

e - c o m p a n i o n

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Electronic Companion—"Quality Management and Job Quality: How the ISO 9001 Standard for Quality Management Systems Affects Employees and Employers" by David I. Levine and Michael W. Toffel, *Management Science*, DOI 10.1287/mnsc.1100.1159.

On-line Appendix (e-companion)

Table A1.
Description and summary statistics of variables used to generate propensity scores for the matching process
(in addition to those in the paper's Table 2)

| Variable | Description | Mean | SD | Min | Max |
|---|--|-------|-----------|-------|------------|
| Adopts ISO 9001 this year (dummy) | Dummy coded "1" if the firm adopted ISO 9001 this year, and "0" otherwise. | 0.006 | 0.08 | 0 | 1 |
| Injury costs _{-1&-2} | Average of the one- and two-year lags of total annual workers' compensation injury costs, in thousands of dollars. ^a | 7.95 | 112.88 | 0 | 27,765.74 |
| Injury costs _{-1&-2} , squared | Square of injury costs _{-1&-2} , reported in billions of dollars. | 12.80 | 2,606.84 | 0 | 770,936.30 |
| Injury rate _{-1&-2} | Average of one- and two-year lags of annual number of injuries reported for workers' compensation. ^a | 1.08 | 18.78 | 0 | 4,149.00 |
| Injury rate _{-1&-2} , squared | Square of injury rate _{-1&-2} , reported in thousands of injuries. | 0.35 | 69.83 | 0 | 17,214.20 |
| No injuries _{-1&-2} | Dummy coded "1" if the firm reported no injuries in the prior two years, and "0" otherwise. | 0.64 | 0.48 | 0 | 1 |
| Payroll _{-1&-2} | Average of one- and two-year lags of annual payroll, in millions of dollars. ^{b,c} | 0.54 | 8.59 | 0.01 | 2,182.77 |
| Payroll _{-1&-2} , squared | Square of payroll _{-1&-2} , reported in trillions of dollars. ^{b,c} | 74.06 | 16,170.04 | 0.00 | 4,764,504 |
| Employment _{-1&-2} | Average of one- and two-year lags of employees. ^c | 14.21 | 25.23 | 1 | 1800 |
| Employment _{-1&-2} , squared | Square of employment _{-1&-2} , reported in thousands of employees. ^c | 0.84 | 14.32 | 0.001 | 3240 |
| Wage _{-1&-2} | Average of one- and two-year lags of payroll/employment, reported in thousands of dollars. ^d | 44.89 | 254.30 | 7.02 | 53,989.38 |
| Log wage _{-1&-2} | Natural log of wage _{-1&-2} , reported in dollars. ^d | 10.21 | 0.78 | 8.86 | 17.80 |
| Wage _{-1&-2} , squared | Square of wage _{-1&-2} , reported in trillions of dollars. ^d | 0.07 | 10.92 | 0.00 | 2,914.85 |
| Sales _{-1&-2} | Average of one- and two-year lags of annual firm sales, reported in millions of dollars. | 2.15 | 5.54 | 0.00 | 329.35 |
| Sales _{-1&-2} , squared | Square of sales _{-1&-2} , reported in quadrillions of dollars. | 0.04 | 0.76 | 0.00 | 108.47 |
| Average occupational riskiness _{-1&-2} | Firm's average annual hazard per payroll dollar. A firm's annual average hazard is the sum across all occupation classes of the following: the payroll dollars in each occupation class multiplied by the WCIRB Pure Premium Rate for each occupation class. We divide this by the firm's payroll that year. | 2.24 | 1.74 | 0.18 | 22.73 |
| Average occupational riskiness _{-1&-2} , squared | Square of average occupational riskiness _{-1&-2} . | 8.08 | 12.57 | 0.032 | 516.65 |

N = 143,580 firm-year observations. Sample includes all non-adopters, and adopters before and in their adoption year, provided they have observations with complete data for the model.

