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Synthesis report – Economic evaluation of prevention measures in Switzerland

Cost-benefit analysis of road accidents prevention: WIG / ZHAW

Cost-benefit analysis of tobacco prevention: IRENE / University of Neuchâtel

Cost-benefit analysis of alcohol prevention: IRENE / University of Neuchâtel

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Abstract

The Swiss Federal Office of Public Health commissioned the Winterthur Institute of Health Economics and the Institute of Economic Research of the University of Neuchâtel to undertake an economic evaluation of disease and accident prevention measures in Switzerland. The main objective of the study was the calculation of the economic return in the three prevention fields of tobacco, harmful use of alcohol, and road accidents with a common methodology. The main questions addressed with regard to prevention measures were: Do these measures work? And, if so, are they worth the money they cost? The main result is a positive return for every franc invested in health promotion and efforts for preventing road accidents, tobacco consumption and alcohol harmful use. The estimated return on investment varies between 9.4 for public road accident prevention programmes, 23 for alcohol prevention and 41 for tobacco prevention. The research has demonstrated the potential benefits of prevention measures; such efforts can deliver good value for money for society as a whole.

Das BAG beauftragte das Winterthurer Institut für Gesundheitsökonomie und das Institut für Wirtschaftsforschung der Universität Neuenburg mit der Durchführung einer ökonomischen Evaluation von Massnahmen zur Krankheits- und Unfallprävention in der Schweiz. Hauptziel der Studie war die Berechnung des Return on Investment der Investitionen in den drei Präventionsbereichen Tabak, Alkoholmissbrauch und Verkehrsunfälle mit einer gemeinsamen Methodologie. Die Hauptfragestellungen zu den Präventionsmassnahmen waren: Funktionieren die Massnahmen? Und lohnen sie sich finanziell? Hauptergebnis ist eine positive Rendite auf jeden für die Gesundheitsförderung und Massnahmen zur Prävention von Verkehrsunfällen, Tabakkonsum und Alkoholmissbrauch eingesetzten Franken. Der geschätzte Return on Investment beträgt 9,4 bei Programmen zur Verkehrsunfall-prävention, 23 bei der Alkoholprävention und 41 bei der Tabakprävention. Die Studie belegt den möglichen Nutzen von Präventionsmassnahmen, und weist nach, dass diese Massnahmen Gewinne für die Gesellschaft als Ganzes erbringen können.

L'OFSP a mandaté l'Institut d'économie de la santé de Winterthur et l'Institut de recherches économiques de l'Université de Neuchâtel pour mener une évaluation économique des mesures de prévention des accidents et des maladies en Suisse. L'objectif principal de l'étude était de calculer le retour sur investissement dans les domaines de la prévention du tabagisme, de la consommation excessive d'alcool et des accidents de la route (en particulier en lien avec l'alcool) selon une méthodologie identique. Dans les trois domaines, l'étude a cherché à répondre aux questions suivantes : Les mesures de prévention fonctionnent-elles ? Valent-elles l'argent qu'elles coûtent ? Le principal résultat est un rendement positif pour chaque franc investi dans la promotion de la santé et les efforts de prévention des accidents de la route, du tabagisme et de l'usage nocif d'alcool. Le retour sur investissement estimé varie entre 9,4 pour les programmes publics de prévention des accidents de la route,

23 pour la prévention de l'alcool et 41 pour celle du tabac. La recherche démontre les bénéfices potentiels des mesures de prévention ; dans les trois domaines choisis, de tels efforts sont économiquement très avantageux pour la société dans son ensemble.

L'UFSP ha incaricato il Winterthurer Institut für Gesundheitsökonomie e l'Institut de recherches économiques dell'Università di Neuchâtel di condurre una valutazione economica delle misure adottate in Svizzera per la prevenzione delle malattie e degli incidenti. Lo studio si è posto come obiettivo principale il calcolo, secondo una metodologia comune, della redditività economica della prevenzione nei campi del tabagismo, dell'abuso di alcol e degli incidenti stradali. Per questi tre settori, lo studio ha cercato di rispondere alle seguenti domande: «Le misure di prevenzione funzionano?», «Valgono quel che costano?». Il risultato principale di queste misure è un rendimento positivo per ogni franco investito nella promozione della salute e negli sforzi di prevenzione degli incidenti stradali, del tabagismo e dell'abuso di alcol. La redditività stimata degli investimenti varia tra 9,4 per i programmi di prevenzione pubblica degli incidenti stradali, 23 per la prevenzione dell'abuso di alcol e 41 per la prevenzione del tabagismo. La ricerca dimostra i potenziali benefici delle misure di prevenzione e i vantaggi economici che tali interventi possono apportare all'insieme della società.

Keywords

economic evaluation, prevention, health promotion, return on investment, cost-benefit analysis, tobacco, alcohol, road accidents

ökonomische Evaluation, Prävention, Gesundheitsförderung, return on investment, Kosten-Nutzen-Analyse, Tabak, Alkohol, Strassenverkehrsunfälle

évaluation économique, prévention, promotion de la santé, retour sur investissement, analyse coûts-bénéfices, tabac, alcool, accidents de la route

Valutazione economica, prevenzione, promozione della salute, redditività degli investimenti, analisi costi-benefici, tabacco, alcol, incidenti stradali

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Summary

The Issue

The health and well being of individuals and society as a whole is largely influenced by individual lifestyles and the environment in which people live. Tobacco, the harmful use of alcohol, risky driving and other unhealthy behaviours lead to human suffering, a high number of premature deaths and considerable costs to society as a whole. Public health efforts in terms of prevention and health promotion measures seek to reduce these human and economic costs through the promotion of healthier lifestyles and environmental improvements.

Over the last decades, there has been growth in activity at Federal and Cantonal level in Switzerland aimed at preventing illness, diseases and disabilities. Such programmes and projects are designed to help bring about changes in behavioural risk factors and provide the structural support to encourage healthy lifestyles. Their effects have been systematically monitored and evaluated; an evaluation of their economic effectiveness, however, has been somewhat neglected.

There are two main questions regarding the economic evaluation of prevention and health promotion interventions: 1) *Do the measures work?* 2) Are *they worth the money they cost?*

To find out the answers, the Swiss Federal Office of Public Health commissioned the Winterthur Institute of Health Economics, and the Institute of Economic Research in Neuchâtel to carry out a Cost-Benefit Analysis of *primary prevention measures* in the prevention fields of tobacco, alcohol and road accidents (Primary prevention aims at averting illnesses, diseases and accidents, while secondary and tertiary prevention focus on the already affected individuals).These prevention fields were chosen because they are responsible for a significant share of premature mortality and morbidity in Switzerland and because each of these fields has been the subject of important prevention efforts over the past decades.

The complete research reports are available at http://www.bag.admin.ch/evaluation under the “reports and ongoing studies” section.

The Study

The study set out to chart new waters in the economic evaluation of Switzerland’s prevention efforts. Whilst for the economic evaluation of health care treatments and programmes (e.g. drugs, medical procedures, screening programmes) the methodology is well established, for prevention and health promotion interventions such evaluations face particular methodological difficulties. For instance, it is often much harder to demonstrate a direct causal link between such public health interventions and their ultimate impact on health, as the use of randomised controlled trials, the method most frequently used in clinical research, is rarely appropriate to the reality of community based interventions.

We adopted a societal perspective, which means that the analysis considers all the relevant costs of an intervention and its resulting benefits in terms of the direct costs (medical costs), production losses (loss of income) and intangible costs (loss of quality of life due to illness, disability and premature death) avoided for the community as a whole rather than the financial return to government.

To find the answer to the two main questions '*Does prevention work?'* and *'Is prevention worth it?'* we applied a common set of methods. The '*Does prevention work?'* question was answered by estimating the effect of prevention measures in terms of health outcomes, in terms of number of prevented diseases, injuries and premature deaths. These health outcomes were summarized with the number of *disability adjusted life years* (DALYs) saved. See Box 1 for a simplified example on how DALYs are calculated and what they mean.

We *compared* the health outcomes of a situation where *existing* prevention measures were in force with the health outcomes of a *hypothetical situation* in which, during the same period no additional prevention measures were introduced. An example is the reduction of the maximum blood alcohol level for drivers from 0.8 to 0.5 per mil introduced in 2005. The effect of this reduction is estimated by comparing the actual

Box 1 – How DALYs are calculated and what they mean – an example

DALYs were developed by the WHO and are computed by adjusting age-specific life expectancy for loss of healthy life due to disability.

A simplified fictitious example may be helpful to understand the meaning of the DALY. Suppose that a 55 year old cyclist has an accident and suffers a severe head injury leading to his death and that the average life expectancy of a 55 year old man is 27 years. In this case 27 years of life in normal health are lost due the accident.

Now suppose that the cyclist does not die but suffers a permanent disability and that the life expectancy of 27 years does not change as a consequence of the disability.

The DALY is an instrument 'translating' the reduced quality of life in these 27 years into the number of normal health years that have been lost. WHO experts have developed DALY weights for a multitude of health states. Suppose that the DALY weight for a year of a permanently disabling severe head injury is 0.367. By multiplying the DALY weight with the 27 remaining expected life years we obtain a total of 9.9 DALYs. These 9.9 DALYs mean that 9.9 years in normal health are lost due to the accident.

In case of death, the 27 years of life lost correspond to 27 DALYs.

The main advantage of the DALY is that we can sum up the quality of life lost due to disabling injuries e.g. caused by bicycle accidents, in a single year with the life years lost due to premature death caused by such accidents in the same year and bring it to a single number. And of course this method can also be applied to calculate the health burden of illness caused by tobacco consumption or alcohol harmful use.

number of road accident casualties with the 0.5 limit in place with the hypothetical number of casualties with the old 0.8 limit in place.

For public road accident prevention, the hypothetical situation is based on the prevention efforts existing at the beginning of the estimation period, in 1975. For alcohol and tobacco prevention, the hypothetical situation is based on the prevention efforts in force at the beginning of the estimation period, in 1997. The benefit of prevention is the economic outcome of the increased prevention effort over the period up to the year 2007.

We took account of the changes that would have taken place *in the absence of prevention measures*. An example of such changes for road accident prevention programmes is the reduction of casualties due to the improvement of car safety, and for tobacco it is the decline in smoking rate due to tax increase. We thus isolated the effect of prevention from all other influence factors, which was certainly the most difficult task of the research.

The following prevention measures considered in the study: For road accidents we took account of all measures initiated by public authorities, with the exception of investments in the safety of road infrastructure. Prevention costs include private expenses induced by public prevention measures, e.g. when motorcycle riders are obliged to buy helmets after the introduction of compulsory helmet use. For tobacco we took account of all prevention programmes implemented by the Confederation, the cantons the NGOs and assessed only the outcome of interventions aimed at changing behaviour through information or education. For alcohol harmful use we took account of all prevention programmes implemented by the Confederation, the cantons and the NGOs. The outcome of behavioural and structural interventions (limiting access to the product) was assessed and the effects of alcohol taxation (a structural intervention) were not included in the cost and benefit estimates.

Many data sources were used for the analysis. For example, the Neuchâtel team conducted a cantonal survey to supplement existing data on prevention activities and costs and made use of the Swiss Health Survey data; the Winterthur team turned to two major databases, the Federal Statistical Office for data on accidents recorded by police, and the consequences of accidents (costs and type of injuries) compiled by the Central Office for Statistics in Accident Insurance.

A panel of scientific experts was constituted. Its members were drawn from national and international organizations, including representation from the OECD, WHO and Swiss Health Observatory. The panel provided the two research teams with critical comment throughout the study.

The *'Is prevention worth it?'* question was answered with a Cost-Benefit Analysis (CBA) approach. A CBA shows whether prevention programs bring more benefits to the population than they cost the taxpayers and allows a direct comparison of the results in different prevention fields. A CBA provides the basis for calculating the return on investment (ROI) on prevention measures – how many francs were spent – by comparing the expenditure with the attributed benefits – how many francs were gained, or more precisely, what were the total costs avoided due to prevention

measures. A positive ROI means that the benefits of prevention outweigh its costs. See Box 2 for a simplified example on how the ROI is calculated and what it means.

BOX 2 – How the ROI is calculated and what the ROI means – an example

A simplified fictitious example may be helpful to understand the meaning of the ROI. Suppose that an educational programme, costing 100’000 Francs, convinces 1’000 cyclists to wear a bicycle helmet. Suppose that one of those 1’000 cyclists would have suffered a severe head injury leading to permanent disability at the age of 55, if he had not worn a helmet. This prevented casualty is the effect of an educational programme. Now suppose that the monetary value of this effect consists of

1. prevented medical costs of 100’000 francs,
2. prevented income loss of 500’000 francs, due to the fact that the cyclist would have stopped working at the age of 55 instead of 65,[1]
3. prevented loss of the value of the quality of life of a non-disabled life from the age of 55 to the death at the age of 82, amounting to 500’000 francs.[2]

Total benefits of prevention thus amount to 1’100’000 francs.

The ROI is calculated as

(benefits of prevention – cost of prevention) / cost of prevention

in our case

(1’100’000 francs – 100’000 francs) / 100’000 francs = 10

A ROI of 10 thus means that for every franc invested in the educational programme there is a net benefit to society of 10 francs. A positive ROI means that benefits outweigh costs and that the community has a net benefit for each franc spent on prevention. A ROI of zero means that the costs of prevention are equal to its monetary benefits. In our example this would be the case if only the prevented medical costs were taken into consideration.

This is a simplified and fictitious example; it does not include several additional features of the ROI calculations we applied and which are presented in our specific CBA reports, such as the discounting of benefits and costs occurring at different points of time to their present value in the year 2007.

[1] Even if the unfortunate cyclist receives a disability pension amounting to CHF 500’000 for these 10 years, society still loses 500’000 francs as this amount would have been his contribution to national income as a member of the work force. The 500’000 francs he receives as disability pension correspond to a transfer of income from the remaining economically active population.

[2] The average life expectancy at the age of 55 is 27 years. The yearly DALY weight of the severe head injury leading to permanent disability is 0.367. Over 27 years this corresponds to 9.91 DALYs lost. The value of a life year in full health of 50’400 CHF multiplied by 9.91 corresponds to CHF 500’000.

The two research teams followed the same methodology, included the same cost categories and quantified these costs with the same approach. Both teams calculated effectiveness by applying statistical methods which compared prevention efforts and health outcomes between cantons and their evolution over time. Costs and benefits were discounted at the common rate of 2%. Estimations of the costs and benefits adopted a conservative approach with a generous valuation of the costs of prevention measures and a cautious valuation of their benefits (see single studies for further details).

Nevertheless, there are some differences between the three CBAs that are due to differences in data availability and the time period of prevention efforts in the three prevention fields. The data available on the road accidents is more detailed as information is available on every single accident registered by the police since 1975. The time periods considered differ substantially as road accident prevention took off at the beginning of the 1970s while major efforts in tobacco and harmful alcohol use on a national scale are relatively new, dating from the mid 1990s onwards. The period taken into account for each of the individual projects, road accidents, tobacco and alcohol, depended on the availability of reliable data and therefore varied between 10 years (for tobacco and alcohol) and 33 years (for road accidents).

Findings

In answer to the two main questions "*Does prevention work?*" and "*Is it worth it?*", our analysis shows that indeed there are considerable net social benefits of public prevention measures in the prevention fields considered. Prevention achieved a substantial reduction of morbidity and premature deaths. The return on every franc invested varies between 9 francs in road accident prevention, 23 francs in alcohol prevention and 41 in tobacco prevention. The reduction of medical costs due to prevention measures was higher than the prevention costs in all the 3 prevention fields considered.

For *road accidents*, between 1975 and 2007, the number of fatalities and severely injured strongly decreased as expenses in prevention increased by over 50% in real terms. The effect of all interventions was substantial. Taking into account the increase of the population, the increase of the number of vehicles in circulation and the general social and demographic trends which have contributed to a decline in the number and the severity of accidents, we estimated that between 1975 and 2007, road accident prevention measures prevented a total of 13,500 fatalities, 17,300 permanently disabled casualties, 98,900 severely injured, 82,800 moderately injured and 710,200 slightly injured.

Costs totalling CHF 72,800 million were avoided, of which 19% were direct costs (material damages not considered), 41% production losses and 40% intangible costs. The ROI of all public prevention programmes, excluding investments in the safety of the road infrastructure, is estimated at CHF 9.4 for each franc invested (see Box 3). The ROI of all prevention measures, including investments in the safety of road infrastructure and expenses for private safety devices, is estimated at 1.5.

For *tobacco and alcohol* the amount dedicated to prevention quadrupled (for tobacco) and doubled (for alcohol) between 1997 and 2007. For *tobacco* over this period, the number of smokers was reduced by 5.3 percentage points, from 33.2% to 27.9% in 2007, which corresponds to a reduction of 343,000 smokers after adjustment for population growth. The decline in the number of smokers attributable to prevention activities, other than tax increase, is 143,000. This estimate can be considered as robust; it was confirmed using two differently designed econometric models. The decline in smoking prevalence generates significant health benefits, smoking being the single most common cause of disability-adjusted years of life lost (11.2% of all DALYs lost in Switzerland). Tobacco prevention efforts have demonstrated remarkable success in convincing smokers to quit; they have been less effective in convincing young people not to start smoking. In economic terms, the yearly outcome of tobacco prevention is a reduction in the societal cost of smoking-related diseases of close to CHF 800 million (the possible estimates range from around 540[1] to more than 900 million). Each franc invested in smoking prevention thus results in a net benefit of 41 francs.

Similarly, for *alcohol*, between 1997 and 2007, the proportion of the population having an excessive consumption of alcohol dropped from 6.0% to 5.1%. This corresponds to about 55,000 fewer individuals with harmful alcohol use. After taking into account the price effect, close to half (47.3%, ranging from 22.2% to 60.2%) of the change in prevalence is attributable to prevention. In other words, there would have been about 25,000 more affected individuals if no prevention programmes had been implemented, with a range of possible values from 11,500 to 31,500. This goal was achieved, despite the fact that the price of alcohol has dropped and access to alcohol is easier in view of the increasing numbers of outlets at petrol stations. Each franc invested in the prevention of harmful alcohol use thus results in a net benefit of 23 francs.

