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Effects of Premium Discount on Workers' Compensation Claims in Agriculture in Finland

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Background *The objective of this study was to measure changes in injury claim rates after a premium discount program was implemented in the Finnish farmers' workers' compensation insurance. We focused on measures that could indicate whether the changes occurred in the true underlying injury rate, or only in claims reporting.*

Methods *Monthly injury claim rates were constructed at seven disability duration levels from January 1990 to December 2003. We conducted interrupted time series analyses to measure changes in the injury claim rates after the premium discount was implemented on July 1, 1997. Three additional policy change indicators were included in the analyses.*

Results *The overall injury claim rate decreased 10.2%. Decreases occurred at four severity levels (measured by compensated disability days): 0 days (16.3%), 1–6 days (14.1%), 7–13 days (19.5%), and 14–29 days (8.4%). No changes were observed at higher severity levels. Minor injuries had a seasonal pattern with higher rates in summer months while severe injuries did not have a seasonal pattern.*

Conclusions *The premium discount decreased the overall claim rate. Decreases were observed in all categories up to 29 disability days. This pattern suggests that under-reporting contributes to the decrease but may not be the only factor. The value of the premium discount is lower than the value of a lost-time claim, so there was no financial reason to under-report lost-time injuries. Under-reporting would be expected to be greatest in the 0 day category, but that was not the case. These observations suggest that in addition to under-reporting, the premium discount may also have some preventive effect.* Am. J. Ind. Med. 48:100–109, 2005. © *2005 Wiley-Liss, Inc.*

KEY WORDS: agriculture; injury; accident; insurance; workers' compensation; intervention; prevention; evaluation; time series analysis

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INTRODUCTION

Agriculture has been recognized as a hazardous industry worldwide. Many reports have documented high injury and fatality rates [McCurdy and Carroll, 2000; Bailer et al., 2003; Rautiainen and Reynolds, 2003]. International conventions, directives, and standards, as well as national laws, standards, and programs have been implemented to reduce farm injuries. Various regional and local organizations as well as individual farms have made efforts to reduce hazards. Despite all these efforts the progress has been slow, and very few successful interventions have been reported in the literature [DeRoo and Rautiainen, 2000].

Insurance incentives could motivate injury prevention in agriculture. They are relatively inexpensive and easy to implement, but challenging to evaluate since incentives are linked to complex claiming behaviors. Economic reports have concluded that generally, workers' compensation motivates employers to improve safety and save costs, but it also creates a ''moral hazard'' where workers are less careful and report more injuries [Butler and Worrall, 1991]. Higher compensation levels have been associated with increased injury reporting, longer disability durations, and increased claims for difficult-to-diagnose conditions [Meyer et al., 1995; Cassidy et al., 2000].

We aimed to measure the changes in injury claim rates associated with a premium discount. This incentive program was implemented in the Finnish farmers' workers' compensation on July 1, 1997. We used administrative data, which enabled accurate analysis of injury claim rates over time. This insurance program is nationwide, mandatory, well-established, and well-utilized by a relatively large, well-defined population.

This study has some unique characteristics compared to most workers' compensation studies. Our insured population is self-employed; therefore, the employer-employee motivation differences do not exist. The benefits may be considered ''generous'' by US standards. Under-reporting is low, except for no-lost-time injuries [Eskelinen et al., 1989]. The premium discount is based on the individual's record rather than the employer's record, which is used in many experience rating systems. Occupational safety and health regulations are enforced only on a small number of farms. Farmers are covered by many social insurance programs, which provide health, disability, retirement, and other benefits.

We analyzed the results of a quasi-experimental study to detect changes in injury rates, using the interrupted time series method. We had two primary hypotheses: the reported injury rate decreased after program implementation, and the reported injury rate decreased across all severity levels. Potential under-reporting was of specific interest in this study. We examined injury rate trends at seven severity levels, based on the assumption that under-reporting is minimal in severe injuries, but increases towards minor injuries [Moore and Viscusi, 1990; Biddle and Roberts, 2003]. Decreases in claim rates across all severity levels would suggest a decrease in the true underlying injury rate. Decreases in minor claims only would suggest under-reporting.

METHODS

Insured Population and Insurance System

The cohort consisted of Finnish farmers, fishermen, and reindeer herders who are insured by the Finnish farmers' employment accident insurance, known in Finland as the MATA-insurance. All self-employed farmers with at least 2 hectares of agricultural land were covered until January 1, 1994, when the minimum farm size changed to 5 hectares. Self-employed fishermen and reindeer herders are covered as well. Family members are insured if their annual salary from the family enterprise is at least 2,892 Euros (in 2005) [Mela, 2005a]. Employed workers in agriculture, forestry, and fishing are excluded from MATA, but they are covered by other workers' compensation programs. In this study, the insured persons are referred to as farmers, recognizing that about 2.7% of them were actually paid family members, 1.1% were fishermen, and 1.3% were reindeer herders. In 1998, 61% of the insured persons were men. The mean age was 46.2 years.