^a Missing values for injury costs are converted to zeros if data exists for exposure in that year. If one of the two lags is missing, the average will equal the non-missing lag.

^b To minimize the impact of outliers, we omitted very small annual payroll values (less than \$5,000).

^c To minimize the impact of firms that were rapidly growing or shrinking, we omitted instances in which the ratio of the current year's value to its one-year lag was outside the range of 0.5 to 2.

^d To minimize the impact of outliers, we omitted firm-years with very low average annual wages (less than \$7,020, calculated as 20 hours per week * 52 weeks per year * \$6.75 [California minimum wage as of Jan 2002]).

Table A2.
Probit results that generated propensity scores

Dependent variable: Adopts ISO 9001 this year (dummy)

| | Coefficients | SE | | Marginal Effects |
|---|--------------|----------|-----|------------------|
| Injury costs _{.1&-2} | 0.0008 | [0.0004] | * | 0.0000 |
| Log injury costs _{.1&-2} | -0.0458 | [0.0187] | ** | 0.0000 |
| Injury costs _{.1&-2} , squared | 0.0000 | [0.0002] | | 0.0000 |
| Injury rate _{.1&-2} | -0.0015 | [0.0081] | | 0.0000 |
| Log injury rate _{.1&-2} | 0.0342 | [0.0591] | | 0.0001 |
| Injury rate _{.1&-2} , squared | -0.0242 | [0.0572] | | 0.0000 |
| No injuries _{.1&-2} | 0.0590 | [0.0547] | | 0.0001 |
| Payroll _{.1&-2} | -0.0273 | [0.0093] | *** | 0.0000 |
| Log payroll _{.1&-2} | 0.4671 | [0.2719] | * | 0.0007 |
| Payroll _{.1&-2} , squared | 0.0001 | [0.0000] | *** | 0.0000 |
| Employment _{.1&-2} | 0.0015 | [0.0010] | | 0.0000 |
| Log employment _{.1&-2} | -0.1558 | [0.2734] | | -0.0002 |
| Employment _{.1&-2} , squared | -0.0010 | [0.0013] | | 0.0000 |
| Wage _{.1&-2} | 0.0002 | [0.0001] | *** | 0.0000 |
| Log wage _{.1&-2} | -0.1228 | [0.2729] | | -0.0001 |
| Wage _{.1&-2} , squared | -0.0022 | [0.0009] | ** | 0.0000 |
| Sales _{.1&-2} | -0.0047 | [0.0032] | | 0.0000 |
| Log sales _{.1&-2} | 0.1008 | [0.0294] | *** | 0.0002 |
| Sales _{.1&-2} , squared | 0.0186 | [0.0091] | ** | 0.0000 |
| Average occupational riskiness _{.1&-2} | -0.3368 | [0.0556] | *** | -0.0005 |
| Log average occupational riskiness _{.1&-2} | 0.0263 | [0.0881] | | 0.0000 |
| Average occupational riskiness _{.1&-2} , squared | 0.0207 | [0.0024] | *** | 0.0000 |
| Constant | -8.3662 | [0.4965] | *** | |
| Observations | 143,580 | | | |

Brackets contain robust standard errors clustered by firm. *** $p < 0.01$, ** $p < 5\%$, * $p < 0.10$. Additional controls include year dummies (1995-2005), 7 region dummies, and 14 industry dummies. Sample includes adopters before and in their adoption year, and non-adopters in all years.

