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Effects of a penalty point system on traffic violations

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ABSTRACT

We analysed data from the Norwegian driver's licence penalty point register over a three-year period, in order to investigate whether the number of incurred penalty points in a given time period can predict the probability of incurring additional points in the subsequent period. Data for all category B drivers without penalty points at the start of the study period were included in the analyses. Norway's penalty point system implies that speeding and various other traffic violations result in two or three penalty points for full-license drivers and four or six points for probationary-license drivers. Eight points within a three-year period results in a six-month disqualification. Two hypotheses were formulated: 1) A "driving style effect" implying that drivers with previous penalty points have a higher probability of incurring new points than drivers without previous points; and 2) a "deterrence effect" implying that drivers with more than four points have a reduced probability of incurring new points, due to impending risk of license revocation. Results showed an inverted U-shaped relationship between number of penalty points incurred during a one-year period and the number of additional penalty points incurred in the subsequent year, with the highest number for drivers with four previous points. Thus, both hypotheses were clearly supported, and it is concluded that the penalty point system has a significant deterring effect for drivers who are at high risk of losing their license at the next infraction.

1. Introduction

Penalty – or demerit – point systems (PS) are used extensively for deterring drivers from committing traffic violations. Several countries all over the world have adopted such systems. According to Castillo-Manzano and Castro-Nuno (2012), some type of licence point system exists in 44 countries, the earliest examples being the state of Connecticut (PS introduced in 1957), New Zealand (1967), Japan (1968), and Victoria, Australia (1970). The earliest example from Europe is Germany (1974), whereas most countries have introduced PS after year 2000. For an overview of systems in Europe, see for example Van Schagen and Machata (2012). Typically, points are given for infractions that singly are not sufficiently serious to imply licence withdrawal; drivers who exceed a certain limit on the acceptable number of points lose their licence for a specified period of time. Systems vary a lot across jurisdictions regarding type of violations included, number of points, length of licence revocation, whether points are detracted from

a fixed starting number of points or added from zero up, and other aspects.

Speeding is probably the most common criterion for incurring points, and PS is a measure often mentioned in discussions of speed management approaches (for example, ETSC, 2008; Global Road Safety Partnership, 2008). Other examples of violations included in point systems are red-light running, priority infractions, short headways, or non-use of seatbelts. More serious infractions, such as drink driving, are generally not part of point systems, since these violations result in immediate licence withdrawal in many jurisdictions. For an overview of different types of systems, see for example Castillo-Manzano and Castro-Nuno (2012).

Basili and Nicita (2005) have described four different mechanisms by which PS may result in improved road safety: 1) *Deterrence*, that is, drivers refraining from committing traffic violations due to fear of losing their licence; 2) *Selection*, that is, removing repeat offenders from the driver population for some time; 3) *Correction* (or incentive) to change unsafe behaviours; and 4) *Education*, that is, informing drivers about which types of traffic violations are considered most dangerous

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(and therefore result in penalty points), and in some jurisdiction also mandatory courses for repeat offenders.

The widespread use of point systems is based on an assumption that this measure is effective in preventing drivers from committing traffic violations, by one or more of the mentioned mechanisms.

In a meta-analysis study of the effects of implementing new point systems, Castillo-Manzano and Castro-Nuno (2012) found 13 studies where crashes or injuries were used as effect indicators, and eight studies using violations or other risk-related behaviours. In addition, they included five studies using healthcare data. They concluded that there were statistically significant positive effects on all three groups of indicators, which means that implementing a PS seems to result in improved safety. However, they also concluded that the effects seemed to be rather short-lived; an analysis of a subset of the studies with duration data showed that the effects of introducing a new PS only lasted for about 16 months on the average.

Several studies included data on violations or accidents before and after introduction of a PS. However, in some of these cases, introduction of PS was combined with intensified police enforcement or higher fines, so that it is not possible to disentangle any effect of PS from the effect of the other measures (for example, Ferguson et al., 1999; Izquierdo et al., 2011; Mikulik, 2007; Montag, 2014; Sze et al., 2011).