MATA provides a broad range of benefits. The following 1996 breakdown illustrates the types of benefits and their share of the total insurance costs: medical care (16%), lost-time compensation (per diem) up to 1 year from the incident (37%), lost-time compensation (accident pension) after 1 year from the incident (23%), survivors' pension (3%), impairment allowance (7%), rehabilitation (excluding lost time during rehabilitation) (6%), and other costs (including insurance administration) (9%) [Rautiainen, 2002]. Lost-time compensation is based on calculated income, which reflects the farm size and the value of the person's work on the farm. Per diems are typically based on total disability while the accident pensions are often partial, based on the degree of disability. The pensions may be permanent or temporary, subject to future health assessments. The income-replacement benefits (per diems and pensions) are based on full (rather than prorated) income level. One lost day benefit is 1/360th of the annual income. There are no minimum or maximum amounts on medical and income replacement benefits. The injury claim denial rate has historically been about 10%–12% [Mela, 2004].

Premium Discount Program

The premium discount program was implemented on July 1, 1997 in the MATA insurance. Insured persons who had no compensated injury or occupational disease claims during the following 12 months received a 10% reduction in their MATA premiums starting July 1, 1998. Each claim-free

year thereafter adds another 10% reduction up to a maximum of 50% off after five consecutive claim-free years. Each compensated claim results in a 10% loss of discount, but the premiums over the base level are not charged even if the personal discount would turn negative from multiple claims [Mela, 2005b].

The premium discount provides farmers with a new incentive to reduce injuries the best way they can. It also discourages ''small claims.'' The break-even point for a ''small claim'' varies based on many factors. During the 1st year, most persons (about 93%) had no claims and received their 10% discount. One claim would return them to the base level. For the next 5 years, they would be 10% behind, had they not made the claim. The value of the premium discount can therefore be estimated as the accumulation of losses over 5 years, 10% each year—which equals one half of one annual premium payment. In 1996, the mean annual premium was about 75 Euros. In 2004, the full base premium was about 217 Euros at the mean income level. The break-even point for a ''small claim'' varies based on the person's income, current discount level, and changes in the base premium rate, but was likely in the 50–100 Euro range for most insured persons during the study period.

Historically, the insurance costs and premiums have increased. The MATA premium rate increased from 0.48% in 1992 to 0.79% in 1996 and to 42.92 Euros (base fee) +1.3% of income in 2004 [Mela, 2004]. In 1996, the injury rate was 7.4/100 workers—one injury in 13.5 years on the average [Mela, 1997]. The actual claims experience varies between individuals. Since both the value of the discount and the injury risk are quite low, one might not expect this premium discount to have a dramatic effect on injuries and claims reporting. However, it does provide one additional reason for farmers to avoid injuries.

Policy Changes

We included three other policy changes into the analyses besides the premium discount. On July 1, 1991, a new short-term (non work-related) illness insurance policy was implemented. As a result, Farmers Social Insurance Institution received a large number of new illness claims, some of which were determined to be occupational injuries or diseases, and were compensated by the MATA insurance. This new insurance policy created an administrative increase especially in small claims. On January 1, 1994, the minimum farm size for the mandatory MATA insurance increased from 2 to 5 hectares, and some small farms with less than 5 hectares opted to discontinue their MATA insurance policy. Free coverage for certain small groups was also discontinued at this time. These changes in the population base could affect injury rates. On January 1, 1995, Finland joined the European Union, which had significant economic implications for agriculture. The decreased producer prices, increased paperwork, and new uncertainties created stress, which has been linked to injuries [Simpson et al., 2004].

Materials

Data for this study were acquired from the Finnish Farmers Social Insurance Institution in January 2005, based on a research agreement between The University of Iowa and the Farmers Social Insurance Institution. The data included all injury[1] cases from January 1, 1990 to December 31, 2003. Occupational diseases[2] and back injuries were excluded. Small numbers of cases, variable exposure times, and the evolution in diagnostic and compensation practices make them less ideal for this study. For each injury case, we had the incident year and month, as well as the length of disability in days.