Table A3.
Assessing the quality of the matched sample for the treatment analysis

Balancing test results

| Variable | Matched non-adopters | | | Matched adopters | | | t-test p-value |
|---|----------------------|-------|-------|------------------|-------|-------|----------------|
| | N | Mean | SE | N | Mean | SE | |
| Log injury costs _{-1&-2} | 471 | 8.23 | 0.074 | 471 | 8.44 | 0.077 | 0.06 * |
| Percent change ^a in ratio of injury costs | 268 | -0.04 | 0.093 | 268 | 0.25 | 0.088 | 0.03 ** |
| Log injury costs _{-1&-2} – log injury costs _{-3&-4} | 381 | 0.04 | 0.079 | 381 | 0.20 | 0.072 | 0.12 |
| Log injury rate _{-1&-2} | 471 | 0.90 | 0.042 | 471 | 0.98 | 0.045 | 0.20 |
| Percent change ^a in ratio of injury rate | 268 | -0.04 | 0.076 | 268 | 0.16 | 0.069 | 0.06 * |
| Log injury rate _{-1&-2} – log injury rate _{-3&-4} | 381 | 0.02 | 0.030 | 381 | 0.06 | 0.028 | 0.36 |
| Log payroll _{-1&-2} | 471 | 13.64 | 0.043 | 471 | 13.76 | 0.049 | 0.06 * |
| Percent change ^a in ratio of payroll | 364 | 0.25 | 0.018 | 364 | 0.23 | 0.019 | 0.55 |
| Log payroll _{-1&-2} – log payroll _{-3&-4} | 364 | 0.28 | 0.024 | 364 | 0.26 | 0.023 | 0.54 |
| Log employment _{-1&-2} | 471 | 3.14 | 0.045 | 471 | 3.21 | 0.048 | 0.30 |
| Percent change ^a in ratio of employment | 431 | 0.12 | 0.018 | 431 | 0.15 | 0.016 | 0.24 |
| Log employment _{-1&-2} – log employment _{-3&-4} | 431 | 0.13 | 0.022 | 431 | 0.16 | 0.018 | 0.42 |
| Log wages _{-1&-2} ^b | 471 | 10.50 | 0.033 | 471 | 10.55 | 0.040 | 0.27 |
| Percent change ^a in ratio of wages | 328 | 0.08 | 0.022 | 328 | 0.05 | 0.022 | 0.30 |
| Log wages _{-1&-2} – log wages _{-3&-4} | 328 | 0.07 | 0.025 | 328 | 0.05 | 0.024 | 0.45 |
| Log sales _{-1&-2} | 471 | 14.85 | 0.049 | 471 | 14.88 | 0.053 | 0.72 |
| Percent change ^a in ratio of sales | 431 | 0.20 | 0.019 | 431 | 0.21 | 0.019 | 0.71 |
| Log sales _{-1&-2} – log sales _{-3&-4} | 431 | 0.23 | 0.026 | 431 | 0.22 | 0.026 | 0.64 |
| Log average occupational riskiness _{-1&-2} | 471 | 0.74 | 0.029 | 471 | 0.76 | 0.029 | 0.58 |
| Percent change ^a in ratio of average occupational riskiness | 364 | -0.01 | 0.009 | 364 | 0.00 | 0.011 | 0.28 |
| Log average occupational riskiness _{-1&-2} – log average occupational riskiness _{-3&-4} | 364 | -0.01 | 0.009 | 364 | 0.00 | 0.012 | 0.27 |

*** p<0.01, ** p<5%, * p<0.10.

Variables subscripted _{-1&-2} are averages of 1- and 2- year lags, and _{-3&-4} are averages of 3- and 4-year lags.

^a “Percent change” variables are constructed as the difference in the average value of the 3- and 4-year lagged values from the average value of the 1- and 2-year lagged values, divided by half the sum these values. This ratio approximates “percent change,” but is robust to outliers; it ranges from -2 to +2.

^b Wages are the ratio of payroll to employment. To minimize the impact of outliers, we omitted firm-years with very low average annual wages (less than \$7,020, calculated as 20 hours per week * 52 weeks per year * \$6.75 [California minimum wage as of Jan 2002]).

