for the plant.
engineering change notifications, incoming parts defects rate, and manufacturing processes were obtained from the engineering department. Refer to Table 1 for a detailed description of pertinent variables of interest.

I also conducted numerous interviews with senior management and with employees at various levels within the organization (e.g., production supervisors, engineers, and production workers) to gather qualitative information about manufacturing operations; and to assess their opinions about the impact of the incentive schemes on performance. Qualitative information proved invaluable during this investigation because it provided contextual support in developing the various hypotheses, and augmented the reliability of the variables in the quantitative data set. Furthermore, interviews with senior management aided in the identification of several manufacturing innovations that could potentially impact manufacturing performance; these innovations are used as controls in the regression models.

Ideally, the best research approach to follow in measuring the performance impact of the group incentives is to examine changes in performance for each production cell pre- and post the scheme's implementation period. This research design has been previously utilized in experimental studies that examined the performance impact of group-based rewards on group performance (Goldman et al., 1977; Young et al., 1983; Drake et al., 1998). This approach requires having enough time-series observations for each production workgroup throughout the study period. The plant monitors daily performance by production workgroup (i.e., labor productivity, defects rate, material spoilage, absenteeism, etc.). However, the data were less complete than desirable (there
were insufficient time-series observations covering the pre-scheme implementation period) and therefore could not be used in the statistical analysis. Physical records of each production cell performance are kept in the company files for a maximum of twelve weeks, and these records are later discarded. Thus, all statistical tests to validate the various hypotheses are conducted with production subunit and plant-level data.

Uninterrupted monthly data on labor productivity, quality, and the remaining variables of interest is complete from January 2000 for production subunits and for the whole plant. Thus, the study period is from January 2000 through August 2002, providing a longitudinal cross-sectional sample of ninety-two monthly observations. There are thirty-two monthly observations corresponding to each of the retail and institutional units, and twenty-eight observations for the commercial unit. For the same time period, weekly observations are also available for labor productivity and for some of the control variables.\(^2\) Hence, all statistical tests are conducted using pooled cross-sectional month-level data

### 5.2 Empirical Methodology

I first test for the hypothesized effects of the incentives by measuring the performance impact of the output-target and gain-sharing schemes in combination. Simply put, the output-target and gain-sharing schemes are treated as a single compensation scheme for two reasons.\(^3\) First, the close window of separation between

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\(^2\) Weekly data is available to construct the various labor productivity proxies; however, there were not enough weekly observations for the proxy to measure quality (defects rate) over the whole sample period.

\(^3\) The implementation dates of the production target scheme and gain-sharing scheme are combined into a single implementation period denoted in the empirical model as group incentives. There are only three
the schemes' implementation periods makes it difficult to separate cleanly the performance impact associated across each incentive. For instance, potential improvements to productivity and quality associated with the output-target incentives are reflected in future periods and these improvements might be picked up instead by the gain-sharing scheme. Furthermore, even if I try to discern the effect on performance across the schemes, the power of the statistical tests is limited, because there are not sufficient time-series observations surrounding the output-target scheme. Nevertheless, I attempt to discern the effect on performance associated with each incentive scheme in subsequent tests. This is described in greater detail shortly.

More importantly, combining both incentives as one group incentive scheme reflects management's plan of treating both schemes in combination during the design and implementation stages of the group-based compensation plan. As previously indicated, management saw the implementation of both group incentives as complements; expecting that both schemes in combination would create synergies and that the various attributes—explicit and implicit incentives embedded in the schemes—would favorably impact economic performance (i.e., productivity, quality, material waste, manufacturing cycle-time) and also non-economic aspects of performance (i.e., absenteeism, turnover).

Labor productivity and quality could be influenced by numerous factors and interventions in the manufacturing process. Failure to control for these factors potentially confounds the effect of the incentives on both performance outcomes. Hence, I control

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months of separation between their respective implementation dates—April 1, 2000 for the output-target scheme and July 1, 2000 for the gain-sharing scheme, so they are combined.
for a number of factors that could drive labor productivity and product quality. Research in economics, which explores sources of productivity at the factory level (Hayes and Clark, 1985), identifies a broad set of managerial policy factors that impact labor productivity on a general level. Based on these findings, and following work by Banker, Field, Schroeder and Sinha (1996), I identify main factors that could influence labor productivity at the research site, and use these as control variables in the regression models. These same factors are used as controls in the model to estimate the effect of the incentives on quality.

Furthermore, I identified specific manufacturing innovations implemented at the plant that could impact manufacturing performance. During the study period the research site experienced a production cell and plant facility redesign, a process for certification under ISO 9000:2000 quality guidelines, and the introduction of a new product in one of the production subunits. I control for these manufacturing interventions in my regression models.

According to Hayes and Clark, there are five categories of managerial policies that influence total factor productivity (and/or labor productivity) at the factory level. These are (1) equipment policies: average age of equipment, average maintenance expense as a percentage of equipment book value, (2) quality policies: process waste, intermediate and final rejects, customer return rates, (3) inventory policies: WIP as a percent of total materials or production cost, (4) work force policies: average age and education of workers, hours of overtime per week, absenteeism rate, hiring and layoff rates, average hours of training per employee, (5) policies affecting confusion: fluctuations in production volume, number of product types produced, number of production orders scheduled, number and type of engineering change orders (ECOs), introduction of new processing equipment.

Banker et al. (1996) examine the impact of high performance work teams on labor productivity and quality within four production lines of an electromechanical production plant. They followed a similar approach to identify general drivers of productivity using the findings of Hayes and Clark to isolate the effect in productivity and quality attributable to the formation of work teams.

The cell/plant facility reorganization and the implementation of various processes to meet requirements for the ISO 9000:2000 certification occurred simultaneously at all three production subunits. Introduction of a new product line occurred at the commercial unit. While these innovations may create an adverse effect on labor productivity and quality in the short term—for instance, a new product introduction might increase the defect rate or might cause a decrease in labor productivity due to divergence in the assembly
1. TESTS OF THE EFFECTS OF THE INCENTIVES ON PRODUCTIVITY AND QUALITY (HYPOTHESIS 1)

To test for the hypothesized effects of the group incentives scheme on productivity and quality, I employ a longitudinal research design that detects changes in performance before and after the adoption of the group incentives. First, I perform univariate t-tests to determine whether there are significant differences in performance before and after the plant instituted the group incentives. Then, I estimate separate OLS regressions with labor productivity and quality (defects rate) as dependent variables as a function of the combined group incentives and the various general factors influencing labor productivity described earlier (Hayes and Clark, 1985).

To test hypothesis one, I estimate a fixed-effects regression model on productivity and quality using monthly observations from the three production subunits. To estimate the fixed-effects model, I pooled all observations from the three production subunits, and dummy variables were used to capture differences in labor productivity and quality (defects rate) across the three production units. Performance for the commercial unit is captured by the intercept. Moreover, to measure the combined effects of the schemes, the observations between April 1, 2000 and June 30, 2000 are eliminated. The effect on productivity and quality of both schemes is measured from July 1, 2000 and thereafter. The following fixed-effects model is estimated separately for productivity and quality:

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process—all of the above innovations are expected to translate into improvements in overall performance, producing a favorable impact in productivity and quality in the long run.
PRODUCTIVITY_{it} or DEFECTSRATE_{it} = \beta_0 + \beta_1 \text{GROUPINC}_{it} + \beta_2 \text{DLHEAD}_{it} + \beta_3 \text{TURNOVER}_{it} + \\
\beta_4 \text{ABSENTEEISM}_{it} + \beta_5 \text{OVERTIME}_{it} + \beta_6 \text{TRAINHRS}_{it} + \beta_7 \text{ECO}_{it} + \beta_8 \text{VOLUME}_{it} + \\
\beta_9 \text{VOLUMEDEC}_{it} + \beta_{10} \text{PLANTRELAYOUT}_{it} + \beta_{11} \text{ISO9000}_{it} + \beta_{12} \text{RETAIL}_{it} + \\
\beta_{13} \text{INSTITUTIONAL}_{it} + \epsilon_{it}. \tag{1}

Where variables for period \( t \) and production unit \( i \) are defined as follows:

\begin{align*}
\text{PRODUCTIVITY}_{it} &= \text{labor productivity}, \\
\text{DEFECTS}_{it} &= \text{defects rate}, \\
\text{GROUPINC}_{it} &= \text{group incentives scheme}, \\
\text{DLHEAD}_{it} &= \text{direct labor headcount}, \\
\text{TURNOVER}_{it} &= \text{turnover rate}, \\
\text{ABSENTEEISM}_{it} &= \text{absenteeism rate}, \\
\text{OVERTIME}_{it} &= \text{overtime hours}, \\
\text{TRAINHRS}_{it} &= \text{hours of training}, \\
\text{ECO}_{it} &= \text{engineering change orders}, \\
\text{VOLUME}_{it} &= \text{production volume (in units of output)}, \\
\text{VOLUMEDEC}_{it} &= \text{production volume decrease}, \\
\text{PLANTRELAYOUT}_{it} &= \text{plant facility and cell redesigned}, \\
\text{ISO9000}_{it} &= \text{ISO 9000 certification}, \\
\text{RETAIL}_{it} &= \text{retail production subunit}, \\
\text{INSTITUTIONAL}_{it} &= \text{institutional production subunit}, \\
\epsilon_{it} &= \text{random error term}
\end{align*}

An explanation as to how each variable is measured and the expected sign of each parameter estimate immediately follows.

The first hypothesis, \( H_1 \), states that productivity (defects rate) increases (decreases) following the implementation of the group incentives scheme. I test this hypothesis by examining the slope shift coefficients \( \beta_i \) (\text{GROUPINC}) in both regression models. A positive (negative) \( \beta_i \) coefficient estimate in the productivity (defects rate) model is interpreted as the incentives scheme having a positive effect on both performance outcomes.
As a test of robustness, I follow a similar approach as Banker et al. 1996 and also estimate the performance impact of the incentives separately on each production subunit. With slight variation from the fixed-effects model, the following OLS models are estimated separately on each production subunit using monthly observations to provide support for hypothesis 1:

\[
\text{PRODUCTIVITY}_u \text{ or DEFECTS}_u = \beta_0 + \beta_1 \text{GROUPINC}_u + \beta_2 \text{DLHEAD}_u + \beta_3 \text{TURNOVER}_u \\
+ \beta_4 \text{ABSENTEEISM}_u + \beta_5 \text{OVERTIME} + \beta_6 \text{TRAINHRS}_u + \beta_7 \text{ECO}_u + \beta_8 \text{VOLUME}_u \\
+ \beta_9 \text{VOLUMEDEC}_u + \beta_{10} \text{PLANTRELAYOUT}_u + \beta_{11} \text{ISO9000} + \psi_u
\]

**DEPENDENT VARIABLES**

The research site's measure of labor productivity (PRODUCTIVITY) variation is equivalent to labor efficiency variance expressed in ratio form: standard labor hours for actual output divided by total paid hours (Horngren, Foster, and Data, 2002). I use this same metric as a proxy for labor productivity. The metric contains some measurement error given that total paid hours may not equal total worked hours in a given period.

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7 As a robustness check, I also estimate seemingly unrelated regressions (SUR) in addition to OLS as in Banker et al. (1996). The rationale in employing seemingly unrelated regressions (SUR) is that SUR accounts for the correlation of residuals across regression models. Because the three units operate in the same physical location, exhibit similar production technologies, share the same level of support from the various functional areas, and are subject to the same managerial policies, it seems logical to assume that a high degree of interdependence exists across the three production units. A high degree of interrelationship across production units creates a causal relationship wherein any changes or events impacting productivity and quality within a particular production unit affect productivity and quality in the other production units. As a result, when estimating separate regressions to measure the impact of incentives on each production subunit, the residuals from each regression equation are likely to be correlated with each other (Kennedy, 1998: pp.169). SUR is estimated as a test of robustness but these results do not differ in any meaningful way from the OLS results. Finally, when I estimate SUR, an additional control variable (NEWPRODUCT) is used in one of the equations to control for the effect of a new product introduction in the commercial unit. A failure to use different variables across the models would give identical coefficient estimates under a SUR and OLS regression procedure (Greene, 2000; Kennedy, 1998).
however the discrepancy is relatively small.\footnote{Total paid hours may not equal total manufacturing (actual worked) hours in a given period. This is because production setup time, employee training time, and lost production time due to production equipment malfunction are included in total production time. The plant does not separate the unproductive time in its computation of labor productivity, and treats total labor hours as productive time. This discrepancy yields some measurement error in the labor productivity outcome. However, the difference is relatively small. A test was performed to detect significant differences between productive and unproductive time in a given month; the difference between paid hours and worked hours is rather insignificant. Furthermore, classical measurement error or 'white noise' in the dependent variable as opposed to measurement error in the independent variable(s), econometrically speaking, should not be a cause for concern in the regression model since it does not violate any of the standard assumptions of the classical linear regression estimation model. This error in measurement is incorporated in the disturbance term (Kennedy 1998: pp. 140).} As a test of robustness, three additional measures of labor productivity are used in re-estimating the various models as part of the sensitivity analysis: (1) total standard hours given the actual output divided by production headcount, (2) units of output divided by production headcount, and (3) total standard hours given the actual output divided by direct labor cost.

Product quality \((\text{DEFECTS RATE})\) is measured as the number of defects (or rejects) in finished goods found during final inspection. The quality calculation automatically adjusts for fluctuations in volume because the number of units inspected increases (decreases) as production rises (declines). Hence, there is no need to deflate the metric to adjust for fluctuations in production volume.

**INDEPENDENT VARIABLE**

Group incentives \((\text{GROUPINC})\) is a dummy variable that captures the change in labor productivity and quality attributable to the effects of the incentives schemes. I expect this coefficient to be positive and significant in the labor productivity model and negative in the product quality \((\text{DEFECTS RATE})\) model, indicating a positive effect on performance associated with the group incentives scheme.
CONTROL VARIABLES

The variable \textit{DLHEAD} controls for fluctuations in production headcount. While an increasing (decreasing) trend in direct labor headcount might yield an increase (decrease) in labor productivity, no predictions are made ex ante about the expected sign of the \textit{DLHEAD} coefficient because a larger number of workers might yield an increase in total standard hours (numerator) but also increase total paid hours (denominator) in the labor productivity ratio.

Turnover rate (\textit{TURNOVER}), absenteeism rate (\textit{ABSENTEEISM}), and hours of training (\textit{TRAINHRS}) also represent workforce policy factors influencing labor productivity. I expect a negative (positive) relationship between \textit{TURNOVER} and labor productivity (defects rate) and the same relationship with \textit{ABSENTEEISM}.\footnote{Both of these variables might have an adverse impact on productivity and quality due to a reduction in manpower (turnover) and as a consequence of low employee morale (absenteeism). Additionally, the research site is located within an industrial and geographic region where employee turnover seems to be historically high relative to their counterparts operating in the U.S. In fact, management acknowledged that the high turnover rate has been problematic and has adversely impacted labor productivity. Hence, I expect \textit{TURNOVER} to have a stronger negative effect on labor productivity and quality than \textit{ABSENTEEISM}. Hayes and Clark (1985) found evidence of a negative relationship between labor productivity and absenteeism for a pooled sample of factories, but also found contrary evidence when the analysis was conducted for each factory. A greater rate of absenteeism leads to increases in total factor (and labor) productivity in separate regressions by plant. Similarly, they found mixed evidence for the relationship between productivity and turnover on an individual plant basis (Hayes and Clark, 1985: pp. 174-177).} However, \textit{TURNOVER} may also provide insights as to whether the incentives cause a selection effect on workers (Chow, 1983; Waller and Chow, 1985). A positive coefficient for \textit{TURNOVER} could indicate a selection effect—the less skilled workers leave the firm after implementation of the incentives schemes and the more skilled remain with the firm.

