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Authors

Pearce, JL
Stevenson, WB
Perry, JL

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MANAGERIAL COMPENSATION BASED ON ORGANIZATIONAL PERFORMANCE: A TIME SERIES ANALYSIS OF THE EFFECTS OF MERIT PAY

JONE L. PEARCE
WILLIAM B. STEVENSON
JAMES L. PERRY
University of California, Irvine

Performance-contingent compensation is a widely accepted means for rewarding managers, but there are no rigorous empirical tests of its effectiveness. This study reports the results of a longitudinal analysis of the effects of tying managerial pay to organizational performance in the Social Security Administration. A Box-Jenkins time series procedure was applied to organizational performance data available two years before and two years after the implementation of a new compensation system. Statistical analyses indicated that the merit pay program had no effect on organizational performance, suggesting that merit pay may be an inappropriate method of improving organizational performance.

Does tying managerial compensation to organizational performance lead to higher organizational performance? It appears to be a truism that if you want to motivate high performance, you attach rewards to it. Several prominent scholars of organization behavior (Fein, 1976; Lawler, 1971, 1981) support this common sense view. However, although merit pay and bonuses for managers are common forms of compensation, there have been no rigorous tests of their effectiveness (Dyer & Schwab, 1982).

The present study reports the results of a test of the effects of a merit pay compensation system for managers. A Box and Jenkins (1976) time series procedure was used to determine whether or not implementing a merit pay plan that tied managers' salaries to four organizational performance indicators resulted in improved organizational performance. A quasi-experimental design, incorporating a before-and-after time series (Cook & Campbell, 1979), allowed us to consider, over a period of more than four years, the effects of implementing merit pay as an intervention into the trajectories of the four performance indicators. This procedure provided, after removing historical trends or periodic oscillations in organizational performance from the data, a rigorous test of the expected effects of merit pay on overall organizational performance.

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THE EFFICACY OF PERFORMANCE-CONTINGENT PAY

The Connection between Pay and Performance

Many theorists have discussed the motivational aspects of pay. Opsahl and Dunnette (1966) reviewed several prominent psychological theories and discussed their implications for organizational compensation, but did not, however, discuss performance-contingent pay. Gellerman (1963) emphasized the symbolic role of money, but had little to say about how compensation should be administered to increase performance. Herzberg, Mausner, and Snyderman (1959) made the provocative argument that pay is a "hygiene factor," not a motivator of performance. However, King's (1970) comprehensive review of research found no support for Herzberg et al.'s two-factor theory. Proponents of equity theory (Adams, 1965) proposed that individuals who perceive themselves to be underpaid or overpaid may alter their efforts to achieve a balance between performance and reward. Again, subsequent research failed to support the performance predictions of equity theory (Dyer & Schwab, 1982; Goodman & Friedman, 1971).

A different perspective was offered by Deci (1975), who conducted a series of studies on the effects of externally-mediated rewards, such as pay, on laboratory subjects' intrinsic motivation to engage in tasks. Deci drew on this research to argue that contingent payment plans should be avoided because they reduce intrinsic motivation, lead individuals to develop strategies that will enable them to get rewards with the least effort, and can easily break down, if for instance, "no one is looking." These arguments are particularly relevant to managerial jobs, since such jobs are more likely than routine jobs to be intrinsically rewarding and are less likely to be subject to extensive surveillance. Deci suggested that salaries not directly based on performance are less likely to reduce intrinsic motivation than are salaries that are performance-contingent. Unfortunately, it is not clear from his argument whether this substitution in task motivations will necessarily result in either increased or decreased task performance. Furthermore, none of the theories that have been mentioned here, or any other discussions of pay for managers (Dunnette, Lawler, Weick, & Opsahl, 1967) directly address the question of what conditions are required to produce a successful contingent pay system in organizations.

The most recent advocates of merit pay in organizational settings include Lawler (1971, 1981, 1983) and Ellig (1982). Basing his argument on Vroom's (1964) expectancy theory, Lawler argued that pay can be a powerful performance incentive because it can be used to satisfy so many needs (1971: 26). However attractive money may be, Lawler contended (1971, 1981), it cannot motivate performance unless it is contingent on performance; he presented research from numerous studies that showed that managerial pay is seldom contingent on performance. Further support for the lack of connection between pay and performance was provided by Haire, Ghiselli, and Gordon (1967), who reported that managerial raises are often uncorrelated from one year to the next, indicating that either managerial performance is quite dif-

ferent from one year to the next — or, what is more likely — that raises are not based on performance but on other, possibly variable, criteria.