In some studies, possibly confounding factors have been controlled for in regression models. For example, in Italy, where PS was introduced in 2003, Zambon et al. (2008) obtained adjusted prevalence ratios by using Poisson regression and found a significant increase in safety belt use among male drivers. Furthermore, a regression analysis of traffic fatalities and driving offenses over the period 2001–2005 (De Paola et al., 2013) indicated a 9% decrease in road accidents and a 30% decrease in road fatalities ascribable to introduction of the PS. Also in Spain, which adopted a PS in 2006, a regression analysis with pre- vs. post-intervention comparison indicated a decreased crash risk (Novoa et al., 2010).

In another study from Italy, Benedettini and Nicita (2009) found clear evidence of a *selection effect* on number of crashes; i.e., an effect of removing offenders from traffic. However, they found only a transient *deterrence effect*, probably associated with announcement of the PS introduction. They explain the failure to observe a more lasting deterrence to some weaknesses with the Italian PS. First, licences are not withdrawn if the driver takes a test and completes a course within 30 days after losing all points, and second, drivers receive bonus points for each year of driving without violations, a system which gives little incentive for safe driving. It should be noted that the Italian PS implies that drivers are initially assigned a credit of 20 points, from which a certain number of points are detracted for each infraction.

A subsequent study (Benedettini and Nicita, 2012) found that the Italian PS resulted in increased use of seatbelts and a decrease in car occupant fatalities. However, there was an increase in car driver involvement in fatal crashes involving other road users than car occupants, which they ascribe to driver behaviour adaptation to using seatbelts.

Even though lasting effects may be difficult to observe in aggregated data, there may be significant deterrence effects on the individual level, for drivers who approach the point limit for losing their licence. Individual deterrence effects are interesting to demonstrate even though the aggregated effects may be too small to be detectable on a population level.

Some studies show decreases in self-reported traffic violations as a consequence of PS introduction (for example, Gonzalez et al., 2008; Gras et al., 2014). However, self-report data may be subject to social desirability effects, and do not necessarily reflect actual behaviour change.

Individual deterrence as indicated by register data has been investigated in Australia by Haque (1990), who found that the mean inter-offense time interval was longer between 2nd and 3rd offenses than between 1st and 2nd offenses. This indicates that the likelihood of a new violation was reduced as a consequence of incurred penalty points.

In Great Britain, Broughton (2008); see also Corbett et al., 2008) compared reconviction rates for speeding offenses in one-year periods (1996–2004) between drivers with different number of convictions in the two preceding years. He found that among drivers with two (or more) convictions, who would be disqualified from driving after one more conviction (due to reaching the penalty point limit), there was a significantly lower proportion of reconvictions compared to drivers with no or one previous conviction, indicating a change in driving behaviour.

A more recent evaluation of Italy's PS (Basili et al., 2015), consisting of a multivariate analysis of register data from a representative sample of 50 000 drivers over six years, showed that the probability of infractions was positively and significantly correlated with the number of residual points, indicating an individual deterrence effect. At the same time, they also found a positive relationship between the number of previous infractions and the probability of new infractions, that is, a recidivism effect. This finding may seem at variance with the previously mentioned evaluations of Italy's PS, which showed only a transient effect on an aggregated level. However, the individual deterrence effect of approaching the point limit of licence withdrawal possibly affects relatively few drivers, so that it may be difficult to observe an effect at the population level.

The purpose of the present study is to investigate the individual deterrence effect of Norway's penalty point system. This system implies licence withdrawal for six months after incurring a predefined amount of penalty points within a three-year period, and the aim of our study is to analyse whether the number of penalty points incurred during a given time period influences the probability of future infractions, measured in terms of additional penalty points incurred in the subsequent period.