The results show that information and education measures have largely contributed to the reduction of tobacco use, excessive alcohol consumption and road accidents. For instance, in the case of tobacco our study shows strong evidence that taxation on cigarettes is not the only effective tool to stop the smoking epidemic; strategies based on information and education are as well. But it appears that whilst such strategies are more effective in inducing smokers to consider quitting they are less effective in convincing young people not to start smoking. It seems that anti-smoking messages have not yet been successful in countering the favourable image of smoking, probably as a result of tobacco advertising which tends to reduce the perceived health risk of smoking.

As for road accidents, investing in improvements to road and vehicle safety and behavioural interventions plays a major role in the large reduction of severe casualties. But efforts aimed at safer behaviour on the road yield a higher return than investments in road infrastructure and safety devices, which together represent the biggest part of safety expenditure by far. The introduction of new prevention interventions in

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[1] Figures presented in this section have been rounded up.

well established and successful fields where seemingly additional improvements in health outcomes may appear difficult to achieve, may still show a high rate of ROI.

Box 3 – Comparison of return on investment (ROI*) in three prevention fields in Switzerland (in million 2007 CHF)

	Road accidents Public prevention programmes 1975-2007	**Tobacco** Prevention focussing on behaviour 2007	**Alcohol harmful use** Prevention focussing on behaviour 2007
Costs of prevention	5,168	19	22
Benefits of prevention			
Direct medical costs	6,212	139	76
Direct non medical costs	4,138		16
Production losses	22,098	315	152
Intangible costs	21,476	342	277
Total prevented costs	53,924	796	520
ROI	**9.4** (7.6 – 11.3)**	**41** (28 – 48)**	**23** (11– 29)**

**The ROI is calculated as (benefits – costs) / costs. At a ROI of 0 the benefits are equal to costs. A ROI of 1 corresponds to a net gain of 1 franc for every franc invested in prevention.*

***The numbers in parenthesis represent the confidence interval of the ROI. The confidence interval is calculated by varying the coefficients of the prevention measures estimated in the effectiveness estimation by one standard error (a measure of the variability of the coefficient). This variation corresponds to a 68% probability range.*

Costs and benefits occurring before and after the year 2007 have been adjusted for inflation and discounted with a 2% rate to take account of the 'time value' of money (the real interest rate in Switzerland has been approximately 2% over the past decades). All values are thus transformed into 2007 francs.

Type of prevention measures considered in the CBA results presented in the table:

Road accidents: Public prevention programmes include all measures initiated by public authorities, with the exception of investments in the safety of road infrastructure. Prevention costs include private expenses induced by public prevention measures, e.g. when motorcycle riders are obliged to buy helmets after the introduction of compulsory helmet use.

Tobacco: Prevention programmes implemented by the Confederation, the cantons the NGOs. Only the outcome of interventions aimed at changing behaviour through information or education is assessed.

Alcohol harmful use: Prevention programmes implemented by the Confederation, the cantons and the NGOs. The outcome of behavioural and structural interventions (limiting access to the product) is assessed. The effects of alcohol taxation (a structural intervention) are not included in the cost and benefit estimates.

Key Messages

Our analysis demonstrates that the public prevention measures in the fields of road accidents, tobacco and alcohol prevention introduced in Switzerland in the past decades have been effective and a good investment. These measures achieved a substantial reduction of morbidity, of premature deaths and of the consequent human suffering. The benefits to the population were considerably higher than the costs of prevention for the taxpayer.

The results show that information and education measures have contributed significantly to the reduction of road accidents, tobacco consumption and excessive alcohol consumption.

The analysis does not show that every single measure taken was effective but that these measures were globally effective. New prevention measures should be evaluated for their effectiveness and their benefits should be weighted against their costs.

More coordination and standardization of data on prevention costs and how the funds are spent is needed to support and improve any future economic evaluation of prevention measures.

List of acronyms

Bfu	Swiss Council for Accident Prevention (Beratungsstelle für Unfallverhütung)
CBA	cost-benefit analysis
CHF	Swiss franc
DALY	disability-adjusted life year
FDI	Federal Department of the Interior
FOPH	Swiss Federal Office of Public Health (Bundesamt für Gesundheit)
FRS	Fund for Road Safety (Fonds für Verkehrssicherheit)
FSIO	Federal Social Insurance Office
FSO	Swiss Federal Statistical Office (Bundesamt für Statistik)
IRENE	Institute of Economic Research, University of Neuchâtel (Institut de recherches économiques de l'Université de Neuchâtel)
NEEDS	New Energy Externalities Developments for Sustainability
Obsan	Swiss Health Observatory
OECD	Organisation for Economic Co-operation and Development
QALY	quality-adjusted life year
ROI	return on investment
SAB	Swiss Alcohol Board
SAI	Central Office for Statistics in Accident Insurance (Sammelstelle für die Statistik der Unfallversicherung – SSUV)
VOSL	value of statistical life year
VSS	Swiss Association of Road and Transportation Experts (Schweizerischen Verband der Strassen- und Verkehrsfachleute)
WHO	World Health Organisation
WIG	Winterthur Institute of Health Economics (Winterthurer Institut für Gesundheitsökonomie)
ZHAW	Zurich University of Applied Sciences Winterthur (Zürcher Hochschule für Angewandte Wissenschaften Winterthur)

Glossary

cost-benefit analysis (CBA)	Analysis comparing the costs and benefits of an intervention. Both costs and benefits are measured in monetary terms and discounted to their present value. CBA allows the calculation of the return on investment of an intervention.
behavioural intervention	Intervention aiming at a change in unhealthy behaviour, e.g. programmes informing and educating the population.
direct costs	Cost of resources used to deal with the consequences of disease or accident. They usually include costs of health care, assistance to individuals affected and may also comprise administrative costs and material damage.
disability-adjusted life years (DALY)	Indicator developed by the WHO to assess the global burden of disease. DALYs are computed by adjusting age-specific life expectancy for loss of healthy life due to disability. The value of a year of life at each age is weighted, as are health decrements from disability from specified diseases and injuries.
intangible costs	Value of health and quality of life lost due to a disease or accident.
production or productivity losses	Production losses due to workdays lost as a consequence of a disease, illness or accident. These costs are also sometimes called indirect costs.
return on investment (ROI)	Number of monetary units gained for every monetary unit invested. The ROI is calculated as the difference between the benefits and the costs of the intervention over the costs of the intervention. A ROI of 0 means that the benefits of the intervention were equal to its costs.
sensitivity analysis	Analysis of the robustness of the results. Sensitivity analysis involves repetition of an analysis under different assumptions to examine the impact of these assumptions on the results.
societal perspective	A CBA with a societal perspective considers all the relevant costs of an intervention and its resulting benefits to the society as a whole (including individuals, private companies and public authorities).
structural intervention	Interventions designed to reduce access to a product, to limit or prohibit its promotion or to increase its price.

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1 Introduction: Purpose, organisation and structure of the research project

The health and well being of individuals and society as a whole is largely influenced by individual lifestyles and the environment in which people live. Tobacco, the harmful use of alcohol, poor nutritional diets, risky driving and other unhealthy behaviours lead to enormous suffering, a high number of premature deaths and considerable costs to society as a whole. Public health efforts in terms of prevention and health promotion measures seek to reduce these human and economic costs through the promotion of healthier lifestyles and environmental improvements.

As part of its policy, the Swiss Federal Office of Public Health (FOPH) has a clear commitment to support more, and more effective prevention and health promotion measures (FOPH 2007a). Over the past 20 years, it has launched several strategic programmes at a national level that have been aimed at structural changes in the environment, modifying behaviour and promoting healthy lifestyles.

The FOPH called for an economic evaluation of prevention measures in Switzerland to investigate the rate of return on investments (ROI) in a limited number of prevention fields. The FOPH was particularly inspired by an Australian study because of its pioneer work in applying a common methodology to analyse the ROI on prevention measures, and in tackling prevention efforts as a whole rather than the economics of individual measures (Abelson et al. 2003). Applying a coherent methodology to evaluate a number of different fields was seen as particularly important as methodological differences represent one of the main difficulties in the interpretation and comparison of the results of previous Swiss studies.

In the years 2006 and 2007 a series of expert meetings were held at the FOPH in order to identify the prevention fields for which an economic evaluation would be most promising and worthwhile. A study commissioned to the Institute of Health Economics and Management (IEMS) of the University of Lausanne and the Winterthur Institute of Health Economics (WIG)[2] evaluated the feasibility of a cost-benefit analysis (CBA) in the fields of tobacco, harmful alcohol use and road accident prevention (Chevrou-Séverac et al. 2007). These prevention fields were selected because they were, and continue to be responsible for a significant share of premature mortality and morbidity in Switzerland and because considerable prevention efforts have been carried out in the past decades. The field of obesity prevention, which has a high priority in public health policy in Switzerland as in many other developed countries, could not be covered with a CBA because there is still not sufficient data available.

There are two main questions regarding the evaluation of prevention and health promotion interventions: 1) Do the measures work? 2) Are they worth the money they cost? To answer these questions in relation to Switzerland's prevention efforts over the past decades, the FOPH commissioned the Winterthur Institute of Health Eco-

[2] The WIG is part of the School of Management and Law of the Zurich University of Applied Sciences.

nomics (WIG) and the Institute of Economic Research (IRENE), University of Neuchâtel to conduct the research The mandate required a cost benefit analysis of the three selected prevention fields - road accidents, tobacco and the harmful use of alcohol - an exploratory study on the feasibility of a future economic evaluation of obesity prevention measures plus a scientific coordination project to agree and oversee methodological coherence and ultimately synthesise the knowledge gained through the research.

A scientific advisory group composed of Swiss and international experts[3] was set up by the FOPH to accompany and advise the project throughout.

The research teams, the members of the Scientific Advisory Group and the FOPH's representative[4] participated in four workshops and accompanied the research project throughout from a kick-off meeting, to the definition of a common methodology and the discussion of the results.

The research produced the following documents:

- A methodological review on economic evaluation of health promotion and prevention with focus on cost-benefit analysis (CBA). It presents the main principles and procedures of CBAs of public health interventions according to the current state of the art and reports the main difficulties (Schmidhauser et al. 2009b).
- A CBA of road accidents prevention measures in Switzerland from 1975 to 2007 (Wieser et al. (2009) by WIG, see section 3 for synthesis of full report):
- A CBA of tobacco prevention measures in Switzerland from 1997 to 2007 (Füglister-Dousse et al. (2009), study financed by the Tobacco Prevention Fund, see section 4 for synthesis report).
- A CBA of harmful alcohol use prevention measures in Switzerland from 1997 to 2007 (Füglister-Dousse et al. (2009), see section 5 of synthesis report).
- It was not possible to carry out a CBA of obesity prevention because, to date, no Intervention measures have been evaluated in terms of reduced weight or avoided cases of obesity. Instead, the WIG carried out an extended international literature search and review of the environmental determinants of overweight and obesity (Schmidhauser et al. 2009a). A further report by the WIG assesses the availability and quality of the required data in Switzerland and makes recommendations to prepare the ground for a future CBA of prevention interventions against overweight and obesity (Kauer et al. 2009).

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[3] The members of the Scientific Advisory Group were: Günter Ackermann (Health Promotion Switzerland), Brigitte Buhmann (Swiss Council for Accident Prevention bfu), Michele Cecchini (OECD), Gianfranco Domenighetti (Università della Svizzera Italiana), David B. Evans (WHO), Ilona Kickbusch (independent public health consultant), Jean Simos (Université de Genève) and France Weaver (Obsan).

[4] Marlène Läubli, head of the FOPH's evaluation and research management services, was the Project's contractual partner on behalf of the FOPH.

To calculate the returns on investment in prevention, the following steps were taken for the analysis of each of the three prevention fields:

1. Estimation of the costs of prevention.
2. Estimation of the benefits of prevention. These benefits are represented by the medical costs, the loss of income and the human suffering that would have occurred without prevention. The benefits are thus due to those individuals who quit smoking, changed their drinking habits and drove more safely because of the prevention measures. This part of the research is based on an estimation of the number of healthy life years saved due to prevention and the costs caused by unhealthy and unsafe behaviours.
3. Comparison of the costs of prevention with the benefits of prevention. The ROI in single prevention fields shows how many francs were saved for every franc invested in prevention.

The synthesis report gives an overview of the methodology and results of the CBAs in the fields of road accidents, tobacco and the harmful use of alcohol. It is a non technical summary and the interested reader is invited to refer to the complete CBA reports for further details.

- All the reports mentioned above, including the individual CBA studies can be downloaded from the FOPH’s website at http://www.bag.admin.ch/evaluation/01759/07612/index.html?lang=en.

The synthesis report starts with an overview of the methodology applied in the CBAs (section 2). The results of the analysis regarding road accidents, tobacco and alcohol are then presented in sections 3 to 5 respectively. Section 6 contains a discussion of the main results and policy implications.

2 Methodology: CBA of prevention and health promotion measures

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When a politician has to decide whether to adopt a new public health measure (e.g. a ban of advertisements for alcoholic beverages, a law obliging cyclists to wear helmets or an educational programme on healthy nutrition in primary schools), two questions need to be addressed: *Does it work?* and *Is it worth it*?

Finding the answer to the *'Is it worth it?'* question is the central task of economic evaluations. However, while the methodology of economic evaluations of healthcare treatments and programmes (e.g. drugs, medical procedures, screening programmes) is well established, the economic evaluation of prevention and health promotion interventions face particular methodological difficulties. For instance, it is often much harder to demonstrate a direct causal link between such public health interventions and their ultimate impact on health; for example, the use of randomised controlled trials, the method most frequently used in clinical research, is rarely appropriate to the reality of community based interventions. Another particular problem is that generally speaking, health promotion actions involve a *basket of measures* which combine together to prevent ill health and disease, as well as promote healthy lifestyles. Therefore, the challenge is to capture the effectiveness of a basket of measures as a whole rather than isolate the effect of its parts (the single measures).

Nevertheless, many of the principles of economic evaluation can be applied to our economic evaluation of prevention measures in Switzerland. This section describes the general principles of economic evaluations of prevention and health promotion[5] and how these principles were applied to our CBAs of prevention efforts in the fields of road accidents, tobacco and alcohol.

2.1 Study design

The study's main research interest was in calculating the ROI in primary prevention measures.[6] The period taken into account for each of the individual projects, road accidents, tobacco and alcohol, depended on the availability of reliable data and therefore varied between 10 years (for tobacco and alcohol) and 33 years (for road accidents).

The study takes a *societal perspective* and thus considers all the relevant costs of an intervention and its resulting benefits to the society as a whole (including individuals, private companies and public authorities). This societal perspective is particularly relevant for policy making that is aimed at maximizing societal welfare.

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[5] For further details see our methodological review Schmidhauser, et al (2009b) available at the FOPH website

[6] Primary prevention aims to avoid illnesses, diseases and accidents, while secondary and tertiary prevention focus on already affected individuals.

We *compare* the outcomes of the *actual* prevention measures with the outcomes of a hypothetical situation in which, during the same period, there were no prevention measures in place. In the hypothetical case, the outcomes include the changes that would have taken place *despite the absence of prevention measures*; an example of such outcomes, e.g. for road accident prevention programmes, would be a reduction of casualties due to the improvement of car safety or demographic trends.

The *type of analysis* adopted for this economic evaluation is a CBA, which compares both costs and benefits in monetary terms and thus allows us to calculate the returns on every franc invested in prevention. We chose the method of CBA because it is the only type of economic evaluation which synthesises all the benefits of prevention in a single number and allows a direct comparison of the results in different prevention fields. The study design also permits a cost-utility analysis, in which the sum of the costs incurred (e.g. programme costs) and saved (e.g. medical expenses) thanks to prevention measures are compared with the benefits calculated in terms of the number of health-related life years saved.

The economic evaluation follows a conservative estimation approach with a generous valuation of the costs of prevention measures and a cautious valuation of their benefits (see single studies for further details).

2.2 Measuring effectiveness

Deciding whether or not an intervention is effective depends on whether the intervention *works* in reaching its goal, and to *what degree.* The study of effectiveness therefore addresses the question *'Does it work?'*; it has to be answered before moving on to examine the *'Is it worth it?'* question.

The effectiveness of prevention measures is established by building a theoretical model on how prevention measures and other variables may influence health outcomes and then using statistical methods to estimate the magnitude of the effects.

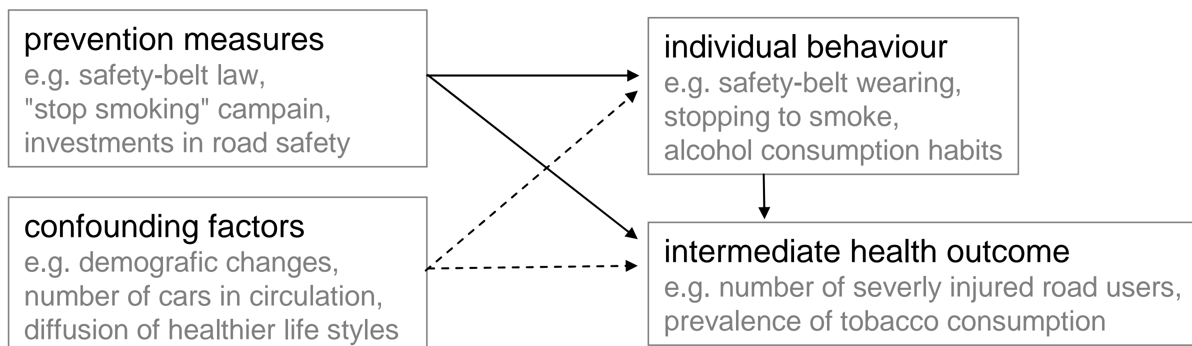
The model may contain the following variables (see figure 2-1):

- Public health indicators (e.g. prevalence of tobacco consumption, number of road accident casualties).
- Individual behaviour (e.g. safety-belt wearing, number of drivers with harmful alcohol use).
- Prevention measures (e.g. sum spent on alcohol prevention programmes, introduction of new speed limits, educational campaigns, taxes and other policy control measures).
- Confounding factors which might influence health outcomes independently of prevention measures (e.g. number of cars in circulation, demography).

The magnitude of the intervention's effect on outcomes is estimated using a multivariate regression or other statistical techniques and the aid of statistical software. The estimated model may contain a *time trend* among the factors influencing health outcomes. This time trend represents factors which lead to a continuous change in health outcomes but cannot be represented explicitly because of lack of data, e.g. improved car and road safety, a general trend towards a safer lifestyle as well as prevention measures, which are hard to quantify.

The methodology used depends on the type and amount of data available on the prevention measures and health effects in the single prevention fields.