Table A4.
Survival analysis: Regression results

Dependent variable: Firm survival

| | (1) | | | (2) | | (3) |
|--|--------------------------------|---------------------|-----------------------|--|-----------------------|---|
| | Cross-sectional logistic model | | | Conditional fixed effects logistic model | | Stratified Cox proportional hazards model |
| | Coefficients | Marginal effects | Odds ratios | Coefficients | Odds ratios | Hazard ratio |
| Adopter | 2.842*** [0.605] | 0.045*** [0.010] | 17.156*** [10.374] | 3.055*** [0.853] | 21.224*** [18.095] | 0.047*** [0.040] |
| Log employment _{t-1&t-2} | 0.127 [0.268] | 0.002 [0.003] | 1.135 [0.304] | -0.067 [0.974] | 0.935 [0.911] | 1.069 [1.042] |
| Log payroll _{t-1&t-2} | -0.059 [0.229] | -0.001 [0.003] | 0.943 [0.216] | 1.830 [1.688] | 6.236 [10.527] | 0.160 [0.271] |
| Log sales _{t-1&t-2} | -0.415** [0.201] | -0.005* [0.003] | 0.660** [0.133] | -0.096 [0.530] | 0.908 [0.481] | 1.101 [0.583] |
| Log average occupational riskiness _{t-1&t-2} | 1.302*** [0.383] | 0.016*** [0.006] | 3.678*** [1.409] | -0.965 [2.523] | 0.381 [0.961] | 2.624 [6.621] |
| Region dummies | Included | Included | Included | Absorbed | Absorbed | Absorbed |
| Industry dummies | Included | Included | Included | Absorbed | Absorbed | Absorbed |
| Conditional fixed effects for (stratified by) matched groups | | | | Included | Included | |
| Constant | 10.609*** [3.969] | | | | | |
| Observations | 1,244 firms | | | 94 firms | | 5,040 firm-years |

In these models, all independent variables are time-invariant, calculated as the log of average values over the two years prior to the match (adoption) year. Model 1 is cross-sectional, estimated on one observation per firm. Model 2 is also cross-sectional, but stratified (grouped) by each match group (i.e., an adopting firm and its control firm). It drops all match groups in which both members survive through 2003 (when our sample is right censored), and is thus estimated only on match groups in which one or both members of the match group dies. Model 3 is a survival model estimated on firm-years, and is also stratified (grouped) by match groups.

Table A5.
Balancing tests: Financial stress

Panel A.

T-tests indicate that the matched samples are balanced on the PAYDEX indicator of financial stress

| Matched sample | Firm's financial stress indicator in the match year | Matched controls: Mean {SD} [SE] | Matched adopters: Mean {SD} [SE] | t-test p-value |
|---------------------------------------|---|---|---|----------------|
| Matched sample for treatment analysis | Minimum PAYDEX score | 68.54 {10.42} [0.51] | 67.59 {9.88} [0.48] | 0.18 |
| | Maximum PAYDEX score | 75.49 {6.68} [0.33] | 75.41 {6.08} [0.30] | 0.85 |
| Matched sample for survival analysis | Minimum PAYDEX score | 68.23 {10.98} [0.48] | 67.36 {10.21} [0.44] | 0.18 |
| | Maximum PAYDEX score | 75.43 {7.25} [0.31] | 75.21 {6.25} [0.27] | 0.59 |

Note: These t-tests compared PAYDEX values in the match year between 415 matched controls to 419 adopters for the treatment analysis, and 533 matched controls to 546 adopters for the survival analysis. The somewhat smaller number of firms than our full matched sample and slight imbalance between adopters and controls in this analysis are due to gaps in the PAYDEX data. SD = standard deviation; SE = standard error.

Panel B.

Wilcoxon rank-sum tests indicate that the matched samples are balanced on the D&B Composite Credit Appraisal indicator of financial stress

| Matched sample | Firm's financial stress indicator in the match year | Matched controls: Mean {SD} | Matched adopters: Mean {SD} | Wilcoxon rank-sum p-value |
|---------------------------------------|---|-----------------------------------|-----------------------------------|---------------------------|
| Matched sample for treatment analysis | Composite Credit Appraisal | 2.52 {0.78} | 2.51 {0.78} | 0.80 |
| Matched sample for survival analysis | Composite Credit Appraisal | 2.49 {0.80} | 2.48 {0.77} | 0.76 |