No prediction is made ex-ante for the effect of training hours (\textit{TRAINHRS}) on productivity and quality. While worker training should lead to improvements in labor
productivity, an immediate positive relationship may not be realized. A significant amount of the total training hours reflect new employee training that may not add incremental value because these hours may not be spent in production. Similarly, some of these hours represent training for on-line workers to reduce mistakes made during the assembly process. However, these short-term losses in labor productivity may be off-set by future gains that are driven by new knowledge and techniques aimed at improving the manufacturing process acquired during process improvement training.\textsuperscript{10}

The effect of \textit{OVERTIME} on labor productivity is ambiguous because the amount of overtime impacts both total standard hours and total paid hours in the labor productivity ratio. Prior evidence has shown a quadratic relationship between productivity and overtime. Productivity tends to increase for small increases in overtime up to a point, but beyond that point the association is reversed, with greater amounts of overtime leading to decreases in labor productivity (Hayes and Clark, 1985).

Engineering change orders (\textit{ECO}) represent management policies relating to confusion. \textit{ECO} measures changes in labor productivity and quality driven by changes in product and manufacturing process specifications. Some of these changes pertain to adjustments in raw materials requirements, modifications for a particular production task, and changes in machinery and equipment used in production. The effect on productivity

\textsuperscript{10}Data on hours of training is not broken down by training category, however an estimate by the human resources department indicates that hours relating to induction training time given to new employees exceed hours of training for process improvements and for corrective measures for the years of 2000 and 2001. Induction training time represents 90\% and 60\% of total training time for 2000 and 2001 respectively. Training data through August of 2002, indicates that this relationship is reversed in 2002 where 60\% of the total accumulated amount of training hours are spent on process improvements and corrective measures, and 40\% is spent on induction training for new employees.
and quality depends on the type of engineering change notification. *ECOs* related to changes in product specification (i.e., materials changes) affect product quality, whereas *ECOs* related to manufacturing process changes affect labor productivity. While in general *ECOs* have a favorable impact on performance, there is also evidence that *ECOs*, at least in the short-run, have a negative impact on labor productivity because process changes disrupt the stability of factory operations (Hayes and Clark 1985). After careful exploration of *ECO* documentation and discussions with process engineering personnel, I conclude that most *ECOs* are related to material changes and do not disrupt the normal course of manufacturing operations during their implementation impact. Therefore, I expect *ECOs* to primarily impact product quality, but I also anticipate a positive impact on labor productivity. I predict a positive (negative) relationship between the number of *ECOs* and productivity (defects rate).

Labor productivity is quite sensitive to changes in production volume and especially to decreases in volume. I control for fluctuations in volume in two ways. The variable *VOLUME* is a continuous variable and it controls for the effects of fluctuations in production volume across time. Volume decreases (*VOLUMEDEC*) is a dummy variable that controls for abnormal decreases in production volume. Abrupt decreases in production volume may aggravate measurement error in the labor productivity proxy. If there are abrupt decreases in production volume and management does not swiftly adjust
its production manpower (labor capacity) in accordance to fluctuations in output demand, the labor productivity measure would be understated and biased downward.\footnote{A failure to swiftly adjust production labor capacity downward in response to large decreases in production volume, understates the labor productivity ratio because the numerator in the equation (total standard hours based on the actual output for the period) is significantly reduced but the denominator (total actual paid hours) does not change when labor capacity is unadjusted.}

Discussions with management revealed significant improvements in manufacturing cycle time efficiency (faster completion of production work orders). These improvements are attributed to an efficient redesign of production cells that consolidated production tasks and permitted group members to more effectively communicate to solve production and quality problems more rapidly. Furthermore, a reorganization of the plant reduced idle space across workstations. This permitted raw materials and finished goods to flow more efficiently across the plant. The potential impact of this change is captured by a dummy variable (PLANTRELAYOUT) in the model. I predict a positive (negative) relationship for labor productivity (defects rate) and PLANTRELAYOUT.

The facility was certified under ISO9000:2000 quality standard guidelines in December 2001. However, to meet all requirements for certification, the research site adopted several internal procedures and met numerous operations requirements that were implemented in stages. Most practices to meet ISO 9000 guidelines were in place by July 2001. Benefits in quality and productivity occurred thereafter and these are captured by a dummy variable (ISO9000) in the regression model.\footnote{Among the various procedures that should be in place before receiving ISO9000 certification, is a comprehensive preventive maintenance system of factory machinery and equipment, certified quality inspectors under ISO guidelines, statistical process control procedures to measure quality, and an integrated...} I expect a positive (negative) relationship between the ISO9000 variable and productivity (defects rate).
2. **Tests of the Persistence of Productivity and Quality Improvements (Hypothesis 2)**

To test whether productivity and quality improvements persist over time, and whether the incentives effects on performance are not simply due to a Hawthorne effect (Banker, Lee, and Potter, 1996; Roethlisberger, 1977), I employ an econometric model similar to that of model (1).\(^{13}\) However, I replace the indicator variable \(GROUPINC\) with a continuous variable to represent the effects of the incentive scheme over time. The variable \(POSTINCTREND\) is measured as the number of months since the implementation of the group incentive scheme (e.g., post-incentive time trend) and assumes a value of zero for the months before the implementation of the scheme.

If the Hawthorne effect is driving performance, gains in productivity and quality are expected to diminish or disappear over time. This would be indicated by a negative (positive) \(POSTINCTREND\) coefficient estimate in the productivity (defects rate) model. Otherwise, if performance improvements persist and increase over time as predicted by hypothesis 2, the \(POSTINCTREND\) coefficient estimate should be positive (negative) in the productivity (defects rate) model.\(^{14}\)

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\(^{13}\) The Hawthorne effect (also referred as a placebo effect) would suggest that improvements in performance during the early stages of the incentive plan may be driven by factors other than the scheme, such as the incentive being a novelty to workers, thus, causing them to respond favorably during the early stages of implementation, or, alternatively, that workers are given special attention during the implementation stages so that they feel motivated to improve performance.

\(^{14}\) The \(POSTINC\) variable could also be included in model 1. This would allow me to test hypotheses 1 and 2 simultaneously. However, I opted to test the hypotheses separately with a continuum of the same model.
3. **Tests to Discern the Effects on Productivity and Quality Across the Two Schemes**

To distinguish the effects on performance of the output-target scheme from the effects of the gain-sharing scheme, I estimate an OLS model similar to model (1), however, with the following modification: I replace the indicator variable *GROUPINC* with two indicator variables, *TARGET* and *GAINSHARING*, to capture each scheme's performance. The following OLS regression model is specified to separate the effects on productivity and quality of the output-target scheme from the gain-sharing scheme:

\[
\text{PRODUCTIVITY}_i \text{ or DEFECTSRATE}_i = \beta_0 + \beta_1 \text{TARGET}_i + \beta_2 \text{GAINSHARING}_i + \beta_3 \text{DLHEAD}_i + \beta_4 \text{TURNOVER}_i + \beta_5 \text{ABSENTEEISM}_i + \beta_6 \text{OVERTIME}_i + \beta_7 \text{TRAINHRS}_i + \beta_8 \text{ECO}_i + \beta_9 \text{VOLUME}_i + \beta_{10} \text{VOLUMEDEC}_i + \beta_{11} \text{PLANTRELOCATION}_i + \beta_{12} \text{ISO9000}_i + \mu_i
\]

The variable *TARGET* takes the value of one for the period of April 2000 through June 2000, zero otherwise, and the variable *GAINSHARING* takes the value of one for the period of July 2000 and thereafter, zero otherwise. The model’s parameters are estimated using 92-month observations; no month observations are removed across the schemes’ implementation dates as was previously done in all the regression models that measured the combined effects of both incentives schemes. Positive (negative) \( \beta_1 \) and \( \beta_2 \) coefficient estimates in the labor productivity (defects rate) model would indicate that each incentive scheme has a positive effect on performance. However, the results from this model should be interpreted with caution since there are a limited number of observations surrounding the implementation period of the output-target scheme (six observations prior and eight observations after the implementation period). Moreover, potential improvements in productivity and quality attributable to the output-target
scheme may be realized in future periods and this may be picked up instead by the gain-sharing scheme.

Moreover, as a check of robustness, the following alternative specification is estimated:

$$\text{PRODUCTIVITY}_i, \text{or DEFECTSRATE}_i = \beta_0 + \beta_1 \text{TARGET}_i + \beta_2 \text{GAINSHARINGBONUS}_i$$

$$+ \beta_3 \text{DLHEAD}_i + \beta_4 \text{TURNOVER}_i + \beta_5 \text{ABSENTEEISM}_i + \beta_6 \text{OVERTIME}_i + \beta_7 \text{TRAINHRS}_i$$

$$+ \beta_8 \text{ECO}_i + \beta_9 \text{VOLUME}_i + \beta_{10} \text{VOLUMEDEC}_i + \beta_{11} \text{PLANTRELAYOUT}_i + \beta_{12} \text{ISO9000}_i + \kappa_i$$

This model is analogous to model (3) but instead of using two indicator variables, it combines an indicator variable with a continuous variable to separate the performance impact across the schemes. The variable \text{TARGET}, as previously defined, takes the value of one for the period of April 2000 through June 2000, zero otherwise, and the variable \text{GAINSHARINGBONUS} represents the bonus (in dollars) earned from the gain-sharing scheme in a particular period. Jointly, the variables may isolate the effects of the output-target scheme. The rationale behind this procedure is for the continuous variable \text{GAINSHARINGBONUS} to extract much of the change in productivity (or quality) attributable to the gain-sharing scheme, thus, allowing the indicator variable \text{TARGET} to absorb whatever change is left in performance. The $\beta_i$ coefficient estimate should capture the effect in productivity (quality) attributed to the output-target scheme. To estimate the effects of the gain-sharing scheme, the same model is re-estimated but both of the variables are inverted. The variable \text{TARGETBONUS} should soak out the effect
attributable to the output-target scheme, leaving whatever change is left in productivity (quality) to be picked up by the GAINSHARING variable.  

4. TESTS OF THE EFFECTS OF THE INCENTIVES SCHEMES ON ABSENTEEISM, TURNOVER, AND OTHER PERFORMANCE OUTCOMES (HYPOTHESIS 3)

To examine whether the group incentive scheme is associated with reductions in rates of absenteeism and turnover as predicted in hypothesis 3, as well as a reduction in material waste and a rise in the production orders completion rate, the following OLS models are estimated:

\[
\text{ABSENTEEISM} = \gamma_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{DLHEAD}_a + \nu_a \\
\text{TURNOVER} = \gamma_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{DLHEAD}_a + \gamma_3 \text{REGIONALTURNOVER}_a + \nu_a \\
\text{MATERIALWASTE} = \gamma_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{PRODUCTIVITY}_a + \gamma_3 \text{DEFECTS}_a + \epsilon_a \\
\text{COMPLETIONRATE} = \gamma_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{PRODUCTIVITY}_a + \nu_a 
\]

Where REGIONALTURNOVER represents the industry’s turnover rate within the geographic region where the facility operates, MATERIAL WASTE is the dollar amount of material spoilage deflated by total standard manufacturing costs in a given period, and COMPLETION RATE equals the percentage of production work orders completed on schedule. The rest of the variables have been defined previously.

A negative \(\gamma_1\) coefficient estimate in the first three regression equations would indicate that the incentive scheme is associated with a reduction in the rates of absenteeism and turnover, and material waste. Likewise, a positive \(\gamma_1\) in the fourth
equation would suggest an improvement in the rate of production orders manufactured on schedule. This may also be interpreted as a measure of manufacturing cycle-time efficiency.\(^\text{16}\)

5. **Tests to Measure the Cost Effectiveness of the Group Incentive Plan**

The implementation of the group-based compensation plan could increase direct labor costs. To measure whether the incentive scheme has been cost effective, that is, whether the marginal improvements in labor productivity off-set the incremental labor cost per unit of output, I perform univariate t-tests to compare direct labor cost before and after the introduction of the group incentives scheme. Given the large degree of product mix heterogeneity, deflating total labor cost by units of output may provide an inaccurate representation of labor cost per unit. Therefore, direct labor cost is adjusted for fluctuations in production volume by using three alternative variables: (1) total standard hours, (2) total manufacturing costs at standard, and (3) production headcount.

To further explore the relationship between the incentive scheme and direct labor costs, I investigate how potential improvements in labor productivity impact direct labor costs, and whether the incentive scheme coupled with the improvements in labor productivity translate into lower labor costs. The following OLS model is estimated to test this conjecture:

\[
DIRECT \text{ LABOR COST (deflated)} = \theta_0 + \theta_1 \text{GROUPINC}_i + \theta_2 \text{PRODUCTIVITY}_i + \kappa_i \quad (6)
\]

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\(^{16}\) Indeed, the plant uses the percentage of work orders manufactured and delivered on time as a proxy to measure manufacturing cycle-time efficiency.
Where *DIRECT LABOR COST* equals total direct labor cost deflated either by standard hours, total manufacturing cost at standard, or production headcount. A negative (positive) $\theta_i$ coefficient estimate would suggest a reduction (increase) in labor costs, implying that the incentive scheme has been cost effective. Likewise a negative $\theta_i$ coefficient would suggest that the incentive coupled with the improvements in labor productivity is associated with a decrease in labor costs over time. This test is motivated by recent developments in the managerial accounting area that suggest that improvements in non-financial measures of performance (i.e., labor productivity) should lead to the enhancement of future financial performance (i.e., lower productions costs) [Johnson and Kaplan, 1987; Kaplan and Norton, 1982].
CHAPTER 6

RESULTS

This chapter describes the results of statistical analyses employed to provide empirical support for the three hypotheses discussed in the previous chapters, and to test the cost effectiveness of the group incentive plan. Hypothesis one (H1) predicts that the combination of the output-target scheme and the gain-sharing scheme is associated with improvements in labor productivity and product quality. The empirical findings are robust in support of hypothesis one. Both performance outcomes, labor productivity and product quality, improved following the adoption of the group performance-based incentive scheme. Moreover, improvements in productivity and quality gradually increase and persist over time, indicating that the effects of the incentive scheme are not driven by a Hawthorne (or placebo) effect. This provides empirical support for hypothesis two. Hypothesis three predicts that the group performance-based incentive scheme is also associated with a reduction in the rates of absenteeism, turnover, and material waste, and with an increase in the work order manufacturing completion rate. This hypothesis is partially supported by the regression results, suggesting a reduction in absenteeism and turnover. However, the hypothesis is not supported with respect to reduction in material waste. Finally, a rise in the work order completion rate is observed following implementation of the incentive scheme.

Results from the various statistical tests performed to measure the cost effectiveness of the incentive scheme suggest that while total direct labor production costs (direct labor
production costs plus the incentives) have increased after the implementation of both incentives, direct labor production cost per standard hour of output decreases after the scheme’s implementation, and contrasting this result, direct labor production cost per unit of output rises for the after period; thus providing mixed evidence of whether the scheme has been cost effective. Finally, there is no change in the average worker’s compensation after implementation.

The balance of this chapter provides a thorough description of these findings, as well as sensitivity analyses conducted to rule out possible alternative explanations for these findings.

6.1 DESCRIPTIVE STATISTICS

Table 1 summarizes descriptive statistics for all variables of interest. The data is listed for the pooled sample and by manufacturing unit. Panel A reports statistics for the pooled sample comprising the three production subunits. The mean production subunit monthly labor productivity is 81.5% and is close to the median (88.2%). However, there appears to be a large variation in labor productivity throughout the sample period as indicated by a standard deviation of .19 (or 19%). The average monthly finished goods defects rate is 1,319.