It is important to note that, although most scholars advocate performance-contingent pay systems, they recognize that under certain conditions the implementation of such systems may be more dysfunctional than functional. According to Lawler (1971, 1981), performance-contingent pay should not be used when trust levels are low, performance cannot be validly and inclusively measured, and large pay rewards cannot be given to the best performers. Lawler (1971) also acknowledged that managers may not control all of the factors that affect their unit's performance, concluding that under such circumstances subjective judgments by superiors and objective unit performance data should be combined into a managerial performance measure on which pay could be based.

Empirical Research on Contingent Pay

Although there have been empirical studies of the effects of performance-contingent pay for nonmanagement employees that supported such plans (Dyer & Schwab, 1982; Fein, 1976), and others reported dysfunctions of such pay plans (Babchuk & Goode, 1951; Whyte, 1955), there have been no direct tests of the effects of performance-contingent pay for managers. The only available information comes from surveys of the relationship between level of executive pay and performance.

Fein (1976), reporting a consulting firm's 1971 survey, writes that firms with formal bonus plans (which, we infer, were based on a measure of firm performance) had an average pre-tax return on investment of 15.8 percent, compared to 11.7 percent for firms without a formal plan; the after-tax profits were 8.6 percent versus 5 percent. Unfortunately, we cannot tell anything about the sample or whether these differences were statistically significant.

In Redling's (1981) study, performance was measured by a 5-year performance ranking that combined earnings growth and return on shareholders' equity. Using a randomly selected sample of 25 companies, he correlated each organization's ranked performance with its base salary growth and with its salary-plus-bonus growth over 5 years. He found a correlation of .16 between base salary increase and firm performance and a correlation of .09 between salary-plus-bonus increase and performance, from which he concluded that there was little indication of the existence of performance-contingent pay plans in current top executive compensation.

A final account of the extent to which compensation for executives is, in fact, contingent on firm performance is offered in a magazine article by Loomis (1982). The author, who plotted 1981 compensation (salaries, bonuses, profit sharing, stock purchase contribution) against return on stockholders' equity, found a less than perfect correspondence, and moreover, highlighted extreme cases of executives receiving relatively large increases in compensation during a period of deteriorating profitability for their firms. Loomis argued that executive compensation in these prominent publicly-held firms should be more directly tied to firm performance.

The assumption that performance-contingent pay should result in enhanced organizational performance is widespread. Redling's (1981) and Loomis's (1982) advocacy of managerial pay based on organizational performance measures echoes the recommendations of compensation specialists (cf., Ellig, 1982). Yet, as this review of theory and research tying managerial compensation to organizational performance shows, there is a lack of conclusive empirical support for this assumption due to an absence of systematic research. Dyer and Schwab (1982) noted that there is research evidence that incentive pay plans for nonmanagement employees produce higher productivity, but that there have been no field studies of managerial merit pay plans. Nevertheless, some argue that managerial performance should be higher using such programs, and even if these programs are not perfect, the alternative of noncontingent pay certainly does not motivate performance (Ellig, 1982). The present study is the first systematic attempt to assess the actual effects on organizational performance of the introduction of performance-contingent pay for managers.

METHODS

This study was conducted as part of a larger study of personnel reform in five federal government agencies (Perry & Porter, 1981). Extensive interviews, on-site observations, surveys, and record audits from this larger study supplemented the archival data reported in the present study. The Social Security Administration (SSA) was the site of this study. The performance-contingent pay system was implemented in the SSA as part of the Civil Service Reform Act of 1978, and, as in all federal agencies, covered managers, but not their subordinates. This new pay system allocated one-half of annual pay increases for managers automatically and the other half on the basis of rated performance; in the prior system, the entire increase was routinely awarded. The new discretionary or merit portion of the annual increase was allocated to managers from a pool of funds according to the distribution of their performance ratings within the pool. The overall size of the annual pay adjustment was determined by a presidential decision based, in part, on a salary survey of comparable jobs in the private sector. In the initial year of implementation, 4.5 percent of the amount of base salaries was available for merit increases, and in the second year, 2.4 percent.

Sample

Performance data were collected from a regional network of 20 local district and branch SSA offices, ranging in size from 12 to 73 employees. The primary functions of each office were to accept claims, determine eligibility for benefits, and maintain records for retirement, insurance, and income supplement programs under Titles II and XVI of the Social Security Act. Managers in these 20 offices were part of the same merit pay pool. We combined performance indicators for the 20 district and branch offices into aggregate time series, because our research hypotheses focused on whether

the merit pay plan had effects on Social Security offices in general, rather than on whether a particular manager or group of employees responded favorably to it.