Typically claims are made in person at the local insurance agent's office. Physicians determine the length of disability. The injury characteristics are coded in detail and missing information is verified by calling the doctor, agent, injured person, or other source as necessary. False information is subject to legal consequences. Various quality control procedures are in place, and data entry errors are controlled in the adjudication process.

Our data consisted of 132,134 injury claims during 1990–2003. Injuries were classified in seven severity categories: 0 disability days (n = 14,296), 1–6 days (n = 17,043), 7–13 days (n = 36,735), 14–29 days (n = 32,436), 30–89 days (n = 23,542), 90–364 days (n = 6738), and 365 days and over (n = 1344). Monthly injury counts were calculated for each category. Monthly population counts were estimated from actual end-of-year population counts, which decreased rapidly from 224,280 to 109,997 over this time period. The monthly injury rates per 10,000 insured shown in Figure 1 were calculated from monthly injury counts and population estimates. Vertical lines were added for the 1991, 1994, and 1995 policy changes as well as the 1997 premium discount. Average monthly injury rates for the seven severity groups are shown in Figure 2.

DATA ANALYSIS AND RESULTS

The assessment of the significance of an observed change in the levels (means) of two sets of independent observations is straightforward. One can calculate the ordinary

[1] An injury is described in MATA as a sudden unexpected forceful event with an external cause, which results in bodily damage or an ailment, and which occurs in the course of agricultural work.

[2] Occupational diseases are specific illnesses defined by legislation, which are probably predominantly due to specific physical, chemical, or biological factors associated with work.
They include respiratory diseases (farmer's lung, occupational asthma, rhinitis), cumulative trauma/repetitive motion injuries (epicondylitis, tenosynovitis), skin diseases (allergic and irritant contact dermatitis), zonooses, and hearing loss. Low back pain is compensated as an injury.

two-sample t-statistic. This statistic standardizes the difference of two unweighted averages (before and after) by its standard error that is derived under the independence assumption. The probability value of the test statistic can be obtained from the t-distribution. It is tempting to proceed the same way when testing for a change in the rates before and after the July 1997 premium discount. However, monthly injury rates are not independent, and with autocorrelation among the observations the standard approach is incorrect for two reasons: (i) The optimal estimate of the intervention effect is no longer the difference of two unweighted averages, and (ii) the standard error obtained under the independence assumption is no longer valid. The autocorrelations in the series must be incorporated into the analysis, and the intervention time series modeling approach proposed by Box and Tiao [1975] must be used.