A basic assumption underlying our study is that the risk of incurring penalty points is determined by two different and opposing behavioural mechanisms. First, we assume that there are individual differences in driving style resulting in different propensities to commit traffic infractions, which means that drivers with a history of incurring penalty points are more likely to incur additional points in the future. Second, fear of licence withdrawal will imply that the probability of additional infractions (and points) will decrease when the number of points approach the limit for licence withdrawal. Our study differs from most previous research on PS in addressing those two underlying behavioural mechanisms. Further knowledge about the effects of those mechanisms will probably be useful for optimising future point system schemes.

2. Norway's penalty point system

Norway's penalty point system was introduced January 1, 2004 (Norwegian Ministry of Transport and Communications, 2003). The purpose of the system is to contribute to increased road user safety and fewer road traffic fatalities and severe injuries, by means of licence revocation after repeated violations that singly do not qualify for revocation.

The penalty point system is supposed to present predictable reactions to traffic offenders who put themselves and other road users in danger. The system also intends to simplify the task of the police to revoke the licence.

After an evaluation based on experiences from 2004 to 2007 (Stene et al., 2008) the system was extended and strengthened from July 1, 2011, by inclusion of additional offenses and the introduction of double penalty points for novice drivers. Originally, penalty points were applied for speeding, priority violations, driving against red traffic light, and illegal overtaking. The car-driver violations added in 2011 included too short headways, driving on painted median barriers, and failure to secure child occupants (below the age of 15) by adequate child restraint system or seatbelt.

In general, a violation entails three penalty points (with the exception of minor speeding violations resulting in two points) for full-licence drivers and six points (or four for minor speeding) for probationary-licence drivers. Drivers with eight or more points in a three-year period get their licence revoked for six months (and all previous points are deleted).

After four penalty points the driver receives a warning letter with information about the consequences of further penalty points. Four points means that for full-licence drivers, the licence will be revoked after two more violations before the current points expire, and probationary-licence drivers will lose their licence after only one more violation.

Penalty points are enforced by the police, who report each instance to a register administered by the Norwegian Public Roads Administration.

3. Hypotheses

The present study is an evaluation of the effects of a penalty point system on individual propensity to commit new violations among drivers who have incurred penalty points. Provided the penalty point system has a deterrent effect on those drivers, the general hypothesis to be tested is: (1) *the probability of committing a traffic violation decreases as a function of the number of previous points, and the decrease will be larger the closer the drivers are to losing their licence.*

Ideally, under a *ceteris paribus* condition, this hypothesis could be tested by comparing the number of penalty points for a given period between groups of drivers with different number of previous penalty points. A problem with such a comparison is that drivers who differ in number of previous penalty points probably differ also in their general propensity towards risky driving behaviour, and consequently have different probabilities of future penalty points to begin with. This behavioural mechanism implies an additional hypothesis: (2) *drivers with previous penalty points have a higher probability of future penalty points than drivers with no previous points.*

If hypothesis (1) is true and hypothesis (2) is false, we will expect the probability of future points to be a *monotonically decreasing* function of previous points. If hypothesis (1) is false and hypothesis (2) is true, we will expect a *monotonically increasing* function. If both hypotheses are true, we expect an *inverted U-shaped* function, implying that drivers with few points have a higher probability than those without points, and that drivers who are close to losing their licence have lower probability of incurring new points than those who have fewer points. Let it also be mentioned that if both hypotheses are false, a flat function is expected.

Both outcomes implying confirmation of hypothesis (1) mean that the penalty point system has some deterrent effect.

4. Method

The hypotheses were tested on data from the national register of penalty points. The probability of new penalty points is reduced when drivers approach the limit for licence loss. With permission from the

Police Directorate we received aggregated group-level data for imposed penalty points in three successive 12-month periods, from July 1, 2011 to June 30, 2014, for category B drivers. A sampling criterion was that the drivers did not have any penalty points incurred during the latest three years preceding the analysis period. We received separate data files for full-licence drivers (licensed before July 1, 2008) and probationary-licence drivers (licensed July 1, 2011 or later). The data set consisted of 2,797,696 full-licence drivers and 68,191 probationary-licence drivers. This number amounts to 93.6% of the total category B driver population, which means that 6.4% of all drivers had incurred points during the preceding three-year period. The annual proportion incurring penalty points can be estimated at about four percent of the driver population.