Measures

Monthly time series for four performance measures were the basis for the present study, with the number of observations in each series ranging from 48 to 53. Although several additional performance indicators were used during one yearly appraisal or the next, we confined our analysis to the following indicators that were used continuously over the study interval: (1) the average number of days for a retirement/survivor's claim to be paid or denied (performance measure 1), measured for 53 months from October 1977 to February 1982; (2) the average number of days for an aged supplemental income claim to be paid or denied (performance measure 2), measured for 53 months from October 1977 to February 1982; (3) the percentage of supplemental income claims with accurate payment documentation (performance measure 3), measured for 49 months from February 1978 to February 1982; and (4), the percentage of post-entitlement actions that took over 30 days to be settled (performance measure 4), measured for 48 months from October, 1977 to September, 1981.

A district office's performance on objective measures accounted for the largest share (40%) of its manager's rating for determining merit pay. The four indicators were designated "critical elements" in the first performance period by the regional commissioner of SSA, which meant that performance below standard on any of them resulted in automatic denial of a merit pay increase. The remainder of the performance rating was composed of supervisory evaluations and objective measures that were not critical and changed each year (e.g., affirmative action progress or meeting office security goals).

Subjective and objective ratings were converted to scores ranging from a 0 for unsatisfactory performance to a 4 for outstanding performance. For example, in fiscal year 1981, the standards for performance measure 1 — the average number of days for a retirement or survivor's claim to be paid or denied — for the Southwest California Area were: level 0, 34 or more days; level 1, 33 days; level 2, 30–32 days; level 3, 29 days; level 4, 28 or fewer days. All of these subjective and objective ordinal scores were then weighted and averaged to produce the overall rating on which the merit pay award was based.

The objective organizational performance measures used in this study were available for 2 years prior to creation of the merit pay system. Because they had become accepted measures of SSA performance, much as profitability is for business firms, they were not changed in any significant way to accommodate merit pay. Managers who were responsible for overseeing them indicated there was a high positive association between objective and final merit ratings. Field observations and extensive interviews also revealed that managers were highly attentive to the objective measures because of concern for their effects on final merit ratings and awareness that failure to perform

satisfactorily on any of them would result in automatic denial of a merit pay increase (Perry & Porter, 1981).

Interventions

The effects of changing to a performance-contingent compensation system were assessed in terms of the hypothesized statistical effects of three interventions into each of the four time series. The first intervention corresponded to the initiation of merit pay orientation and training sessions in September, 1979. We hypothesized that the training intervention would familiarize managers with the new contingent pay program and might sensitize them to attendant expectations, thereby spurring an increase in performance. The second intervention corresponded with the actual start of merit pay on January 1, 1980, the date on which future annual increases became contingent on organizational performance. The third intervention corresponded with the end of the fiscal year on October 1, 1980, when annual merit pay adjustments began to be distributed in monthly paychecks and the second year of merit pay started.

Statistical Methods

The measurements of the four indicators of organizational performance at regular intervals form four time series of observations. We constructed a statistical model describing each time series, and then added the dates of the three interventions to the model. If an intervention produced a significant effect on the time series — that is, a change in level or slope not predictable from the model describing the series — we could conclude that merit pay had an effect on organizational performance.

An important first step in testing the effects of the merit pay interventions was constructing a statistical model of each time series. The reasons why ARIMA modeling was preferred to the alternatives are discussed in the Appendix.

Because of its ability to model the systematic components in the time series, we chose ARIMA modeling for this analysis; however, ARIMA modeling has certain drawbacks. The technique requires lengthy time series; most analysts recommend time series of at least 50 observations in order to identify the parameters of the model. In the present study, the four time series included from 48 to 53 observations. ARIMA modeling could also be criticized because the removal of trend and the estimation of autoregressive and moving average parameters are atheoretical and represent the removal of the effects of unmeasured variables. On the other hand, this technique is no more atheoretical than adjustments for autocorrelated errors made in econometric models, and with lengthy time series, may provide a more accurate model for estimating the effects of interventions (Albritton, 1981; Hibbs, 1977).

