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Effects of the lowering of the legal BAC-limit in Sweden

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ABSTRACT

As of the 1st of July 1990, the legal BAC-limit in Sweden was lowered from 0.05% to 0.02%. To assess the impact of this reform, an intervention ARIMA-analysis was performed on traffic accidents data. Three categories of accidents were analysed: (i) fatal accidents, (ii) single-vehicle accidents, and (iii) all traffic accidents. According to the findings the intervention was followed by a significant decrease in the number of traffic accidents. For all traffic accidents, the reduction was about 7 per cent, for single-vehicle accidents, 11 per cent, and for fatal accidents, 10 per cent. Although the outcome accords with previous experience and some other data that suggest a general downward shift in BAC-level, it cannot be precluded that the estimated intervention effect is confounded by other factors. The results should therefore be interpreted with caution. The intervention models included proxies for mileage and per capita alcohol consumption as controls.

INTRODUCTION

The present study aims at evaluating the impact on traffic safety of the lowering of the Swedish legal BAC-limit from 0.05 to 0.02%.

Most evaluations of changes in per se limit are based on US experiences in several states, of lowering the legal limit from 0.1 to 0.08%. The overall conclusion from these studies is that reforms, of this kind, reduce the number of alcohol related accidents (Hingson, Heeren & Winter, 1996). The Swedish reform is different in that the lowering of the limit was done from an already low level, which cast some doubt as to whether the road safety potential was already exhausted. However, two circumstances speak in favour of a possible effect: a large number of studies indicate that also low BAC's impair driving performance, (for reviews, see Moskowitz et al. (1985), and Kruger (1993)); the lowering of the BAC-limit may have a general effect, reducing also the incidence of drunken driving above the original level (Brooks & Zaal, 1993; Hingson et al., 1996).

The reform in 1990 was analysed previously by Ross & Klette (1995). They found a significant reduction in the number of day-time but not in night-time fatal accidents.

Impact assessment and ARIMA analysis

An approach which is increasingly used to assess the impact of the present kind of reforms is "interrupted time series analysis". The approach is based on the technique for time series analysis that has been developed by Box & Jenkins (1976), often referred to as ARIMA-models. Generally, it is not possible to obtain long time series of any reliable direct measure of drunken driving, such as representative road side tests. Therefore some proxy is often used as criterion (output series), e.g. the number of single-vehicle accidents or some other category of accidents which is known to be strongly alcohol-related. In the present study, mileage and alcohol consumption are included as natural control variables.

DATA AND METHOD

Monthly data on the number of police reported road traffic accidents involving personal injury in the following categories: (i) fatal accidents, (ii) single-vehicle accidents, and (iii) all traffic accidents, were used as outcome variables.

The post-intervention period was July 1990 through June 1996, and the pre-intervention period July 1987 through June 1990. The indicator of alcohol consumption is the total volume of sold alcohol (100%, litres in millions). The proxy for mileage is deliveries of motor petrol (litres in 100'); peak values are observed for the summer half.

Table 1 : Mean and standard deviation by month for various categories of police reported traffic accidents with personal injury, alcohol consumption (100%, litres in millions), and deliveries of motor petrol (litres in 100'). Sweden 8707-9006, and 9007-9306.

Indicator	8507 - 9006 Mean	SD	9007 - 9306 Mean	SD
Fatal accidents	63.00	14.58	55.42	12.55
Single-vehicle acc.	366.83	62.63	312.61	50.84
All accidents	1456.33	220.64	1315.42	215.75
Alcohol	2.85	.53	2.68	.48
Petrol	4.78	.54	4.77	.51

Table 1 shows that the mean of the alcohol consumption series was somewhat lower during the post-intervention period, while the difference in petrol deliveries is negligible.

Time series analysis is associated with a number of complications which, if not duly considered, can create strongly misleading results. The strategy of analysis that will be pursued can be described as follows. In the first step the effects of the control variables (alcohol consumption and mileage) on each outcome variable are estimated through ARIMA-modelling. This analysis is performed on data prior to the intervention (January 1985 through June 1990). On the basis of the estimates the outcome series for the entire study period (July 1987 through June 1996), are adjusted so that they reflect the variation in traffic accidents purged of the effects of alcohol consumption and mileage. In the next step the adjusted series are used for estimating the intervention effect. The rationale of this approach is to minimise the risk of obtaining an estimate of the intervention effect which is contaminated by the effects of the control variables.

RESULTS

Effects of alcohol consumption and mileage

As already mentioned, the first step of the analysis involves the estimation of the effects of the control variables. Since alcohol intake increases the risk of traffic accident, and an increased per capita consumption reflects an increase in the number of drinking occasions, we should expect that an increase in the over-all consumption, other things equal, results in an increase in the number of traffic accidents.

For fatal accidents and single-vehicle accidents none of the effect estimates (not shown) were statistically significant in the models based on differenced data.

Intervention effects

The intervention effect is estimated on the adjusted series for traffic accidents; i.e., first, the estimated impact of the control variables (alcohol consumption and mileage) was removed, next the following model was estimated: $LnAdjAcc_t = \beta D9007_t + N_t$

where *AdjAcc* is the adjusted accident series and *D9007* is a dummy variable which represents the intervention. The dummy takes the value 0 before the intervention, and 1 after (i.e. after June 1990). All data were seasonally differenced. The estimated percentage change following the intervention is obtained from the expression: $(e^b-1)100$. According to the results (Table 2) the intervention had a statistically significant impact on all three outcome measures. *For fatal accidents the reduction is 9.7 per cent; for single-vehicle accidents, 11 per cent; and for the category all accidents, 7.5 per cent.* The differences between these estimates are indeed small; nevertheless the pattern is consistent in that the strongest intervention effects are obtained on the accident categories which have the largest alcohol involvement.