Panel B reports the results of F-tests that are performed to detect significant differences in the means of each performance outcome and control variable across the three production subunits. These results indicate that other than labor productivity, which shows a significant difference, there are no significant differences in the defects rate,
absenteeism, employee turnover, and work order completion rates across the three production subunits. These results are consistent with management’s perception that despite differences in size and some degree of divergence in production technology, the three subunits have realized similar improvements in performance over time. However, significant differences were detected for most of the control variables due to size differences across the three units.¹

Panel C reports the results of t-tests; comparing differences in means across the various performance outcomes before and after implementation of the incentive scheme. These results indicate a statistically significant increase (decrease) in labor productivity (defects rate) after implementation of the incentives. There are also statistically significant decreases in the rates of absenteeism, turnover, and material waste, as well as a rise in the work order completion rate after implementation. All control variables also exhibit a statistically significant mean change after implementation.

Table 2 presents results of univariate correlations for the pooled sample. The variable measuring the impact of the incentives scheme (GROUPINC) is positive and significantly correlated with labor productivity ($p<.01$), and negatively correlated with defects rate ($p<.01$). Similarly, a negative correlation is observed between GROUPINC and absenteeism and turnover, while a positive correlation is observed between

¹The RETAIL and COMMERCIAL units are similar in size; the INSTITUTIONAL is the smallest of the three units. Untabulated results of t-tests comparing differences in means across two units at a time reveal that the RETAIL and COMMERCIAL units are indeed comparable in size. There were differences in production volume and training hours, but no significant differences were detected in the rest of the control variables across these units. Conversely, when comparing means of the RETAIL and COMMERCIAL units respectively with those of the INSTITUTIONAL unit, significant differences in means for most variables were detected.
GROUPINC and the work order completion rate (COMPLETION). The correlation between GROUPINC and material waste is not significant.²

Results derived from descriptive statistics suggest that improvements occurred in productivity, quality, absenteeism, and turnover following implementation of the incentive scheme. These findings furnish partial empirical support for the three hypotheses.

6.2 REGRESSION RESULTS

I examined the data for violations of ordinary-least square (OLS) assumptions, the residuals for outliers, and the presence of multicollinearity among the predictor variables. With the presence of interconnected production units coupled with the use of time-series data, it is likely that the presence of serial correlation across the residuals and heteroscedasticity could yield inefficient estimates of the parameters or produce biased and inconsistent standard errors of the parameters' estimates.

After estimating separate fixed-effects regression models for productivity and defects rate (equation 1) using raw data, no significant degree of multicollinearity is detected among the variables. No potential problems with heteroscedasticity, serial correlation across residuals, or non-normality in the distribution of errors is detected in the productivity regression model.³ However, the tests revealed the presence of non-

² Separate univariate correlations are also estimated by separating the observations between a pre-scheme and post-scheme period, and similar correlation coefficients are found for the post scheme's period.
³ White's tests are performed to check for heteroscedasticity. To augment the reliability of my results, I also perform a Lagrange Multiplier (LM) test to detect heteroscedasticity. The Shapiro-Wilk and Jarque-Bera (JB) tests are employed to test for normality in the distribution of residuals. To test for serial-correlation among residuals, I perform a Durbin-Watson, as well as a Breusch-Godfrey's test. The DW
constant variance in the defects model, errors not being normally distributed, and the presence of autocorrelated residuals in the quality (defects rate) model. However, a simple logarithmic transformation of the defects rate data eliminated the statistical problems that were encountered in the regression using the untransformed data.

1. RESULTS OF THE EFFECT ON PRODUCTIVITY AND QUALITY (HYPOTHESIS ONE)

Hypothesis one predicts that productivity gains and improvements in product quality (a decline in finished good defects) occurred after the implementation of the group incentives. If this is the case, the parameter estimate $GROUPINC$ should be positive (negative) in the productivity (defects rate) regression model. Table 3 summarizes the results from estimating the fixed-effects model from equation (1) to test this hypothesis. The first column reports the empirical results from estimating the effects of the scheme on labor productivity. The parameter estimate is positive ($\beta = .1420$) and statistically significant at the one percent level, indicating that after controlling for numerous factors impacting labor productivity, the incentive scheme leads to an average increase in labor productivity of fourteen percentage points after the scheme’s implementation. While I am not able to attribute to specific factors as the driver of productivity (i.e., greater effort, attraction of better skilled workers, improved peer monitoring, workers learning new way to improve productivity, improved team cooperation), these results are consistent with prior research findings which document a statistic ($DW = 1.88$) is close the cut-off value of two in the productivity model to rule out the presence of serial correlation. Finally, to check for near perfect multicollinearity among the predictors, I use the variance inflation factor (VIF) and condition index. None of the variables exceed the maximum condition index cut-off value of thirty to conclude the presence of multicollinearity among predictors.
positive effect of budget-based contracts on group performance (Nalbantian and Schotter, 1997; Petersen, 1992; Sprinkle et al., 2003).

Furthermore, several of the control variable coefficient estimates related to workforce policies are statistically significant. The coefficient on changes in production headcount ($DLHEAD$) is positive ($\beta_2 = .0006$) and statistically significant ($p = .07$) although small, suggests that each additional production employee leads to an increase in labor productivity of .06 percentage points, holding all other factors influencing productivity in the regression model constant. If the new incentive plan is effective in sorting employees by attracting more productive and suitable workers for a team production environment (i.e., team players), then worker turnover after the implementation of the incentive scheme should be higher. However, the results do not support this conjecture as indicated by the parameter estimate $TURNOVER$, which is negative ($\beta_3 = -1.64$) and statistically different from zero at the one percent level, suggesting that a change equal to one standard deviation in turnover leads to a reduction in labor productivity of approximately 6.5%. Also, as predicted, the coefficient $ABSENTEEISM$ is negative ($\beta_4 = -2.95$), but only marginally significant ($p = .06$), suggesting that for a one standard deviation change in the rate of absenteeism, labor productivity decreases on average by 2.4%.

\[\text{When measuring the economic impact on productivity caused by changes in the rates of absenteeism and turnover, the effect is computed in terms of one standard deviation change in either absenteeism or turnover as opposed to a one unit change in order to grasp a better interpretation of the coefficient estimate. Productivity, turnover, and absenteeism are expressed in percentage terms, thus making it more difficult to interpret the results of the coefficient estimate. Hence, the effect on productivity is calculated by multiplying each coefficient estimate by the respective standard deviation.}\]
Both of these results are consistent with prior findings exploring sources of labor productivity at the factory level. Higher levels of absenteeism and turnover in the workforce lead to a decline in labor productivity. Furthermore, these findings also provide empirical support of the importance of these workforce variables as relevant drivers of labor productivity at the factory level (Clark and Hayes, 1985).\footnote{While research in economics has explored the effects on numerous factors (i.e., capital, labor) on total physical productivity, little empirical evidence exists about sources of labor productivity at the factory level (Clark and Hayes, 1985).}

Furthermore, management’s perception about potential improvements in productivity stemming from the physical redesign of the manufacturing facility and its internal production cells is supported by a positive ($\beta_{PLANTRELAYOUT} = .1052$) and highly significant ($p = .0006$) coefficient for \textit{PLANTRELAYOUT}. The economic interpretation of this result suggests that the facility and cell redesigned leads to an average rise in productivity of 10.5 percentage points. Engineering change orders also has a favorable but minor impact on labor productivity. The \textit{ECO} coefficient estimate is positive ($\beta_{ECO} = .007$) and statistically significant at the ten percent level, indicating that each manufacturing process and material component change notification yields on average a 0.7% rise in labor productivity.

The second column of table 3 summarizes the regression results from estimating the effects of the incentive on the level of finished goods at the three production subunits. The parameter estimate \textit{GROUPINC} coefficient is negative ($\beta_{GROUPINC} = -2.14$) and statistically significant at the one percent level ($p < .0001$), suggesting an average decrease of 21.4% in the rate of finished goods defects after implementation of the group based incentive plan.
These findings suggest that both incentive schemes (output-based scheme and gain-sharing) have effectively motivated workers (and production teams) to enhance product quality.

The findings also support some of the coefficient sign predictions for the control variables. The ABSENTEEISM coefficient is positive but marginally significant ($p<.10$), suggesting that high rates of absenteeism negatively impact product quality. The effect of the manufacturing facility redesign had a positive impact on product quality. The PLANTRELAUOUT coefficient estimate is negative ($\beta_{10}=-.7547$) and significantly different from zero at the five percent level, suggesting that quality defects decreased on average by 75% after the facility and cell redesigned.

The ISO9000 coefficient is negative ($\beta_{11}=-.819$) and statistically significant at the one percent level, implying that defects decreased on average by 82% after the adoption of all procedures linked to the ISO 9000 certification. These findings support the presumption that all necessary procedures and practices linked to an ISO certification indeed lead to improvements in product quality.\(^6\)

In summary the results shown in table 3 indicate that the combination of the output-target and gain-sharing schemes is associated with improvements in labor productivity and product quality. Plant-wide labor productivity increased by 68% on average and the finished goods defects rate decreased by an average of 95% after the introduction of the

\(^{6}\)As previously indicated in chapter 5, among the various procedures to receive ISO9000 certification are a comprehensive preventive maintenance system of factory machinery and equipment, certified quality inspectors, and statistical process control procedures.
group incentive scheme. These results provide empirical support to validate hypothesis one.

While I cannot distinguish the specific factors leading to the improvements in productivity and quality, these findings suggest that this combination of schemes has effectively motivated production teams to improve performance (and minimize free-riding) in this particular setting. These findings provide empirical support for the predictions of the analytical contracting literature on output-target (budget) based scheme’s effectiveness in reducing moral hazard (i.e., minimize free-riding) and in promoting efficiency in team-production settings (Holmstrom, 1982). Further, the evidence also supports the conjecture from the organizational behavior literature suggesting that gain-sharing plans enhance cooperation and encourage mutual monitoring across groups to minimize free-riding, thus both leading to improvements in group performance.

To augment the robustness of the fixed-effects pooled sample results, I also examine the effects on productivity and quality by production subunit. The same OLS equation is estimated separately for each of the three production subunits. Results from the individual regressions (untabulated) show an increase in productivity for all three

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7 Data limitations preclude me from finding what causes the favorable impact on performance: greater effort levels, increased monitoring within and across production cells, workers findings new ways to improve the manufacturing processes (learning), greater levels of cooperation, the framing of the reward, and less free-riding occurring in each production cell. I cannot discriminate between the above competing explanations.
units, and a decrease in the defects rate for two of the three units, after implementation of
the incentive scheme.8

2. RESULTS OF THE PERSISTENCE OF PRODUCTIVITY AND QUALITY IMPROVEMENTS
(HYPOTHESIS TWO)

Hypothesis two predicts that productivity and quality gains do not plateau and that
these improvements persist over time. Table 4 summarizes the results from estimating
the effects of the incentive schemes on productivity and quality across time. Recall that
the model estimated for each dependent variable is analogous to the model used to test
hypothesis one; however, the indicator variable GROUPINC (the variable measuring the
impact of the incentives scheme) is replaced by a continuous variable POSTINCTREND
to capture the post-incentive scheme time trend. The POSTINCTREND is positive
($\beta_1=.0085$) and significant at the five percent level in the productivity model, and
negative ($\beta_1=-.1451$) and significant at the one percent level in the defects rate
regression, indicating that labor productivity and (defects rate) increase (decrease) on
average by 0.0085 and 14 percentage points every month after the scheme’s
implementation. This suggests that the improvements in productivity and quality are not
driven by a Hawthorne effect that levels off shortly after the adoption of the scheme.
These performance improvements may also be observed in figures 4 (productivity) and 5
(defects rate). Productivity increases gradually after the scheme’s implementation and

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8 The GROUPINC coefficient was statistically different from zero at the one percent level for each of the
three production units in the productivity regressions. In the DEFECTS regression, the GROUPINC
coefficient is significant only for the RETAIL and INSTITUTIONAL units. However, these results should be
interpreted with caution given the limited number of observations when estimating each equation. The
small number of monthly observations may cause a loss in statistical power.
continues to increase for several months afterwards. An abrupt decline in finished goods defects is also observed in the plant immediately after implementation and a gradual (but less attenuated) reduction in defects is also observed in the months following the scheme's implementation.⁹

In sum, these results provide empirical support for hypothesis two, suggesting that the incentive effects on productivity and quality persist throughout time. Improvements in both performance outcomes continue for several months after the adoption of the incentive plan.

3. TESTS TO DISCERN THE EFFECTS ON PRODUCTIVITY AND QUALITY ACROSS SCHEMES

Table 5 summarizes the results from estimating equation (3) to discern the impact on productivity and quality across schemes. The coefficient \(TARGET\) is positive \((β_1=0.0276)\) but statistically insignificant in the productivity model. In contrast, the coefficient \(GAINSHARING\) is positive and statistically significant \((β_2=0.1143, p=0.004)\), suggesting that the gain-sharing scheme is associated with an average rise in labor productivity of 11 percentage points after the implementation. The results from estimating the defects rate model indicate a significant reduction in finished goods.

⁹ In figure 4, productivity begins to exhibit an increasing trend on the second month after implementation of the output-target scheme (observation 5, May 2000), and this upward trend continues over time throughout the study period. There is also an abrupt decrease in defects rate (figure 5) also in May 2000, and the decreasing trend continues throughout time. An explanation as to the abrupt decrease in productivity during the implementation period of the output-target based scheme (April 2000) is due to the transfer of operations of a new product line to the commercial manufacturing unit. Numerous changes in operations were executed to accommodate the new product line; additionally, production teams were transferred to the new manufacturing operation, thus, disrupting the normal course of operations and negatively impacting labor productivity and product quality.
defects attributable to each scheme. The estimated parameters \( TARGET (\beta_1=-1.315) \) and \( GAINSHARING (\beta_2=-2.172) \) are both statistically significant at the five and one percent levels of significance respectively. However, these results should be interpreted with caution given the limited number of observations surrounding the pre and post-implementation periods of the output-target scheme. This limits the power of the statistical tests.\(^\text{10}\)

An alternative specification of model (3) is also estimated to isolate the effect of the output-target scheme from the effect of the gain-sharing scheme. As indicated in chapter five, instead of using two dummy variables to measure each scheme's effect, equation (3) is estimated using a dummy variable in combination with a continuous variable equal to the respective monetary bonus of each scheme. These results (untabulated) are similar to the ones reported in table 5, indicating improvements in quality attributable to each scheme individually and improvements in productivity associated with gain-sharing.

4. RESULTS OF THE EFFECTS ON ABSENTEEISM, TURNOVER, MATERIAL WASTE, AND WORK ORDER COMPLETION RATE (HYPOTHESIS THREE)

Hypothesis three predicts that the new incentives should lead to a reduction in the rates of absenteeism, turnover, and material waste, as well as a rise in the work orders completion rate. These results are summarized in table 6. The parameter estimate \( GROUPINC \) in the first column is negative \( (\gamma_1=-.009) \) and significant at the one percent level, suggesting a reduction in the rate of absenteeism for the after period. Likewise, the

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\(^{10}\) There are only six observations prior and eight observations post the implementation period. This limits the power of the statistical tests. Moreover, potential improvements in productivity and quality attributable to the output-target scheme may be realized in future periods, and this may be picked up instead by the gain-sharing scheme.
GROUPINC coefficient estimate (columns 2) in the turnover model is negative ($\gamma_1 = -0.0298$) and statistically significant at the one percent level, suggesting an average reduction in the rate of voluntary turnover of 0.03 percentage points following the scheme's implementation. Trends in the rates of absenteeism and turnover can also be observed in figures 6 and 7 respectively. Absenteeism and turnover for the plant gradually subside in the months following the scheme's implementation; both rates are less than the regional industry average. Additional analyses using descriptive statistics are performed to quantify the impact of the incentives on absenteeism and turnover. On average, the rate of absenteeism and turnover for the plant as a whole decreases by 47% and 67% respectively from the pre scheme period.