Figure 2-1 Framework of effectiveness measurement



Effectiveness measurement aims to identify the effect of prevention measures on health. Prevention measures may have a direct effect, e.g. when investments in road safety lower the number of accidents, but mainly work indirectly by changing individual behaviour, e.g. when a person quits smoking or starts to make use of safety-belts. However, changes in health outcomes are also affected by confounding factors. A decrease of the share of young children in the total population may for example lead to a decrease of fatalities among pedestrians if young children are highly at risk. Individual behaviour may also change independently of prevention due to the adoption of healthier lifestyles. In order to obtain accurate estimation of prevention effects these confounding factors have to be considered in effectiveness measurement.

2.3 Framework of CBA

In order to find out whether an intervention is worth the effort and money spent, its costs are compared with the benefits gained as a result of the intervention – thus providing the answer to the question *'Is it worth it?'*

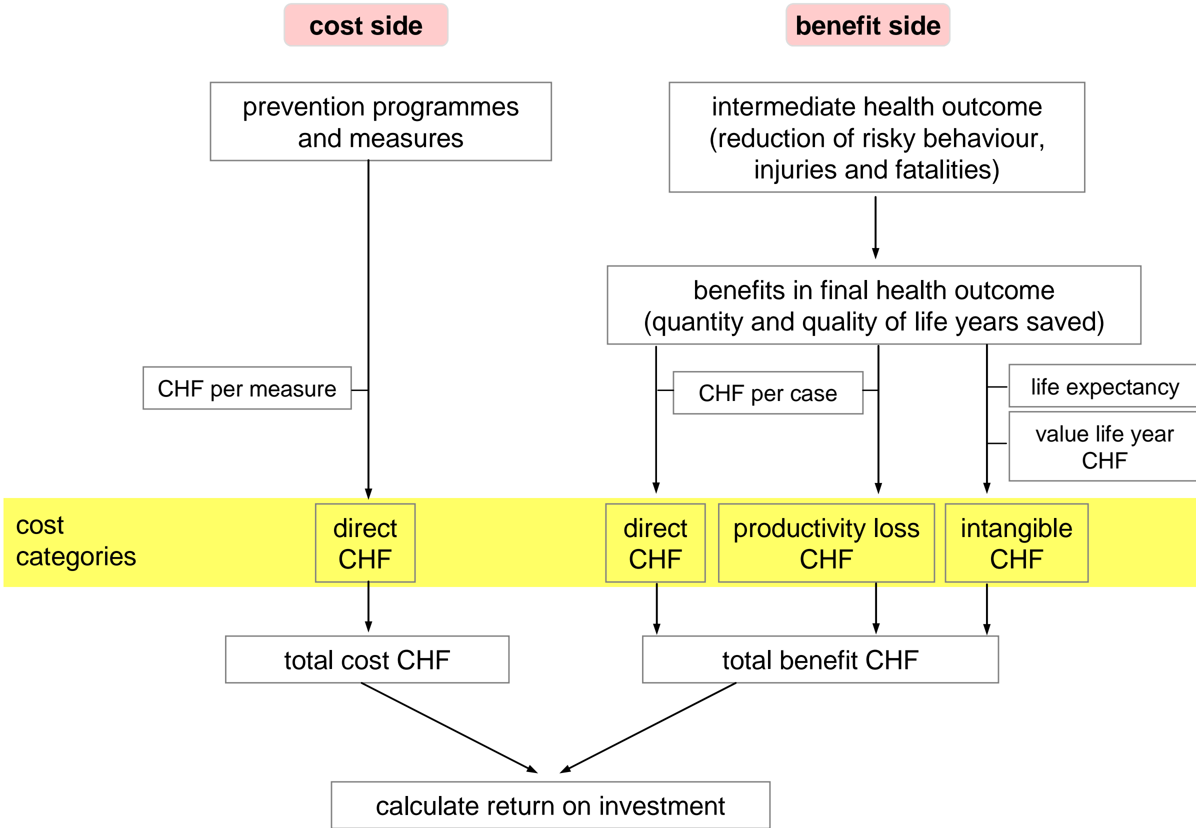
Figure 2-2 represents the general structure of the CBA applied to all three of the individual studies used for our evaluation of prevention measures in Switzerland. The figure shows that costs and the benefits of prevention are first calculated separately and then compared in the calculation of the ROI.

The *cost side* is limited to the direct costs of the prevention programmes. Most of these costs are borne by the agency organizing the programme, which are usually financed by the government. However, some of the direct costs associated with a programme may also be borne directly by the households or private businesses (e.g. additional safety devices for cars).

We do not consider possible production losses (e.g. longer business travel time due to the introduction of a lower speed limit for the prevention of road accidents) and possible intangible consumer welfare losses due to prevention (e.g. loss of pleasure of smoking in night clubs due to a smoking ban) as these costs have hardly ever been taken into consideration in the economic evaluations of prevention measures (Richardson 2004).

The *benefit side* is represented by *avoided costs* that would have occurred without the successful prevention effort. These cost categories include direct costs (e.g. health care expenditures for treating a pedestrian injured in a road accident), production losses (e.g. work years lost due to the premature death of a smoker) and intangible costs (e.g. lost quality of life and number of life years lost due to a disease caused by the harmful use of alcohol).

Figure 2-2 Framework of cost-benefit analysis



Cost-benefit analysis compares the costs and benefits of prevention. The benefits of prevention are represented by the medical costs (direct costs), the loss of income (productivity loss) and the human suffering (intangible costs) that would have occurred without prevention. These benefits are measured by first estimating the effect of prevention measures on the intermediate health outcomes in effectiveness measurement (see figure 2-1). The intermediate health outcomes are then transformed into the final impact on health by calculating the direct costs, the productivity loss and the number of disability adjusted life years (DALYs) saved. The DALYs are multiplied with the statistical value of a life year (VOSL) in order to obtain the monetary value of the intangible costs prevented. Total costs and benefits are discounted to their present value. The return on investment (ROI) is calculated as (total benefits – total costs) / total costs. A ROI of 0 thus means that costs are equal to benefits. A ROI of 1 means a net gain of 1 franc for every franc invested in prevention.

The calculation of intangible costs requires the transformation of intermediate health indicators (e.g. reduced morbidity and mortality due to reduced smoking) into final impact on health in terms of the number of *health-related life years* saved. A health-related life year is a measure combining the gains of additional life years with the gains of increased quality of life due to the disease or injury prevented. We applied the DALY (disability-adjusted life years) method to carry out this transformation. This method was developed by the World Health Organisation (WHO) and is based on expert judgements on the quantity and quality of life lost due to specific diseases and injuries.

The transformation of health-related life years saved into a monetary value to be used in the CBA requires calculating the monetary value of a statistical life year (VOSL). The valuation of life years in monetary terms has been criticised as unethical because human life is seen as priceless. But consider that the value of a statistical life year is not the value of a single life year of an individual, but the sum of money that an average individual is ready to pay for the probability of avoiding the loss of a year of life due to diseases or injuries. We applied a value of CHF 50,400 per DALY prevented in the year 2007 based on a study by Jeanrenaud et al. (2006). In order to give a complete picture of the effects of prevention measures, we also reported the results in terms of the number of diseases or casualties prevented.

The last step of the CBA is the comparison of costs and benefits, which includes the discounting of past and future costs and benefits to the reference year. We applied a discount rate of 2%, which is the Swiss norm in CBAs in the field of road accidents (VSS 2006). This discount rate is lower than the discount rate used for CBAs in most other countries because Switzerland has lower real rates than these countries, with a real interest rate on government bonds of 2% over the last 20 years; the use of this figure for the three CBAs is therefore justified. The return on investment (ROI) of prevention measures to society was then calculated by dividing the difference between total benefits and total costs of prevention by total costs (both benefits and costs valued at their present value in the year 2007). If the ROI is bigger than 0, the investment has a positive return.

Finally, a sensitivity analysis of the results is carried out to examine whether any modifications of our assumptions and estimates produce substantially different results and conclusions. In this synthesis report we focus on the variation in the estimated effects on the intermediate health outcomes, further approaches to the sensitivity analysis are presented in the full reports of the single CBAs (e.g. variation of VOSL, inclusion of material damage, threshold analysis).

2.4 Methodology of the single CBAs

The development and application of a methodology in the evaluation of different prevention fields is a particularly important aspect of this research project, as methodological differences represented one of the main difficulties in the interpretation and comparison of the results of previous Swiss studies.

The two research teams followed the same CBA methodology, included the same cost categories and quantified these costs with the same approach. Quality adjusted life years were always calculated as DALYs and valued with the same VOSL of 50,400 CHF for the year 2007 proposed by Jeanrenaud et al. (2006). Costs and benefits were discounted at the common rate of 2%. Whenever possible the information generated in one CBA was used by the other CBAs, as when the effect of alcohol prevention measures estimated in the CBA on harmful alcohol use (see section 5) is employed in the road accident CBA (see section 3). Both research teams calculated effectiveness by applying statistical methods which compared prevention efforts and health outcomes between cantons and their evolution over time. Both research teams evaluated whole packages of prevention measures as it is usually impossible to clearly identify the effect of single measures (Richardson 2004).

Nevertheless, there are some important differences between the three CBAs, which are due to differences in the quantity and detail of the data available for the single studies. The data available for the road accidents CBA is much more detailed, as information is available on every single accident registered by the police since 1975, while the data on the levels of tobacco consumption and harmful alcohol use is more limited. The data available on tobacco and alcohol prevention efforts and expenditures is very limited, while it is comparably good in the field of road accident prevention. Time periods also differ substantially as road accident prevention took off at the beginning of the 1970s while major efforts in tobacco and harmful alcohol use on a national scale are relatively new, dating from the 1990s onwards.

These differences in data availability inevitably led to differences in the methodology used to measure the effectiveness of prevention measures in the time periods considered (see sections 3.2, 4.2 and 5.2) and in the presentation of the results.[7] The results of the single CBAs are nonetheless absolutely comparable, as the same methodology was followed in the calculation of costs and benefits.

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[7] In the road accident CBA the effectiveness of prevention is for example estimated in 4 road user categories and 5 severity-of-injury categories over a period of 33 years while in the tobacco and harmful alcohol use CBAs the effectiveness of prevention is estimated for the level of consumption over a 10 year period. In this synthesis report it was not possible to report the results of the road accident prevention effectiveness estimates in the same detail as in the other two studies, and the interested reader should thus refer to the full project reports.

3 CBA of road accident prevention measures

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Road accidents lead to numerous fatalities, permanent disabilities and injuries in Switzerland. Although fatalities due to road accidents have declined substantially since the beginning of the 1970s, road accidents are still responsible for considerable societal costs. A recent study estimates these costs at CHF 14 billion for the year 2003 (Sommer et al. 2007).

In the context of the economic evaluation of prevention measures in Switzerland, a CBA of road accident prevention measures appears to be particularly useful for a number of reasons:

- The immediate temporal link between road accident prevention measures and their effect on health makes it relatively easy to quantify the effectiveness of these measures. If, for example, a new law introducing a lower limit for blood alcohol content leads to a lower number of accidents, this effect should already be observable in the year in which the new law is introduced.
- The detailed data available on accidents (recorded by police and compiled by the Federal Statistical Office (FSO)) and consequences of accidents (costs and type of injuries compiled by the Central Office for Statistics in Accident Insurance (SAI)) allowed a detailed analysis over a time period of 33 years. The combination of these two datasets also allowed an estimation of the actual number of road accident casualties in Switzerland, which is underestimated by the FSO road accident data.
- There may be important links with other prevention fields. In this regard it was of particular interest to identify the effects of prevention measures against alcohol misuse aimed *at the general population* and those of measures that are *exclusively targeted at drivers* in relation to the number of road accident victims and the severity of the accidents.

Road users were classified into 4 categories for this analysis (cars and lorries, motorcycles and mopeds, bicycles, pedestrians) and into 5 categories of injury severities (fatalities, permanently disabled, severely injured, moderately injured, slightly injured).

To our knowledge, this is the first CBA of road accident prevention measures in Switzerland which has taken into account such a broad spectrum of measures over such a long time period (1975 to 2007), has aggregated the effects of a bundle of measures and, at the same time, been able to show the effects of single measures as well.

3.1 Prevention programmes

Road accident prevention consists of expenditures aimed at a *safer environment*, such as investments in safer roads and safety devices for vehicles, and *safer behaviour* by road users. Investments aimed at behaviour change are characteristic of the

typical road safety programmes and include measures such as laws limiting traffic speed, the maximum blood alcohol level or imposing the use of safety-belts, as well as educational programmes and information campaigns. We distinguish between public and private prevention *expenditure* and public and private *prevention measures*. Public prevention measures are all those that are initiated by public authorities. Note that public prevention measures may in turn lead to private expenditure, e.g. with the introduction of compulsory helmet use by motorcycle riders who are then obliged to buy helmets. Private prevention measures are voluntary prevention efforts, e.g. the purchase of a car equipped with non compulsory safety devices.

Our estimation of the prevention costs is mainly based on the report by Basler + Partner (2001) produced for the Swiss Council for Accident Prevention (bfu) and the Swiss Federal Roads Office. The report estimates the total yearly expenses for road safety in Switzerland for the year 2000. We then extrapolated these costs to the years from 1975 to 2007 and adjusted them as and when we were able to obtain more detailed information on single prevention expenditures.

The following *public* prevention expenditure was considered in our study:

- Road safety programmes aimed at changing behaviour through education: The two main organisations financing road safety in Switzerland are the Fund for Road Safety (FRS) and the bfu. We were able to obtain detailed information on the expenditures of the FRS from 1978 to 2007 and use this information to model expenditures on road safety programmes over the whole period of 33 years. Total programme expenditures were estimated at 2.56 times the expenditures of the FRS as many other public and private organizations (e.g. cantons, traffic associations) finance road accident prevention measures. This estimation is in line with the value proposed by Basler + Partner (2001) for 1999.
- Introduction of new laws and regulation: Following Basler + Partner (2001) the cost of a new law or regulation was estimated at CHF 250,000 for the year 2000.
- Police forces engaged in road safety: The number of police officers engaged full time in road safety promotion was estimated at 10-15% of the regular police staff for 2007. Total police costs were calculated by multiplying the wage of full time police officers by 2 in order to include the full cost of equipment and infrastructure.
- Investments in road infrastructure: We assume that the share of road safety within the investments in road infrastructure is 7.5% for national roads and 15% for cantonal and communal roads in the year 2000. As expenses aimed at improving road safety have clearly increased, alongside growing public awareness of the need for road safety, since 1975, we assume that the share of expenses in 1975 was 50% below the level of 2007.

The following *private* prevention expenditure was also considered:

- Safety devices on cars and commercial vehicles: The number and quality of these devices have greatly increased since 1975 when most cars were barely equipped with simple safety-belts on the front seats. We estimated the cost of the safety devices at CHF 1,250 for a new car and CHF 10,053 for a commercial vehicle for

the year 2000. We further assumed that the cost in real terms of these devices was only a third in 1975 and that it has since increased in a linear way

- Safety devices for other vehicles, including motorcycle, moped and bicycle helmets.
- Compulsory vehicle safety inspections and compulsory medical check-ups for senior drivers.

Private expenses constituted the main share of prevention expenditures, representing 56.9% of total expenses in 2007. Private expenses were above all expenses for safety devices on new cars and commercial vehicles (40.2% of total expenses). Public expenses were dominated by investments in the safety of the road infrastructure, which represented 32.2% of total expenses in 2007. Police forces' efforts represented 8.3% of total expenses. The expenses of measures aimed at changes in behaviour and new laws and regulations were relatively modest, accounting for only 2.6% of total expenditures. Total expenses increased 55% in real terms from 1975 to 2007.

3.2 Effectiveness of road accident prevention

What effect did public road accident prevention measures have on the evolution of road traffic victims from 1975 to 2007? This is the *'Does it work?'* question on the effectiveness of the prevention. For this we developed a theoretical model representing the factors potentially influencing the evolution of the number of road accident casualties to determine the effectiveness of prevention by estimating how prevention measures and other variables influenced the number of casualties (see section 2.2).

The variables used to estimate effectiveness were the number of casualties per 100,000 residents in single cantons for 4 road user categories and 5 injury categories. The distinction between cantons is useful as there are important differences between them in terms of behaviour, prevention activity and geography. By merging all cantons with less than 100,000 residents together with closely integrated smaller and bigger cantons we could reduce the number of cantons from 26 to 18. This increased the probability that a person involved in an accident in a determinate geographical area was also a resident in that area. The distinction between cantons also permitted a more precise estimate of the effects of prevention measures because of the considerable number of 594 observations (18 cantons or groups of cantons over a period of 33 years) for each of the 20 categories of casualties. By explaining the number of victims per 100,000 residents, we also controlled for the 19.1% increase in the Swiss population between 1975 and 2007.

We estimated the effect of road safety programmes with a log-level model. For this, the explanatory variables were thus the logarithm of the number of victims (e.g. the number of severely injured car occupants) per 100,000 residents in a canton and a given year. This estimation approach, which is similar to the one used by Abelson et al. (2003), is useful because the coefficients of the explanatory variables multiplied by the change of these explanatory variables can be interpreted as percentage

changes of the explanatory variables. This takes account of the fact that it is easier to reduce the number of casualties when the number of casualties is high (e.g. the 579 fatalities of car occupants in 1975), but that it becomes increasingly challenging to reduce this number any further once great efforts to reduce this number have already been made (e.g. when, as in 2007, the number of fatalities of car occupants had been reduced to 191).

Explanatory variables

The explanatory variables used in the estimation model were those representing road safety prevention measures, safety behaviour and variables indicating confounding factors.

Variables representing prevention measures and behaviour included:

- A series of variables representing the *introduction of new traffic laws and regulations* and *public information campaigns* aimed at safer behaviour by road users. We distinguished between measures that should lead to a decrease of casualties in *all categories* of road users (e.g. law reducing speed limits) from those which should have led to a decrease of casualties in *only one category* of road users (e.g. the law on compulsory safety-belt use in the front seats of cars).