The three successive 12-month periods were denoted Period 1, Period 2 and Period 3, and we made two comparisons for each group of drivers. First, we estimated probabilities of incurring new penalty points in Period 2 as a function of incurred points in Period 1. Second, we estimated probability of incurring points in Period 3 as a function of accumulated points in Periods 1 and 2. Thus, we were able to make two separate tests of our hypotheses.

New penalty point probabilities for Periods 2 and 3 are expressed as *percentage of drivers incurring new points*, as a function of the number of accumulated points in the previous period. For each driver group, as defined by the number of points accumulated by the end of the previous period, the new point probability is estimated as the number of drivers with incurred new points or licence revocation, divided by the total number of drivers in the respective group. In the results section, these probabilities are converted to percentages.

For the first set of tests (Period 2 probabilities), a total of 2,794,693 full-licence drivers and 67,996 probationary drivers were available for analysis. For the second set (Period 3 probabilities), 2,789,786 full-licence drivers and 67,302 probationary-licence drivers were available. There were slightly fewer drivers in Period 2 than in Period 1, and slightly fewer in Period 3 than in Period 2, because drivers whose licence was withdrawn in the first of the two periods were excluded from the analyses of point probabilities in the subsequent period.

5. Results

5.1. Full-licence drivers

5.1.1. Period 2 penalty point probabilities

Fig. 1 shows the percentage of drivers with different number of penalty points incurred in Period 1, who incurred additional penalty points (or licence revocation) in Period 2. The probabilities increase from the “zero points” driver group (2.1%) up till the group with four previous points (11.3%), and then there is a decreasing probability with increasing number of previously incurred points above four. Pairwise comparisons between the groups were carried out by using the function *pairwise.prop.test* in the statistical software R (R Core Team, 2016), with correction of p values for multiple testing using the method by Holm (1979). The “4 points” group had a significantly higher percentage of drivers with additional points than all other groups ($p < .001$ for all comparisons). This also holds with the more conservative Bonferroni correction. It is also interesting to note that the probability decreased significantly from the “5 points” to the “6+ points” group ($p = .01$; Bonferroni: $p = .04$), considering that the “6+ points” are certain to lose their licence at the next violation, whereas for the “5 points” group, a minor speed violation is still tolerated.

For all groups except the “zero points” and the “6+ points” groups, the percentages are higher than the national annual average of about four percent.