Interventions are added to the ARIMA model by specifying a transfer function that translates the effect of an intervention into an expected effect on the series. The effect hypothesized by the analyst may take a variety of

forms (Box & Tiao, 1975; Hibbs, 1977). For example, an intervention like a new law reducing the hydrocarbons in gasoline may be expected to have a sudden, abrupt effect on air pollution in the Los Angeles basin (Box & Tiao, 1975); another intervention, such as a new law requiring seat belts in new automobiles, may be expected to produce a gradual, constant change in the automobile death rate as new automobiles are purchased (Bhattacharyya & Layton, 1979). In the present case, assuming that managers cannot cause instantaneous changes in organizational performance, we hypothesized that the implementation of merit pay would produce a gradual and permanent change in organizational performance over a period of months, a process that can be represented as a transfer function (McCleary & Hay, 1980):

$$Y_t = \frac{U_0}{1 - S_1 B} I_t + N_t$$

where

Y_t = the original time series,

U_0 = a parameter representing the initial impact of the change,

S_1 = a parameter representing the rate of change after the impact,

B = the backshift operator — when applied to a variable, the variable is shifted backward one time point (Box & Jenkins, 1976),

I_t = the impact variable, equal to 0 before intervention, to 1 afterward,

N_t = the ARIMA noise model,

and where $-1 < S_1 < 1$.

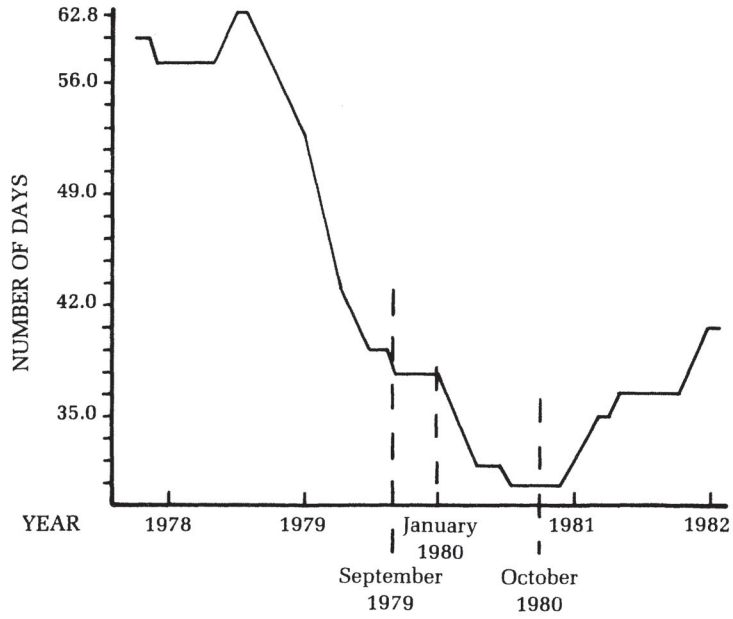
The rate of change variable S_1 is constrained to be less than ± 1 to insure a stable impact. If both the U_0 and S_1 parameters were statistically significant, the implementation of merit pay for managers would have had a significant gradual, constant impact on organizational performance. If the U_0 parameter alone were significant, the implication would be that the initial impact was instantaneous, and therefore, the rate of change parameter (S_1) was unnecessary. In this case, the transfer function may have been misspecified and a transfer function reflecting an instantaneous change in the series may have been more appropriate. If the U_0 parameter were not significant, then the implementation of merit pay had no initial effect, and the S_1 parameter was irrelevant.

RESULTS

Figure 1 presents plots of the four performance measures over time. We smoothed the data, reducing variation around the general trend by calculating running medians of 4, then 2, then 3, and then calculating a running average, and then reapplying the entire process, in order to clarify the pattern of the data. This process, implemented by the MINITAB interactive

FIGURE 1
Smoothed Time-Series for Four Performance Measures

(a) Days for a Retirement/Survivor's Claim to Be Paid or Denied (Measure 1)



(b) Days for an Aged Supplemental Income Claim to Be Paid or Denied (Measure 2)