The decline in the rate of absenteeism could have been driven by several factors. The gain-sharing scheme replaced an individual attendance bonus. Nonetheless, workers still have a strong incentive to work regularly because of the requirements of the cash bonus from gain-sharing. This could be a possible explanation of the observed reduction in absenteeism.

Absenteeism could also be curtailed by peer pressure within each production cell. This assessment is supported by qualitative evidence I gathered from numerous interviews with production workers. Co-workers within a production team can exert peer pressure and formally request a transfer or dismissal from the team. The level of peer pressure might have increased following implementation of the output-target scheme. When a team member fails to show up for work, the probability increases of losing the cash bonus for output. As a final point, a reduction in the rates of absenteeism is
consistent with prior findings that causally link improvements in absenteeism with the use of gain-sharing plans (Schuster 1983, 1984).

A reduction in the rate of turnover could also be linked to several extraneous factors. The maquiladora industry as a whole experienced a significant downturn in September of 2000 and the downturn continued for several months afterward. Also, there was a significant economic downturn in the geographic region where this facility operates. These factors brought major layoffs in several manufacturing facilities across the region, increasing the level of unemployment and possibly driving down the rate of voluntary turnover. However, although the events could confound the effect of the incentive scheme with respect to turnover, figure 7 shows that the turnover rates for the plant decreased substantially after implementation. While turnover is a historically significant problem in this industry, the turnover rate for the plant decreased substantially following the adoption of the output-target scheme (May 2000). Although the decline in turnover is predominantly more profound for the months during the region’s economic contraction (i.e., September 2000 through December 2000), the reduction in turnover is observed gradually across the months after the schemes are implemented. Moreover, it may also be observed that while the regional turnover increases for some months after the scheme’s implementation, the rate of turnover for the plant instead declines (refer to observations 19 and 27).

Overall, these results suggest that the incentive scheme has effectively mitigated absenteeism and turnover in the plant, thus, providing empirical support for hypothesis three.
The regression results that estimate the effects of the compensation scheme on material waste (table 6, column 3) suggest that the scheme is not directly associated with a reduction in material waste. This result fails to provide empirical support for hypothesis three. However, a significant reduction in material waste could be linked to improvements in labor productivity. The \textit{PRODUCTIVITY} coefficient is negative and statistically significant at the one percent level, suggesting that for a one unit (percentage) increase in labor productivity the rate of material waste in the factory decreases on average by 3%. Improvements in the rate of material waste represent an average reduction of 44% in material waste after the adoption of the incentive scheme. The trend in material waste may be observed in figure 8.

Finally, the results from estimating the effects of the scheme on the percentage of on-schedule work orders complete, suggest that the incentive is associated with an increase in the order completion rate, which represents on average a 7% rise from the pre-scheme period. This coefficient (\textit{COMPLETIONRATE}) is positive and significant at the one percent level.

In summary, the results from table 6 suggest that the incentive scheme effectively curtailed the rates of absenteeism and turnover in the plant, and improved the number of work orders manufactured and delivered on schedule. However, the results fail to provide direct evidence of improvements in the rate of material waste but the findings suggest that productivity improvements lead to a decline in material waste. These findings provide partial empirical support for hypothesis three.
6.3 RESULTS OF THE SCHEME’S COST EFFECTIVENESS

Various statistical methods were employed to evaluate the cost effectiveness of the scheme. First, I performed t-tests, using level and deflated labor cost data, to detect significant changes in means in production labor costs before and after the scheme’s implementation period. Additionally, I use an OLS regression model to estimate changes in production labor costs. These tests are conducted with aggregate labor cost data from the plant’s records.

The univariate t-tests of means analyses (provided in table 7) indicate that direct labor cost, excluding monetary incentives, increased by 75% on average for the plant following implementation of the scheme. Likewise, the total amount of monetary incentives incurred by the plant increased by 62% after implementation. Similarly, total production labor costs, which combines direct labor cost plus incentives, increased by 73% on average following implementation. These findings are not surprising because the plant expanded its production capacity significantly in April 2000 to accommodate production of a new product line. Additional production workers were added to the plant during this period, thus, increasing the facility’s direct labor, incentives, and production labor costs.

After deflating production labor costs (direct labor cost plus incentives) to adjust for fluctuations in volume, the results of tests of means are mixed (using various proxies to deflate production labor costs). Production labor cost per unit of output increased from 15 cents prior to the scheme’s implementation, to 24 cents following implementation of the scheme. However, production labor costs per standard hour of output decreased by
an average of $2.55 U.S. dollars (a 39% decrease) following the introduction of the new incentives plan. Both of these differences are statistically significant at the one percent and five percent level respectively. When production labor costs are deflated by total manufacturing costs for the period, the mean difference across the periods is not significant. Furthermore, average monthly compensation per production worker increased slightly by $42 dollars (a 9% increase), but this change is not statistically significant.

Table 8 presents the results from estimating separate regressions for labor production costs using level data. The results in column one indicate that total direct labor costs (excluding incentives) increased after the implementation. Likewise, the amount of monetary bonus stemming from the incentives schemes also increased. Finally, total production labor costs (direct labor cost plus the incentives) also rise after the adoption of the new incentives plan. As previously indicated, these results are expected, given the expansion in production at the facility. Neither of the productivity coefficients are significant, suggesting that improvements in labor productivity do not translate to a reduction in production labor costs.

Table 9 summarizes the results obtained by estimating separate regressions after deflating production labor costs (direct labor cost plus the incentives) to adjust for fluctuations in volume. In column 2, the parameter estimate GROUPINC is negative ($\beta_{1m}=-2.25$) and statistically significant at the five percent level, indicating that production labor costs per each standard hour of output decreased on average by $2.25$ dollars following implementation. Similarly, the coefficient on labor costs deflated by production
volume (column 4) is positive ($\beta_i = 0.0816$), but marginally significant; suggesting that production labor costs per each unit of output have risen by an average of eight cents after the implementation.

In summary, the findings from tables seven, eight, and nine, are somewhat inconclusive with respect to whether the scheme has been cost effective. While production labor costs per worker increased slightly (about 9%) following implementation of the new incentive plan, labor costs per standard hour decreased by thirty nine percent, and, conversely, labor cost per unit of output increased by sixty percent. However, labor costs per standard hour provides a more accurate depiction of the changes in labor costs because this proxy better adjusts for changes in the production mix relative to changes in production volume. In sum, I cannot conclude with certainty whether the schemes have been cost effective. Figures 9 through 13 provide a detailed depiction of the trend in production labor costs across time.

6.4 SENSITIVITY ANALYSES

Several sensitivity tests are performed to rule out alternative explanations and possible confounding effects regarding interpretation of the observed results discussed herein. First, I re-estimate the fixed effects model for productivity and defects rate without eliminating any observations surrounding the output-target and gain-sharing schemes' implementation period. After re-estimating the productivity and defects rate models, the statistical results remain robust and support an increase (decrease) in labor productivity (defects rate) following the introduction of both schemes. The same
procedure is repeated for the regression models for absenteeism, turnover, material waste, and order completion rate; and, consistently similar results are observed.\textsuperscript{11}

Secondly, as a test of robustness, I also estimate the effects of the incentive on productivity using alternative proxies of labor productivity. These results, reported in table 10, support improvements in labor productivity in two of the three alternative labor productivity proxies.\textsuperscript{12}

Finally, there exists the possibility that the main structural econometric model employed is incorrectly specified. For instance, productivity and defects might be highly correlated, or both of these outcomes might be simultaneously determined. If both dependent variables are correlated outcomes, then the residuals from each equation are likely to be correlated with each other, thus causing a loss in efficiency in the estimators (Kennedy, 1998). Further, if each outcome is simultaneously determined, then a problem of endogeneity could arise. This situation would yield inconsistent (biased) coefficient estimates when estimating the models using an OLS regression procedure.

\textsuperscript{11} Inclusion of these additional observations allows me to increase the sample size to 92 observations. The inclusion of all available observations increases the number of observations between the schemes' implementation dates from six to fourteen. This increases the power of the statistical tests as indicated by an increase in goodness of fit of some models and the level of significance for some of the parameter estimates.

\textsuperscript{12} Productivity gains are observed with the following labor productivity proxies: standard hours divided by production headcount and standard hours divided by direct labor cost. No improvements in productivity are observed with the ratio of production volume divided by production headcount. A possible explanation of this result is due to changes in the production mix. Volume could either bias downward or upward this labor productivity proxy. For instance, in some periods the facility could be manufacturing a smaller volume but the manufacturing process to manufacture these units could be more complex, thus, requiring greater assembly time. If this were the case, it would generate more standard hours of output. However, the productivity proxy using volume fails to adjust for the amount of standard hours given fluctuations in the product mix.
To address the issue of correlation of residuals across the equations, I re-estimate both regression models using a seemingly unrelated regression (SUR) procedure. These results are reported in table 11. Results are similar to the main structural OLS models. The GROUPINC coefficient is still positive (negative) and statistically significant at the one percent level in the productivity (defects rate) model, after adjusting for the correlation of residuals across both equations.

To assess whether simultaneity exists across productivity and quality, I perform a Hausman test to detect causality among these variables (Hausman, 1975, 1978). Results of the Hausman test indicate that both variables are not simultaneously determined, ruling out the possibility of endogeneity problems. The Hausman test to detect simultaneity between productivity and defects is performed with the use of instrumental variables in the first stage of the regression procedure. The outcome productivity becomes a regressor in the log defects model, similarly, log defects is also a regressor in the productivity equation. I use the number of rejects of raw materials components upon arrival at the plant (REJECTSINCOMING) as an exogenous instrumental variable for the defects variable, and the production target monetary bonus (TARGETBONUS) as an exogenous instrumented variable for the productivity variable. The decision to use the number of defective components upon arrival at the factory (DEFECTSINCOMING) as an instrument for quality (finished goods defects rate) relies on the presumption and

It should be noted that this seemingly unrelated regression estimation procedure is distinct from the one performed to adjust for the correlation of residuals across production sub-units when estimating the effects of the incentives independently on each production sub-unit. The other SUR procedure is performed as a check of robustness to the results from the OLS estimation across manufacturing subunits (refer to chapter 5, footnote 7). Moreover, in this SUR estimation, the variable DEFECTSINCOMING is used when estimating the defects rate model.
management's belief that the number of defects of raw material components is negatively correlated with the finished goods defects rate. However, there are limitations in finding a valid instrument for labor productivity other than the exogenous instrument target bonus (TARGETBONUS). Hence, the results of the Hausman test are dependent on the supposition that both instruments are valid.

In performing the Hausman test, the errors from the first regression procedure are used as a predictor in the second stage-least squares procedure of the test (Gujarati, 1995; Wooldridge, 2003). The hypothesis of simultaneity is rejected with a probability of 0.5221 when estimating productivity as a predictor of defects rate. Likewise, when estimating the effect of defects on productivity the hypothesis of simultaneity is also rejected with a probability of 0.2255. These results suggest that endogeneity is not a problem in the models estimated for productivity and quality.

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The objective of this study is to examine the effects of a group compensation plan on labor productivity, product quality, and organizational performance, in three independent manufacturing subunits of the same manufacturing plant. More specifically, the study investigates whether the use of two distinct budget-based incentives, a group output-target and a gain-sharing scheme offered in combination as part of group performance-based compensation contract, motivates production teams to improve economic performance in this manufacturing setting. After controlling for numerous factors that influence labor productivity and product quality in a multivariate regression model, I find that the combination of incentive schemes is associated with improvements in performance. Labor productivity increases by sixty eight percent and defects rate decrease by ninety five percent following implementation of the incentive scheme. I also found a reduction in absenteeism and turnover, as well as improvements in the percentage of work orders completed on schedule.

Although I cannot attribute the observed performance improvements to a specific scheme, nor discern whether the improvements are causally linked in some proportion to greater worker effort, improved peer monitoring, improved team cooperation, or better strategy development (i.e., worker learning); the empirical results of the study suggest that team (and group) performance is enhanced through the use of standard-based incentives contracts. Moreover, the results suggest that both schemes offered jointly with
mechanisms to prevent free-riding and promote worker learning (timely performance feedback) create synergies in this particular setting that motivate production teams to improve performance.

Although not a test of principal agent theory, these findings are consistent with the theoretical conjecture that output-target (or budget-based) based schemes effectively mitigate moral hazard problems in team production settings (i.e., free-riding) and aid in restoring efficiency as proposed by the analytical contracting literature (Holmstrom, 1982). These findings are also consistent with the results of experimental studies in team settings. The use of budget-based ('forcing') contracts outperform group piece-rates contracts (Nalbantian and Schotter, 1997; Sprinkle, Peffer, and Fisher, 2003). The discontinuity that exists under a standard-based contract (i.e., an output-target scheme) motivates team members to cooperate and exert greater levels of effort relative to piece-rates contracts (Petersen, 1992).

Furthermore, these findings also provide support for the notion that gain-sharing incentive contracts aid in mitigating free-riding by encouraging mutual monitoring within work units (Welbourne and Gomez-Mejia, 1995), and in promoting intra- and inter-team cooperation (Gomez et al., 1992; Schuster 1983, White, 1979).

The study has several implications for both theory and practice. First, empirical research documenting the effect of group rewards on performance has been scant and limited to experimental studies (Young et al., 1983; Drake et al., 1999; Towry, 2001). This may be the first empirical study in the incentive contracting literature in accounting that documents the performance impact of group incentives in a natural setting.
Furthermore, the use of group-based incentives are on the rise, and firms are searching for effective pay systems to motivate workers to raise productivity and to induce cooperation in team environments. However, despite the increase in group incentives, the design of group incentives contracts continues to be problematic for firms. While I did not conduct a test the optimality of this compensation contract, the findings are, nevertheless, important, because they have implications for the design of performance measurements and effective group rewards systems in team (or group) settings (Sprinkle, 2003; Young et al., 1993). The observed improvements in organizational performance provide indirect support that both incentive schemes, offered in combination, help to prevent free-riding in natural team production settings.

The study also makes a significant contribution to the incentive-contracting theory by documenting the effects of economic agents in real settings. Very few studies have examined the effects of performance-based incentives on workers' productivity in field-settings (Banker et al., 1996, 2001). Hence, these findings are important in the further development of contracting theory.

7.1 LIMITATIONS

Several caveats are recognized. First, confounding factors thrive in field-based research (Eldenburg, 1991). Thus, I attempt to establish reasonable controls for numerous factors that are known or suspected to influence performance (productivity and quality) during the study period. However, single factors or subtle combinations of factors, unaccounted for in the regression models, may contribute to improvements
productivity and quality. In addition, characteristic of field-based research, the results are constrained by threats to internal validity.

Data restrictions precluded me from testing the effects of the incentive schemes at the group-level. Due to lack of performance data at the group level, all tests were performed using aggregate plant-level performance data. This presents a future research opportunity. An experimental study could examine how both schemes offered in combination affect the performance of groups. Testing the effects in a contrived setting would overcome the issue of internal validity as well.

Furthermore, I recognize the impossibility of performing a direct test of the effectiveness of the output-target scheme in reducing moral hazard (i.e., shirking) in a team-setting as developed in the analytical contracting literature. The difficulty is that workers' effort levels are unobservable, and the schemes' implementation periods are very short. Thus, the ability to provide direct support for this theoretical conjecture is effectively precluded.