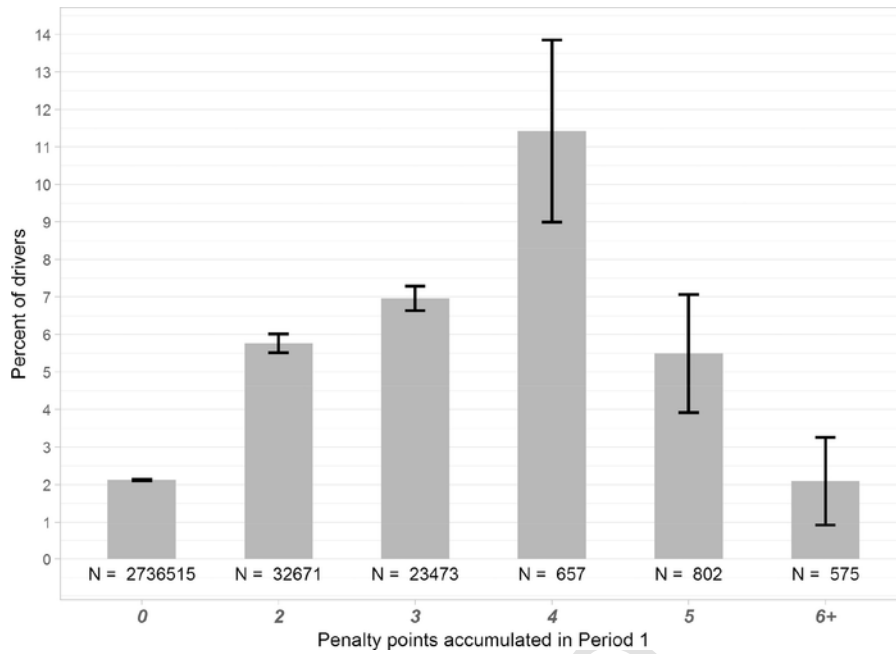


Fig. 1. Full-licence drivers incurring new penalty points (or having their licence revoked) in Period 2, by number of points incurred in Period 1. Percent. Vertical lines show 95% confidence intervals.

5.1.2. Period 3 penalty point probabilities

Percentage of drivers incurring additional penalty points in Period 3 is shown in Fig. 2 for drivers with different number of points accumulated throughout Periods 1 and 2.

Like in the previous comparison, the probabilities increase from the “zero points” driver group up till the group with four previous points, and then the probabilities decrease with increasing number of points above four. Pairwise comparisons showed that the “zero points” group has significantly lower probability of incurring new points than all other groups ($p < .0001$ for all comparisons). The “6+ points” group

had significantly lower probability than both the “3 points” group ($p = .0009$) and the “4 points” group ($p < .0001$), but not significantly lower than the “5 points” group.

5.2. Probationary-licence drivers

5.2.1. Period 2 penalty point probabilities

For probationary-licence drivers, Fig. 3 shows probabilities of incurring additional penalty points in Period 2 for drivers with different number of points incurred in Period 1.

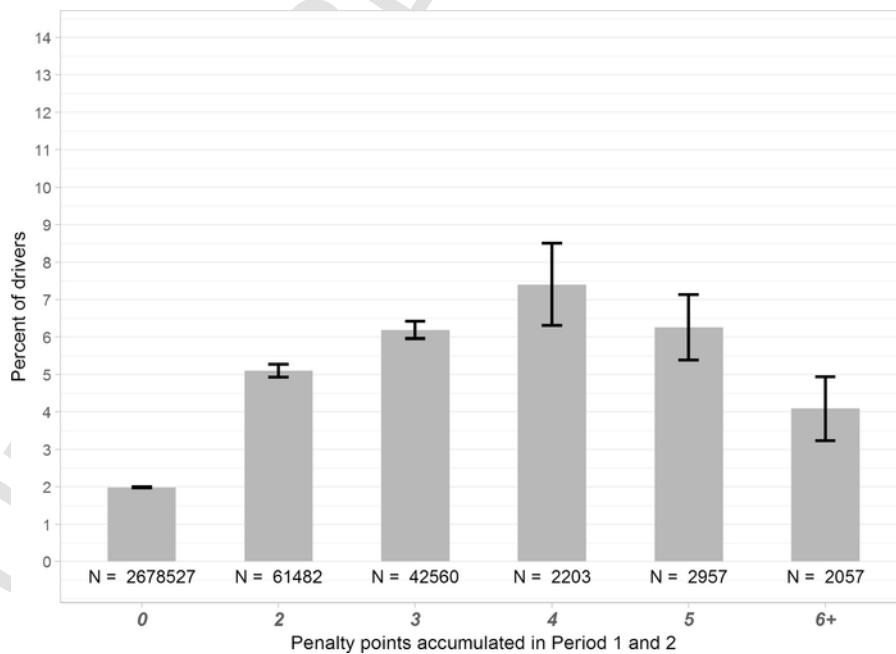


Fig. 2. Full-licence drivers incurring new penalty points (or having their licence revoked) in Period 3, by number of points accumulated during Period 1 and Period 2. Percent. Vertical lines show 95% confidence intervals.