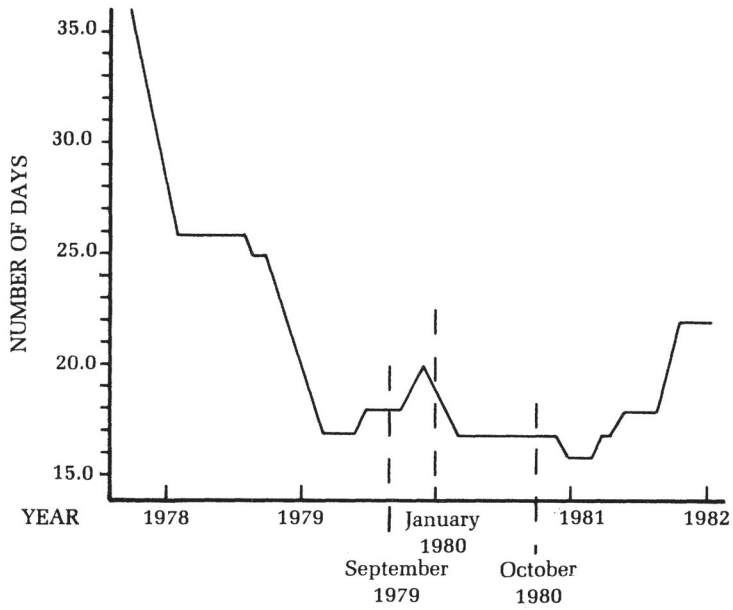
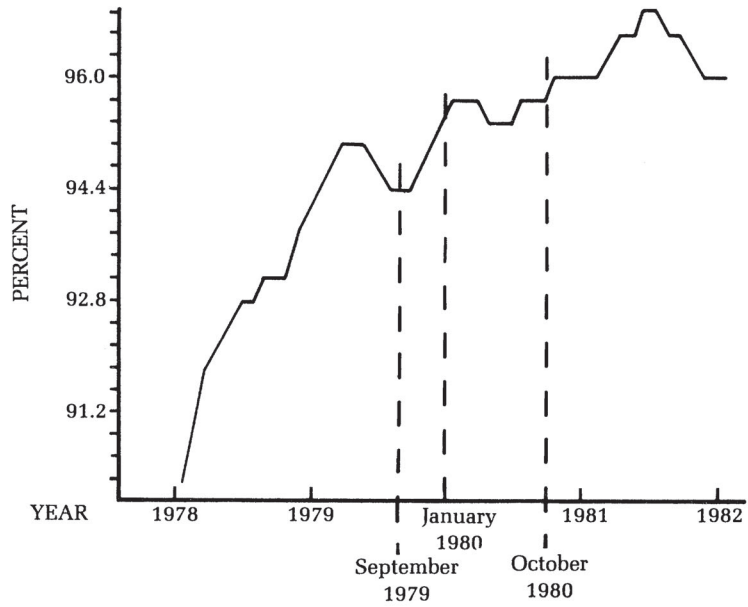
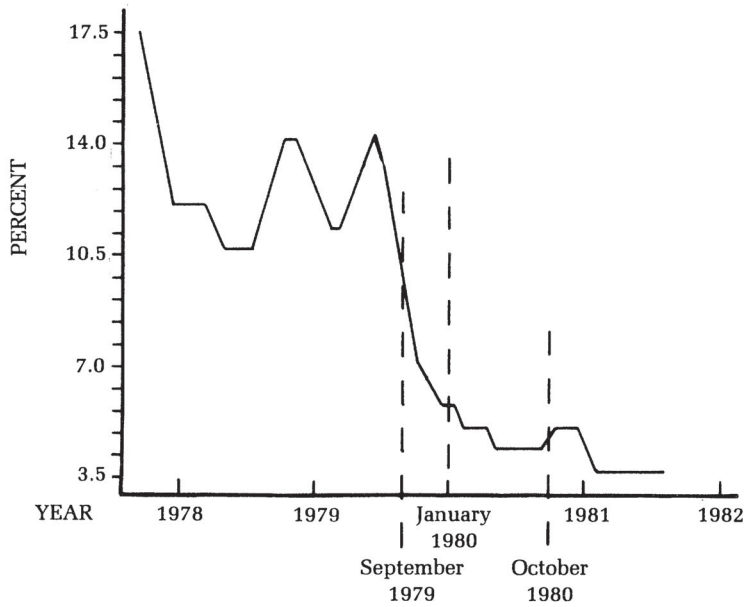


FIGURE 1 (continued)

(c) Percentage of Supplemental Income Claims with Accurate Documentation (Measure 3)



(d) Percentage of Post-Entitlement Actions That Took Over 30 Days (Measure 4)



computer program (Ryan, Joiner, & Ryan, 1981), provides a smoothing procedure resistant to extreme values but retaining the overall pattern of data (Velleman & Hoaglin, 1981).¹

As can be seen in the figures, performance was improving before the implementation of merit pay. Our data do not extend far enough back in time to detect the origin of the trend, but it is clear that there is a general upward trend in performance over the study period, with no obvious changes in direction due to the implementation of merit pay.