Finally, I do not examine the effects of ratcheting targets on performance. While the daily output quotas across production cells have been relatively unchanged since early 2001, the targets for productivity and defects rate have changed every quarter. The study is silent about the effects of increasing performance targets.

In spite these limitations the study contributes to the stream of accounting research that examines the use of incentive alignment (i.e., contingent incentives contracts) to aid in mitigating agency problems of moral hazard for firms (principal).
APPENDIX A
NUMERICAL EXAMPLE OF AVERAGE WORKER COMPENSATION UNDER THE OLD AND NEW COMPENSATION PLAN

Compensation prior to the Introduction of the Group Incentives Schemes
Each worker received a daily flat wage of 70, 80, 91, or 101 Mexican pesos, depending on a worker’s seniority and level of certification. In addition, to the daily wage, each worker could receive an attendance bonus of approximately $115 pesos per week ($23 pesos per day). There was also a group piece-rate bonus, which fluctuates according to the output generated by each production group. While some groups were more dynamic than others, each worker earned on average a piece-rate bonus of $600 pesos. Total daily and monthly compensation for a production worker was as follows:

<table>
<thead>
<tr>
<th>Compensation</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily wage</td>
<td>$90</td>
</tr>
<tr>
<td>Attendance bonus</td>
<td>23</td>
</tr>
<tr>
<td>Group-piece rates</td>
<td>30</td>
</tr>
<tr>
<td>Total daily compensation</td>
<td>$143 pesos</td>
</tr>
</tbody>
</table>

Compensation after the Introduction of the Output-Target Scheme and Gain-Sharing
For simplification purposes, the daily flat wage remains the same and it represents the daily wage earned currently. Under the production-target scheme, each team member could receive a daily bonus of $30 pesos if the team meets the daily production quota and maintains the quality quota. Furthermore, if each production subunit achieves the pre-specified productivity and quality goals in a given quarter, each employee receives a bonus equal to 6%, 8%, and 10% of the total compensation earned during the past quarter. Assuming a 10% bonus, the average daily compensation under the new incentive schemes is as follows:

<table>
<thead>
<tr>
<th>Compensation</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily wage</td>
<td>$90</td>
</tr>
<tr>
<td>Output target bonus</td>
<td>30</td>
</tr>
<tr>
<td>Gain-sharing</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>$145 pesos</td>
</tr>
</tbody>
</table>

---

1 The daily flat wage earned by each worker has been constant throughout the study period. There have been two minor increases to the minimum wage in the country, and the flat wage in the factory has increased in the same proportion.

2 I use an average of 22 working days in a month to estimate the daily piece-rate bonus.

3 The gain-sharing plan removes the attendance bonus and makes it a requirement not to exceed a maximum amount of employee absents to receive the bonus.
Under the old compensation plan, individual compensation equals a daily flat wage ($\alpha$), an attendance bonus ($\psi$), and piece rates ($\beta$). Thus, compensation may be represented mathematically as follows:

$$\omega = \alpha + \psi + \beta (x)$$

where $x =$ number of units of output.

Average worker compensation is represented graphically as follows:
APPENDIX B
PART II
MATHEMATICAL AND GRAPHICAL REPRESENTATION OF THE OUTPUT-TARGET SCHEME

The mathematical representation of the output-target scheme is expressed as follows:

$$\omega = \alpha + r(x) - p(\phi)$$

Let,

$$r(x) = \begin{cases} 
\gamma + \beta(x_i - x_t) & \text{if } x_i > x_t \\
\gamma & \text{if } x_i = x_t \\
0 & \text{if } x_i < x_t 
\end{cases}$$

$$p(\phi) = \begin{cases} 
\text{if } \phi_i \geq \phi^*, \text{ given } x_i \\
0 & \text{if } \phi_i < \phi^*, \text{ given } x_i
\end{cases}$$

Where, $r(x)$ is the reward function, $p(\phi)$ is a penalty function for failing to maintain quality, $\omega$ = total compensation, $\alpha$ = a daily flat wage, $\gamma$ = group-based bonus for meeting the output target, $\beta$ = a piece-rate factor bonus for exceeding the output target, $x_t$ = output target (in units), $x_i$ = actual output, $\phi^*$ = defects rate threshold, $\phi_i$ = actual defects rate.

The output-target scheme takes the form of a flat wage and a group bonus to be paid if an output target is attained and if the output is below a defects rate threshold. It should be noted that there is no specific quality target to be achieved as in the case of the output target. Instead workgroups should pass a threshold of three quality rejects or fewer during intermediate inspection, otherwise the quality penalty takes effect when exceeding or equaling a threshold of four rejects.

The following are the possible reward solutions when falling below the quality rejects threshold ($\phi_i < \phi^*$, no penalty on quality is applied):

1. $x_i > x_t$ and $\phi_i < \phi^*$, then $\omega_i = \alpha_i + \gamma_i + \beta(x_i - x_t)$
2. $x_i = x_t$ and $\phi_i < \phi^*$, then $\omega_i = \alpha_i + \gamma_i$
Equations (1) and (2) are graphically illustrated as follows:

When failing to maintain the quality rejects threshold the penalty takes effect and all solutions lead to the reward being equal to a flat-wage ($a$).

1. $x_i > x_t$ and $\phi_i \geq \phi^*$, then $\omega_i = [\alpha_i + \gamma_i + \beta(x_i-x_t)] - [\gamma_i + \beta(x_t-x_t)] = \alpha_i$
2. $x_i = x_t$ and $\phi_i \geq \phi^*$, then $\omega_i = [\alpha_i + \gamma_i] - \gamma_i = \alpha_i$

When maintaining quality but failing to reach the output target, the reward solution also leads to a flat-wage ($a$).

3. $x_i < x_t$ and $\phi_i < \phi^*$, then $\omega_i = [\alpha_i + \gamma_i] - 0 = \alpha_i$

The following graphical representation illustrates equations (3), (4) and (5):
APPENDIX B
PART III
MATHEMATICAL REPRESENTATION OF THE GAIN-SHARING SCHEME

The mathematical representation of the gain-sharing scheme is expressed as follows:

\[ \omega = \gamma [x' \cdot \hat{w}] + (1 - \gamma) [\phi' \cdot \hat{w}] \]

\[ x' = \begin{cases} 
0.06 \text{ if } x_2 > x^a \geq x_1 \\
0.08 \text{ if } x_3 > x^a \geq x_2 \\
0.10 \text{ if } x^a \geq x_3 
\end{cases} \]

\[ \phi' = \begin{cases} 
0.06 \text{ if } \phi_2 < \phi^a \leq \phi_1 \\
0.08 \text{ if } \phi_3 < \phi^a \leq \phi_2 \\
0.10 \text{ if } \phi^a \leq \phi_3 
\end{cases} \]

Where,
\( \omega \) = gain-sharing cash bonus,
\( x' \) = labor productivity quarterly targets, \( x' = \{ x_1, x_2, x_3 \} \),
\( \phi' \) = quality (defects rate) quarterly targets, \( \phi' = \{ \phi_1, \phi_2, \phi_3 \} \),
\( \gamma \) = reward weight,
\( \hat{w} \) = worker’s average wage for the quarter
\( x^a \) = actual productivity in the quarter
\( \phi^a \) = actual defects rate in the quarter

Notes:
1. Workers could earn 6%, 8%, or 10% of their average wages for the quarter depending on the level of productivity and quality targets achieved during the period.
2. The quality target is expressed as a finished goods defects rate.
3. The reward weight may be the same across each performance outcome or it may be adjusted depending on where improvements are more needed. For simplification purposes, the targets for productivity and quality share the same reward weight of fifty percent each.
APPENDIX C
MATHEMATICAL PROOF OF HOW THE USE OF STANDARD (OUTPUT)-TARGET SCHEME LEADS TO PARETO OPTIMAL NASH EQUILIBRIUM

The following mathematical model is an extension of the Holmstrom (1982) model and demonstrates why the use of an output-target scheme leads to a Pareto Optimum Nash Equilibrium.

In the present model, I assume risk neutrality and certainty in the setting. I also assume that there are no reciprocal interdependences between workers and only the group output is observable.

Consider the following model of team production where there are $n$ agents, each agent is indexed $i$, exerts unobservable effort $e_i$ to produce output $x$. Thus, a production function is expressed as follows:

$$x = f(e_i, e_{i-1})$$

where $e_{i-1}$ represents other team members’ effort (a vector of dimension $n-1$).

Let $e_i \in E_i = [0, \infty]$, and $e = (e_1, \ldots, e_n) \in E = \times e_n$, and assume that $e_i$ has a cost $c_i : E_i \to \mathbb{R}$, and the cost function $c_i(e_i)$ is convex, differentiable, and increasing with effort.

Each agent reward function may be expressed as $r$, and it is a function of the wages earned $\omega_i$, and $\omega_i$ is a function of $e_i$, given that $x = f(e)$. Each agent reward function is expressed as follows:

$$r[\omega_i(x)]$$

given that $\omega_i(x) = \omega[f(e_i, e_{i-1})]$.

Each agent’s preferences are represented by a utility function $U_i$ which is an additive and separable function of wage and effort. The utility function is expressed as follows:

$$U_i(\omega_i, e_i) = k(\omega_i, e_i) = r(\omega_i) - c(e_i)$$

[See that $U_i = k(\omega_i, e_i, e_{i-1})$ given that $x = f(e)$]

The utility function of individual $i$ is maximized as follows:

$$\max U_i(e_i, e_{i-1}) = h(e_i, e_{i-1}) - c(e_i)$$

Subject to the $n-1$ constraints,

$$h(e_i, e_{i-1}) - c(e_i) \geq U_j^* \text{ for each } j \neq i.$$
Where $h$ is a function composed as follows:

$$h(\varepsilon_i, \varepsilon_d) = r \{ f(\varepsilon_i, \varepsilon_d) \}$$

[Where $U_j^*$ represents the reservation utility of each agent different from agent $i$. In my setting, the reservation utility equals a base salary regardless of effort and this is represented by $\alpha$ in the mathematical representation in Appendix B, part II].

To achieve equilibrium, I derive the following condition where utility is maximized given effort (equation 4):

$$\max_{\varepsilon_i, \varepsilon_d} U_i(\varepsilon_i, \varepsilon_d) = h(\varepsilon_i, \varepsilon_d) - c(\varepsilon_i)$$

s.t. $h(\varepsilon_i, \varepsilon_d) - c(\varepsilon_i) \geq U_j^*$

The Lagrangian to solve the problem is:

$$L(\varepsilon_i, \varepsilon_d, \lambda) = h(\varepsilon_i, \varepsilon_d) - c(\varepsilon_i) - \lambda \left[ h(\varepsilon_i, \varepsilon_d) - c(\varepsilon_i) - U_j^* \right]$$

The first order conditions for a maximum are:

$$\frac{\partial L}{\partial \varepsilon_i} = \frac{\partial h}{\partial \varepsilon_i} - \frac{\partial c}{\partial \varepsilon_i} - \lambda \left( \frac{\partial h}{\partial \varepsilon_i} - \frac{\partial c}{\partial \varepsilon_i} \right) = 0,$$

$$\frac{\partial L}{\partial \varepsilon_j} = \frac{\partial h}{\partial \varepsilon_j} - \lambda \left( \frac{\partial h}{\partial \varepsilon_i} - \frac{\partial c}{\partial \varepsilon_j} \right) = 0 \quad \text{for each } j \neq i.$$

Therefore, I arrive at a Nash equilibrium:

$$\frac{\partial h}{\partial \varepsilon_i} - \sum_{j} \lambda_j \left( \frac{\partial h}{\partial \varepsilon_i} - \frac{\partial c}{\partial \varepsilon_i} \right) = \frac{\partial c}{\partial \varepsilon_i}$$

The marginal benefit of an extra unit of effort exceeds the marginal cost of working.
Improvements in productivity are realized through greater effort and more worker involvement. Specifically gains in labor productivity are driven by (1) improvements in the planning and organization of the work, including the removal of bottlenecks and other sources of inefficiency from the production process, and (2) increased worker effort toward the attainment of productivity goals (or any other goals embedded in the gain-sharing plan). In sum, higher levels of effort and a more efficient organization of work lead to improvements in productivity.

The labor productivity outcome may be substituted with multiple performance outcomes, depending on the structure of the plan. In the case of the research site’s gain-sharing plan, the goal-setting measures were productivity and quality and it may be represented mathematically as follow:

$$\omega_i = f (\gamma_i X_i + \gamma_2 \phi_i)$$

Where $X_i$ and $\phi_i$ are productivity and quality goals respectively, and $\gamma$ represents the reward weights on each performance outcome.

---

$^1$ The model was adapted and reconfigured based from the works of T. Hammer (1988) and from the empirical findings from Rosenberg and Rosenstein (1980).
**TABLE 1**  
Descriptive Statistics for Dependent, Independent, and Control Variables  
Pooled Monthly Data for the Period of January 2000 through August 2002