  We included a variable representing the bundle of new regulations introduced in 2005 which included the introduction of a maximum blood alcohol level of 0.5 for all vehicle drivers and the possibility for police to test drivers' blood alcohol levels without indication of prior consumption of alcohol. Existing sanctions were also reinforced, including the increased likelihood of driver's loss of licence.
- The variable *alcohol driver* represents excessive alcohol consumption by drivers. It is based on the information contained in police reports of road accidents on whether the reporting police officers suspect that excessive alcohol consumption was part of the factors leading to the accident.
- The *safety-belt wearing rate* is a particularly interesting variable. Although safety belts are a compulsory feature on new cars registered in Switzerland since 1971 usage remained quite limited until compulsory safety-belt wearing on front seats was first temporarily introduced from January 1976 to May 1977 and then permanently re-enacted in July 1981. This temporary introduction represents a natural experiment, as we can observe the immediate effect of this measure on the number of traffic victims and the severity of injuries. As a substantial number of drivers did not comply with the law, we looked at the actual safety-belt wearing rate obtained from the relevant surveys carried out by the bfu and the analysis of the FSO road accident data.
- *Motorcycle and moped-helmet wearing rates*. Compulsory helmet wearing for motorcyclists was introduced in 1981 and the actual helmet wearing rate reached 100% soon after the regulation was introduced. Compulsory helmet wearing for moped riders was introduced in 1990 but was still at only 85% in 2007.

- *Bicycle helmet wearing rate*. Although bicycle helmet wearing is not compulsory in Switzerland there have been substantial efforts to increase their use through information campaigns.

Variables representing confounding factors included:

- The *number of vehicles in circulation*.
- Differences in road infrastructure and in the degree of urbanization between the cantons, which may be responsible for the number of casualties per 100,000 residents.[8]
- The relative weighting applied to certain *age groups* in the total population.[9]
- The *general economic situation* may influence the frequency of road accidents as people are more likely to be on the road for work or leisure activities in an expanding economy than in a recession.

Results of effectiveness estimations

The results of estimations of the 20 models (4 road user categories × 5 severity categories) showed an important contribution of prevention measures to the reduction of road accident casualties in the period from 1975 to 2007.[10] In the following paragraphs we illustrate the results for the statistically significant factors influencing changes in the number of fatalities of *car and lorry occupants*, and then report the other results in lesser detail.[11] [12]

Fatalities of car and lorry occupants decreased by

– 1.7% with a year to year time trend,

---

[8] The variable *urban* represents the fraction of the residents of a canton living in municipalities with more than 29,000 residents. Residents in urban areas are more likely to have a different commuting behaviour than residents in rural areas, as they are more likely to use public transport in their daily mobility. Furthermore, the traffic speed is considerably lower in urban areas which should lead to less severe accidents. The *variable* mountain represents the fraction of unproductive surface of a canton on its total surface. Residents in rural areas are more likely to travel longer distances for their daily mobility and are thus more exposed to the risk of having an accident.

[9] The group aged between 18 and 24 years is for example highly affected by car and motorcycle accidents, while children and the elderly are especially vulnerable as pedestrians and bicyclists.

[10] Estimations of all the variables representing prevention efforts are highly statistically significant with p-values below 0.01. See full report for details of the estimation procedure and results (Wieser et al. 2009).

[11] In the estimation we took account of possible interdependencies between the severity of the casualty categories of a single road user category. A decrease of the disabled casualties among car occupants due to an increased use of safety-belts may for example result in an increase of the less severe injuries among car occupants, as the road accident in itself is not prevented, but the injuries are less severe. In order to take account of these interdependencies we estimated a seemingly unrelated regression (SUR) system for each of the 4 road user categories, thus obtaining a more precise estimation of the prevention effects than with an isolated OLS estimation of the 20 models.

[12] See full report for details on estimation results for all road user and severity of injury categories.

– 8.0% as the safety-belt wearing rate increases by 10.0%,

– 8.1% as the number of drivers with harmful alcohol use per 100,000 residents decreases by 100,

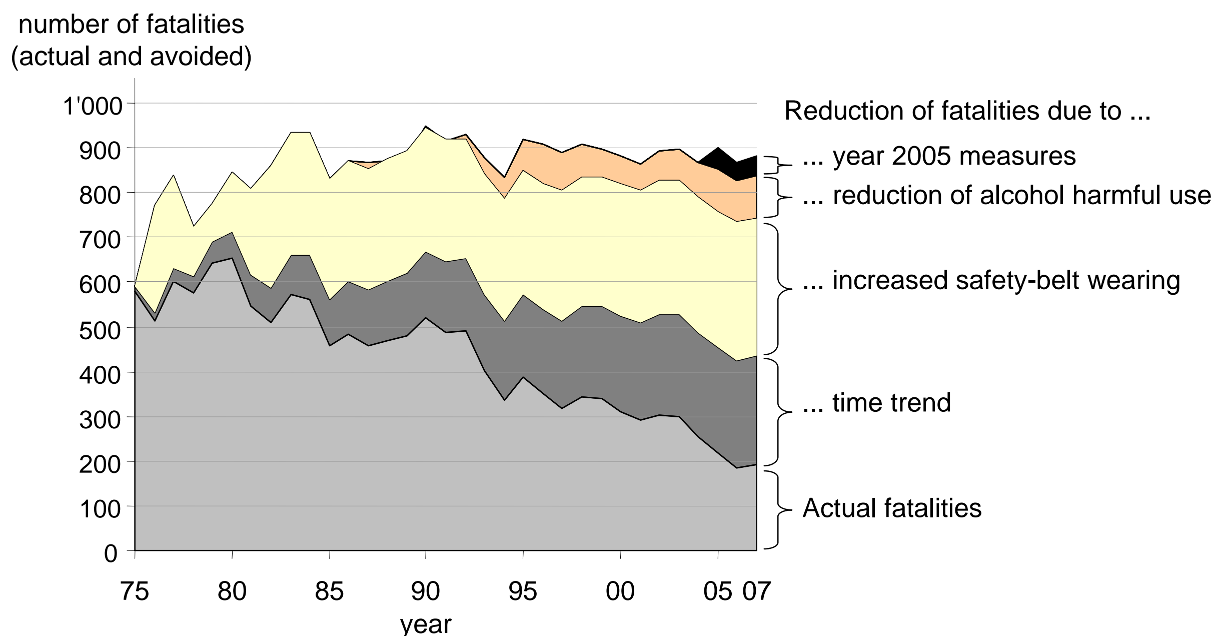
– 22.9% with the introduction of the 2005 prevention measures,

and are further explained by the increased number of cars and regional characteristics (lower in urban and higher in mountain areas).

Figure 3-1 shows the effect of prevention measures and the time trend on the total number of fatalities of car and lorry occupants in Switzerland. The actual number decreased from 579 fatalities in 1975 to 191 in 2007 (lower band in figure). The horizontal bands show the reduction of fatalities due to the prevention measures and the time trend. Note that the estimated number of fatalities would have increased to 880 fatalities in 2007 without prevention measures and time trend. This increase would have resulted from the growth of both the population and the number of cars in circulation, and the fact that there were particularly few accidents in 1975 because of a deep recession.

The effect of increased safety-belt wearing appears to be the most important effect, but the fall in the number of drivers under the influence of alcohol has also contrib-.

Figure 3-1 Effect of prevention measures and time trend on fatalities of car and lorry occupants



The actual number of fatalities of car and lorry occupants in Switzerland would have increased from 579 in 1975 to 880 in 2007 due to the increase in population (+19.1%) and number of vehicles in circulation (+155.0%). The horizontal bands show the reduction of the number of fatalities due to prevention measures and time trend. Note that part of the reduction of fatalities due to the time is also due to prevention measures.

Sources: FSO, own estimation

uted to a reduced number of fatalities. While the effect of the prevention measures introduced in 2005 appears to be comparably modest, it should be noted that it represents a considerable reduction of 23% with regard to the number of fatalities in the year 2005.

The time trend also plays a crucial role in the reduction of fatalities of car occupants. As we cannot estimate the weights of the single factors behind the time trend (continuous improvement of car and road safety, general societal trends, continuous increase of prevention efforts) we decomposed the trend effect in section 3.4. In the case of fatalities of car and lorry occupants we will for example assume that 50% of the fatalities prevented are due to improved road and vehicle safety, 45% due to a general societal trend towards a healthier and safer lifestyle and 5% due to a continuous increase of prevention efforts (see section 3.4 on the reasoning leading to these assumptions).

The results for the other models regarding car and lorry occupants confirm the effect of increased safety-belt use, the decrease of drivers with alcohol harmful use the introduction of the 2005 prevention measures. The number of severely and moderately injured also decreases with the time trend and the lowering of speed limits.

The estimations of the models regarding *motorcycle and moped riders* show a considerably lower effect of prevention measures. The number of casualties goes down as the number of drivers with harmful alcohol use decreases; time trend and the introduction of the 2005 prevention measures also contribute to the reduction of injured casualties. Surprisingly we detected only a fairly small effect of the laws introducing compulsory motorcycle and moped helmet use.[13] [14]

The only prevention variable with an impact on the number of casualties amongst *cyclists* is the rate of bicycle helmet use (permanently disabled, severely and moderately injured). A time trend explains part of the reduction of fatalities among cyclists and most probably also includes the bicycle helmet effect.

The decline in the number of casualties among *pedestrians* is mainly explained by the time trend (all casualties), but the decrease of drivers with harmful alcohol use and the introduction of lower speed limits have also contributed to a reduction of casualties (permanently disabled, severely and moderately injured).[15]

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[13] We discussed this point with bfu road accident experts and they provided two possible explanations: *First*, unlike seat belt use, motorcycle helmet use was already high before the introduction of the law. *Second*, helmets cannot always protect against head injuries. Due to excessive speed and helmet misuse, even today 8 of the 10 motorcycle fatalities are a result of head injuries.

[14] The evolution of the number of casualties of motorcycle and moped riders is also strongly influenced by the number of vehicles per capita in circulation: Between 1975 and 2007 it decreased from 10.4% to 2.3% for mopeds and it increased from 1.4% to 8.2% for motorcycles (FSO, Superweb – statistical database).

[15] The number of casualties is also explained the decrease of the share of the younger generation in the population and the urbanity of the canton.

3.3 Societal cost of road accidents

The benefits of road accident prevention can be measured by comparing them with the costs of the additional road accidents that would have occurred in absence of road accident preventions. These costs were then multiplied by the number of accidents avoided thanks to prevention measures in order to obtain the benefit-part of our cost-benefit-analysis. We distinguished three categories of societal costs avoided: direct costs, production losses and intangible costs (see section 2).

Severity of injury is the main cost driver, as medical costs, production losses and intangible costs all increased with the severity of the injury. The means that transport has an influence on the severity of the injury because, for example, pedestrians are much more vulnerable than car occupants. The age affects not only the exposure, and thus the risk of having an accident, but also the work days lost due to premature death or permanent disability: The younger the victim, the higher the production loss. By weighting by gender and age and using average values where no information is available, we calculate the cost per injury and road user category.

The main source of our cost calculations is the accident insurer dataset, containing information on medical costs, days of work lost due to road accident injuries, average degree of disability and type of injuries.

a) Direct costs

Direct costs of road accidents consist of medical costs, costs of police and consequential legal costs, administrative costs of the insurances.

Medical costs were based on those paid by the accident insurer, and adjusted to take into account public subsidies to hospitals and private hospitalisation insurance, which cover a sizeable proportion of the resident population.

Cost of police and consequential legal costs include the costs of labour, material and vehicles used by police officers while dealing with an accident (e.g. traffic management, reporting, interrogating witnesses). Costs to the judicial system include costs (labour, material) of lawyers and courts for the legal proceedings of the accident. Following Sommer et al. (2007) these costs are valued at CHF 7,469 per accident reported to the police in the year 2003.

Insurers' administrative costs were valued according to the relevant figures published in the annual reports of the Federal Social Insurance Office.

We did not consider material damages among the direct costs because in the first place the prevention of human suffering is the focus of public prevention measures and in the second, we always took a conservative approach when measuring the benefits of prevention. Nonetheless, we included an estimate of material damages in one of the sensitivity analysis (see full road accident report Wieser et. al (2009).

b) Production losses

Production losses of road accidents occur when a person injured in a road accident is absent from work. We make a distinction between temporary and permanent absences. Temporary absence from work is defined as the period that lasts from the day of the accident to the day the person can return to work. The SAI dataset provides information on the number of days of daily allowances paid, which corresponds to the number of days of absence from work. The value of the production loss is the total labour costs corresponding to the gross wage, including the social insurance premiums paid by the employer.

Production losses due to premature death and permanent disability correspond to the potential production lost from the moment of death or onset of permanent disability, to the moment in which the person would have retired. The calculation considers the average age of the victim when the accident happened in order to reflect the number of years the victim could have been active in his/her profession.

Reoccupation costs occur when a worker cannot return to his/her job because of permanent disability or premature death. The costs the company incurs to replace the worker include search and selection costs (job announcement, finding the able person) and on-the-job training. We refer to the study by Sommer et al. (2007) for the valuation of these costs.

c) Intangible costs

Intangible costs of a road accident are the suffering, pain, grief and loss of happiness caused by the accident, which can be summarized as a loss of quantity and quality of life years. As discussed in section 2 we used the DALY approach to calculate these costs. The information needed to calculate DALYs includes:

- Detailed information on the part of the body affected and the type of injury (e.g. fracture, dislocation). We were able to obtain a special dataset from the SAI containing this information for road accident victims in Switzerland.
- Life expectancy at the moment of a mortal accident.
- Disability weights (from 0 equivalent to perfect health to 1 equivalent to death) and estimated duration of disability conditions. Tables containing these values have been estimated by experts for the Global Burden of Disease study organized by the WHO (Murray and Lopez 1996).

The DALYs calculated based on this information most probably underestimate the DALYs due to road accidents because of the limitations of the WHO disability weight tables, and because our SAI data set does not take into account a victim's multiple injuries, but only of the injury generating the highest cost. Intangible costs are calculated by multiplying the DALYs with the monetary value applied to a DALY of CHF

50,400 at prices in the year 2007 and deflated for earlier years according to the consumer price index.[16]

d) Total costs

Table 3-1 gives an overview of the total societal costs per avoided casualty in the year 2007. The average total cost increases with a factor of 4 from the slightly injured to the moderately, and then to the severely injured. Total costs of a casualty increase with a factor of 10 from the severely injured to a casualty with a disability pension and

Table 3-1 Average total societal costs in CHF per casualty in the year 2007

		type of casualty				
		Slightly injured	*moderately injured*	*severely injured*	*disability pension*	*Fatality*
type of road user	motorcycles and mopeds	6,430	28,074	84,960	977,507	2,631,597
	cars and lorries	8,860	25,011	111,774	991,010	2,075,388
	bicycles	4,017	22,989	62,490	793,103	1,093,556
	pedestrians	8,822	30,621	84,659	847,359	1,465,921
	average over participants	*7,032*	*26,674*	*85,971*	*902,245*	*1,816,616*
index of average (slightly injured =1)		*1.0*	*3.8*	*12.2*	*128.3*	*258.3*

Sources: SAI and variety of other sources; own estimations

Table 3-2 DALYs and intangible costs saved due to prevention among car and lorry occupants in the year 2007

	type of casualty				
	slightly injured	*moderately injured*	*Severely injured*	*disability pension*	*Fatality*
average DALY per car and lorry occupant casualties	0.0078	0.0175	0.0161	6.1621	23.1525
number of prevented casualties	38,615	4,314	5,011	823	689
number DALYs gained thanks to prevention	301	76	81	5,074	15,956
intangible costs saved due to prevention (million CHF)	15.2	3.8	4.1	255.7	804.2

Intangible costs are calculated by multiplying the number of DALYs gained thank to prevention by a VOSL of 50,400 CHF.

Sources: SAI; own estimations

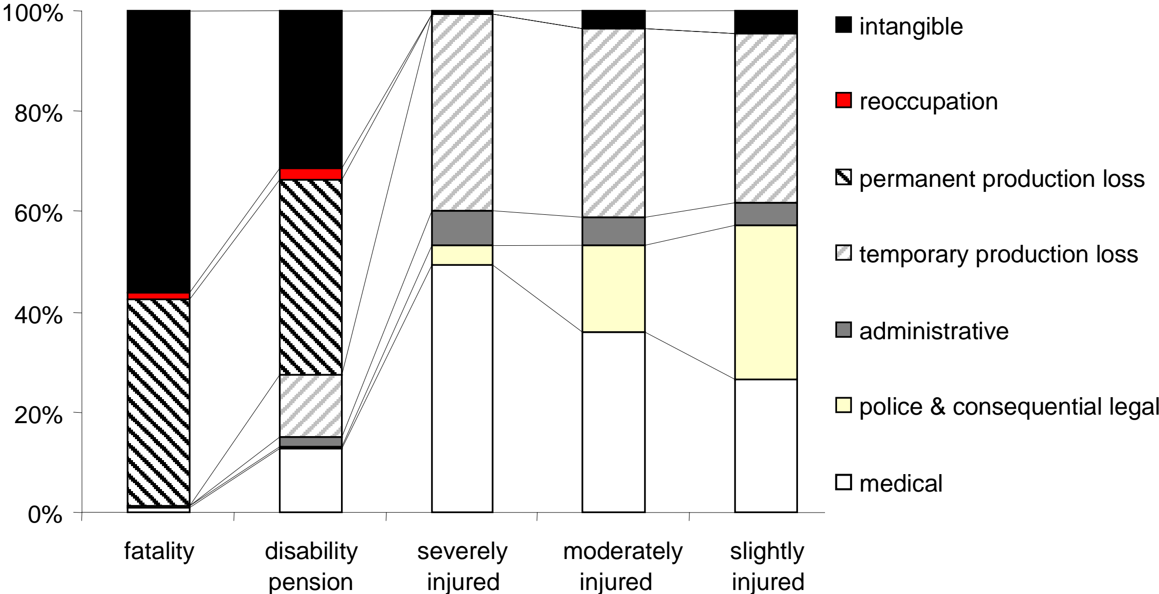
[16] As mentioned in section 2.3, throughout this research we applied the monetary value of CHF 50,400 for a DALY which is based on estimations from a Swiss study (Jeanrenaud et al. 2006).

then with a factor of 2 to a fatality. The strong increase from the severely injured to the permanently disabled is explained by the much higher production losses and intangible costs. The different average age of the victims is the main reason for the variation between the road user categories.

Table 3-2 shows the DALYs and intangible costs saved due to prevention among car and lorry occupants in the year 2007. Note the low DALY values calculated for the slightly, moderately and particularly for the severely injured. A DALY of 0.0161 means that the injuries caused by an accident resulting in a hospital stay of more than 7 days lead to an average loss of only 1.6% of a life year or 6 days in full health. This value appears too low and is due to the inadequate representation of accident injuries in the DALY tables.