We supplemented these descriptive results with formal hypothesis testing using ARIMA analysis (McCleary & Hay, 1980); Table 1 presents the results. Before the analysis, we removed trends in the data, evident in the figures, by differencing. Then, we formulated a model describing the time series in terms of any month-to-month repetition and thus autoregressively correlated data points or repetitive moving average random shocks. Any systematic component in the data based on more than month-to-month repetition could have been removed by adding seasonal components to the model, but this was unnecessary. Because several of these time series exhibit floor or ceiling effects — that is, the series asymptotically approach an upper bound of performance that may be impossible to surpass, for instance 100 percent accuracy — and because several series approach this boundary nonlinearly, all of the time series except that for supplemental security income claims were transformed to their natural logarithms (McCleary & Musheno, 1981).

The appropriate models are displayed in Table 1 in Box and Jenkins (1976) “*p d q*” notation where *p* indicates the order of the autoregressive parameter, *d* indicates the degree of differencing, and *q* denotes the order of the moving average parameter. First, we estimated all models with a trend constant to account for any additional trend after first differencing. If the trend constant was not statistically significant it was deleted, and the equation was reestimated. The coefficients in the initial models were statistically significant (twice their standard errors) except for the coefficients of performance measures 2 and 4, for which transforming the data to logarithms and taking a first difference to remove trends were adequate to model the data.

Once the ARIMA models were specified, analysis proceeded to testing the effects on the time series of events treated as interventions by adding a transfer function to the model. If the parameters of the transfer function are significant, the intervention had had a significant effect on the time series above and beyond any trends in the data and autoregressive and moving average regularities. As can be seen in Table 1, the gradual, constant intervention hypothesis was not supported. The parameters of the transfer function added to the ARIMA model were not significantly different from zero for any of the performance measures, except for the September 1979 training effect for the first differenced logarithm of performance measure 4. This one

¹However readers are cautioned that smoothing data does remove some of the important detail; we relied upon statistical analysis of the raw data in the testing of our hypothesized intervention effects.

significant result could be taken as evidence of some slight positive effect of merit pay, but in order for this result to be considered substantive support for the effects of merit pay plans on performance, we would have to assume that managers began to manage in a way that brought about an increase, beginning during the training period, in the speed of processing one particular type of claim, even though managers did not know during the training period exactly which indicators from among those available would be used to evaluate their performance. Substantively, however, it seems more likely that a positive effect of merit pay would be manifested in more than one performance indicator. Indeed, if these tests are not considered to be independent of each other and the probability level for statistical significance is appropriately altered, the statistically significant effect for performance measure 4 vanishes. Overall, then, positive effects of the implementation of merit pay, whether conceived of as caused by a training effect on September 1979, a simple implementation effect on January 1980, or a delayed effect on October 1980, were not supported by the data.

DISCUSSION

Our analysis of the effects of the implementation of a performance-contingent pay program for managers indicated that its implementation had no statistically significant, gradual, permanent effect on the general trend of organizational performance in 11 out of 12 tests. These statistical results confirm the pattern seen in an examination of plots of 4 measures of organizational performance from October 1977 to February 1982. For whatever reason, organizational performance was improving in the Social Security Administration offices well before the passage of the Reform Act, and neither the implementation of merit pay as a system, nor the first year of rewarding managers with merit pay had any additional effects.

There are limitations to this study that prevent drawing definitive conclusions about the effect of merit pay on organizational performance. First, of necessity, the majority of our statistical tests focus on the implementation of merit pay. The program was clearly designed to improve organizational performance, and 8 of our 12 tests assess the effect of training and the start of the program on organizational performance, an emphasis somewhat different from testing changes in organizational performance after merit pay rewards were distributed. Thus, although we did examine four performance measures at one point after rewards began to be distributed, we were more oriented to the question of whether implementation of the program had effects, rather than to possible effects of rewards over a longer period of time. This merit pay program has continued in operation, and further testing may reveal long term positive or negative effects on organizational performance.

Second, there is evidence that the implementation of this federal merit pay program was flawed in several ways. The program was implemented amid court challenges and disputes among responsible agencies, such as the Office of Personnel Management and the General Accounting Office, over its

TABLE 1
 ARIMA Estimates of the Effects of Events Implementing
 Merit Pay on Four Time Series of Organizational Performance

Performance Measure	Model ^a	Event Date	Trend ^b	Noise ^b	U_0^b	S_1^b
1: Days for a retirement/survivor's claim to be paid or denied (log) (n = 53)	(011)	—	—	.3495 (2.59)*	—	—
		Startup/January 1980	—	.1815 (1.25)	.0021 (0.55)	-1.1387 (13.59)*
		Training/September 1979	—	.3406 (2.54)*	-.0172 (0.51)	-.5176 (0.35)
		Payout/October 1980	—	.3280 (2.46)*	.0116 (0.35)	-.4364 (0.19)*
2: Days for an aged supplemental income claim to be paid or denied (log) (n = 53)	(010)	—	—	—	—	—
		Startup/January 1980	—	—	.0227 (0.52)*	-.3065 (0.18)
		Training/September 1979	—	—	.0566 (1.31)	.3040 (0.46)
		Payout/October 1980	—	—	-.0330 (0.83)	-.6413 (1.12)