Table 2 : Estimated effects (ARIMA-models) of the intervention in July 1990 (D9007) on various categories of police reported traffic accidents with personal injury. Estimated on seasonally differenced data 8707-9306 which are adjusted for estimated effects of alcohol consumption and motor petrol. Semi-logarithmic models.

	Fatal accidents		Single-vehicle accidents		All accidents	
	Effect	SE	Effect	SE	Effect	SE
D9007	-.102*	.042	-.117*	.054	-.078*	.031
Noise						
AR(1)			.12	.13	.22(*)	.13
AR(2)			.27*	.13		
SAR(1)	-.58	.11	-.34*	.14	-.43**	.14
Test						
Q[a]	8.46 (lag 12), p>.74		6.92 (lag 12), p>.86		8.57 (lag 12), p>.73	
Q[a]	24.53 (lag 36), p>.92		28.36 (lag 36), p>.81		32.26 (lag 36), p>.64	

(*)p<.10; *p<.05; **p<.01

[a]Box-Ljung test for auto-correlated residuals

Proxies for the two most obvious determinants of changes in the number of traffic accidents, i.e. alcohol consumption and mileage, were included as controls in the analyses. If alcohol consumption is not included as a control the estimated intervention effect increases to a 13.1% reduction of fatal accidents. The corresponding figures for single-vehicle accidents and all accidents are 13.9, and 10.2 % respectively.

It is hardly surprising that the magnitude of the estimated intervention effect is contingent upon what controls are included, i.e. the very point of the analytic design. At the same time it raises the issue whether there is some omitted determinant, which underwent a shift at the time of the intervention. A plausible candidate among several (see Wagenaar & Streff, 1989) is the proportion of driving done by young people, who, as a group, are over-represented in alcohol related accidents. Available data indicate that this has decreased in relation to total mileage, probably as a consequence of the economic recession. Given the higher accident risk of young motorists, this should have an impact on the number of traffic accidents. Due to lack of monthly data it is not possible to control for this factor in the same manner as we did for alcohol consumption and mileage. However, an approximate estimate of its effect can be made on the basis of available figures for exposure (mileage) and relative risk of fatal accidents for young people. Such an estimate suggests that the number of fatal accidents decreased by 1.7 to 3.3 per cent during the post-intervention period due to the decrease in driving in the age group 18-24 years (Norström & Andersson, 1997). This would mean that about one third of the reduction in the number of fatal accidents during the post-intervention period could be attributed to this factor.

Comparison of BAC-levels

Assuming that the lowering of the legal BAC-limit to 0.02 per cent did produce a reduction of the number of traffic accidents, one may ask in what way this effect was brought about. The most common argument for a reduced BAC-limit is that also low alcohol dosages impair driving. However, some studies suggest that the most important impact of a lowered limit is more general, in that it reduces DWI at all levels.

To test whether the Swedish reform in 1990 had such a generally reducing effect on the BAC-level the distributions of BAC's in 1987 and 1991 were compared. was 0.98.

Table 3. Distribution of BAC-levels among convicted drunken drivers 1987 and 1991

BAC (per mille)	1987	1991	Total
0.50-0.99	17.7	24.4	22.2
1.00-1.49	25.2	28.2	27.2
1.50-1.99	26.0	23.9	24.6
2.00-2.49	18.0	15.0	16.0
2.50-	13.1	8.5	10.0
Total	100.0	100.0	100.0
Mean BAC	1.68	1.54	
Median BAC	1.63	1.45	
N	373	777	1150
Not available (N)	10	21	31

As can be seen in the table, there is a downward shift in the distribution between the two points in time; in 1991 the average BAC was 9 per cent lower than in 1987 ($p<.01$).

DISCUSSION

According to the impact analysis, the lowering of the legal BAC-limit in July 1990 in Sweden to 0.02% was followed by a significant reduction in the number of traffic accidents. For all traffic accidents inclusive, the reduction was about 7 %, for single-vehicle accidents 11 %, and for fatal accidents 10 %. However, these results should be interpreted with great caution. As is always the case with quasi-experimental studies, no definite statements about causality can be made as to what extent the observed reduction in traffic accidents can be attributed to the intervention. Even though we controlled for the effects of alcohol consumption and mileage the possibility remains that the observed reduction in traffic accidents might be due to some other change that coincided with the intervention. In future research one should consider carefully what additional controls should be included. For instance, it appeared that the decrease in driving, done by young people, probably accounts for about one third of the decrease in fatal accidents.

Granted that the intervention effect is real it seems to have been materialised through a general reduction of the BAC-level, i.e. that DWI also at higher BAC- levels decreased. However, here, too, a caveat is in order. Although the difference between 1987 and 1991 in average BAC is statistically significant, the comparison includes two single years only.

However, the outcome is in line with previous experience and also gets some independent support from a couple of other studies which use more direct measures of DWI. First, there is Åberg's (1993) study, which is based on two surveys conducted in 1987 and 1991, respectively. It appears that at the latter occasion it was three times as frequent that one had cancelled a drive because one believed that one's BAC was too high. There is, of course, more than one way of interpreting this difference, but it may reflect an increased tendency to refrain from driving after consumption of alcohol. Secondly, Norström (1997) analysed the development of DWI between 1957 and 1993, as indicated by the fraction of drivers involved in traffic accidents, and who were suspected to be under the influence of alcohol according to the police report. The finding, based on ARIMA-modelling, and controlling for alcohol consumption, suggested a reduction in DWI by 16 per cent following the 1990 reform.

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