Figure 3-2 shows the share of the different cost categories on total costs for cars and lorries in the year 2007. Medical costs, temporary production loss and, to some extent, police and the consequential legal costs are the main costs of vehicle occupants in the less severe injuries categories. The main costs of vehicle occupants in the severe injuries categories are permanent production loss and intangible costs. With only 0.7% of total costs, intangible costs appear to be implausibly low in the case of the severely injured. This is most probably because the DALYs proposed by the existing studies do not adequately capture these costs for severely injured casualties of road accidents.

Figure 3-2 Share of cost categories in total societal costs by severity of casualty (cars and lorries, year 2007)



The figure shows the shares of the single cost categories as a graphical decomposition of the absolute values would be indistinguishable due to the huge differences between the absolute cost levels of the single types of casualties (see 3.1). The costs of fatalities and casualties leading to disability pensions are dominated by intangible costs and production losses.

Sources: SAI and variety of other sources, own estimations

3.4 Return on investment of road accident prevention

We are now ready to answer the question of whether the money spent in road accident prevention measures in the period between 1975 and 2007 was worth it, by comparing the costs of prevention efforts with the benefits of prevention efforts to society as a whole, expressed in monetary terms.

The analysis in section 3.2 has shown the effectiveness of a number of prevention measures in reducing the number of road accident casualties. While the effect of prevention measures expressed in such terms represents a direct input for our CBA, the effect of reduced harmful alcohol use and the time trend are not as clear cut as they may be due to general social trends that are independent from prevention measures. We therefore need to define how much of the reduction due to the effects of the variables *alcohol driver* and *time trend* can be ascribed to prevention measures.

For the effects of prevention measures on reduced alcohol consumption by road users, we apply the results of the CBA harmful alcohol use project conducted by Füglister-Dousse et al. (2009) as part of this overall research (see section 5 of this report for the synthesis). In their analysis for the period from 1997 to 2007, the research team estimates that the collective prevention efforts of the different actors involved were responsible for half of the reduction in harmful alcohol use (47.3%, see section 5.2.)

In order to identify the effects of prevention measures on the time trend, we had to assess the importance of the many possible effects influencing the time trend. These included the effects of prevention programmes not captured by the other variables, as well as those of road safety improvements, car safety improvements after the deduction of the safety-belt effect, improved emergency services and changes in behaviour and lifestyle. The effects of improved vehicle and road safety are likely to be much higher for occupants of cars and lorries and much lower for motorcycle riders and pedestrians (no effect on bicycles as no time trend was identified). We weighted these effects according to previous studies on road accident prevention and distinguished the size of these effects among categories of road users:

- *Car and lorry occupants*: 50% of the time trend effect is attributed to improvements in vehicle and road infrastructure safety, 5% to prevention measures (education, information campaigns etc.) and 45% to independent social, economic and technical changes.
- *Motorcyclists, cyclists and pedestrians*: 34% of the time trend effect is attributed to improvements in road safety, 34% to prevention measures (effect of increased helmet wearing not captured by statistical analysis, education, information campaigns, outfits increasing visibility for other road users etc.) and 32% to independent social, economic and technical changes.

The effects of prevention measures are quantified in terms of the changes in the number of casualties due to the newly introduced prevention measures over the study period. On the cost side we therefore consider the changes in the level of prevention expenditure compared to that of 1975. An example may be helpful to illus-

trate this procedure: regarding the cost of car safety devices, we only account for the changes with regard to the level of real expenditures in 1975, when newly registered cars were already equipped with safety-belts and few other safety devices. The changes in real expenditures for safety devices thus represent the costs of additional safety devices.

Benefits are calculated by multiplying the effect of the prevention measure (e.g. number of fatalities prevented by the use of safety-belts in the year 2000) with the corresponding societal cost. The resulting costs saved are then aggregated over all prevention measures. Costs and benefits are first calculated at prices of the current years and then discounted to the value of the year 2007 with a discount rate of 2%.

Before looking at the results of the single CBAs it may be useful to explain our terminology of the different types of prevention measures:

- *Private prevention measures* consist of all voluntary private expenditures for improved vehicle safety and safety devices.
- *Public prevention measures* consist of 1) public expenditures for safety of road infrastructure and 2) *public prevention programmes*, which include all other public road accident prevention measures (new laws and regulation, education, information, etc.).

CBA of public and private prevention measures

The total cost of public and private prevention measures from 1975 to 2007 was CHF 28,654 million. The total benefit of these measures was CHF 72,816 million. The return on every CHF invested in prevention is therefore estimated at *CHF 1.54*. This is largely attributable to the increase in the level of safety-belt use, to the time trend representing improvements of vehicle and road safety (90% of adjusted time trend effect) and to prevention programmes (10% of adjusted time trend effect).[17]

CBA of public prevention programmes

A second CBA focused on prevention programmes trying to force or convince road users to adopt safer behaviour. For this, we excluded public expenses for the improvement of road infrastructure and the voluntarily private expenditures for increased vehicle safety. Quantifying the benefits of these mainly publicly financed prevention programmes was, however, challenging; some of the prevention measures were aimed at an increased use of safety devices (e.g. bicycle helmets) and thus implied an increase of private expenditure. Including these private expenditure therefore, we estimated a ROI of *CHF 9.43* for each CHF invested in this type of prevention programme.

The cost side includes police costs as many of the regulations imposing a safer behaviour on road users are only effective if they are enforced by the police. We did not

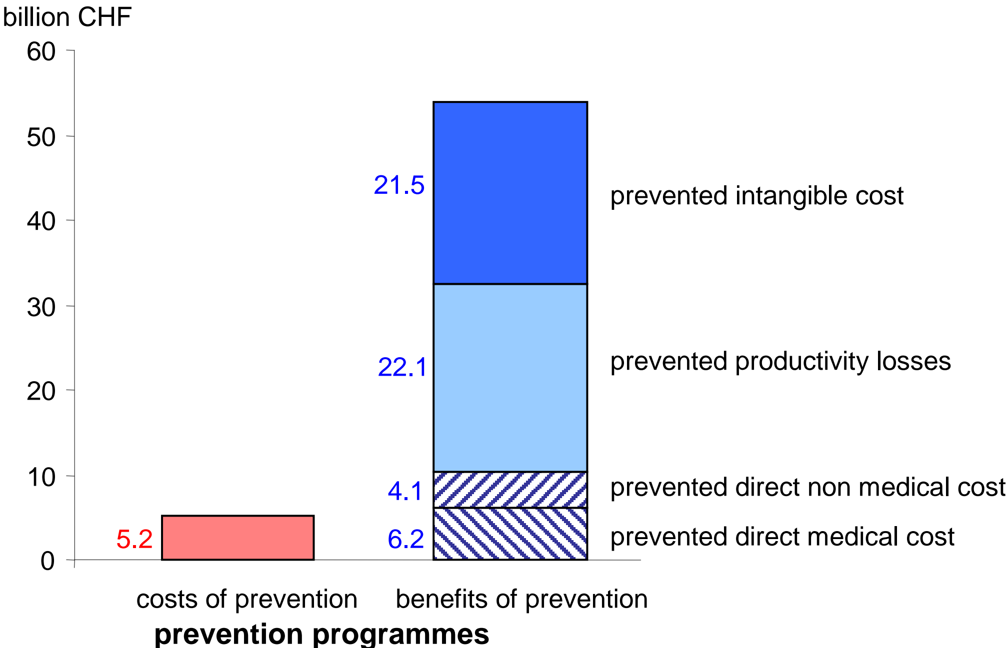
[17] The number of prevented casualties amounts to 13,484 fatalities, 16,418 permanently disabled, 97,035 severely injured, 80,060 moderately injured and 710,214 slightly injured.

include the cost of safety belts because they were already a standard safety device in 1975. On the benefit side, the effect of increased safety-belt use (72.6% of total benefit) is the dominant factor. The effect of the time trend is considerably lower than in the CBA of public and private prevention measures because we considered only the effect of road safety programmes (5% of time trend effect for car occupants and 34% for motorcyclists and pedestrians).[18]

The results of this section are described in more detail than the other CBAs of road accidents prevention measures, as we will compare it with the results of the tobacco and alcohol harmful use CBAs in the concluding section 6.

A decomposition of total benefits of the public prevention measures from 1975 to 2007 into the single categories of prevented costs is shown in figure 3-3. Note that total costs of prevention (CHF 5.2 billion) are lower than the direct medical costs prevented (CHF 6.2 billion). As the costs of prevention include CHF 1.2 billion of private expenses for safety helmets (motorcycles, mopeds and bicycles) clearly appears to be cost-saving from a public payer's perspective.

Figure 3-3 Decomposition of benefits according to CBA of public road accident



CBA of alcohol prevention measures from 1986 to 2007

The effect of alcohol prevention efforts on road accident casualties is included in the effects of the variables *alcohol driver* and *measures 2005*. We applied the value calculated by the IRENE team (see section 5.2) to quantify the effect of behavioural prevention measures on the reduction of road accident casualties due to harmful alcohol use (47.3%). We also assumed that half of the *measures 2005 effect* was

[18] The number of prevented casualties amounts to 10,229 fatalities, 16,059 permanently disabled, 59,112 severely injured, 64,398 moderately injured and 710,180 slightly injured.

due to the lowering of the blood alcohol level to 0.5 per mil and the possibility for the police to test for blood alcohol level without signs that the driver may be intoxicated.

On the cost side we computed all expenditures financed by the FRS for education and information measures aimed at a reduction of harmful alcohol use by road users. These programmes were first financed by the FRS in 1986 and thus our CBA on alcohol prevention measures covers the period from 1986 to 2007. We multiplied FRS expenditures by 2.56 in order to include additional expenses carried out by the traffic associations, the cantons and other public organizations (see section 3.1). We further assumed that 30% of police efforts for road safety are aimed at the containment of excessive alcohol consumption by road users.

The return on every franc invested in the prevention of excessive alcohol use by road users is estimated at *CHF 5.81.*[19]

The difference between this ROI of 5.81 of alcohol prevention measures in the context of the road accident prevention CBA and the ROI of 22.9 calculated by IRENE in the alcohol harmful use prevention CBA (see section 5.5) is due to the fact, that our analysis is limited to the alcohol prevention measures aimed at road users, and to important differences in the data availability discussed in section 2.4: *First*, our ROI refers to costs and benefits over the whole period from 1986 to 2007 while the ROI calculated by IRENE refers to the year 2007. As prevention was significantly less effective in the period from 1987 to 1991 this is one reason for our lower ROI. *Second*, we assume that 33% of traffic police costs are owed to the prevention of drunk driving, while the IRENE study does not consider these costs. This share of 33% is most probably too high as part of our conservative assumptions. If we assume a share of 6.5% of drunk driving prevention in total traffic police costs, which might still be plausible, we obtain the same ROI as the IRENE for 2007.

CBA of bicycle helmet promotion

The efforts to improve the rate of cyclists wearing a helmet can be evaluated with a relatively straightforward CBA; costs included only those related to the prevention campaigns themselves and the cost of the bicycle helmets purchased by the cyclists. The level of reduced casualties estimated by the variable *bicycle helmet* and the relative societal costs prevented were used to calculate the benefits.

The return on each franc invested in prevention is estimated at *CHF 16.31*. It should be noted that private expenditure for bicycle helmets represents 88% of prevention costs.[20]

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[19] The number of prevented casualties amounts to 717 fatalities, 2,097 permanently disabled, 2,485 severely injured, 4,750 moderately injured and 16,619 slightly injured.

[20] The number of prevented casualties among cyclists amounts to 1,099 permanently disabled, 6,231 severely injured and 10,439 moderately injured. Note that it is probable that also a number of fatalities were prevented by increased helmet wearing, but that this effect is contained in the time trend.

CBA of year 2005 road safety measures from 2005 to 2007

Evaluating the effects of the road safety measures introduced in 2005 is also relatively simple in our framework. The measures comprised the introduction of a lower maximum blood alcohol level, the possibility for the police to test for blood alcohol level with no prior indication that the driver may be intoxicated, a tightening of sanctions for infractions of traffic laws and several other measures. We assume that the cost for the introduction of these measures was four times the usually assumed cost of the introduction of new laws and regulation (several new regulations were introduced) and that 50% of the increased real cost of road safety efforts by the police in the years from 2005 to 2007 was due to the enforcement of the new regulation. The return on each franc invested in year 2005 measures is estimated at *CHF 8.06*.[21]

CBA of safety-belt wearing

The increased use of safety-belts is the single most important factor for the reduction of road accident casualties in the period from 1975 to 2007. We assume that 20% of police efforts for road safety (1976, 1977, and from 1981 to 2007) are aimed at the enforcement of safety belt use. As these costs represent 98% of total costs the other costs are negligible in comparison. Note that we do not include the cost of safety-belts in our calculations as they are compulsory for newly registered cars since 1971. The benefits are calculated with the estimated effect of the variable *safety-belt*.

Investments in safety-belt measures yield a return of *CHF 101.03* for each franc invested in these measures. The introduction of compulsory safety-belt use and its legal enforcement is thereby the measure yielding the highest return on all the measures considered in our study.[22]

Comparison of CBAs of road accident prevention measures

A comparison of the single CBAs of road accident prevention measures may be useful for a better understanding of the magnitude of the effects of specific measures. Table 3-3 reports the main results of these CBAs and shows their hierarchical structure, i.e. how some CBAs are contained in other CBAs. The CBA of public and private prevention measures (row 1: ROI of 1.54) includes all road accident prevention measures taken and thus includes the measures analysed in the CBA of prevention programmes (row 1a: ROI of 9.43). The difference between these two packages of prevention measures consists of the public investments for road safety and the voluntary private expenditures for safety devices on vehicles. The ROI of these measures is negative with CHF –0.20 for every franc (row 1b). Note that the ROI of

[21] The number of prevented casualties amounts to 169 fatalities, 581 permanently disabled, 478 severely injured, 1,001 moderately injured and 33,136 slightly injured.

[22] The number of prevented casualties amounts to 8,327 fatalities, 9,'554 permanently disabled, 37,545 severely injured, 42,996 moderately injured and 676,959 slightly injured.

measures would be positive under slightly less conservative assumptions, as in the case of using the VOSL of CHF 91,000 applied in the evaluation of public infrastructure investments in Switzerland (see Sommer et al. (2007) or if material damages were to be included.

The impressive effect of the increased use of safety-belts is demonstrated in the CBA figures and in the resulting ROI of 101.03 (row 1ad). Calculating the average ROI of other prevention programmes we obtain a considerably lower ROI of CHF 1.01 per franc spent (row 1ae). Note that in the case of prevention programmes alcohol prevention, bicycle helmet and 2005 measures, for which we were able to isolate the effect on road accident fatalities, show a substantially higher ROI.

Table 3-3 Comparison of CBAs of road accident prevention measures

row		costs (CHF million)	avoided costs (benefit) (CHF million)	ROI (benefits– costs) / costs	number of fatalities prevented (benefits)
1	CBA of public and private prevention measures [a]	28,654	72,816	1.54	13,484
1a	CBA of public prevention programmes [b]	5,168	53,924	9.43	10,229
1b (=1–1a)	CBA of public road infrastructure and private prevention measures	23,486	18,892	-0.20	3,255
1aa	CBA of alcohol prevention measures	616	4,195	5.81	717
1ab	CBA of bicycle helmet promotion	86	1,489	16.31	-
1ac	CBA of year 2005 road safety measures	127	1,147	8.06	169
1ad	CBA of safety-belt wearing	384	39,160	101.03	8,327
1ae (=1a–1aa to 1ad)	CBA other prevention programmes	3,955	7,933	1.01	1,016

The table shows the hierarchal structure of the CBAs presented. Row 1 is decomposed into rows 1a and 1b and row 1a is decomposed into rows 1aa to 1ae. The costs, avoided costs and number of fatalities prevented in rows 1b and 1ae are calculated as differences.

[a] Public and private prevention measures include all expenditure for road accident prevention including investments in road infrastructure and the voluntarily private expenditures.

[b] Public prevention programmes include all public expenditures for road accident prevention excluding investments in road infrastructure.

3.5 Sensitivity analysis

A sensitivity analysis illustrates how the results of a study change if the main assumptions and key parameters employed in the study are modified. A sensitivity analysis thus gives an idea of the robustness of the results.

We focused our sensitivity analysis on the estimation of the effectiveness of road accident prevention measures (see section 3.2). The estimated coefficients of single explanatory variables representing successful prevention measures (e.g. safety-belt wearing rate, introduction of lower speed limits) and the time trend were varied by adding or subtracting the estimated standard error of the coefficient, a measure of the variability of the coefficient. These adjusted coefficients were then entered into the CBA procedure in order to calculate the upper and the lower bound of the ROIs and the number of fatalities prevented as a result of the prevention measures. The interval between the lower and the upper bound corresponds to a 68% probability range centred on the reference estimate.

The results of the sensitivity analysis (table 3-4) show an upper and lower bound of the ROI of, on average, 20% above or below the reference estimate. The highest variation appears in the CBA of the year 2005 road safety measures. In a sensitivity analysis with a 95% probability range the ROI is, on average, 40% above or below the reference estimate. The results are in the same order of magnitude as our reference estimate and thus support the robustness of our results.

Table 3-4 Sensitivity analysis of ROI and number of fatalities prevented

	ROI (benefit-cost)/cost			number of fatalities prevented (benefits)		
	lower bound	reference estimate	upper bound	lower bound	reference estimate	upper bound
CBA of public and private prevention measures [a]	1.05	1.54	2.03	10,564	13,484	16,404
CBA of public prevention programmes [b]	7.59	9.43	11.28	8,281	10,229	12,177
CBA of alcohol prevention measures from 1986 to 2007	4.96	5.81	6.67	612	717	821
CBA of bicycle helmet promotion	13.40	16.31	19.22	-	-	-
CBA of year 2005 road safety measures	5.55	8.06	10.56	107	169	230
CBA of safety-belt wearing	84.11	101.03	117.96	6,840	8,327	9,815

Lower und upper bounds were calculated by varying the estimated coefficients of the single explanatory variables (prevention measures, road safety behaviour, time trend) by one standard error (a measure of the variability of the coefficient) within the estimated confidence interval. This variation corresponds to a 68% probability range.