<table>
<thead>
<tr>
<th>Panel A: Pooled Sample (N=92)</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>First Quartile</th>
<th>Median</th>
<th>Third Quartile</th>
<th>Max.</th>
<th>Min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor productivity (%)</td>
<td>0.815</td>
<td>0.190</td>
<td>0.711</td>
<td>0.882</td>
<td>0.943</td>
<td>1.061</td>
<td>0.298</td>
</tr>
<tr>
<td>Defects Rate</td>
<td>1,319</td>
<td>2,628</td>
<td>101</td>
<td>311</td>
<td>821</td>
<td>11,310</td>
<td>0</td>
</tr>
<tr>
<td>Material Waste (%)</td>
<td>0.006</td>
<td>0.008</td>
<td>0.002</td>
<td>0.004</td>
<td>0.007</td>
<td>0.078</td>
<td>0.001</td>
</tr>
<tr>
<td>Employee Turnover (%)</td>
<td>0.0393</td>
<td>0.0398</td>
<td>0.009</td>
<td>0.023</td>
<td>0.054</td>
<td>0.162</td>
<td>0</td>
</tr>
<tr>
<td>Employee Absenteeism (%)</td>
<td>0.012</td>
<td>0.008</td>
<td>0.006</td>
<td>0.009</td>
<td>0.017</td>
<td>0.043</td>
<td>0.003</td>
</tr>
<tr>
<td>Work Order Completion Rate (%)</td>
<td>0.981</td>
<td>0.048</td>
<td>0.989</td>
<td>0.998</td>
<td>1.000</td>
<td>1.000</td>
<td>0.880</td>
</tr>
<tr>
<td>Production Headcount</td>
<td>214</td>
<td>54</td>
<td>186</td>
<td>222</td>
<td>245</td>
<td>317</td>
<td>71</td>
</tr>
<tr>
<td>Standard Labor Hours</td>
<td>29,222</td>
<td>10,390</td>
<td>23,076</td>
<td>30,811</td>
<td>37,163</td>
<td>47,426</td>
<td>2,275</td>
</tr>
<tr>
<td>Paid Labor Hours</td>
<td>35,023</td>
<td>10,562</td>
<td>28,718</td>
<td>35,956</td>
<td>41,607</td>
<td>61,481</td>
<td>7,624</td>
</tr>
<tr>
<td>Overtime Hours</td>
<td>2,327</td>
<td>3,403</td>
<td>210</td>
<td>1,032</td>
<td>2,592</td>
<td>20,191</td>
<td>0</td>
</tr>
<tr>
<td>Training Hours</td>
<td>356</td>
<td>303</td>
<td>128</td>
<td>229</td>
<td>585</td>
<td>1,102</td>
<td>34</td>
</tr>
<tr>
<td>Production Volume (units)</td>
<td>1,001,521</td>
<td>463,068</td>
<td>702,211</td>
<td>932,414</td>
<td>1,376'086</td>
<td>2,148,570</td>
<td>111,952</td>
</tr>
<tr>
<td>Engineering Change Orders</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Labor productivity: total standard hours divided by total (worked) paid production hours.  
Defects rate: (number of finished goods defects rate at final inspection divided by the number of 
audited finished goods) x 1,000,000.  
Material waste: amount of material waste divided by total manufacturing standard cost.  
Employee turnover: total voluntary production headcount resignations divided the average direct labor headcount for the period.  
Employee absenteeism: number of missing working days of direct labor personnel divided total amount of employees' 
working days for the period.  
Production headcount: average number of direct labor personnel during the period.  
Standard labor hours: standard labor time per unit of output multiplied 
by the actual units of output during the period.  
Paid labor hours: amount of direct labor hours incurred during the period.  
Overtime hours: total overtime hours incurred during the period.  
Training hours: the sum of induction training hours and training hours on continuous improvements practices given to direct labor personnel.  
Production volume: total number of locks manufactured during a period.  
Engineering change orders: number of material and manufacturing process change notifications implemented during a period.
<table>
<thead>
<tr>
<th>Variable</th>
<th>RETAIL</th>
<th></th>
<th>INSTITUTIONAL</th>
<th></th>
<th>COMMERCIAL</th>
<th></th>
<th>F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor productivity (%)</td>
<td>0.884</td>
<td>0.131</td>
<td>0.762</td>
<td>0.190</td>
<td>0.828</td>
<td>0.169</td>
<td>3.71**</td>
</tr>
<tr>
<td>Quality (defects rate)</td>
<td>1,416</td>
<td>3,155</td>
<td>1,724</td>
<td>2,854</td>
<td>506</td>
<td>592</td>
<td>1.07</td>
</tr>
<tr>
<td>Material Waste (%)</td>
<td>0.004</td>
<td>0.002</td>
<td>0.006</td>
<td>0.005</td>
<td>0.007</td>
<td>0.014</td>
<td>1.31</td>
</tr>
<tr>
<td>Employee Turnover (%)</td>
<td>0.042</td>
<td>0.034</td>
<td>0.037</td>
<td>0.040</td>
<td>0.033</td>
<td>0.040</td>
<td>0.17</td>
</tr>
<tr>
<td>Employee Absenteeism (%)</td>
<td>0.011</td>
<td>0.005</td>
<td>0.014</td>
<td>0.010</td>
<td>0.011</td>
<td>0.007</td>
<td>0.93</td>
</tr>
<tr>
<td>Work Order Completion Rate</td>
<td>0.959</td>
<td>0.076</td>
<td>0.993</td>
<td>0.009</td>
<td>0.992</td>
<td>0.009</td>
<td>5.54***</td>
</tr>
<tr>
<td>Production Headcount</td>
<td>239</td>
<td>37</td>
<td>173</td>
<td>42</td>
<td>241</td>
<td>42</td>
<td>28.13***</td>
</tr>
<tr>
<td>Standard Labor Hours</td>
<td>34,576</td>
<td>7,526</td>
<td>22,001</td>
<td>9,178</td>
<td>32,513</td>
<td>8,154</td>
<td>24.90***</td>
</tr>
<tr>
<td>Paid Labor Hours</td>
<td>39,455</td>
<td>8,741</td>
<td>28,177</td>
<td>9,712</td>
<td>39,020</td>
<td>7,232</td>
<td>19.42***</td>
</tr>
<tr>
<td>Overtime Hours</td>
<td>2,640</td>
<td>4,248</td>
<td>2,178</td>
<td>3,035</td>
<td>2,218</td>
<td>2,771</td>
<td>0.17</td>
</tr>
<tr>
<td>Training Hours</td>
<td>160</td>
<td>101</td>
<td>200</td>
<td>72</td>
<td>786</td>
<td>175</td>
<td>239.1***</td>
</tr>
<tr>
<td>Production Volume (units)</td>
<td>1,433,991</td>
<td>375,169</td>
<td>806,551</td>
<td>343,860</td>
<td>756,978</td>
<td>253,723</td>
<td>39.93***</td>
</tr>
<tr>
<td>Engineering Change Orders</td>
<td>1.96</td>
<td>2.07</td>
<td>1.81</td>
<td>2.34</td>
<td>2.62</td>
<td>2.25</td>
<td>1.05</td>
</tr>
<tr>
<td>N</td>
<td>32</td>
<td></td>
<td>32</td>
<td></td>
<td>28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*, **, *** denote significance at the 0.10, 0.05, and .01 levels, respectively.
**Panel C: Univariate Tests of Mean Differences Before and After the Implementation of The Group Incentive Scheme.**

<table>
<thead>
<tr>
<th></th>
<th>Mean Before</th>
<th>Mean After</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor productivity (%)</td>
<td>0.521</td>
<td>0.874</td>
<td>0.353 ***</td>
</tr>
<tr>
<td>Defects Rate</td>
<td>7,759</td>
<td>405</td>
<td>-7,354 ***</td>
</tr>
<tr>
<td>Material Waste (%)</td>
<td>0.009</td>
<td>0.005</td>
<td>-0.004 ***</td>
</tr>
<tr>
<td>Employee Turnover (%)</td>
<td>0.087</td>
<td>0.028</td>
<td>-0.058 ***</td>
</tr>
<tr>
<td>Employee Absenteeism (%)</td>
<td>0.019</td>
<td>0.010</td>
<td>-0.009 ***</td>
</tr>
<tr>
<td>Work Order Completion Rate (%)</td>
<td>0.925</td>
<td>0.986</td>
<td>0.061 ***</td>
</tr>
<tr>
<td>Direct Labor Headcount</td>
<td>149</td>
<td>198</td>
<td>49 ***</td>
</tr>
<tr>
<td>Production Headcount</td>
<td>169</td>
<td>220</td>
<td>51 ***</td>
</tr>
<tr>
<td>Standard Labor Hours</td>
<td>12,603</td>
<td>31,539</td>
<td>18,936 ***</td>
</tr>
<tr>
<td>Paid Labor Hours</td>
<td>21,372</td>
<td>35,627</td>
<td>14,255 ***</td>
</tr>
<tr>
<td>Overtime Hours</td>
<td>2,421</td>
<td>1,625</td>
<td>-796 ***</td>
</tr>
<tr>
<td>Training Hours</td>
<td>86</td>
<td>397</td>
<td>310 ***</td>
</tr>
<tr>
<td>Production Volume</td>
<td>616,176</td>
<td>1,045,397</td>
<td>429,221 ***</td>
</tr>
<tr>
<td>Engineering Change Orders</td>
<td>0.50</td>
<td>2.33</td>
<td>1.83 ***</td>
</tr>
<tr>
<td>N</td>
<td>6</td>
<td>78</td>
<td>84</td>
</tr>
</tbody>
</table>

Two tailed t-tests (*, **, *** denote significance at the 0.10, 0.05, and .01 levels, respectively).

To show consistency with subsequent regression analyses, eight observations were eliminated to combine the output-target based scheme and the gain-sharing scheme implementation dates into a single implementation period. The omitted observations represent the period between the initial date of adoption of the output-target scheme and the date of adoption of the gain-sharing scheme (March 1, 2000 through June 30, 2000). The test was also performed without elimination of observations and the results show the same trend. With the exception of paid hours, the differences in means were statistically significant for all variables (N=14 for the before period, and N=78 for the period after).
### TABLE 2

Pearson (Lower Diagonal) and Spearman-Rank (Upper Diagonal) Correlation Coefficients

Pooled Sample (N=92)

<table>
<thead>
<tr>
<th>Material</th>
<th>Volumedec</th>
<th>Training</th>
<th>Volume</th>
<th>ECO</th>
<th>Volumeend</th>
<th>ISO</th>
<th>Plantrelayout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groupinc</td>
<td>.1000</td>
<td>.5460</td>
<td>-.5750</td>
<td>-.9410</td>
<td>-.4290</td>
<td>2.930</td>
<td>-.0327</td>
</tr>
<tr>
<td>Productivity</td>
<td>.6882</td>
<td>.1000</td>
<td>-.8039</td>
<td>-.2262</td>
<td>-.3811</td>
<td>.1000</td>
<td>-.0486</td>
</tr>
<tr>
<td>Defects</td>
<td>-.8458</td>
<td>.0001</td>
<td>2.000</td>
<td>.4684</td>
<td>.7103</td>
<td>.0001</td>
<td>-.0503</td>
</tr>
<tr>
<td>Turnover</td>
<td>-.5826</td>
<td>.5596</td>
<td>.1000</td>
<td>.4673</td>
<td>.0703</td>
<td>.0001</td>
<td>-.0589</td>
</tr>
<tr>
<td>Absenteeism</td>
<td>-.5194</td>
<td>.7038</td>
<td>.5250</td>
<td>.5898</td>
<td>1.000</td>
<td>.0001</td>
<td>-.0555</td>
</tr>
<tr>
<td>Material Waste</td>
<td>-.1458</td>
<td>.5170</td>
<td>.1328</td>
<td>.2391</td>
<td>.3250</td>
<td>.1000</td>
<td>-.0205</td>
</tr>
<tr>
<td>Completion</td>
<td>.2724</td>
<td>.0591</td>
<td>-.3415</td>
<td>-.1002</td>
<td>-.0169</td>
<td>.1000</td>
<td>-.0166</td>
</tr>
<tr>
<td>Headcount</td>
<td>.1291</td>
<td>.2624</td>
<td>-.1173</td>
<td>.0880</td>
<td>-.0887</td>
<td>.0001</td>
<td>-.0345</td>
</tr>
<tr>
<td>Overtime</td>
<td>-.5534</td>
<td>.4818</td>
<td>.4414</td>
<td>.4422</td>
<td>.5059</td>
<td>.0001</td>
<td>.0130</td>
</tr>
<tr>
<td>Training</td>
<td>.3059</td>
<td>.1788</td>
<td>-.2360</td>
<td>-.1991</td>
<td>-.1791</td>
<td>.0001</td>
<td>.0160</td>
</tr>
<tr>
<td>ECO</td>
<td>.3669</td>
<td>.5917</td>
<td>.4140</td>
<td>.5007</td>
<td>-.6448</td>
<td>.0001</td>
<td>.0326</td>
</tr>
<tr>
<td>Volumeend</td>
<td>.6031</td>
<td>.2495</td>
<td>.5012</td>
<td>.4172</td>
<td>-.2379</td>
<td>.0001</td>
<td>.0279</td>
</tr>
<tr>
<td>ISO</td>
<td>.5866</td>
<td>.1519</td>
<td>-.3944</td>
<td>.1288</td>
<td>.1444</td>
<td>.0001</td>
<td>.0144</td>
</tr>
<tr>
<td>Plantrelayout</td>
<td>.2365</td>
<td>.4852</td>
<td>-.2272</td>
<td>-.2205</td>
<td>-.3950</td>
<td>.0001</td>
<td>.0134</td>
</tr>
</tbody>
</table>

p-values are reported in parenthesis.

Variable definitions:
- Groupinc = indicator variable equal to one for the period of July 1, 2000 and, thereafter, zero otherwise.
- Volumedec = indicator variable taking a value of one if the percentage decrease in volume for the period exceeds the mean percentage decrease in volume for the sample period, zero otherwise.
- ECO (ISO 9000 certification) = indicator variable taking a value of one for the period of July 2001 and, thereafter, zero otherwise.
- Plantrelayout = indicator variable taking a value of one for the period of December 2001 and thereafter, 0 otherwise.

(All other variables have been previously defined.)
TABLE 3
Fixed-Effects OLS Regression Results Measuring the Effects of the Incentive Scheme on Labor Productivity and Product Quality
Pooled Monthly Data from January 2000 through August 2002

$\text{PRODUCTIVITY}_n$ or $\ln\text{DEFECTSRATE}_n = \beta_0 + \beta_1\text{GROUPINC}_n + \beta_2\text{DLHEAD}_n + \beta_3\text{TURNOVER}_n$
+$\beta_4\text{ABSENTEEISM}_n + \beta_5\text{OVERTIME}_n + \beta_6\text{TRAINHRS}_n + \beta_7\text{ECO}_n + \beta_8\text{VOLUME}_n + \beta_9\text{VOLUMEDEC}_n$
+$\beta_{10}\text{PLANTRELAYOUT}_n + \beta_{11}\text{ISO9000}_n + \beta_{12}\text{RETAIL}_n + \beta_{13}\text{INSTITUTIONAL}_n + \varepsilon_n$

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Productivity Predicted Coefficient</th>
<th>Productivity Sign</th>
<th>Productivity (t-stat.)</th>
<th>Defects Rate (Quality) Predicted Coefficient</th>
<th>Defects Rate (Quality) Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>.64189</td>
<td>+</td>
<td>(1.58)</td>
<td>7.74</td>
<td></td>
</tr>
<tr>
<td>GROUPINC</td>
<td>.1420</td>
<td>+</td>
<td>(3.21)**</td>
<td>-2.14</td>
<td></td>
</tr>
<tr>
<td>DLHEAD</td>
<td>.00066</td>
<td>?</td>
<td>(1.78)*</td>
<td>.0034</td>
<td></td>
</tr>
<tr>
<td>TURNOVER</td>
<td>-1.6445</td>
<td>-</td>
<td>(-4.75)**</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>ABSENTEEISM</td>
<td>-2.9594</td>
<td>-</td>
<td>(-1.85)*</td>
<td>30.37</td>
<td></td>
</tr>
<tr>
<td>OVERTIME</td>
<td>-.000006</td>
<td>?</td>
<td>(-1.32)</td>
<td>.00004</td>
<td></td>
</tr>
<tr>
<td>TRAINHRS</td>
<td>-.00009</td>
<td>?</td>
<td>(-0.79)</td>
<td>.00008</td>
<td></td>
</tr>
<tr>
<td>ECO</td>
<td>.00703</td>
<td>+</td>
<td>(1.71)*</td>
<td>.00078</td>
<td></td>
</tr>
<tr>
<td>VOLUME</td>
<td>4.15 E-8</td>
<td>+</td>
<td>(1.06)</td>
<td>-3.21E-7</td>
<td></td>
</tr>
<tr>
<td>VOLUMEDEC</td>
<td>-.02597</td>
<td>?</td>
<td>(-.10)</td>
<td>-.0681</td>
<td></td>
</tr>
<tr>
<td>PLANTRELAYOUT</td>
<td>.10525</td>
<td>+</td>
<td>(3.62)**</td>
<td>-.7547</td>
<td></td>
</tr>
<tr>
<td>ISO9000</td>
<td>.01650</td>
<td>+</td>
<td>(0.57)</td>
<td>-.819</td>
<td></td>
</tr>
</tbody>
</table>

**Correlation between dependent variables:**
- Intercept and Grouping: **(3.21)**
- Intercept and DLhead: * (1.78)
- Intercept and Turnover: *** (-4.75)
- Intercept and Absenteeism: * (-1.85)
- Intercept and Overtime: * (-1.32)
- Intercept and Trainhours: * (-0.79)
- Intercept and ECO: * (1.71)
- Intercept and Volume: ** (1.06)
- Intercept and VolumeDec: ** (-.10)
- Intercept and Plantrelayout: *** (3.62)
- Intercept and ISO9000: ** (0.57)
<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Predicted Coefficient</th>
<th>Predicted Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>RETAIL</td>
<td>.00471</td>
<td>-.324</td>
</tr>
<tr>
<td>INSTITUTIONAL</td>
<td>-.0507</td>
<td>.2007</td>
</tr>
</tbody>
</table>

Adjusted $R^2$  
F value  
N

Two-tailed t-tests (*, **, ***) denote significance and p-values at the 0.10, 0.05, and .01 levels respectively.