TABLE 1 (continued)

Performance Measure	Model ^a	Event Date	Trend ^b	Noise ^b	U ₀ ^b	S ₁ ^b
3: Percentage of supplemental income claims with accurate documentation (log) (n = 49)	(011)	-	.1135 (2.15)*	.4366 (3.55)*	-	-
		Startup/ January 1980	.1786 (2.99)*	.5258 (4.50)*	-.0522 (0.60)	1.0929 (11.95)*
		Training/ September 1979	.0985 (1.86)	.4446 (3.58)*	.9942 (1.56)	-.4445 (0.83)
		Payout/ October 1980	.1629 (2.62)*	.4398 (3.23)*	-.0625 (0.49)	1.1660 (4.87)*
4: Percentage of post-entitlement actions that took over 30 days (n = 48)	(010)	-	-	-	-	-
		Startup/ January 1980	-	-	.0069 (0.45)	-1.1212 (7.99)*
		Training/ September 1978	-	-	-.1572 (2.32)*	.7115 (4.18)*
		Payout/ October 1980	-	-	.0229 (0.28)	.5131 (0.23)

^aModels follow the Box-Jenkins (p d q) notation where p = autoregressive order, d = the degree of differencing, and q = the moving average order.
^bt-ratio in parentheses
 * p < .05

salient features; these disputes could have reduced managers' expectations that pay would be made contingent on measured organizational performance. In their surveys of managerial perceptions, Perry and Porter (1981) found that many managers did not trust the motives behind this compensation program, seeing it as political "window dressing" by the Carter and Reagan administrations; some managers apparently believed that this program was intended by the political leadership to communicate its dissatisfaction with bureaucratic inefficiency to the electorate rather than to actually reward high performance (Perry & Porter, 1981).

Third, in this research, as in so many real world quasi-experimental designs, it was not possible to study a comparable control group, although looking at 4 years of monthly performance measures gave us some control over rival hypotheses. The trend towards improved performance that existed before the implementation of merit pay was not significantly altered by training or implementation of the merit pay system, but, even though performance did not improve beyond existing trends, without a control group it was not possible to eliminate the rival hypothesis that performance would have deteriorated without the implementation of merit pay.

With the above caveats in mind, the evidence presented indicates that the implementation of merit pay had no significant effects on organizational performance. These empirical results, when combined with the absence in the scholarly literature of any reported successes of performance-contingent pay for managers, tentatively suggest that the concept of tying managerial compensation to organizational performance may deserve reexamination. It is possible that the concept itself may be invalid because (1) the nature of managerial work is too complex to be adequately captured in organizational performance measures, and (2) organizational performance is something over which managers have only limited control.

Much has been written about the open-ended, nonroutine nature of managerial work. Mintzberg (1973) found that chief executive officer jobs were characterized by brevity, variety, fragmentation, and an unrelenting pace, that managers were forced to react to immediate events, and that their schedules were frequently interrupted by crisis. Further evidence indicates that lower-level managers' jobs require even more frequent reactions to events (Chapple & Sayles, 1961) than do those of upper-level managers. Corroborating evidence can be found in the goal-setting literature: In his review of goal-setting research, Latham (1975) found that goal-setting programs for managers had encountered more problems than those for "simple jobs." He suggests that the complexity of managerial work may account for the lack of consistent success of managerial goal-setting programs.

These complexities suggest that objective measures of managerial performance may not be specifiable in advance. Therefore, someone — either peers, or more likely, the manager's supervisor — must judge performance; Lawler (1971) suggests that under these circumstances a combination of objective and subjective judgments be used in managerial evaluation, as was done in the merit pay program that figures in the present study. This approach may

solve the problem of devising fair performance appraisals for managers, but avoids the difficult question of whether a merit pay program based on such measures will improve organizational performance.