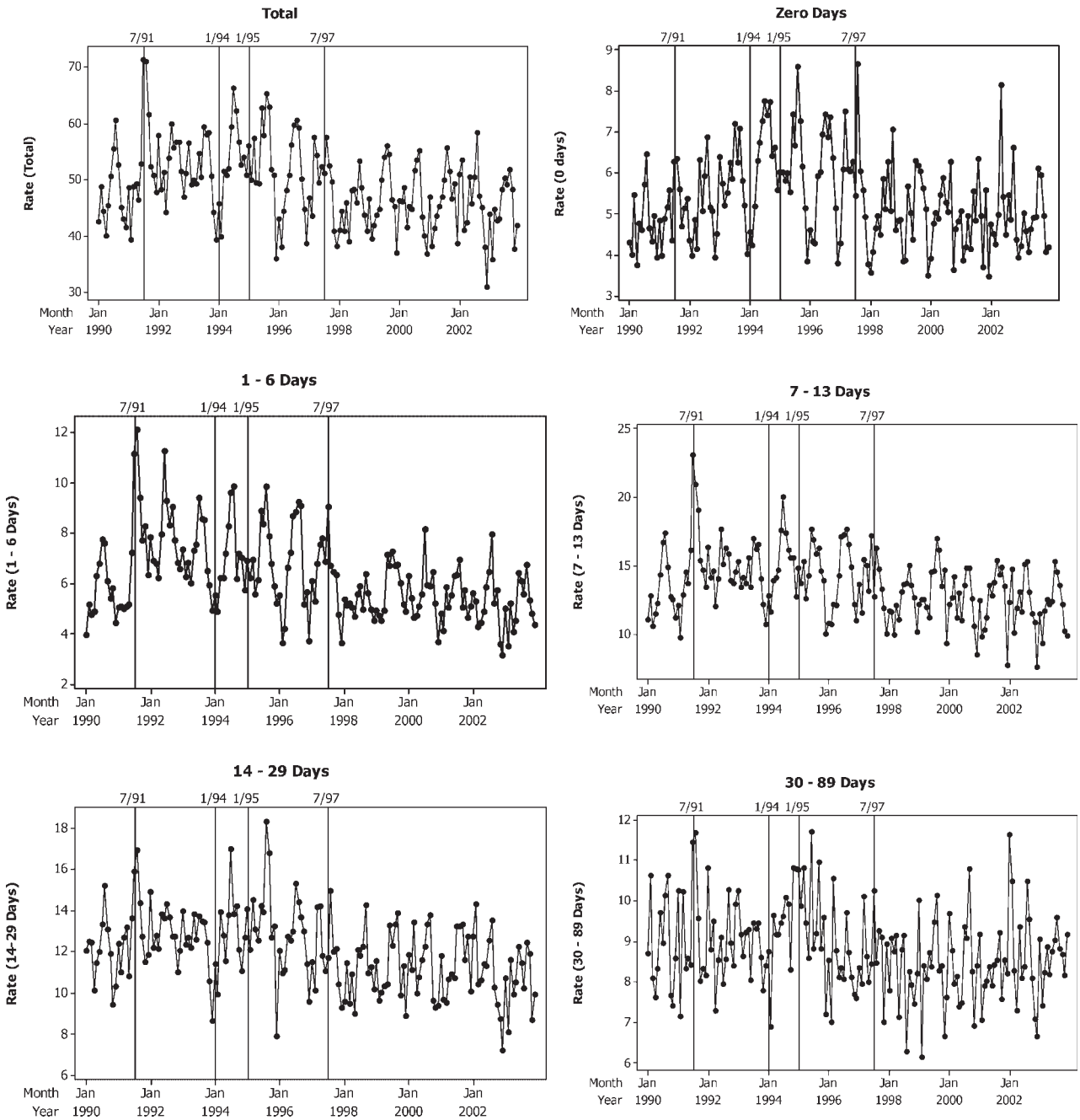

FIGURE 1. Monthly injury rates per 10,000 insured for all injuries combined and for each of seven severity groups. Farmers in Finland

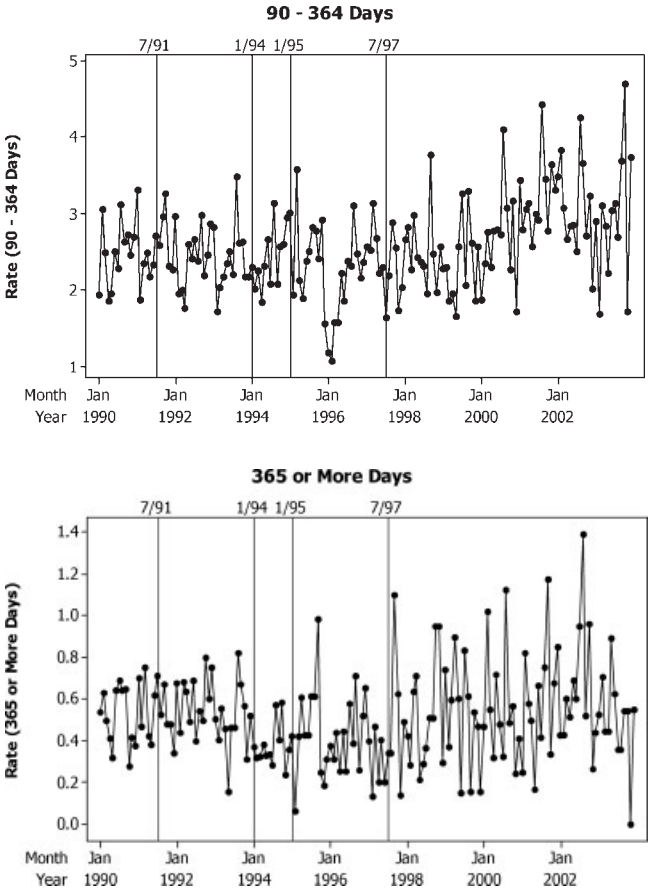

FIGURE 1. (*Continued*)

With monthly time series observations one can expect carry-over effects from one period to the next. If rates are unusually high in one month, one can expect higher than average rates in adjacent months. Furthermore, one can expect a seasonal component since injury rates tend to be higher in certain months than in others. The non-seasonal and seasonal carry-over, measured by the autocorrelations, is due to slowly changing economic conditions and seasonal effects. The autocorrelations up to lag 24 are shown in Table I. Autocorrelations that exceed twice their standard error are shown in bold-face. The standard error of the lag k autocorrelation is given by $1/\sqrt{n}$, where n is the length of the series.