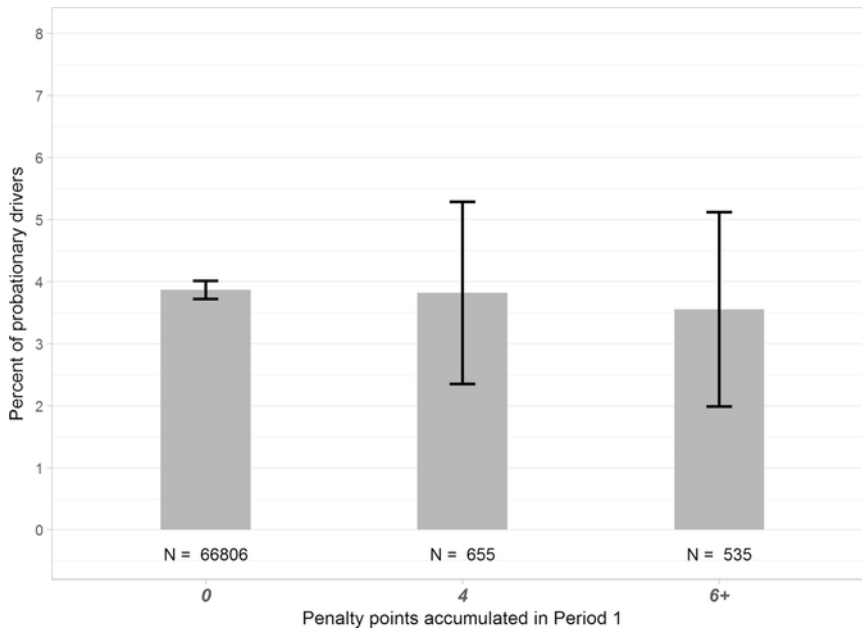


Fig. 3. Probationary-licence drivers incurring new penalty points (or having their licence revoked) in Period 2, by number of points incurred in Period 1. Percent. Vertical lines show 95% confidence intervals.

Since probationary-licence drivers receive double number of points for each infraction, the possible numbers of points incurred without licence revocation are 0, 4, or 6. There is a slightly decreasing trend in new point probability in Period 2 with increasing number of previous points, but the trend is not statistically significant. It should be noted that since all the drivers had been licensed for one year or less, the varying duration of holding a licence has influenced the probability of incurring points in period 1, thus attenuating a possible hypothesis (1) effect.

5.2.2. Period 3 penalty point probabilities

Fig. 4 shows percentage of drivers with additional penalty points in Period 3 for probationary-licence drivers with different number of points accumulated throughout Periods 1 and 2. Like for full-licence drivers, those who have accumulated 4 points by Period 2 are significantly more likely to get points in Period 3 than drivers with zero points ($p < .0001$), and the “6+ points” group had a significantly lower percentage of drivers with incurring points in Period 3 than the “4 points” group ($p < .0001$). It is also notable that the “6+ points” group has significantly lower new point probability in Period 3 than the “zero points” group ($p = .038$). However, with the more conser-