Note: This table reports results of Wilcoxon rank-sum tests of the D&B Composite Credit Appraisal score, an ordinal variable that we reverse coded so that higher values correspond to more credit worthiness (1=Limited; 2=Fair; 3=Good; 4=High). These rank-sum tests compared Composite Credit Appraisal scores in the match year of 355 matched controls to 343 adopters for the treatment analysis, and 445 matched controls to 457 adopters for the survival analysis. The somewhat smaller number of firms than our full matched sample and slight imbalance between adopters and controls in this analysis are due to gaps in the D&B Composite Credit Appraisal data. SD = standard deviation.

Table A6.
Robustness tests: Financial stress

Predicting adoption of ISO 9001 including various indicators of financial stress

Dependent variable: Adopts ISO 9001 this year (dummy)

| | (1) | | (2) | | (3) | | (4) | |
|---|------------------------|------------------------|------------------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|
| | Probit coefficients | 100 x marginal effects | Probit coefficients | 100 x marginal effects | Probit coefficients | 100 x marginal effects | Probit coefficients | 100 x marginal effects |
| Log sales _{-1&-2} | 0.1226*** [0.0234] | 0.0345 | 0.1227*** [0.0233] | 0.0345 | 0.0922*** [0.0205] | 0.0156 | 0.0918*** [0.0205] | 0.0155 |
| Log payroll _{-1&-2} | 0.2616*** [0.0336] | 0.0736 | 0.2624*** [0.0335] | 0.0738 | 0.2793*** [0.0266] | 0.0474 | 0.2793*** [0.0267] | 0.0472 |
| Log employment _{-1&-2} | 0.0390 [0.0353] | 0.0110 | 0.0376 [0.0352] | 0.0106 | 0.0021 [0.0279] | 0.0004 | 0.0033 [0.0279] | 0.0006 |
| Log injury costs _{-1&-2} | -0.0390** [0.0153] | -0.0110 | -0.0390** [0.0153] | -0.0110 | -0.031** [0.0146] | -0.0054 | -0.031** [0.0145] | -0.0053 |
| Log injury rate _{-1&-2} | 0.0003 [0.0335] | 0.0001 | 0.0000 [0.0336] | 0.0000 | 0.0150 [0.0311] | 0.0026 | 0.0133 [0.0311] | 0.0023 |
| Log average occupational riskiness _{-1&-2} | -0.3790*** [0.0401] | -0.1068 | -0.3780*** [0.0401] | -0.1065 | -0.349*** [0.0350] | -0.0593 | -0.35*** [0.035] | -0.0592 |
| Minimum PAYDEX score in prior year | 0.0001 [0.0013] | 0.0000 | | | | | | |
| Maximum PAYDEX score in prior year | | | 0.000 [0.0021] | -0.0002 | | | | |
| CCA in prior year (ordinal) | | | | | -0.0200 [0.0226] | -0.0034 | | |
| CCA in prior year = High (dummy) | | | | | | | -0.0050 [0.0889] | -0.0010 |
| CCA in prior year = Good (dummy) | | | | | | | 0.0369 [0.0698] | 0.0065 |
| CCA in prior year = Fair (dummy) | | | | | | | 0.0911 [0.0680] | 0.0171 |
| Observations (firm-years) | 93,863 | | 93,863 | | 155,750 | | 155,750 | |

CCA = Composite Credit Appraisal. Brackets contain robust standard errors clustered by firm. *** p<0.01, ** p<5%, * p<0.10. Variables subscripted _{-1&-2} are averages of 1- and 2- year lags. Additional controls include year dummies (1995-2005), 7 region dummies, and 14 industry dummies. The ordinal measure of CCA used in Model 3 is inverted so that higher values correspond to greater credit worthiness. Models 3 and 4 also include a dummy indicating when missing values of *D&B Composite Credit Appraisal* were recoded to 0. Sample includes adopters before and in their adoption year and all years for non-adopters.