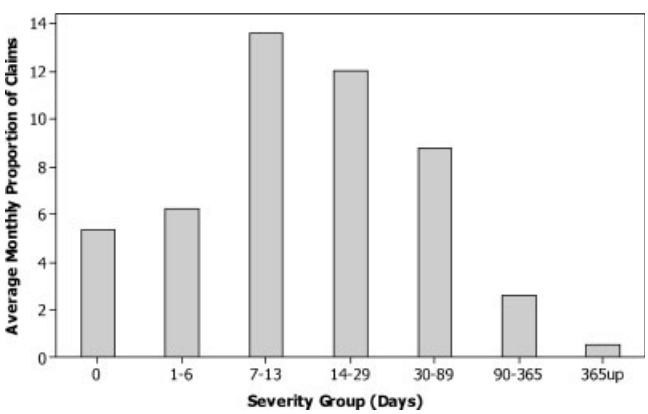

FIGURE 2. Average monthly proportion of claims per 10,000 insured for each of seven severity groups.

Injury rates resulting in short disability periods (0 days, 1–6 days, 7–13 days, 14–29 days) are seasonal, with higher rates during the summer months (July through September). The total rate is also seasonal as it cumulates the individual components. Seasonality in injury rates associated with longer disability periods (31–89, 90–364, and 365 and more) is considerably weaker. Severe injuries, such as bone fractures, appear to occur throughout the year, whereas minor injuries, such as cuts, sprains, and strains increase during the summer.

The first step in time series intervention modeling is to specify a time series model that represents the autocorrelation among the observations. It is standard practice to consider members from the class of seasonal autoregressive integrated moving average (ARIMA) models. The construction of these models is explained in time series texts such as Abraham and Ledolter [1983] and Box et al. [1994]. The seasonal multiplicative (0, 1, 1)(0, 1, 1) s = 12 model provides a useful representation of the autocorrelations in the considered series. The model,

$$(1-B)(1-B^{12})y_t = (1-\theta B)(1-\Theta B^{12})a_t$$
$$\text{or} \quad y_t = \frac{(1-\theta B)(1-\Theta B^{12})}{(1-B)(1-B^{12})}a_t \qquad (1)$$

transforms the time series of autocorrelated observations y_t into a sequence of uncorrelated errors a_t. $By_t = y_{t-1}$ is the backshift operator, $(1-B)y_t = y_t - y_{t-1}$ is the regular difference, $(1-B^{12})y_t = y_t - y_{t-12}$ is the seasonal difference, $(1-\theta B)$ is the nonseasonal moving average component, and $(1-\Theta B^{12})$ is the seasonal moving average operator. The regular and seasonal differences model the nonstationarity of the series.

Time series intervention models combine the time series part with regression-type intervention components that represent changes in the level. These level shifts can be step functions, or more elaborate dynamic shifts; for a detailed discussion, see Box and Tiao [1975]. In our application we are interested in the effects of the July 1997 premium discount, after having accounted for the other policy changes discussed earlier. We consider models of the form

$$y_t = \omega_1 S_t^{\text{July97}} + \omega_2 S_t^{\text{July91}} + \omega_3 S_t^{\text{Jan94}} + \omega_4 S_t^{\text{Jan95}} + \frac{(1-\theta B)(1-\Theta B^{12})}{(1-B)(1-B^{12})}a_t \qquad (2)$$

where S_t^T is an indicator sequence that takes the values 0 for times prior to T, and 1 from T onwards. The parameters ω_1,