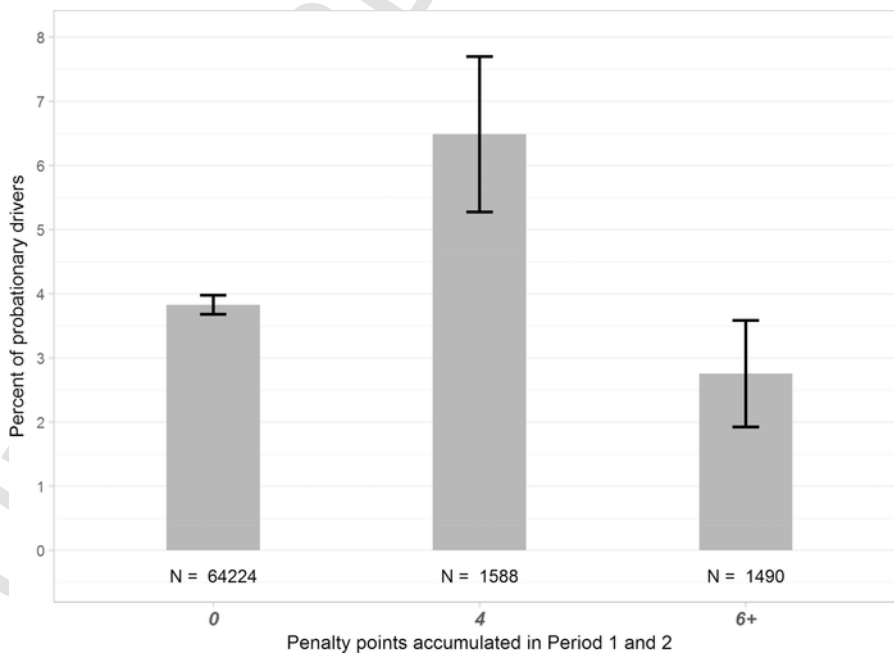


Fig. 4. Probationary-licence drivers incurring new penalty points (or having their licence revoked) in Period 3, by number of points accumulated during Period 1 and Period 2. Percent. Vertical lines show 95% confidence intervals.

vative Bonferroni correction for multiple testing this effect is not significant ($p = .11$). Such an effect was not observed for any of the comparisons for the full-licence drivers.

6. Discussion and conclusions

Three out of the four analyses reported here show a clear inverted U-shaped relationship between the number of penalty points incurred in one period, and the probability of new points in the subsequent period. The failure to find such a relationship in the first analysis for probationary drivers is probably explainable by the fact that some of them had held their licence for considerably less than one year in Period 1, and thus the “zero point” group contains a large share of drivers who most likely would have incurred some penalty points if they had held their licence for a full year.

The findings provide strong support for both hypotheses presented in the introduction. First, the fact that drivers with more than four penalty points in the first period decrease their probability of new points in the subsequent period indicate a deterrent effect of the penalty point system, to the effect that drivers at risk of losing their licence tend to change their driving behaviour so that they avoid further penalty points. The second hypothesis, i.e., that individual differences in the number of incurred penalty points reflect different propensities for traffic violations, was also supported, since we found that drivers with up till four points in the first period had a higher new point probability in the subsequent period than those with zero points in the first period. This is consistent with previous research; e.g., a study from Queensland, Australia, showed that crash risk among drivers was higher after having received a penalty for traffic violations (Walter and Studdert, 2015), a finding that the authors explain by penalties for traffic infringements indicating episodes of risky driving. Similar results were found also by Chen et al. (1995).

The two behavioural mechanisms illustrated by our hypotheses work in opposite direction, the “driving style effect” resulting in increased probability of violations for drivers with previous penalty points, and the “deterrent effect” results in decreased probability. And the finding of the U-shaped relationship is consistent with the assumption that the deterrent effect increases as the criterion for licence withdrawal draws near.

The lower new penalty point probability among drivers with five as compared to four previous penalty points may partly be explained by the fact that drivers receive a warning letter as soon as the number of penalty points exceeds four, reminding them of the risk of licence revocation at eight points. The even lower probability among those with six or more previous points, is most likely an effect of the risk of licence revocation after only one more infraction. This indicates that an impending threat of licence loss constitutes a real deterrence to many drivers.

An interesting question is whether the deterrent effect of the penalty point system is stronger among probationary-licence than among full-licence drivers, since the consequences of incurring penalty points are more serious for this group. In addition to receiving double penalty points, probationary-licence drivers who lose their licence have to undergo a new driving test, and their probationary-licence period is extended for another two years. Although not statistically significant, an indication of such an effect may be the observed tendency in the direction of a lower new point probability among drivers with more than four previously incurred points than among drivers with no points. No such tendency was observed among full-licence drivers.

Whether the penalty point system has a deterrent effect also for drivers with few or no previous points is not possible to determine from our results. One could imagine that the driving style effect is attenuated by the deterrent effect also among drivers with few points. In principle, this could be investigated if register data were available on

an individual level, so that it could be investigated whether incurring points increased the time until the next violation already from the first penalty points.

