

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

<i>Dependent variable: Adopts ISO 9001 this year (dummy)</i>				
	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.