TABLE I. Autocorrelations of Injury Rates of Farmers Finland

Lag	Total	0 Days	1–6 Days	7–13 Days	14–29 Days	30–89 Days	90–364 Days	≥365 Days
1	**0.61**	**0.50**	**0.68**	**0.61**	**0.47**	**0.16**	**0.24**	0.08
2	**0.39**	**0.35**	**0.48**	**0.41**	**0.31**	0.05	**0.28**	0.01
3	0.12	0.15	0.24	0.17	0.10	0.04	**0.27**	0.09
4	−0.04	−0.01	0.05	−0.02	0.01	0.10	0.07	0.00
5	−0.09	−0.06	−0.05	−0.12	0.09	0.06	0.16	−0.11
6	−0.07	−0.12	−0.08	−0.13	0.11	**0.22**	0.11	**0.20**
7	−0.07	−0.10	−0.03	−0.15	0.03	**0.21**	0.15	0.07
8	−0.03	−0.00	0.09	−0.04	0.01	0.00	0.10	−0.05
9	0.06	0.16	0.20	0.10	0.04	−0.05	0.14	0.06
10	**0.29**	**0.29**	**0.42**	**0.29**	**0.21**	−0.07	0.15	0.14
11	**0.44**	**0.40**	**0.52**	**0.44**	**0.34**	0.05	0.19	0.00
12	**0.55**	**0.44**	**0.58**	**0.55**	**0.44**	0.16	**0.24**	0.16
13	**0.38**	**0.39**	**0.46**	**0.37**	**0.31**	0.02	0.21	**0.20**
14	0.23	0.31	0.30	0.23	0.19	−0.02	0.10	−0.06
15	−0.05	0.04	0.10	−0.01	−0.07	−0.04	0.04	−0.06
16	−0.12	0.01	−0.09	−0.14	−0.04	0.07	0.10	0.14
17	−0.11	−0.11	−0.13	−0.16	0.01	0.04	0.12	−0.06
18	−0.13	−0.22	−0.17	−0.15	0.01	**0.19**	0.09	0.02
19	−0.11	−0.17	−0.13	−0.13	0.01	0.01	0.17	0.12
20	−0.07	−0.03	−0.04	−0.07	−0.03	0.01	0.08	−0.10
21	0.04	0.12	0.10	0.06	−0.03	0.01	0.09	−0.07
22	0.25	0.20	0.30	0.25	0.15	0.00	0.11	0.08
23	**0.38**	**0.40**	**0.39**	**0.37**	**0.28**	0.05	0.20	0.03
24	**0.53**	**0.44**	**0.46**	**0.50**	**0.42**	**0.22**	0.16	−0.00

Significant correlations are in bold.

ω_2, ω_3, and ω_4 measure the level changes that are due to the four policy changes.

The exact maximum likelihood approach of the SCA software was used to estimate the parameters in the model, obtain their standard errors, and to conduct hypotheses tests about the effect of the July 1997 premium discount [SCA, 2005] (See Appendix 1 for further description). E-Views [E-Views, 2005] and SAS [SAS, 1997] software (among others) could have been used instead. Residuals from the model were checked for remaining autocorrelations, but none were found.

Table II shows estimates of the parameter ω_1; this parameter assesses the effect of the July 1997 premium discount. The results indicate that this incentive resulted in a significant 10.2% level reduction in the overall injury claim rate at the 5% significance level. A significant reduction was also observed in claims resulting in short disability durations (0 days, 1–6 days, 7–13 days, 14–29 days). The implied percentage reductions in Table II are 16.3%, 14.1%, 19.5%, and 8.4%, respectively. For injuries with longer disability periods (30–89 days, 90–364 days, 365 and longer) the effect of the July 1997 premium discount was not significant.

Results for the other three policy changes (not shown here) indicate that the implementation of a non-work related illness insurance policy in July 1991 was associated with increases in the claim rates for most severity categories. The January 1994 change in the farm size requirements and

TABLE II. Estimation Results for the Time Series Intervention Model in Equation (2)

		July 1997 premium discount		
Series	Average	Estimate	t-ratio	Percent effect
Total	49.081	**−5.014**	**−1.78**	**−10.2**
0 day	5.341	**−0.873**	**−3.33**	**−16.3**
1–6 days	6.254	**−0.882**	**−1.96**	**−14.1**
7–13 days	13.601	**−2.650**	**−2.69**	**−19.5**
14–29 days	12.027	**−1.007**	**−1.70**	**−8.4**
30–89 days	8.783	+0.004	+0.01	+0.1
90–364 days	2.567	−0.300	−1.19	−11.7
365 or more days	0.508	+0.091	+1.10	+17.9

Significant effects in bold.
Only estimates of the July 1997 intervention are shown.

Finland's entry into the European Union in January 1995 had little effect on the rates.

DISCUSSION

Insurance provides compensation for specific losses in exchange for premium payments. Various factors affect premiums. For instance, life insurance premiums are typically based on gender and age (life expectancy). The rates can be adjusted further by smoking status, flying private airplanes, mountain climbing, or other risk factors. Safe driver discounts are commonly used in auto insurance. Participation in safety programs can reduce property-liability insurance premiums. Many other factors can be used for setting premiums.

Workers' compensation premiums are commonly determined for industry classification groups using ''manual rating''. The US workers' compensation premium rates are in the range of 1.3%–4.1% of the payroll for most industries. Rates for agriculture vary from 2.8% to 18% depending on the state and type of agriculture [Oregon Department of Consumer Business and Service, 2001]. ''Experience rating'' is used for adjusting premiums for individual employers based on their own claims history. It takes into account both claim frequency and severity (cost). The experience rating provides an incentive for employers to develop loss-control programs, which could reduce their claims and premiums [NCCI, 2004]. In MATA insurance, the experience rating was applied at the individual farmer level, rather than industry classification or employer level. A personal incentive is likely a stronger motivator, but its effect was limited in this case by the fact that the Finnish farmers' workers' compensation premiums are very low—only 0.79% of income (in 1996). This low rate is possible due to a relatively low injury rate and support from the state and the national health insurance, which cover about 2/3 of the total insurance costs.