Finally, there is evidence from a body of organizational theory and research indicating that managers have little direct and immediate control over organizational performance. Pfeffer and Salancik (1978), among others, suggest that managerial actions account for as little as 10 percent of the variance in organizational performance and that more attention should be given to environmental influences on organizational performance. Mayors are elected to provide leadership for cities, yet research indicates that, compared to outside influences, they exert little control over city budgets (Salancik & Pfeffer, 1977); the appointment of new corporation presidents can make headlines in the business sections of newspapers, but Lieberman and O'Connor (1972) found leadership change to have no effect on organizational indicators such as profits; coaches of athletic teams are changed and win/lose records do not seem to improve (Brown, 1982). Control over organizational performance is complex, and the role of management is not simply to supervise employee productivity, even in organizations employing a simple technology like the distribution of social security benefits.

In conclusion, one study cannot definitively prove or refute the effectiveness of merit pay for managers. However, this study has illustrated the advantages of assessing attempts at organizational change over time. By examining performance for several years before and after an organizational change, it was possible to isolate the impact of a new merit pay program from any trends, transient improvements, and systematic oscillations in performance. Since organizational performance was improving before implementation of merit pay and continued to improve at a similar rate after that intervention, a simple before-and-after comparison would have led to the misleading conclusion that merit pay had a favorable effect on organizational performance. Future longitudinal studies of merit pay plans in other organizational settings should be able to determine under what conditions, if any, merit pay plans produce improvements in organizational performance.

APPENDIX

A variety of techniques for analyzing the impact of events affecting the performance measures were available. This appendix provides a discussion of alternative techniques and explains the advantages of Box-Jenkins intervention analysis. One alternative was to simply compare data from before and after the implementation of merit pay, but such a comparison would not have taken into account any upward or downward trends in the series. Thus, although improvement or decline in performance may have been occurring for some time independent of any changes in compensation to managers, before-and-after testing could have erroneously attributed changes to the implementation of merit pay. Therefore, it was desirable to construct a model that took account of trends in performance over time before testing the effects of merit pay.

A second alternative was to construct an econometric linear regression model fitting a regression line through the performance data over time, which could have been done by estimating two equations, one for performance data before the intervention and one for data after

intervention. The equations would have had time as an independent variable, and the differences in their slopes and intercepts would reflect differences in performance before and after the implementation of merit pay.

A third, equivalent alternative would have been to test the differences in the slope and intercept of the regression line predicting performance over time in one equation by using the following as independent variables: a dummy variable equal to zero before the intervention and to one afterwards; a variable representing time; and an interaction term constructed by multiplying the dummy variable by the time variable (Rao & Miller, 1971).

In either form, such a model is more sophisticated than simple before-and-after testing, in that it accounts for trends in the data and can include additional independent variables to explain organizational performance. However, such econometric time series models are inadequate if observations on the dependent variable are not independent of each other from one time point to the next. It is well-known that violations of the assumption of independence of observations result in incorrect estimates of the residual variance associated with the regression equation, and, even though coefficient estimates remain unbiased, significance tests of coefficients in the regression equation become unreliable. Modifications to regression analysis such as generalized least-squares regression (GLS) are possible, but GLS estimation can only take account of simple correlations of residual variance from one time point to the next.

Unfortunately, observations can be associated over time in several ways. A time series can be autocorrelated: that is, an observation may be correlated positively or negatively with the immediately preceding observation or with more than one previous observation. A time series can also exhibit a moving average process in which an observation is related to the previous observation, or to more than one previous observation, by a positive or negative random shock. Occasionally, a time series can be characterized by both autoregressive and moving average parameters.

The Box-Jenkins autoregressive integrated moving average (ARIMA) model — after detrending data, if necessary, by subtracting one value from the next — can take account of autoregressive and moving average processes. The ARIMA model differs from the better known regression model, in which independent variables are used to account for variance in the dependent variable, in that the former models a time series only in terms of autoregressive and moving average parameters that characterize a series itself. Given output from this modeling process — a residual series of data from which any recurring systematic components have been removed — a researcher can test an intervention into the series to see if it reflects a significant change above and beyond any recurring systematic components.

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Jone L. Pearce is Assistant Professor and Associate Dean in the Graduate School of Management, University of California, Irvine. She received her doctorate in Administrative Sciences from Yale University. The central theme of her research concerns the behavioral and interpersonal effects of various modes of compensation and related personnel practices.

William B. Stevenson earned his Ph.D. in Sociology from the University of California, Riverside. He is currently Assistant Professor of Management in the Graduate School of Management, University of California, Irvine. His current research interests include the relationship between coalition formation, social networks, and organizational structure.

James L. Perry is Professor of Management and Political Science at the University of California, Irvine. He received his Ph.D. from the Maxwell School, Syracuse University. His current research interests include organizational structure and performance in the public sector.