The defects rate has been transformed using a logarithmic (natural log) transformation.

"GROUPINC captures the combined effect of the incentives schemes acting together. The variable is measured as one for the period of July 1, 2000 and, thereafter, zero otherwise.

Eight observations were eliminated for the period beginning April 2000 and ending June 2000, i.e., the implementation dates of the output-target and gain-sharing schemes respectively.

Four additional observations are lost when performing the logarithmic transformation on defects rate. These observations had a value of zero.
### TABLE 4
OLS Results Measuring the Effect of the Incentive Scheme on Labor Productivity and Product Quality Over Time
Pooled Monthly Data from January 2000 through August 2002

\[ \text{PRODUCTIVITY}_t = \beta_0 + \beta_1 \text{POSTINCTREND}_t + \beta_2 \text{DLHEAD}_t + \beta_3 \text{TURNOVER}_t + \beta_4 \text{ABSENTEEISM}_t + \beta_5 \text{OVERTIME}_t + \beta_6 \text{TRAINHRS}_t + \beta_7 \text{ECO}_t + \beta_8 \text{VOLUME}_t + \beta_9 \text{VOLUMEDEC}_t + \beta_{10} \text{PLANTRELAYOUT}_t + \beta_{11} \text{ISO9000} + \beta_{12} \text{RETAIL}_t + \beta_{13} \text{INSTITUTIONAL}_t + \epsilon_t \]

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Predicted Sign</th>
<th>Coefficient (t-stat.)</th>
<th>Predicted Sign</th>
<th>Coefficient (t-stat.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td></td>
<td>0.5567 (8.87)**</td>
<td></td>
<td>8.275 (11.46)**</td>
</tr>
<tr>
<td>POSTINCTREND</td>
<td>+</td>
<td>0.0085 (2.30)**</td>
<td>-</td>
<td>-0.1451 (3.33)**</td>
</tr>
<tr>
<td>DLHEAD</td>
<td>?</td>
<td>0.0093 (2.68)**</td>
<td>?</td>
<td>0.0002 (0.06)</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>-</td>
<td>-1.428 (-3.88)**</td>
<td>+</td>
<td>-0.7599 (-0.18)</td>
</tr>
<tr>
<td>ABSENTEEISM</td>
<td>-</td>
<td>-1.522 (-0.84)</td>
<td>+</td>
<td>4.268 (0.21)</td>
</tr>
<tr>
<td>OVERTIME</td>
<td>?</td>
<td>-0.00008 (-1.73)**</td>
<td>?</td>
<td>0.00006 (1.21)</td>
</tr>
<tr>
<td>TRAINHRS</td>
<td>?</td>
<td>-0.00005 (-1.16)</td>
<td>?</td>
<td>-0.0018 (-0.35)</td>
</tr>
<tr>
<td>ECO</td>
<td>+</td>
<td>0.01068 (2.61)**</td>
<td>-</td>
<td>-0.0486 (-1.06)</td>
</tr>
<tr>
<td>VOLUME</td>
<td>?</td>
<td>7.60E-8 (2.19)**</td>
<td>+</td>
<td>-8.40E-7 (-2.10)</td>
</tr>
<tr>
<td>VOLUMEDEC</td>
<td>?</td>
<td>0.0191 (0.78)</td>
<td>-</td>
<td>-0.3508 (-1.28)</td>
</tr>
<tr>
<td>PLANTRELAYOUT</td>
<td>+</td>
<td>0.0398 (1.06)</td>
<td>-</td>
<td>0.1842 (0.44)</td>
</tr>
<tr>
<td>ISO9000</td>
<td>+</td>
<td>-0.0282 (-0.76)</td>
<td>-</td>
<td>-0.0331 (-0.08)</td>
</tr>
<tr>
<td>TABLE 4 (CONTINUED)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.7648</td>
<td>.6848</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F value</td>
<td>25.54</td>
<td>16.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>84</td>
<td>80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

©Two-tailed t-tests (*, **, ***) denote significance and p-values at the 0.10, 0.05, and .01 levels respectively.

The defects rate have been transformed using a logarithmic (natural log) transformation.

©POSTINCTREND (post-incentive time trend) captures the combined effect of both incentives schemes working together across time. The variable is measured as the number of months since the implementation of the group incentive scheme (July 2000), and assumes a value of zero for the months before the implementation of the scheme.

®Eight observations were eliminated for the period beginning April 2000 and ending June 2000, i.e., the implementation dates of the output-target and gain-sharing schemes respectively.

©Four additional observations are lost when performing the logarithmic transformation on defects rate. These observations had a value of zero.
TABLE 5
OLS Results To Discern the Impact on Performance Across Schemes
Pooled Monthly Data from January 2000 through August 2002

\[ \text{PRODUCTIVITY}_a \text{ or } \ln\text{DEFECTSRATE}_a = \beta_0 + \beta_1\text{TARGET}_a + \beta_2\text{GAINSHARING}_a + \beta_3\text{DLHEAD}_a + \beta_4\text{TURNOVER}_a + \beta_5\text{ABSENTEEISM}_a + \beta_6\text{OVERTIME}_a + \beta_7\text{TRAINHRS}_a + \beta_8\text{ECO}_a + \beta_9\text{VOLUME}_a + \beta_{10}\text{VOLUMEDEC}_a + \beta_{11}\text{PLANTRELAYOUT}_a + \beta_{12}\text{ISO9000} + \epsilon_i \]

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Predicted Coefficient</th>
<th>Predicted Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sign</td>
<td>(t-stat.)</td>
</tr>
<tr>
<td>INTERCEPT</td>
<td>.5462</td>
<td>(10.88)***</td>
</tr>
<tr>
<td>TARGET</td>
<td>+ .0276</td>
<td>(0.56)</td>
</tr>
<tr>
<td>GAINSHARING</td>
<td>+ .1143</td>
<td>(2.92)***</td>
</tr>
<tr>
<td>DLHEAD</td>
<td>+ .00086</td>
<td>(2.76)***</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>-1.486</td>
<td>(-4.90)***</td>
</tr>
<tr>
<td>ABSENTEEISM</td>
<td>-2.808</td>
<td>(-1.89)*</td>
</tr>
<tr>
<td>OVERTIME</td>
<td>? -0.00005</td>
<td>(-1.42)</td>
</tr>
<tr>
<td>TRAINHRS</td>
<td>? -0.0006</td>
<td>(-1.43)</td>
</tr>
<tr>
<td>ECO</td>
<td>+ .00831</td>
<td>(2.09)***</td>
</tr>
<tr>
<td>VOLUME</td>
<td>? 7.24 E-8</td>
<td>(2.17)***</td>
</tr>
<tr>
<td>VOLUMEDEC</td>
<td>? .0177</td>
<td>(0.76)</td>
</tr>
<tr>
<td>PLANTRELAYOUT</td>
<td>+ .1009</td>
<td>(4.40)***</td>
</tr>
<tr>
<td>ISO9000</td>
<td>+ .0292</td>
<td>(1.06)</td>
</tr>
</tbody>
</table>
**TABLE 5 (CONTINUED)**

<table>
<thead>
<tr>
<th></th>
<th>Adjusted R²</th>
<th>F value</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.8294</td>
<td>37.45</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>.7617</td>
<td>14.15</td>
<td>87</td>
</tr>
</tbody>
</table>

*Two-tailed t-tests (*, **, ****) denote significance and p-values at the 0.10, 0.05, and .01 levels respectively.*

*The defects rates have been transformed using a logarithmic (natural log) transformation.*

*The variable TARGET equals one for the period of April 1, 2000 through June 2000, zero otherwise. GAINSHARING equals one for the period of July 1, 2000 and, thereafter, zero otherwise.*

*An extreme outlier (observation #10) is eliminated when estimating both regression models. Also, four additional observations are lost in the defects model when performing the logarithmic transformation on defects rate.*
## Table 6
OLS Results Measuring the Effects of the Incentive Scheme on Absenteeism, Turnover, Material Waste, and Work Order Completion Rate
Pooled Monthly Data from January 2000 through August 2002

**Absenteeism** = \( y_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{DLHEAD}_a + \pi_d \)

**Turnover** = \( y_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{DLHEAD}_a + \gamma_3 \text{REGIONALTURNOVER}_a + \eta_d \)

**Material Waste** = \( y_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{PRODUCTIVITY}_a + \gamma_3 \text{DEFECTS}_a + \xi_d \)

**Completion Rate** = \( y_0 + \gamma_1 \text{GROUPINC}_a + \gamma_2 \text{PRODUCTIVITY}_a + \xi_d \)

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Absenteeism</th>
<th>Turnover</th>
<th>Material Waste</th>
<th>Completion Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predictor Variable</strong></td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
</tr>
<tr>
<td>INTERCEPT</td>
<td>.02050 (5.36)***</td>
<td>.0124 (0.75)</td>
<td>.0237 (6.41)</td>
<td>.9592 (33.35)***</td>
</tr>
<tr>
<td>GROUPINC</td>
<td>-.0090 (-3.0)***</td>
<td>-.0298 (-2.85)***</td>
<td>-.0003 (-0.13)</td>
<td>.0845 (3.46)***</td>
</tr>
<tr>
<td>DLHEAD</td>
<td>-.000005 (-0.29)</td>
<td>.00004 (0.74)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>REGIONALTURNOVER</td>
<td>-</td>
<td>.5644 (5.72)***</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PRODUCTIVITY</td>
<td>-</td>
<td>-</td>
<td>-.0206 (-6.74)***</td>
<td>-.0657 (-1.57)</td>
</tr>
<tr>
<td>DEFECTS RATE</td>
<td>-</td>
<td>-</td>
<td>-4.7E-7 (-1.32)</td>
<td>-</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>.0926</td>
<td>.5423</td>
<td>.3822</td>
<td>.1112</td>
</tr>
<tr>
<td>F value</td>
<td>5.24</td>
<td>36.54</td>
<td>18.12</td>
<td>6.19</td>
</tr>
<tr>
<td>N</td>
<td>84</td>
<td>84</td>
<td>84</td>
<td>84</td>
</tr>
</tbody>
</table>

---

a. Two-tailed t-tests (*, **, *** denote significance and p-values at the 0.10, 0.05, and .01 levels respectively).
b. The variable REGIONALTURNOVER controls for the effect of turnover in the geographic region where the manufacturing plant operates. All other variables have been previously defined.
c. All regression models are estimated eliminating eight observations for the period of April 2000 through June 2000 as done previously in the regressions reported in tables 3 and 4.
TABLE 7

t-Tests of Differences in Means of Direct Labor Costs Before and After Implementation of the Incentive Scheme

Plant Monthly Data for the Period of January 2000 through August 2002

<table>
<thead>
<tr>
<th></th>
<th>Mean Pre-Scheme</th>
<th>Mean Post-Scheme</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Labor Cost ($)</td>
<td>173,026</td>
<td>302,473</td>
<td>129,448***</td>
</tr>
<tr>
<td>Incentives ($)</td>
<td>37,481</td>
<td>60,695</td>
<td>23,214***</td>
</tr>
<tr>
<td>Total Direct Labor Production Cost ($)</td>
<td>210,507</td>
<td>363,168</td>
<td>152,662***</td>
</tr>
<tr>
<td>DL Production Cost per Production Worker ($)</td>
<td>454</td>
<td>496</td>
<td>42</td>
</tr>
<tr>
<td>DL Production Cost per Unit of Output ($)</td>
<td>.15</td>
<td>.24</td>
<td>.09***</td>
</tr>
<tr>
<td>DL Production Cost per Standard Hour ($)</td>
<td>6.47</td>
<td>3.91</td>
<td>-2.55**</td>
</tr>
<tr>
<td>DL Production Cost + Total Std. Mfg. Cost ($)</td>
<td>.11</td>
<td>.08</td>
<td>.03</td>
</tr>
<tr>
<td>N</td>
<td>6</td>
<td>26</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Two tailed t-tests (*, **, *** denote significance at the 0.10, 0.05, and .01 levels, respectively).
\(^b\) Direct labor cost equals the sum of direct labor wages excluding incentives.
\(^c\) Incentives equal the sum of monetary incentives paid to production workers, and is computed as follows: for the months of January through March 2000, monetary incentives equal the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equal the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equal the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus, so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months for each quarter.
\(^d\) Direct labor production cost is the sum of direct labor cost plus incentives for the period.
TABLE 8
OLS Regression Results Measuring the Incentive Scheme's Cost Effectiveness
Plant Monthly Level Data from January 2000 through August 2002

\[
\text{DIRECT LABOR (INCENTIVES) COST} = \theta_0 + \theta_1 \text{GROUPINC}_{it} + \theta_2 \text{PRODUCTIVITY}_{it} + \kappa_{it}
\]

Dependent Variables (Level Data)

<table>
<thead>
<tr>
<th></th>
<th>Direct Labor Cost</th>
<th>Incentives</th>
<th>Total Direct Labor Production Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>117,934</td>
<td>26,518</td>
<td>144,452</td>
</tr>
<tr>
<td></td>
<td>(1.72)*</td>
<td>(2.30)**</td>
<td>(1.84)*</td>
</tr>
<tr>
<td>GROUPINC</td>
<td>101,841</td>
<td>17,719</td>
<td>119,560</td>
</tr>
<tr>
<td></td>
<td>(2.50)**</td>
<td>(2.59)**</td>
<td>(2.57)**</td>
</tr>
<tr>
<td>PRODUCTIVITY</td>
<td>94,370</td>
<td>18,781</td>
<td>113,151</td>
</tr>
<tr>
<td></td>
<td>(0.85)</td>
<td>(1.00)</td>
<td>(0.38)</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>.4633</td>
<td>.5001</td>
<td>.4851</td>
</tr>
<tr>
<td>F Value</td>
<td>14.38</td>
<td>16.51</td>
<td>15.37</td>
</tr>
<tr>
<td>N</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

\(^a\text{Two-tailed t-tests (*, **, *** denote significance and p-values at the 0.10, 0.05, and .01 levels respectively).}\)

\(^b\text{The three regression models were estimated using cost data for the plant.}\)

\(^c\text{Direct labor cost equals the sum of direct labor wages excluding incentives.}\)

\(^d\text{Incentives equal the sum of monetary incentives paid to production workers computed as follows: for the months of January through March 2000, monetary incentives equal the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equal the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equal the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months of each quarter.}\)

\(^e\text{Total direct labor production costs is the sum of direct labor cost plus incentives for the period.}\)
**Table 9**

OLS Regression Results Measuring the Incentive Scheme's Cost Effectiveness Using Deflated Direct Labor Cost Data

Plant Monthly Deflated Data from January 2000 through August 2002

**DIRECT LABOR PRODUCTION COST (deflated) = \( \theta_0 + \theta_1 \text{GROUPINC}_t + \theta_2 \text{PRODUCTIVITY}_t + \eta_t \)**

- Proxy 1: Direct labor production cost + production headcount
- Proxy 2: Direct labor production cost + standard hours of output
- Proxy 3: Direct labor production cost + total standard production costs
- Proxy 4: Direct labor production cost + production volume (units of output)

### Dependent Variables (Deflated Data)

<table>
<thead>
<tr>
<th>Labor cost deflated by:</th>
<th>Proxy 1 Headcount</th>
<th>Proxy 2 Standard Hrs.</th>
<th>Proxy 3 Std. Production Costs</th>
<th>Proxy 4 Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>285.71 (2.65)**</td>
<td>7.06 (4.60)*****</td>
<td>0.1346 (-0.90)</td>
<td>0.1266</td>
</tr>
<tr>
<td>GROUPINC</td>
<td>-42.35 (0.66)</td>
<td>-2.25 (-2.48)**</td>
<td>-0.0190 (1.67)*</td>
<td>0.0816</td>
</tr>
<tr>
<td>PRODUCTIVITY</td>
<td>288.03 (1.65)</td>
<td>-1.01 (-0.41)</td>
<td>-0.3369 (-0.58)</td>
<td>0.0461</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.0576</td>
<td>0.3919</td>
<td>0.1013 (0.34)</td>
<td>.2174</td>
</tr>
<tr>
<td>F Value</td>
<td>1.95</td>
<td>10.99</td>
<td>2.75</td>
<td>5.30</td>
</tr>
<tr>
<td>N</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

*Two-tailed t-tests (*, **, ****) denote significance and p-values at the 0.10, 0.05, and 0.01 levels respectively.