[a] *Public and private prevention measures include all expenditure for road accident prevention* including *investments in road infrastructure and the voluntarily private expenditures.*

[b] *Public prevention programmes include all public expenditures for road accident prevention* excluding *investments in road infrastructure.*

3.6 Strength and limitations

The main strength of this CBA on road accident prevention is that for the first time the multitude of data sources tracking road accidents and road accident prevention were

combined to study the effectiveness and economic return of prevention measures in Switzerland from 1975 to 2007. The actual and prevented number of road accident casualties in 4 road user and 5 severity categories were calculated for this period of 33 years. A detailed calculation of the costs and benefits of prevention (direct costs, production losses and intangible costs of casualties prevented) enabled the calculation of the ROI in relation to a whole bundle of measures as well as some single interventions.

The ROIs and the sensitivity analysis show that investments in road accident prevention interventions yield positive returns. These results can be considered as a conservative estimate because we systematically estimated the factors influencing possible benefits conservatively and the factors influencing costs generously. The estimation of intangible costs is an example as the calculated DALYs represent a very low lower bound of actual intangible costs. In addition, the value of a statistical life year of CHF 50,400 is rather low in the case of road accidents.[23] Moreover, material damage was not included in the reference estimate of this study, although it may seem indisputable that prevention has also saved some costs in this cost category and would therefore yield an even higher ROI.

The main limitations of the study are that although we dispose of relatively comprehensive data on road accidents, the data on road accident prevention are relatively scarce, which forced us to make a number of assumptions e.g. on the share of safety expenditures in road infrastructure investments and their evolution in time, or on the share of resources employed by the road police in the enforcement of alcohol controls. To make sure that these assumptions would not lead to an overestimation of the benefits of prevention, we made generous assumptions regarding the costs of prevention and conservative assumption regarding the benefits.

A second limitation is that the DALY approach we chose to translate the suffering and injuries caused by road accidents into the number of years of life in full health lost does most probably not capture the full loss of quality of life, particularly for the severely injured. In combination with a relatively conservative VOSL of CHF 50,400 , this leads to an underestimation of the intangible costs.

A third limitation is that we were not able to identify the full effect of many measures, e.g. the increased helmet wearing by motorcycle, moped and bicycle riders, although these effects may be captured by the trend effects.

3.7 Conclusions

The main results of this CBA study are the ROIs for a basket of prevention measures as well as for some single measures: The ROI for all public and private prevention interventions carried out between 1975 and 2007 amounts to CHF 1.54 for every franc invested in prevention. Considering only public prevention programmes (excluding investments in the safety of road infrastructure) the ROI rises to 9.43. The

[23] The value is usually higher (e.g. Sommer et al. (2007) use a value of CHF 91,000 for the year 2003 in line with a European guideline for transport costing and project assessment (Bickel et al. 2006)).

ROI of alcohol prevention measures is estimated at 5.81, for promoting bicycle helmet wearing, at 16.31, and for the combined measures introduced in 2005, at 8.06. The ROI for measures aimed at the imposition and promotion of safety-belt use shows an exceptionally high ROI of 101.03. The effect of all interventions between 1975 and 2007 was substantial, with 13,484 fatalities, 909,213 casualties prevented and a total of CHF 72,816,000 saved, thanks to prevention.

Measures aimed at changes in safety behaviour thus appear to have a high return, while investments in road infrastructure and safety devices, which by far represent the biggest part of safety expenditures, have considerably lower returns. Furthermore, relatively recent interventions, such as the bundle of measures introduced in 2005, have a relatively high economic return.

A main limitation in the economic evaluation of road accident prevention measures is due to the scarce availability of data on the quantity of resources spent on prevention and how they are spent. A systematic collection of this kind of information should thus be encouraged in order to allow the coordination of data and evaluation of future road accident prevention measures.

Overall the analysis shows the importance of public prevention programmes in the substantial reduction of road casualties in the period between 1975 and 2007. The case of road accident prevention in Switzerland thus appears to be an example of a highly successful prevention strategy.

4 CBA of tobacco prevention programmes[24]

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From 1997 to 2007, the prevalence of tobacco consumption fell from 33.2% to 27.9%, i.e. a 5.3 percentage point reduction, corresponding to 343,000 fewer smokers. One of the objectives for this research was to estimate which part of the decline in smoking prevalence is attributable to prevention and which part to price increase, as well as all other economic and social factors.

The aim of our study was to evaluate the potential net benefits arising from investment in smoking prevention programmes, namely to compare the costs of the programmes and the societal benefits they generate. We focused on the measures adopted between 1997 and 2007[25] and the data from these two years' national health surveys.

The first step in this type of research consists of evaluating the share of the prevalence decline which is attributable to prevention. The second step requires an evaluation of its effects on morbidity and mortality. Lastly, the change in health state of the population is expressed in monetary terms in order to assess its societal benefit (or the avoided cost) and to calculate the return on investment in prevention.

4.1 Prevention programmes

Various parties are engaged in preventing tobacco consumption in Switzerland at the national as well as at the local level. Prevention focuses on behavioural and structural interventions, since it comprises interventions such as education and information aimed at changing behaviour as well as the regulatory environment (excise duties, labelling, advertising restrictions, non-smokers protection). We evaluated both types of preventative interventions, at both national and local levels. Prevention expenditure rose substantially during the last ten years from about CHF 0.70 to CHF 2.70 per capita (see the complete report for details, Füglister-Dousse et al. (2009)). The creation of the Tobacco Control Fund was the key factor explaining the rapid increase of the funds available for prevention programmes[26]. In order to inventory all these interventions, we conducted a survey in the cantons. At the cantonal level, most interventions were started in the early years after 2000. The main structural interventions, – protection against passive smoking, restricted advertising, and restricting young people's access to the product – were adopted towards the end of the period and some were only enacted after 2007. For this reason, regulatory interventions probably had no, or limited, effects on smoking

[24] Study commissioned by Tobacco Control Fund Decision Nr. 08.000515.

[25] During the second half of the 1990s prevention programmes were launched at a national level under the aegis of the Federal Office of Public Health in the fields of both alcohol and tobacco.

[26] The fund receives 2.6 centimes for every pack of cigarettes sold, which amounts to about 18 million Swiss francs available for tobacco control.

prevalence within the period under consideration. The effectiveness of each information campaign was evaluated separately (see Ensmann et al. 2002; Honegger and Rudolf 2004; Boggio and Zellweger 2007; Rudolf et al. 2009) by means of the following indicators: recall rate, interest, awareness, social acceptance, intention to change and behaviour. The evaluations concluded that the population has a high level of smoking-related risk perception and a high acceptance of prevention programmes. These studies do not permit us to estimate the number of smokers avoided by prevention; the evaluations do, however, suggest a clear change in awareness and in the intention to change behaviour. A selected list of prevention interventions is presented in Table 4-1.

Table 4-1 Selected list of behavioural and structural prevention interventions

Behavioural interventions	Description	Year(s)
New enjoyment – without tobacco	Nation-wide campaign	1992-2000
Smoking hurts	Nation-wide campaign	2001-2003
Smoking hurts – more air!	Nation-wide campaign	2004-2005
BRAVO, life, not smoke	Nation-wide campaign	2006-2007
Life, not smoke	Nation-wide campaign	2008
Life, not smoke – makes sense, doesn't it	Nation-wide campaign	2009
Stop smoking site	Help to stop smoking	As of 1997
Smoke-free work place	Help geared to businesses	2006-2009
Non-smoking experience	Help geared to school-children	2000-2010
Cool and clean	National prevention programme in sport	2004-2009
Structural interventions	**Source**	**Enactment on:**
Warning on cigarette packs; obligation to declare the tar and nicotine content; prohibition of advertising aimed at under 18 year olds	Ordinance on tobacco (OTab) of 1st March 1995	01.07.1995
Fixing maximum nicotine, tar and carbon monoxide contents with mandatory declaration on the packet; warning printed in large and explicit letters on the packet; prohibition to use the terms « light » or « mild »;	Ordinance on tobacco (OTab) of 27th October 2004 (complete revision of OTab 1995)	01.11.2004
Prohibition to smoke in trains and enclosed public areas and in open public areas, and in general in underground railway stations and shopping malls.	Measures adopted by the Swiss Federal Railways and enterprises affiliated to the Public Transport Union (UTP)	11.12.2005
Additional warnings: colour photographs, visual warnings (« stop smoking »)	Ordinance of the FDI (Federal Department of the Interior)on the combined warnings on tobacco products of 10th December 2007	01.01.2008

4.2 Effectiveness of tobacco prevention

Various factors can explain the reduction in smoking prevalence: the price of cigarettes, the tobacco industry's advertising and promotion expenditure, prevention interventions and a whole slew of other, less visible factors. We use econometric modelling to separate out the effect of tobacco prevention programmes. The effect on prevalence arising from the change in age structure was neutralised. Adjustment for the effect of migration, though envisaged initially[27], was eventually not deemed necessary.

We established a first model based on the individual data of the 2007 Swiss Health Survey[28], drawing from the studies by Douglas et al. (1994) and López Nicolás (2002). By using the survival analysis framework, it was possible to estimate the impact of price, of prevention and of socio-demographic variables on the probability of smoking initiation and cessation in the course of a year. It is precisely because the prevention efforts vary from canton to canton that it was also possible to highlight the effect of this variable on the risks to start or quit smoking.

The models show that in the cantons with the largest prevention efforts – expressed in per capita expenditure – the probability to quit smoking is higher. For every additional franc spent per capita, this probability increases by 17.3% (coefficient significant at 1%). This increase in the probability of quitting is higher for young smokers than it is for older smokers. Between 1997 and 2007, 343,000 current smokers[29] quit smoking. Based on the model, we estimate that about 105,000 cases of smokers quitting can be attributed to the increase in prevention expenditure[30]. Increased expenditure, however, shows no or very little effect on the probability of smoking initiation. The coefficient, albeit positive, turns out to be insignificant[31].

[27] We observed that the mean prevalence of the migrant population was not significantly different from the mean prevalence of the Swiss population (FOPH 2007b) and, thus, we concluded that an adjustment for the effect of migration was not necessary.

[28] The Swiss Health Survey has been carried out every 5 years since 1992. The 2007 edition was conducted on a representative sample of about 30,000 households, in which one person aged 15 or above was randomly selected. With a 60% response rate, the whole sample contained 18,760 individuals.

[29] Individuals who responded "yes" to the question "are you smoking even occasionally" in the Swiss health survey.

[30] This is a very conservative estimate. Firstly, we admit that prevention expenditure does not reduce the probability of initiation. Secondly, we do not take into account the effect of promotion of cigarettes on prevalence in the model, thus underestimating the residual reduction in prevalence (not explained by price of cigarettes and tobacco promotion) which has to be explained by prevention.

[31] This is not an unexpected result, if one refers to the recent sociological research on the process of societal learning and the role rules transgression in the development of young people's identity (Cattacin and Minner 2009). We also point out that price makes no difference when it comes to the probability of smoking initiation. In this context it should be mentioned that young people often pay a promotional price whereas the model is based on the evolution of the price of the pack of cigarettes sold most. There is however strong scientific evidence supporting that media campaigns combined with other interventions is an effective strategy to reduce smoking initiation (Hopkins et al. 2001).

However, we should not put too much weight on this result since the use of retrospective data is not well suited to the analysis of the smoking onset, as the respondents do not recall their exact date of initiation (recall bias).

The second type of model follows the basic idea of the Australian study (Abelson et al. 2003). In the first stage the decline in prevalence attributable to price increase was estimated using a literature based elasticity parameter[32] (Harris 1994; Holly et al. 1999). If a price increase reduces prevalence, the tobacco industry's marketing efforts have the opposite effect. We took this effect into account by applying a prevalence elasticity coefficient based on the academic literature (Keeler et al. 2004)[33]. The growth of tobacco marketing expenditure in Switzerland is known from a survey we conducted in several cantons in 2008. After considering these two factors there still remains an, as yet, unexplained reduction of prevalence, called residual variation. After accounting for the effect of price but not for that of the tobacco industry's marketing efforts, the Australian authors considered, arbitrarily and prudently, that the share of residual variation, which could be attributed to prevention, was 10%.

Our objective was to obtain an estimate of the share of residual variation in smoking prevalence attributable to prevention based on the Swiss data. To do so, we established a relation between residual variation in the prevalence and the intensity of the prevention effort (annual per capita expenditure) in the Swiss regions. Initially we wanted to use the cantonal data, but it turned out that in several cantons the samples in the Swiss health survey were too small. Moreover, since the effect of interventions frequently spills over the cantonal boundaries, the procedure we chose seems more appropriate. The estimation results are presented in Table 4-2.

Table 4-2 Regression (dependent variable: LnRes)

Variable	Coefficient	St. error.	P
LnDep	0,513	0,266	0,091
Constant	1,210	0,290	0,009
			R^2 = 0,368

LnRes: logarithm of the residual variation in prevalence
LnDep: logarithm of the mean annual per capita prevention expenditures (1997-2007)

The results of the statistical analysis indicate a share of residual variation, which can be attributed to prevention, of 57%. Thanks to the increased prevention efforts between 1997 and 2007, the number of non-smokers increased to 143,000.

The results of the two models are convergent, even though the estimated number of non-smokers achieved is smaller in the first model. The main explanation for this difference lies in the fact that the first model does not account for the tobacco

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[32] We used the conventional value of -0.4 for the price elasticity of cigarette consumption. We assumed that half of the effect of price was on prevalence (Townsend et al. 1994), resulting in a price elasticity of smoking prevalence of -0.2.

[33] A 1% increase in tobacco promotion expenditure results in a 0.15% increase in smoking prevalence.

industry's marketing efforts, simply because the relevant expenditure data is not available for a sufficiently long period. Moreover, in the first model we consider the effect of tobacco prevention on quitting, and not on initiation. Therefore, the decline in the number of smokers attributable to prevention activities in the second model is probably closer to reality; for this reason we based our ensuing calculations on this model.

4.3 Sensitivity analysis

The role of sensitivity analysis is to provide information about the robustness of the results of a statistical model and to determine how sensitive these results are to the uncertainties in the parameters. The key parameter is the fraction of the residual variation in the prevalence, which is explained by the differences in per capita expenditures in the regions. Due to the small size of the sample – six regions – the confidence interval might be influenced excessively by extreme observations. In order to obtain a more robust estimate of the variability, we applied a re-sampling method (jack-knifing). The obtained variability of the coefficient – the standard error – is used to calculate a lower and an upper bound in the change in prevalence attributable to tobacco prevention. The estimated decline in the number of smokers attributable to the increase in prevention efforts between 1997 and 2007 lies between 98,100 and 167,500[34].

Table 4-3 Range of parameter estimates

Range of estimates (68% probability)	Elasticity coefficient*	Fraction of the residual change due to prevention**	Decline in prevalence due to prevention***	Decline in the number of smokers due to prevention
Lower bound	0.247 (=0.513 - 0.266)	39.3	1.53	98,100
Reference estimate	0.513	57.4	2.23	143,100
Upper bound	0.779 (=0.513 + 0.266)	67.2	2.61	167,500

* Average estimate 0.513, standard error 0.266; ** Residual change means decline in prevalence not explained by price or marketing expenditure; *** Percentage points

4.4 Societal cost of smoking

Tobacco consumption is a heavy burden in terms of public health: 9,200 deaths and 85,000 years of life lost from excess mortality and disabilities were the consequence of tobacco consumption in 2007. Indeed, tobacco consumption is the principal cause of disability-adjusted years of life lost (11.2% of years of life lost, all causes taken together (OECD/WHO 2006). 45,000 productive years were lost for ages up to 74

[34] The prevalence rate and the number of smokers vary proportionally with the elasticity coefficient.

years. As to temporary working incapacity caused by disease, they accounted for 4.7 million days, and 15,000 cases of invalidity can be attributed to tobacco consumption.

Without any increase in prevention expenditure, there would have been a higher number of premature tobacco-related deaths (approximately 740, ranging from 500 to 860) as well as a higher number of disability-adjusted years of life lost (+6,790, values range from 4,645 and 7,939). As to days of working incapacity, they would have increased by 380,850 units (the possible values range from 260,700 to 444,800). These estimates are based on the 1998 Swiss Cost-of-smoking Study (Jeanrenaud et al. 1998), on the WHO Global Burden of Disease study (Mathers et al. 2003; WHO 2008), on the recent estimations on tobacco-related mortality (FSO 2009), and on the trend in demographic change and smoking prevalence.

Table 4-4 Effects of tobacco consumption, 2007

	Tobacco-related	Avoided by prevention		
		Lower bound	*Reference estimate*	*Upper bound*
Deaths	9,201	504	736	860
DALYs	84,770	4,645	6,790	7,926
Loss of productive life-years (between 35 and 74 years of age)	44,805	2,455	3,587	4,189
Working days lost due to disabilities	4,756,900	260,678	380,850	444,770
Invalidity	15,000	822	1,200	1,402

Sources: Jeanrenaud et al. (1998); Frei (1998); Mathers et al. (2003); WHO (2008) ; OECD/WHO (2006); FSO (2009); own estimations

The societal cost is made up of the usual categories: the direct costs (inpatient and outpatient treatment), the production losses due to both morbidity and mortality in paid and unpaid work and the intangible costs (loss of quality of life, years of life lost). In order to estimate the societal cost, adverse health effects of smoking are expressed in monetary terms.

a) Direct costs

The cost of outpatient treatment is based on health services consumption (consultations and prescriptions) and unit costs of these services (average cost of a prescription and of a consultation). To calculate the cost of inpatient treatments, the number of days is multiplied by the average cost per day spent in a general hospital (FSO, Hospital statistics).

Table 4-5 Outpatient and inpatient treatment in 2007: tobacco-related costs and avoided costs in million CHF, and cases/days

	Tobacco- related		Avoided by prevention					
	Cases/days	Costs	Cases/days			Costs		
			Lower bound	*Ref. estimate*	*Upper Bound*	*Lower bound*	*Ref. estimate*	*Upper Bound*
Outpatient treatment								
Consultations	1,900,000	181.4	*104,120*	152,120	*177,650*	*9.9*	14.5	*17.0*
Prescriptions	1,370,860	70.6	*75,123*	109,750	*128,175*	*3.9*	5.7	*6.6*
Days of hospitalisation								
Long-term hospitalisation	116,900	213.7	*6,406*	9,360	*10,930*	*11.7*	17.1	*21.7*
Acute disorders	693,200	1,267.3	*37,987*	55,500	*64,814*	*69.5*	101.5	*118.5*
Total		**1,733.0**				**95.0**	**138.8**	**163.8**

Sources: Jeanrenaud et al. (1998); Frei (1998); FSO Hospital statistics, various years; own estimations

b) Production losses

The morbidity costs were calculated on the basis of gross median income in 2007 adjusted for the average activity and employment rates. The costs of mortality correspond to the net loss of income[35] for the remaining active working life (time between average age at the time of death and the target age of 74 years), taking into account future gains in productivity. All future losses were discounted at 2% in order to obtain the current value of the losses.