This study showed that the injury claims decreased significantly (at the 5% level) after the premium discount was implemented. The interrupted time series analysis showed a 10.2% decrease in claims overall. This result confirms the first hypothesis. The second hypothesis was not confirmed. The injury reduction did not occur across all severity levels. Significant reductions (8.4%–19.5%) were observed in the four least severe injury categories but the three most severe categories did not change significantly. These results raise questions about the reduction in claims where the two likely explanations are under-reporting and/or true injury rate reduction.

The results provide evidence which points to under-reporting as a contributor to the decrease in claims. The decrease in the 0 day category is expected and appears consistent with under-reporting. It would no longer be feasible to file claims for minor no-lost-time injuries that are worth less than the value of the premium discount. The rate reduction occurred only in the least severe claims up to 29 disability days. Minor categories decreased most while two severe categories had (insignificant) increases. These tendencies appear consistent with under-reporting.

The results also provide evidence suggesting that under-reporting may not be the only factor reducing claims. It would be expected that the no-lost-time injury category would decrease clearly more than the lost-time categories, but that was not the case. The 7–13 day category, which has the largest claim counts (see Fig. 2), had the greatest decrease. This does not appear consistent with under-reporting. Examination of lost-time injury claims raises further questions. MATA has a 3-day minimum disability duration (exceptions accounted for 26 of 132,134 claims). The lost time per diem compensation for a 3-day disability is $3 \times 1/360$ of the annual income, which is equal to 0.83% of the annual income. This is greater than the estimated value of the premium discount: 0.39% in 1996, increasing to 0.65% in 2004. Since even the shortest compensable 3-day per diem is more valuable than the premium discount, there was no financial reason for farmers to leave lost-time injuries unclaimed. Yet, claims decreased significantly in the 1–6, 7–13, and even the 14–29 day category where the lost-time compensation ranges from 3.89% to 8.06% of the annual income—about 10–20 times greater than the value of the premium discount. It is clear that anyone with a 2–4 week disability would suffer a significant financial loss when not filing an eligible claim. Assuming that farmers consider their financial interest when making claims, these results suggest that actual injury reductions may have occurred, along with under-reporting.

While there was no apparent economic reason to under-report lost-time injuries, there may be alternative reasons to do so. The farmers may have over-estimated the value of the premium discount. This could be due to the fact that most Finnish consumers are familiar with a similar auto insurance discount, which has greater financial value. There may be confusion about the value of the MATA discount since it cannot be accurately estimated for an individual, due to unknown future claims experience, income development, base premium rate changes, and other factors. The farmers may also have considered other issues, such as potential future benefits. Having a good MATA discount rating could potentially help negotiate lower rates for other insurance products, and there could be other unforeseen benefits.

Financial incentives and their effect on claims and risk-taking behaviors have been discussed in the literature. In the economic literature, the word incentive is often used in a context of undesired outcomes, such as over-reporting and fraud. Dembe and Boden [2000] provide a critical review of one of the central themes, the moral hazard. Further discussion of the literature is provided in Appendix 2.

While numerous studies address the moral hazard effects on claims, there are few reports that appear to be closely related to our study. Our population is self-employed where

the roles of the employers and employees are combined in the same person. While our incentive program is similar to experience-rating programs, the individual rather than larger employer approach makes a difference. Before the premium discount, farmers were in a similar situation as employees where moral hazard effects may apply. After the premium discount' farmers were in a similar situation as business owners and managers with an incentive to improve their experience rating. While experience rating systems are common, we did not find studies that addressed their effect on injuries and claims.

The benefits in the MATA insurance system may be considered ''generous'' by US standards. Medical care is compensated in full. Income replacement is based on full (rather than prorated) income. Lost-time benefits do not have minimums or maximums and they can continue up to the usual retirement age (65), when other pensions begin. Other benefits include permanent impairment, rehabilitation, and survivor benefits. These insurance characteristics should lead to low under-reporting, and in fact one survey indicated that under-reporting is low, except for no-lost-time injuries. A mail survey in 1986 found that about three of four self-reported injuries requiring professional medical care were found in the claims data and out of unclaimed injuries, 80.7% caused no disability [Eskelinen et al., 1989].