*Direct labor production cost is the sum of direct labor cost plus incentives for the period, where incentives equal the sum of monetary incentives paid to production workers. The incentives portion is computed as follows: for the months of January through March 2000, monetary incentives equal the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equal the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equal the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus, so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months of each quarter.
### TABLE 10
OLS Results Using Alternative Proxies of Labor Productivity
Pooled Monthly Data from January 2000 through August 2002

\[
\text{PRODUCTIVITY}_{it} = \beta_0 + \beta_1 \text{GROUPINC}_{it} + \beta_2 \text{DLHEAD}_{it} + \beta_3 \text{TURNOVER}_{it} \\
+ \beta_4 \text{ABSENTEEISM}_{it} + \beta_5 \text{OVERTIME}_{it} + \beta_6 \text{TRAINHRS}_{it} + \beta_7 \text{ECO}_{it} + \beta_8 \text{VOLUME}_{it} + \beta_9 \text{VOLUMEDEC}_{it} \\
+ \beta_{10} \text{PLANTRELA YOUT}_{it} + \beta_{11} \text{ISO9000} + \varepsilon_{it}
\]

**Productivity Proxy 1:** Total Standard Hours / Production Headcount  
**Productivity Proxy 2:** Production Volume (in units) / Production Headcount  
**Productivity Proxy 3:** Total Standard Hours / Direct Labor Cost

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Productivity 1</th>
<th>Productivity 2</th>
<th>Productivity 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
</tr>
<tr>
<td>INTERCEPT</td>
<td>101.79 (7.15)***</td>
<td>4,573 (13.09)***</td>
<td>-0.0411 (-0.25)</td>
</tr>
<tr>
<td>GROUPINC</td>
<td>42.29 (4.31)***</td>
<td>32.46 (0.13)</td>
<td>0.2354 (2.05)**</td>
</tr>
<tr>
<td>DLHEAD</td>
<td>-0.3146 (-3.80)***</td>
<td>-25.20 (-12.41)***</td>
<td>-0.0004 (-0.50)</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>-168.85 (-2.08)**</td>
<td>-2.199 (-1.10)</td>
<td>-0.0466 (-0.05)</td>
</tr>
<tr>
<td>ABSENTEEISM</td>
<td>-488.72 (-1.24)</td>
<td>422.40 (0.04)</td>
<td>6.80 (1.47)</td>
</tr>
<tr>
<td>OVERTIME</td>
<td>-0.002 (-0.18)</td>
<td>0.03886 (1.34)</td>
<td>-0.00006 (-0.47)</td>
</tr>
<tr>
<td>TRAINHRS</td>
<td>0.0421 (3.80)***</td>
<td>0.5352 (1.97)**</td>
<td>-0.00167 (-1.29)</td>
</tr>
<tr>
<td>ECO</td>
<td>1.338 (1.33)</td>
<td>13.32 (0.54)</td>
<td>0.0004 (0.04)</td>
</tr>
<tr>
<td>VOLUME</td>
<td>0.0006 (7.66)***</td>
<td>0.0052 (25.18)***</td>
<td>2.2056 E-7 (2.23)**</td>
</tr>
<tr>
<td>VOLUMEDEC</td>
<td>-2.733 (-0.46)</td>
<td>142.59 (0.99)</td>
<td>-0.0117 (-0.17)</td>
</tr>
<tr>
<td>PLANTRELA YOUT</td>
<td>3.958 (0.70)</td>
<td>-69.38 (-0.50)</td>
<td>0.1243 (1.87)*</td>
</tr>
<tr>
<td>Predictor Variable</td>
<td>Productivity 1</td>
<td>Productivity 2</td>
<td>Productivity 3</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
<td>Coefficient (t-stat.)</td>
</tr>
<tr>
<td>ISO9000</td>
<td>-1.212 (-0.17)</td>
<td>-112.50 (-0.65)</td>
<td>-.0047 (-0.06)</td>
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<tr>
<td>Adjusted $R^2$</td>
<td>.7559</td>
<td>.8503</td>
<td>.2591</td>
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<tr>
<td>N</td>
<td>84</td>
<td>84</td>
<td>84</td>
</tr>
</tbody>
</table>

*Two-tailed t-tests (*, **, *** denote significance and p-values at the 0.10, 0.05, and .01 levels respectively).

$^b$GROUPINC captures the combined effect of both incentives schemes. The variable is measured as one for the period of July 1, 2000 and, thereafter, zero otherwise.

$^c$Eight observations were eliminated for the period beginning April 2000 and ending June 2000, i.e., the implementation dates of the output-target and gain-sharing schemes respectively.
TABLE II
Seemingly Unrelated Regression (SUR) to Adjust for the Correlation of Residuals Across the Labor Productivity and Defects Rate Regressions Models
Pooled Monthly Data from January 2000 through August 2002

\[
\text{PRODUCTIVITY}_u = \beta_0 + \beta_1 \text{GROUPINC}_u + \beta_2 \text{DLHEAD}_u + \beta_3 \text{TURNOVER}_u + \beta_4 \text{ABSENTEEISM}_u + \beta_5 \text{OVERTIME}_u + \beta_6 \text{TRAINHRS}_u + \beta_7 \text{ECO}_u + \beta_8 \text{VOLUME}_u + \beta_9 \text{VOLUMEDEC}_u + \beta_{10} \text{PLANTRELAYOUT}_u + \beta_{11} \text{ISO9000} + \mu_u
\]

\[
\ln \text{DEFECTS RATE}_u = \beta_0 + \beta_1 \text{GROUPINC}_u + \beta_2 \text{DLHEAD}_u + \beta_3 \text{TURNOVER}_u + \beta_4 \text{ABSENTEEISM}_u + \beta_5 \text{OVERTIME}_u + \beta_6 \text{TRAINHRS}_u + \beta_7 \text{ECO}_u + \beta_8 \text{VOLUME}_u + \beta_9 \text{VOLUMEDEC}_u + \beta_{10} \text{PLANTRELAYOUT}_u + \beta_{11} \text{ISO9000} + \beta_{12} \text{DEFECTSINCOMING} + \epsilon_u
\]

Dependent Variables

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Productivity Predictor</th>
<th>Coefficient (t-stat.)</th>
<th>lnDefects Rate (Quality) Predictor</th>
<th>Coefficient (t-stat.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td></td>
<td>.6433 (7.41)***</td>
<td></td>
<td>8.419 (9.14)***</td>
</tr>
<tr>
<td>GROUPINC</td>
<td>+</td>
<td>.1406 (3.34)***</td>
<td>-</td>
<td>-2.64 (-6.09)***</td>
</tr>
<tr>
<td>DLHEAD</td>
<td>+</td>
<td>.00068 (1.82)*</td>
<td>-</td>
<td>.0013 (0.34)</td>
</tr>
<tr>
<td>TURNOVER</td>
<td>-</td>
<td>-1.653 (-4.92)***</td>
<td>+</td>
<td>3.55 (1.02)</td>
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<tr>
<td>ABSENTEEISM</td>
<td>-</td>
<td>-2.951 (-1.96)**</td>
<td>+</td>
<td>37.22 (2.40)**</td>
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<tr>
<td>OVERTIME</td>
<td>?</td>
<td>-.000006 (-1.37)</td>
<td>?</td>
<td>.00004 (0.85)</td>
</tr>
<tr>
<td>TRAINHRS</td>
<td>?</td>
<td>-.0001 (-0.85)</td>
<td>?</td>
<td>-.00005 (-0.04)</td>
</tr>
<tr>
<td>ECO</td>
<td>+</td>
<td>.00701 (1.81)*</td>
<td>-</td>
<td>-.0191 (-0.47)</td>
</tr>
<tr>
<td>VOLUME</td>
<td>?</td>
<td>.423 E-7 (1.14)</td>
<td>+</td>
<td>-.13 E-6 (-0.35)</td>
</tr>
<tr>
<td>VOLUMEDEC</td>
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<td>-.0021 (-0.09)</td>
<td>-</td>
<td>-.1396 (-0.56)</td>
</tr>
<tr>
<td>PLANTRELAYOUT</td>
<td>+</td>
<td>.1067 (3.78)***</td>
<td>-</td>
<td>-.7869 (-2.76)***</td>
</tr>
<tr>
<td>Predictor Variable</td>
<td>Predicted Sign</td>
<td>Predicted Coefficient (t-stat.)</td>
<td>Sign</td>
<td>Coefficient (t-stat.)</td>
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<td>--------------------</td>
<td>----------------</td>
<td>-------------------------------</td>
<td>------</td>
<td>----------------------</td>
</tr>
<tr>
<td>ISO9000</td>
<td>+</td>
<td>0.0164 (0.61)</td>
<td>-</td>
<td>-0.9382 (-3.37)***</td>
</tr>
<tr>
<td>RETAIL</td>
<td>?</td>
<td>-0.0064 (-0.008)</td>
<td>?</td>
<td>-0.4879 (-0.55)</td>
</tr>
<tr>
<td>INSTITUTIONAL</td>
<td>?</td>
<td>-0.0534 (-0.81)</td>
<td>?</td>
<td>0.1447 (0.21)</td>
</tr>
<tr>
<td>DEFECTS INCOMING</td>
<td></td>
<td>-</td>
<td>-</td>
<td>0.0003 (-2.39)**</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td></td>
<td>0.7695</td>
<td></td>
<td>0.7393</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td>80</td>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

*Two-tailed t-tests (*, **, *** denote significance and p-values at the 0.10, 0.05, and .01 levels respectively).

GROUPINC captures the combined effect of both incentives schemes. The variable is measured as one for the period of July 1, 2000 and thereafter, zero otherwise.

DEFECTS INCOMING equals the number of defects of raw material components during inspection upon arrival to the facility.

Eight observations were eliminated between the period of April 2000 and June 2000, the implementation dates of the output-target and gain-sharing schemes respectively.
Figure 1
Timeline of Implementation of Group Incentives

Study Period

Initiation of Operations: April 1998
Output-Target Scheme: January 2000
Gain-sharing Scheme: April 2000
ISO9000 Guidelines: July 2000
Facility & Cell Relayout: July 2001

GROUPING
Date used to measure the combined effect of both incentives schemes.

^ The facility was certified for ISO9000 in December 2001; however, all operational requirements for certification were in place by July 2001. Therefore, changes in productivity and quality, which are attributable to the ISO9000 implementation, are measured from July 2001.
The above diagram depicts a simple representation of a metal lock assembly process. The complexity in the production process may vary depending on the lock model. Furthermore, the size of a production cell may vary depending on the complexity of the assembly process; cell size fluctuates between 8 and 15 members per production cell.
Labor productivity targets are reported to production workers as the ratio of production labor hours to standard labor hours of output. A decreasing trend in the productivity targets implies that a higher (i.e., harder) standard have been set for each quarter. Likewise, a decreasing trend in the targets for finished goods defects implies that higher (i.e., harder) quality targets have been set for each quarter.
Defects rate combines the average monthly finished goods defects for the three production subunits, measured as \( \bar{\phi} \), where \( \phi \) = number of quality defects. An explanation as to the abrupt increase in the defects rate during the implementation period of the output-target based scheme (April 2000) is due to the transfer of operations of a new product line to the commercial manufacturing unit. Numerous changes in operations were executed to accommodate the new product line; additionally, production teams were transferred to the new manufacturing operation, thus disrupting labor productivity and quality.
FIGURE 5
AVERAGE MONTHLY DEFECTS RATE FOR THE PLANT
JANUARY 2000 - AUGUST 2002

Defects rate combines the average monthly finished goods defects for the three production subunits, measured as $(\sum \phi)$, where $\phi$=number of quality defects. An explanation as to the abrupt increase in the defects rate during the implementation period of the output-target based scheme (April 2000) is due to the transfer of operations of a new product line to the commercial manufacturing unit. Numerous changes in operations were executed to accommodate the new product line; additionally, production teams were transferred to the new manufacturing operation, thus disrupting labor productivity and quality.
Regional absenteeism rate data is unavailable prior to January 2001. It should be noted that within the maquiladora industry, the rate of absenteeism rises in January. This cyclical event is easily explained. During the month of December it is customary to shut down operations for at least one week so workers can return to their places of origin. Since a large majority of the workforce supporting the maquiladora industry come from regions of the country that are remotely located from factories where they work, some workers are unable to arrive back on the factories on time at the start of operations in January—giving rise to a higher than normal rate of absenteeism.
FIGURE 7
AVERAGE MONTHLY EMPLOYEE TURNOVER RATE FOR THE PLANT
JANUARY 2000 - AUGUST 2002

Rate of Turnover

Scheme Implementation
July 2000

Plant
Region

Month
FIGURE 8
AVERAGE MONTHLY RATE OF MATERIAL WASTE FOR THE PLANT
JANUARY 2000 - AUGUST 2002

Rate of material waste is measured as the sum of total (actual) material waste in dollars divided by total manufacturing standard cost in a given period.
Total direct labor payroll costs include direct labor cost plus monetary incentives incurred for each period. For the months of January through March 2000, monetary incentives equaled the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equaled the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equaled the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus, so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months of each quarter.
FIGURE 10
TOTAL MONETARY INCENTIVES FOR THE PLANT
JANUARY 2000 - AUGUST 2002

For the months of January through March 2000, monetary incentives equal the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equal the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equal the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months of each quarter.
FIGURE 11
AVERAGE DIRECT LABOR PAYROLL COSTS PER PRODUCTION WORKER\(^1\)
January 2000 - August 2002

---

\(^1\) Average direct labor payroll costs per production worker equals the sum of total direct labor cost plus monetary incentives divided by the average production headcount for the period.
FIGURE 12
AVERAGE MONETARY INCENTIVE PER PRODUCTION WORKER¹
January 2000 - August 2002

¹ Average monetary incentives per production worker equal the sum of monetary incentives divided by the average production headcount for the period, where monetary incentives for the period are as follow: for the months of January through March 2000, monetary incentives equal the group piece-rates bonus plus the attendance bonus. For the period of April 2000 through June 2000, monetary incentives equal the output-target scheme bonus plus the individual attendance bonus. For the period of July 2000 through August 2002, incentives equal the output-target scheme bonus plus the gain-sharing bonus. The gain-sharing bonus is a quarterly bonus so the figure for the quarter has been pro-rated and distributed equally in each of the three preceding months of each quarter.
Figure 13
Average Direct Labor Payroll Cost per Standard Hour of Output\(^1\)
January 2000 - August 2002

\(^1\) Average direct labor payroll cost per standard hour of output calculated as the sum of total direct labor payroll costs (direct labor cost plus incentives) divided by standard hours given the actual output for the period.
REFERENCES