Another question that we cannot answer from our results is what effect the penalty point system has on drivers who lose their licence for six months as a result of incurring eight points or more. Do they reduce their probability of violations compared to their previous record after they get their licence back? This could be investigated with data on exact time of each penalty point issue, as well as times for licence withdrawal and reissue. Further analyses of register data for individual drivers would be an interesting topic for future research.

Our study seems to be one of very few studies investigating effects of a penalty point system by comparing drivers with different number of incurred points. Most previous studies have investigated effects on a population level, and have generally concluded that effects are small and transient. Some have even concluded that it is (almost) impossible to evaluate effects of a penalty point system, as shown for example by the following statement in Van Schagen and Machata (2012):

... it is very difficult, in practice almost impossible, to evaluate the effects of a DPS in a scientifically sound way. First, the introduction of a DPS generally goes together with a lot of media coverage, and with increased (or at least the threat of) enforcement.... In addition, since a DPS is always introduced on a country-wide basis, it is impossible to include a good reference group. As a consequence, it will remain largely unknown whether observed changes in behaviour or in number of casualties are the result of the DPS or enforcement, the publicity or other unknown factors. (Van Schagen and Machata, 2012, pp. 9–10)

This may be true for evaluations of population-level effects, but as we have shown in this study it is possible to show effects among drivers that are directly affected by the penalty point system. Since we compare penalty point distributions for the same sample of drivers in different periods, the drivers serve as their own controls, and no other reference group is needed. And there is no reason to believe that the type of effects we have observed here are only transient. There may, however, not necessarily be a discrepancy between findings from our study and from population studies. It should be kept in mind that the number of drivers who approach the criterion number of penalty points for losing their licence is low compared to the total driver population, and although this small group change their behaviour, the effect may be difficult to detect on an aggregated level.

Although effects may be difficult to detect at a population level, it should be noted that population effects may reflect a combination of all the four mechanisms by which PS could influence safety (deterrence, selection, incentive, and motivation), whereas our study includes only the deterrence and incentive mechanisms. The selection effect is not included, since we have not looked at the safety effects of some drivers losing their licence. And the education mechanism is not investigated since the Norwegian PS does not include a driver improvement course.

The ultimate goal of any point system is accident prevention. Although we have not investigated effects of penalty points on crash involvement, it seems reasonable to conclude that a reduced probability of traffic violations qualifying for penalty points also means reduced probability of crash involvement. This is particularly the case for speeding, which is the most common cause of penalty points, and which is also clearly related to crash risk and crash severity. Furthermore, a reduced probability of incurring penalty points means that several drivers have changed their driving style in the direction of more defensive driving. Previous research has shown that individual differences in driving styles are correlated both with number of violations and crash risk (see e.g., Sagberg et al., 2015, for a review on re-

search on driving styles and road safety), thus providing further support for a relationship between penalty points and increased safety.

A pertinent question is whether our results could possibly be explained as deterrence effects of the reactions (fines) to each single violation rather than the accumulation of penalty points, since all violations that result in points are also penalised by rather high fines. For example, for speeding violations resulting in penalty points, but below the limit of licence withdrawal, the fines are in the order of magnitude from 300 to 1000 euros. Since we find that the probability of new violations decreases only when a driver has received more than four points (which means at least two previous violations) and tends to decrease further from five to six or more points, we consider it unlikely that this can be an effect of the penalties for each single violation, but is rather explained by the impending danger of losing the licence.

By conclusion, our study showed that the probability of committing additional penalty point violations becomes significantly lower when a driver has incurred four or more penalty points, which means that the driver has received a warning letter and risks licence revocation after one or two additional violations. This can be interpreted as solid evidence for a deterrent effect of the penalty point system, in terms of reduced incidence of speeding and other traffic violations, and probably also in terms of lower crash involvement, at least among drivers approaching the criterion of licence withdrawal.

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