The strengths of this study include quality of data. Similar injury data resources on self-employed farmers may not exist elsewhere. The cohort is large and well defined. The accident insurance system is well-established, well-utilized, and comprehensive as practically all farmers are insured. Under-reporting is low [Eskelinen et al., 1989]. Accurate population and claims data enable time series analysis and assessment of policy changes with good accuracy.

The limitations of this study include the uncertainties regarding the relationship of actual injuries and injury claims. This is a common limitation for studies based on claims data. Other study designs, such as self-reported population-based surveys, suffer from biases, especially reporting bias, and it remains a challenge to obtain objective data on both claims and actual injuries. In our study design, the potential under-reporting of minor injuries was addressed by stratification, and determining whether the incentive reduced claims at all severity levels. While this methodology provides valuable insight into the nature of changes after the premium discount, it cannot ultimately measure the changes in actual injury rates, but only claim rates. The results remain subject to interpretation. Another limitation in this study is related to policy change indicators in the time series analyses. We used four points in time marking clearly defined policy changes. However, despite the intention to isolate and measure the effect from only these policy changes, we recognize that other unspecified societal changes could occur simultaneously, and could either increase of decrease the observed effect from the policy changes.

CONCLUSIONS

This study found that the premium discount decreased injury claims by 10.2%. The decrease occurred in minor and moderately severe injury categories. The relatively low decrease in no-lost-time claims and relatively high decreases in moderate lost-time claims suggest that the decreases may not be explained by under-reporting alone, but a combination of under-reporting and true injury rate decrease.

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APPENDIX 1

It is instructive to look at the test statistic that arises when testing a single step change in a time series intervention model without a seasonal component. In this case the model is given by

$$y_t = \omega_1 S_t^{July97} + \frac{(1-\theta B)}{(1-B)} a_t \qquad (3)$$

Box and Tiao [1975] show that the optimal (that is, the maximum likelihood) estimate of the intervention effect is given by

$$\hat{\omega}_1 = (1-\theta)\sum_{j\geq 0}\theta^j y_{T+j} - (1-\theta)\sum_{j\geq 0}\theta^j y_{T-1-j} \qquad (4)$$

The estimate involves the difference between two weighted averages; one average uses the data after the intervention; the other average uses the observations prior to the intervention. The moving average parameter determines how observations are discounted. If the moving average parameter θ is small (close to zero), one essentially looks at the difference of two (single) observations; $y_T - y_{T-1}$. If the moving average parameter is close to one, the estimate simplifies to the difference of unweighted averages of observations before and after the intervention, $\bar{y}_{After} - \bar{y}_{Before}$, the numerator in the ordinary two-sample t-test. For cases in between $(0 \leq \theta \leq 1)$, the estimate is a difference of two exponentially weighted averages. An advantage of time series intervention analysis is the fact that this approach obtains the correct standard error for this difference. The extension to the seasonal ARIMA model is straightforward; the test statistic involves the differences of two weighted averages that incorporate both nonseasonal and seasonal averaging.

APPENDIX 2

For more than two centuries numerous authors have claimed that the availability of insurance motivates individuals to be less careful in protecting themselves from perils. The financial gain from the insurance can also motivate cases of outright fraud. The term moral hazard has been used

frequently in connection with private and social insurance systems during the past century and following are some examples. Arrow [1963] concluded that insurance incentives increase the utilization of health services by influencing the behavior of both patients and physicians. Many economists have examined the effect of workers compensation benefit levels on claims reporting, including Butler and Worrall [1983, 1985], Chelius [1982, 1983], Moore and Viscusi [1990, 1992], and Neuhauser and Raphael [2004]. These reports, among others, conclude that increased benefits lead to higher reporting of injuries and extended recovery periods. Krueger [1988] argues that higher benefits may induce workers reduce the level of safety, or to file fraudulent claims. Derrig [2002] discussed the extent of insurance fraud. Smith [1990] discusses how over-insurance is connected to deliberate losses. Meyer et al. [1995] found that higher workers compensation levels increased injury durations. Cassidy et al. [2000] found that the removal of compensation for pain and suffering was associated with decreased incidence and improved prognosis of whiplash injuries. Biddle [2001] found that higher claim-denial rates are associated with decreased claims reporting. Other incentive programs, besides insurance, have also been found to discourage claims reporting. Pransky et al. [1999] concluded that employee safety award programs deter claims reporting in fear of employer reprisal. While numerous reports discuss the moral hazard and over-reporting of injuries in worker's compensation systems, opposite views have also been presented. Biddle et al. [1998] found that only 22.6%–62.5% of Carpal Tunnel syndrome cases and 11.6–46.9% of sprains and strains are filed with workers compensation. Many other reports indicate that a large number of eligible claims are not filed.