Table 4-6 Production losses due to smoking in 2007, in million CHF

Type of costs	Tobacco-related	Avoided by prevention		
		Lower bound	*Ref. estimate*	*Upper bound*
Net cost of mortality	1,248.0	68.4	100.0	116.7
Cost of morbidity	2,681.2	146.9	215.0	250.7
Total production losses	**3,929.2**	**215.3**	**315.0**	**367.4**

Sources: Jeanrenaud et al. (1998); own estimations

c) Intangible costs

The intangible costs were calculated on the basis of the DALYs lost, i.e.: the disability-adjusted years of life lost. The WHO Global Burden of Disease study (Mathers et al. 2003), conducted for 2002, served as the starting point of the

[35] It is the value of the net resources which in a given year are unavailable to the community as a result of tobacco-related mortality.

evaluation. The change in the years of life lost between 2002 and 2007 takes account of population growth and the decline in prevalence. The intangible cost estimate corresponds to the years of life lost multiplied by the value of a year of life in a normal state of health (VOSL), which has been estimated at CHF 50,400 in Switzerland (Jeanrenaud et al. 2006)[36]. The tobacco-related intangible costs amount to CHF 4.3 billion

Table 4-7 Tobacco-related intangible costs in 2007, in million CHF

	Tobacco-related	Avoided by prevention		
		Lower bound	*Ref. estimate*	*Upper bound*
Intangible costs	**4,272.6**	**234.1**	**342.1**	**399.5**

Sources: OECD/WHO (2006)/; Jeanrenaud et al. (2006); own estimations

d) Total cost

In 2007, the societal cost of tobacco consumption in Switzerland amounted to nearly CHF 10.0 billion The intangible costs accounted for the largest share of the societal burden of tobacco consumption in Switzerland, followed closely by the smokers' loss of production.

It is noteworthy that the societal cost avoided by prevention represents the benefit for the whole society (taxpayer, patient, relatives, and general population). Societal benefit is not to be confused with saving in public expenditure, which accounts for only a fraction of the societal benefit. The possible values for the societal benefit of tobacco prevention range from 544 to 931 million.

Table 4-8 Societal costs of tobacco consumption and social benefits of tobacco prevention in Switzerland in 2007, in million CHF

Type of costs	Tobacco-related	Benefits of prevention (avoided costs)		
		Lower bound	*Ref. estimate*	*Upper bound*
Direct costs	1,733.0	95.0	138.8	163.7
Production losses	3,929.2	215.3	315.0	367.4
Intangible costs	4,272.6	234.1	342.1	399.5
Societal costs/benefits	**9,934.8**	**544.4**	**795.9**	**930.6**

Sources: Frei (1998); Jeanrenaud et al. (1998); FSO Hospital statistics, various years; Jeanrenaud et al. (2006); OECD/WHO (2006); own estimations

[36] The IRENE made such an estimation for Switzerland under a European research programme (NEEDS) conducted in 12 countries. The subject of the research was atmospheric pollution-related excess mortality and hence deaths occurring at a relatively advanced age.

4.5 Return on Investment

According to our own survey regarding the Swiss Confederation and the cantons, the cost of prevention programmes amounted to CHF 20.6 million in 2007, and 4.8 million in 1997. Structural interventions other than taxation of tobacco products (protection against passive smoking, advertising restrictions, age limit) were implemented at the end of the evaluation period (as of 2007) in most cantons and have not yet had a significant effect on prevalence. Therefore, no costs related to structural interventions were added to the costs of prevention programmes.

Without any increase in tobacco prevention expenditures between 1997 and 2007 – this is the counterfactual scenario – there would have been both a significantly higher number of smokers (+143,000, ranging from 98,000 to 167,500) and a significantly higher societal cost (CHF +796 million, ranging from 544 to 930) in 2007. The relevant cost used to compute the return on investment (ROI) is then the difference in prevention expenditures between 1997 and 2007, which is CHF 15.8 million. In order to take the unobserved costs into account, we added 20% to this amount, resulting in a cost of CHF 18.9 million for prevention programmes. Lower tobacco consumption implies a reduction in ambient tobacco smoke and hence less damage from passive smoking. Our results do not account for these benefits for non-smokers, so our estimations may be seen as being conservative. With a societal benefit of tobacco prevention that lies between CHF 544 and 930 million we obtained a return on investment (ROI) ranging between 28 and 48, with a central estimate of 41[37]. Without accounting for intangible costs, we would have obtained a ROI of 23 (ranging from 15 to 27). Thus, even with a lower elasticity coefficient and a narrower measure of the benefits, the ROI for tobacco prevention programmes remains largely above unity.

Table 4-9 Return on investment

	Lower bound	*Ref. Estimate*	*Upper bound*
ROI	**28**	**41**	**48**

4.6 Strengths and limitations

The main strength of the tobacco study is that it confirms the fact – based on extensive international evidence – that information and education campaigns significantly reduce tobacco use. The result is obtained using two different statistical methods: a pseudo panel analysis with a large sample of the Swiss population (18,700 individuals) and a cross-sectional analysis of aggregated regional data. In both cases the coefficient associated with prevention is statistically significant (at 1% for the large sample study, at 10% for the study using aggregated regional data). The study shows that the fall in prevalence can be attributed to the increase in the price of cigarettes and to the additional effort made regarding information and education. Indeed, the restrictions to access were still quite limited in 2007 and the advertising constraints are weak. As to the protective measures regarding ambient smoke, they

[37] ROI=(796-18.9)/18.9=41

were introduced by some cantons, but too late to influence the evolution of prevalence in 2007. The results of the statistical studies therefore coincide with the scientific evidence in literature: there is, indeed, strong evidence that consumer information, education, and counter-advertising campaigns as well as warning labels increase quit rates. The evaluations of the campaigns using a follow-up sample have shown high recall rates and improved awareness of the health risks caused by smoking. While these evaluations may not be able to reveal the number of avoided smokers, they still clearly point to changes in attitude and behaviour (Ensmann et al. 2002; Honegger and Rudolf 2004; Boggio and Zellweger 2007; Rudolf et al. 2009).

The study also has some limitations. The model using individual data relies on retrospective information on events such as smoking initiation or quitting, which could have happened long before the time of the survey. The fact that people do not recall the precise date of the event anymore may explain why no significant result is found regarding the campaigns' effect on starting to smoke. In the model using aggregated data, the sample size is very small – it was necessary to use a re-sampling method - the link between prevention effort and an increased reduction in smoking is weaker (coefficient significant at 10%).

4.7 Conclusion

Prevention interventions have significantly contributed to the recent decline in smoking prevalence and consumption in Switzerland. The decline in prevalence from 1997 to 2007 – from 33.2% to 27.9% – corresponds to a reduction of 343,000 smokers after adjustment for population growth. The decline in the number of smokers attributable to prevention activities other than tax increase is 143,000. This estimate can be considered as robust; it has been confirmed using two differently designed econometric models.

The decline in smoking prevalence generates significant health benefits, smoking being the single most common cause of disability-adjusted years of life lost (11.2% of all DALYs lost in Switzerland). In economic terms, the yearly outcome of tobacco prevention is a reduction in the societal cost of smoking-related diseases of close to CHF 800 million (the possible values range from 544 to 931 million). Each franc invested in smoking prevention thus results in a net benefit of CHF 41 (between CHF 28 and 48 considering the range of uncertainty). This result is in line with evidence found in the international literature (Hopkins et al. 2001; Abelson et al. 2003).

Prevention activities other than tax on cigarettes have proven to be effective in reducing smoking consumption and prevalence. Our study submits strong evidence showing that tax on cigarettes is not the only effective tool to curb the smoking epidemic, but so are strategies based on information and education. Prevention efforts should not be reduced in the years to come: smoking prevalence remains high in Switzerland when compared with rates observed in other developed countries. Moreover, the resources for advertising and promotion of tobacco products are several multiples of those available for prevention activities.

Initiation and cessation rates are key determinants of change in smoking prevalence. One obstacle to a faster decline in prevalence is the high smoking initiation rate amongst adolescents and young adults. The pursuit of the reduction in smoking prevalence requires both an increase in the number of smokers quitting and a large reduction in the number of children and young adults taking up smoking. Our research shows that prevention programmes are more effective in terms of inducing smokers to consider quitting than in terms of convincing young people not to start smoking. Adolescents and young adults are highly receptive to tobacco advertising, which aims at giving a positive lifestyle image of smoking, and less sensitive to prevention messages based on health risks. Anti-smoking messages have not been successful in countering the favourable image of smoking, which reduces the perception of risk (Slovic 2001). Tobacco advertising thus undermines prevention efforts. The key to the success of reducing smoking prevalence in the future is to achieve a significant lower initiating rate amongst the young. The goal will not be achieved by solely raising tobacco risk perception without changing the (positive) image of smoking. The perception of smoking as a normal behaviour has to be reversed. Currently based on four pillars (taxing tobacco products, providing information about risks, helping smokers to quit, protection from second-hand smoke), prevention policy should be supplemented by a comprehensive ban of all forms of cigarette promotion and advertising.

5 CBA of harmful use of alcohol prevention programmes[38]

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The study set out to provide an estimation of the societal benefits of alcohol prevention programmes. Once we know the cost of these programmes and their societal benefits, we are able to measure the return on investment in alcohol prevention. The evaluation period for the economic assessment is from 1997 through 2007[39] and refers to the data from these years' national health surveys. The Swiss Health Survey gives a snapshot of the Swiss population's state of health as well as of a large range of health indicators at the beginning and the end of this period. As a result, we know that the prevalence of excessive alcohol consumption went from 5.99 to 5.14 percentage points during the evaluation period, i.e.: a 0.85 percentage point reduction[40]. In the first step, the part played by prevention in this reduction was estimated with the help of a statistical model based on cantonal data. In a second step, the effects of lower excessive alcohol consumption on morbidity and mortality were evaluated. In a third step, the societal benefits of improved health were assessed, and then compared with the cost of prevention interventions.

5.1 Prevention programmes

We considered two broad strategies for alcohol prevention: behavioural interventions and structural interventions. The first included programmes aimed at informing and educating the population, whilst the second consisted of all the interventions designed to reduce access to the product, to limit or prohibit its promotion or to increase its price. It has been established that to be effective prevention must be comprehensive, i.e. combine behavioural as well as structural interventions.

Alcohol prevention requires the interaction of various players, both at the local and the federal level. The first national programme was started in 1999 and was initially planned to last until 2002. It was subsequently prolonged. The Swiss Alcohol Board (SAB) is also entrusted with the mission of prevention. In addition to distributing part of its profits to the cantons in order to promote interventions through the alcohol tithe, the SAB has a line item in its budget devoted to the prevention of excessive alcohol

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[38] Research funded by the Swiss Federal Office of Public Health, contract number 08.001719.

[39] During the second half of the 1990s prevention programmes were launched at a national level under the aegis of the Federal Office of Public Health in the fields of both alcohol and tobacco.

[40] Individuals at "risky" levels and at "high risk" levels are included. For females, this means a daily consumption exceeding 20 grams, for males, an average consumption of more than 40 grams a day (FSO (1998b) based on Swiss Health Survey 1997). In 2007, 297,000 individuals presented risky or high risk daily alcohol consumption (FSO 2008 based on Swiss Health Survey 2007).

consumption long before any national programmes were launched. Thus, the Board grants subsidies to prevention organisations.

Table 5-1 Selected list of behavioural and structural interventions, 1997-2007

Behavioural interventions	Description	Year(s)
What's the purpose – Look at yourself rather than into the bottom of a glass	Nation-wide campaign	1999-2008
Partnership	Provision of posters and advertising material to regional and local alcohol prevention and advice centres	1999-2002
GPs	Continued training of practitioners on the interviewing techniques of short interventions.	2000-2001
Internet	Prevention and information messages via the internet	As of 2000
Helpline	National help-line for individuals with an alcohol problem	As of 2000
Municipalities on the move	Promoting the elaboration of and enactment of local alcohol prevention policies.	2000-2007
Drink or drive	Nation-wide road safety campaign on the theme of alcohol	2003-2005
Cantonal Alcohol Action Plans « PCAA »	Assistance to the cantons during the implementation of the alcohol actions plans.	As of 2003
Structural interventions	**Source**	**Enactment on:**
Alcopops governed by the law on alcohol resulting in: - Considerable price increases - Prohibition to sell to under 18 year olds	Federal Law on Alcohol (Lalc) of 21 June 1932	01.12.1997
- Prohibition to sell and to remit alcoholic beverages to under 16 year olds (subject to the provisions of the Lalc) - Prohibition of advertising for alcohol-containing beverages aimed at under 18 year olds - If necessary the label must bear the mention "sugar-containing alcoholic beverage" and must specify the alcoholic strength	Ordinance on Food Products (ODAI) of 1st March 1995	01.05.2002
Limitation of blood-alcohol level to 0.5g per mille	Ordinance of the Federal Parliament on maximum blood-alcohol level admissible in road traffic of 21st March 2003.	01.01.2005
Driver's license issued on probation for a probationary period of 3 years.	Federal law on road traffic (LCR) of 19th December 1958	01.12.2005
Prohibition to sell alcohol after 10 pm in stores and outlets located at railway stations.	Measure adopted by the Swiss Federal Railways	01.04.2007

There are many interventions at the local level, initiated by cantons, communes and NGOs. In order to inventory all the interventions at the local level, both structural and behavioural, we conducted a survey amongst the cantonal authorities in charge of prevention and health promotion.

Regarding behavioural interventions, we computed the prevention expenditures from 1997 to 2007. During this period, they rose from CHF 1.45 to 2.55 per capita (see the full report for details, Füglister-Dousse et al. (2009)). The principal structural interventions in the cantons concern product availability (prohibition of selling alcohol at certain times of the day or night, at certain places, age limit applied to purchasing, limited access to certain establishments) and advertising. At the federal level interventions mainly concern excise duties and taxes, age limits regarding purchasing, advertising, and lowering the legal limit of blood-alcohol level for driving from 0.08% to 0.05% in 2005.

5.2 Effectiveness of alcohol prevention

Average annual per capita resources devoted to the population's information and education (behavioural prevention) vary substantially from canton to canton. If prevention interventions are effective, one must be able to observe a statistical relationship between the prevention effort (average per capita expenditure from 1997 to 2007) and the evolution of prevalence in these cantons[41] and, as a result, be able to express this relationship by means of an elasticity coefficient. The statistical model we adopted in this study is based on this very assumption. It is interesting to note that the method we designed is comparable with the one adopted in the Australian study on the prevention of tobacco consumption (Abelson et al. 2003). However, there is a substantial distinction: we estimated the link between prevention and the frequency of excessive alcohol consumption based on observed values, whereas the Australian researchers opted for a hypothetical value. The regression analysis revealed that the decline in prevalence is greater in the regions that devoted more resources to prevention[42] (Table 5-2). The coefficient is not significant at the standard confidence level of 5% or 10%. The statistical analysis indicates a positive relation between prevention efforts and reduction in prevalence, but with a p-value of 14.4%. The 10% confidence interval thus includes 0. Using a binary significant/non significant decision rule, however, we could possibly ignore a result that might be

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[41] The changes in prevalence are measured assuming an unchanged real price of alcohol. The prevalence rates one could have observed in each canton, if prices remained unchanged, were estimated with a prevalence elasticity-to-price ratio of –0.27 (Clements et al. 1997; Fogarty 2004).

[42] The prevalence of excessive consumption and prevention expenditure were surveyed in the 7 large regions (Lake Geneva region, the Mittelland, North-Western Switzerland, Zurich, Eastern Switzerland, Central Switzerland, Ticino). In order to obtain variation intervals that correspond to robust parameter estimates, a re-sampling method was applied. We decided to regroup data by large regions as prevention interventions implemented by one canton also benefited the inhabitants of neighbouring cantons (mobility of the population, regional written press, etc.).

important in practice[43]. We therefore consider the statistical evidence as one indication of campaign effectiveness, which has to be confirmed by other arguments such as the time coincidence between interventions and reduction in alcohol-related damages (see road accidents) or by the impact of prevention campaign evaluation (message exposition, recall-rate, awareness, change in attitude or intention).

Table 5-2 Regression (dependent variable: LnRes)

Variable	Coefficient	St. error.	*p*
LnDep	1,451	0,990	0,144
Constant	-0,879	0,605	0,146
			R^2 = 0,55

LnRes: logarithm of the residual variation in prevalence
LnDep: logarithm of the mean annual per capita prevention expenditures (1997-2007)

Between 1997 and 2007, the prevalence of excessive alcohol consumption dropped from 5.99 to 5.14 percentage points (a decline of 0.85 percentage points or 55,000 fewer individuals in 2007)[44]. According to the regression model, close to half (47.3%) of the change in prevalence after price effect was taken into account is attributable to prevention.

There is no significant relationship between structural interventions (other than price variations) and the reduction in prevalence in the regions, which at first glance is surprising since structural interventions are mentioned among the best practices policy options whereas education and information are not, except for campaigns aimed at reducing drinking and driving (Babor et al. 2003)[45]. One should not, however, conclude from the results of the statistical analysis that the structural interventions had no effect. We did indeed observe that the cantons with substantial information and education efforts tend to implement more stringent structural interventions[46]. The two variables being correlated, this possibly undermines the statistical significance of the variable “structural interventions”. We also point out in this context that it is difficult to measure the scale of structural interventions in the regions, and that the rules are more or less well implemented. The statistical model shows that an increase in the prevention effort is associated with a reduction in the proportion of individuals with excessive alcohol consumption. Structural prevention has certainly contributed to the outcome, even though this cannot be proved statistically.

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[43] Gelman et al. (2006) note that « most statisticians and many practitioners are familiar with the notion that automatic use of a binary significant/non significant decision rule encourages practitioners to ignore potentially important observed differences ».

[44] The reduction is 0.91 percentage points when prevalence has been adjusted for changes in the real price of alcohol.

[45]There is no good evidence, however, that advertising is influencing alcohol consumption and prevalence, see Nelson (2001).

[46] Prevention expenditure (behavioural interventions) was correlated with the indicator of structural interventions (the correlation coefficient is 0.459).

5.3 Sensitivity analysis

The procedure used to provide information about the uncertainty of the results is the same as the one followed for tobacco. The key parameter for which a confidence interval is being calculated is the fraction of the residual variation in the prevalence, which is explained by the differences in prevention expenditure per capita. Due to the small size of the sample – seven regions in this case – the confidence interval could be excessively influenced by outliers. In order to obtain a more robust estimate of the variability, we used a re-sampling technique (bootstrapping). The variability of the coefficient – the standard error – served to calculate a lower and an upper bound for the key parameter (fraction of the residual decline in prevalence attributable to prevention programmes). The decline in the number of excessive alcohol users attributable to the increase in prevention efforts between 1997 and 2007 lies between 11,700 and 31,500. There is a 68% probability that the correct value lies within this range.

Table 5-3 Range of parameter estimates

Range of estimates (68% probability)	Elasticity coefficient*	Fraction of the residual change due to prevention**	Decline in prevalence due to prevention***	Decline in the number of consumers due to prevention
Lower bound	0.46 (=1.45-0.99)	22.2	0.20	11,700
Reference estimate	1.45	47.3	0.43	24,800
Upper bound	2.44 (=1.45 + 0.99)	60.2	0.54	31,500

* Average estimate 1.45, standard error 0.99; ** Residual change means decline in prevalence not explained by price; *** Percentage points.

Prevention programmes at the federal and local levels produced a reduction in prevalence. The possible values range from 0.20 and 0.54 percentage points, the reference value being 0.43.

5.4 Societal cost of the harmful use of alcohol

In 2007, excessive alcohol consumption caused about 3,160 deaths (gross effect); this figure recedes to 1,800 (net effect) after accounting for the reduced mortality resulting from the protective effect of moderate alcohol consumption[47]. Harmful alcohol use is responsible for nearly 65,700 years of life lost or DALYs (net effect) because of excess mortality and disease-related disabilities[48]. As to the years of productive life lost because of excess mortality (counted up to the age of 74 years) – which represent lost output linked to alcohol-related mortality - they are about 33,000 units. Thus, the harmful use of alcohol also compounds the risk of becoming

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[47] Moderate alcohol intake is associated with a reduced incidence of and mortality from coronary heart disease (CHD).

[48] These figures are based on the estimation of alcohol-related mortality made by Rehm et al. (2003). The values were adjusted to take into account the reduction in prevalence, which occurred between 2002 and 2007, and the increase of the population.

unemployed or even permanently work disabled (invalidity): a little over 3,100 individuals were unemployed and about 2,600 received invalidity insurance allowances as a result of excessive alcohol consumption. The societal cost of harmful alcohol use includes: chronic excessive consumption, binge drinking and inappropriate alcohol use.

The reduction of alcohol-related morbidity and mortality is in line with the change in harmful alcohol use prevalence. The number of avoided disabilities and unemployed workers was estimated on the basis of a previous study published in 2003 and commissioned by the Federal Office of Public Health (Jeanrenaud et al. 2003). The values were adjusted for demographic and labour market change.

Table 5-4 Effects of excessive alcohol consumption in 2007

	Alcohol-related cases	**Avoided by prevention**		
		Lower bound	*Reference estimate*	*Upper bound*
Deaths (gross)	3,156	124	263	335
Deaths taking into account the protective effect (net)	1,799	71	150	191
DALYs	65,739	2,577	5,488	6,978
Invalidity	2,554	100	213	271
Excess unemployment	3,118	122	260	331

Sources: Rehm et al. (2006); Jeanrenaud et al. (2003); Rehm et al. (2007); own estimations

The effects of alcohol consumption are expressed above in natural units. In order to calculate the return on investment in prevention, these values have to be converted into monetary units. Thus, we obtain the societal cost of excessive alcohol consumption or the societal benefit of the decline in prevalence.

There are three types of damage from the harmful use of alcohol which burden society. First, there are the costs generated by the treatment of individuals, whose health is impaired, as well as the material damage caused by accidents and violent behaviour and crime. These are the *direct costs*, measured by the resources required to repair the damage. Secondly, alcohol-related morbidity and mortality undermine the economy's productive capacity: working days are lost because excessive alcohol consumers are sick more frequently and health impairment sometimes even leads to permanent disability. The analysis of the results of the Swiss Health Survey in fact revealed that individuals with heavy alcohol consumption are more at risk of becoming unemployed[49]. The value of sacrificed output due to excess mortality and alcohol-related morbidity corresponds to the *production losses*. It must be specified that only that part of production of which society is deprived counts as a cost: in the

[49] The threshold, as of which the risk of unemployment grows significantly, is 6 glasses for men and 4 glasses for women daily (Jeanrenaud et al. 2003).

case of a premature death it is the cost of the residual production – after subtraction of the deceased person's own consumption –, which is included in the societal cost[50]. Lastly, there are the *intangible costs*, or the loss of quality of life of those, whose health is impaired, as well as the years of life lost due to premature mortality.

a) Direct costs

The largest part of the direct costs is generated by treatment (alcohol-related diseases and admission to specialised institutions) and by road accidents. Outpatient treatment and the consumption of medication were estimated on the basis of the Swiss Medical Diagnosis Index (IHA-IMS market survey). The values contained in the study published in 2003 (Jeanrenaud et al. 2003) were updated taking into

Table 5-5 Outpatient and inpatient treatment in 2007: alcohol-related costs and avoided costs in 2007, in million CHF, and in cases/days

	Alcohol-related		**Avoided by prevention**					
	Cases/days	Costs	Cases/days			Costs		
			Lower bound	*Ref. estimate*	*Upper Bound*	*Lower bound*	*Ref. estimate*	*Upper Bound*
Outpatient treatment								
Consultations	742,530	84.7	*29,106*	61,990	*78,819*	*3.3*	7.1	*9.0*
Prescriptions	365,634	24.1	*14,332*	30,520	*38,812*	*0.9*	2.0	*2.6*
Days of hospitalisation								
Chronic diseases	276,850	506.1	*10,852*	23,110	*29,387*	*19.8*	42.3	*53.7*
Co-morbidities	82,720	151.2	*3,243*	6,910	*8,781*	*5.9*	12.6	*16.1*
Acute disorders	11,160	20.4	*437*	930	*1,184*	*0.8*	1.7	*2.2*
Specialised institutions								
Days	108,372	61.9	4,248	9,050	11,504	2.4	5.2	6.6
Total		**848.5**				**33.3**	**70.8**	**90.1**

Sources: Jeanrenaud et al. (2003); Frei (2001); FSO Hospital statistics (1998a) and (2007); own estimations

account the decline in prevalence of excessive alcohol consumption since 1997 (-14.3%), rising prices in the public (+8.7%) and private (+10.8%) sector, and population growth (+7.0%). With respect to inpatient treatment, the reduction in the length of hospitalisation more than compensated for population growth, to such an

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[50] This is a controversial issue (see Alfaro et al. 1994; Collins and Lapsley 1996; Jeanrenaud et al. 1998; Lightwood et al. 2000; Collins and Lapsley 2002). Other authors consider that own consumption should not be subtracted. As we account for the cost of the deceased person's loss of ability to live (see the section on intangible costs), we believe that not subtracting the deceased own consumption would end up double counting. We also point out that the method chosen allows for a more prudent estimation of the social costs.

extent that the overall number of days spent in hospitals has dropped. The reduction in prevalence brought about a decline in the number of alcohol-related days spent in hospitals. The cost per day in hospital has however increased mightily.[51] The decline in the number of outpatient and hospital treatments represents 8.3% of alcohol-related cases in 2007[52].

The data concerning alcohol-related road accidents has been extracted from the 2007 Road Accident Statistics (FSO 1975 - 2007) and has been combined with the special statistics of the Central Office for Statistics in Accident Insurance (SAI)[53]. Since 1997, the number of alcohol-related deaths in road accidents has fallen by more than half. The largest share of this reduction followed the lowering of the blood-alcohol level to 0.05% in 2005. Considering all causes together, the number of seriously injured persons fell by 15%, whilst the number of slightly injured remained nearly unchanged. There is an obvious link between the stricter regulations regarding alcoholemia and lower mortality numbers. A large part of the reduction in fatal accidents, following the introduction of the new limits, can therefore be attributed to prevention, albeit structural interventions, but also to information campaigns[54]. The data concerning the cost of treatment per case has been extracted from a special analysis of the SAI[55]. As far as the cost of rehabilitation, material damages and legal

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[51] The cost per day spent in hospital is obtained by correlating the operating costs of general hospitals with the total number of days (FSO Hospital statistics 1998 - 2007).

[52] Under the influence of price and in the absence of any other factors of influence, excessive consumption prevalence would thus have risen to 6.04% in 2007 (slight decrease in price between 1997 and 2007). Considering the effect of prevention and price, prevalence would have attained 5.56%.

[53] The FSO road accident statistics only include those cases for which there was a police report. On the other hand, the SAI statistics include all cases; they also indicate whether they were or may have been the subject of a police report, but only in the case of salaried employees. It is thus possible to also use the « grey areas » (i.e.: the cases for which there is no police report) of the SAI statistics in addition to the FSO's more comprehensive data, since together they cover the entire population, on the assumption that the grey areas are similar in both cases. The less serious the accident is, the more important the grey area is (3% of fatal accidents are not reported to the police compared with 55% of accidents involving seriously injured and 80% with slightly injured or material damage). See also Frei (2001).

[54] If there were no increase in road accidents prevention efforts, there would be 30% more deaths from alcohol-related road accidents, 10% more injured and 10% more accidents with material damage. In fact, we observed that the share of fatal alcohol-related accidents remained stable in 2004, prior to receding to 30% in 2005 at exactly the same time as the blood-alcohol level was reduced from 0.8 to 0.5 per mille. The reduction in the share of alcohol-related accidents with injured persons was less, at about 10%. The same rate applied to accidents with material damage (source: FSO, Superweb Statistical Data Base).

[55] Only the costs of treatment were taken into account, excluding compensation for work impairment. These are momentaneous statistics, which include all costs generated in 2007, regardless of whether the accident occurred in 2007 or earlier. Experience shows that the largest share of costs materialises within 2 years. As long as the number of accidents remains stable, this approach contains no important bias. Care must be taken when the number of accidents tends to rise or fall. Given the tendency of fewer accidents, the figure of 4,100 francs per person overestimates the actual cost. For reasons of caution we have reduced the value taken from the official statistics by 15%.

costs are concerned, the costs per case were taken over from the estimation made by Frei (2001) and adjusted for price increases[56].

Table 5-6 Alcohol-related road accidents: observed direct costs and avoided direct costs in 2007, in million CHF, and in cases/days [57]

	Alcohol-related		Avoided by prevention	
	Cases (with grey area)	*Costs*	*Cases (with grey area)*	*Costs*
Victims with light injuries	*9,978*		*998*	
Victims with serious injuries	*1,657*		*166*	
Deaths	*57*		*16*	
Treatment of victims		40.7		4.1
Rehabilitation	123	7.1	12	0.7
Material damage	30,808	137.8	3,081	13.8
Legal costs	6,175	19.6	618	2.0
Total		**205.2**		**20.6**

Sources: Frei (2001); FSO, Road Accident Statistics on the Internet, 2008; SAI; own estimations

b) Production losses

Alcohol-related morbidity compounds the risk of temporary (sickness) and permanent (invalidity) work disability. The higher rate of unemployment for individuals with excessive alcohol consumption is a third component of the production losses. All in all, they amount to CHF 260 million and represent the value of alcohol-related sacrificed output. Both paid and domestic work is included in this estimation[58].

The mortality costs correspond to the value of output, – market and non-market – that individuals would have generated had they not died prematurely, for the entirety of their lives up to the age of 74. Future output was discounted at 2%. On the whole, the mortality costs totalled CHF1.9 billion. Societal costs correspond to the value of output of which society is deprived. This is why we calculated the net mortality costs by subtracting the prematurely deceased person's own consumption. Net mortality costs amounted to CHF 1.6 billion.

The reduction in the production losses of morbidity and mortality is proportionate with the fall in prevalence, which can be explained by prevention programmes. It is equal to 8.3% of the costs observed in 2007, i.e.: the possible values range from 71.5 to 193.7 million.

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[56] The cost of rehabilitation of a victim of an accident in 2007 amounts to CHF 57,406 whilst the average cost of material damage caused by a road accident amounts to CHF 4,474.

[57] Since the probability distribution is not known, we cannot estimate a range of possible values.

[58] The value of annual production is that of a statistical person with an average income of CHF 76,500 in 2007.

Table 5-7 Annual production losses due to harmful alcohol use in 2007, in million CHF

Type of costs	Alcohol-related	Avoided by prevention		
		Lower bound	*Ref. estimate*	*Upper bound*
Gross cost of mortality	1,864.8	73.1	155.7	198.0
(-) Deceased person's own consumption	- 300.1	- 11.8	- 25.1	- 31.9
Net cost of mortality	1,564.7	61.3	130.6	166.1
Cost of morbidity	260.0	10.2	21.7	27.6
Total production losses	**1,824.7**	**71.5**	**152.3**	**193.7**

Sources: Jeanrenaud et al. (2003); Rehm et al. (2007); own estimations

c) Intangible costs

The intangible costs were assessed using the disability-adjusted life year (DALY), a measure that combines years of life lost due to premature death and years of life lost due to time lived in states of less than full health (WHO 2008). According to the WHO studies on burden of diseases, alcohol ranks third in Switzerland as a risk factor, after tobacco consumption and hypertension in terms of years of life lost due to disability or premature death. Thus, 7.2% of all the years of life lost are alcohol-related.

We based our own estimation on the work by Rehm et al. (2007). According to these authors, 70,300 years were lost (in 2002). These values were adjusted for population growth and for the decline in the prevalence of excessive alcohol use. The disability-adjusted years of life lost (DALYs) amounted to close to 65,700 in 2007. Our calculations show that thanks to prevention programmes, the number of alcohol-related DALYs was significantly reduced: the possible values range from 2,600 to 7,000. The intangible costs expressed in monetary terms are a function, therefore, of the value of a year of life in normal health (VOSL). For Switzerland, the estimated value of a year of life in normal health came to 50,400 Swiss francs. As far as alcohol is concerned this is a rather conservative value, as alcohol-related deaths on average occur at a less advanced age than those caused by atmospheric pollution (Jeanrenaud et al. 2006).

Table 5-8 Intangible costs of harmful alcohol use, in million CHF

	Alcohol-related	Avoided by prevention		
		Lower bound	*Ref. estimate*	*Upper bound*
Intangible costs	**3,313.2**	**129.9**	**276.6**	**351.7**

Sources: Rehm et al. (2007) ; Jeanrenaud et al. (2006); own estimations

d) Total cost

The estimate of the societal cost of harmful alcohol use amounted to CHF 6.2 billion in 2007. A little less than half of this cost accounted for the intangible costs. It is interesting to note that the production losses attributable to excessive alcohol use also represent a substantial part of the societal cost. As mentioned previously concerning tobacco control, the societal cost avoided by the prevention of harmful alcohol use represents the benefits to society as a whole (taxpayer, patient, relatives, society): the possible values for the social benefits of alcohol prevention range from 255 to 656 million.[59] Reduction in public expenditure – mainly health care costs – represents a small part of the social benefit.

Table 5-9 Societal benefit of alcohol prevention in Switzerland in 2007, in million CHF

Type of costs	Alcohol-related	Benefits of prevention (avoided costs)		
		Lower bound	*Ref. estimate*	*Upper bound*
Direct costs	1,053.7	53.8	91.4	110.6
Production losses	1,824.7	71.5	152.3	193.7
Intangible costs	3,313.2	129.9	276.6	351.7
Societal cost/benefit	6,191.7	**255.2**	**520.3**	**656.0**

Sources: Jeanrenaud et al. (2003); Rehm et al. (2006); Rehm et al. (2007); own estimations

5.5 Return on Investment

Federal and cantonal prevention programmes amounted to CHF 19.5 million in 2007, whereas they only amounted to 10.4 million in 1997. Initially, this expenditure rose sizeably and then levelled out as of 2004. Here we are only referring to the resources allocated to information and education (behavioural interventions). The relevant amount to use in our calculation is the increase in prevention expenditures observed between 1997 and 2007, i.e. CHF 9.1 million. We added 20% to this amount in order to account for unobserved interventions. The full effect of education and information programmes, however, only comes to bear if they are underpinned by structural interventions (limiting access in particular). Statistical analyses have in fact shown quite a close link between the efforts of educational and information deployed by the cantons and the scale of structural alcohol interventions. This does not permit us to attribute the reduction in prevalence to either behavioural or structural prevention. The cost of structural interventions (other than excise duties) remains unknown, but there is a consensus among the experts recognising that these are relatively cost-effective measures. Out of caution it has been accepted that every franc spent on behavioural prevention is matched by a franc spent to ensure that structural measures are implemented. The estimated increase in alcohol prevention

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[59] The prevalence rate and the number of harmful users vary proportionally with the elasticity coefficient (see sensitivity analysis, section 5.3).

expenditure between 1997 and 2007 is thus 21.8 million. The societal benefits of alcohol prevention programmes lie between CHF 255 and 656 million and the return on investment (ROI) lies between 11 and 29, with a central estimate of 23[60]. If quality of life benefits are excluded, the ROI still exceeds 1: possible values then range from 4.7 to 13.0. Thus, even with a lower elasticity coefficient and a narrower measure of the benefits, the ROI for alcohol prevention programmes remains largely above unity.

Table 5-10 Return on investment

	Lower bound	*Ref. estimate*	*Upper bound*
ROI	**11**	**23**	**29**

5.6 Strengths and limitations

The strength of the study is that it provides a set of indices showing a probable link between the scale of the prevention interventions and the decline in prevalence of excessive alcohol use. Thus, the prevalence decreased between 1997 and 2007 at a time when the price of alcoholic beverages declined. The statistical model designed on the basis of the aggregated regional data confirms the correlation between the increase in prevention expenditures and the decline in prevalence (adjusted for the effect of price changes) in the regions: the more resources a region devotes to prevention, the greater the decline in prevalence observed between 1997 and 2007. It appears that the resources devoted to information and education programmes (behavioural interventions) and the scale of alcohol control activities in the regions (structural prevention) are correlated: the regions, which adopted the strictest structural measures are also those which spend most on informing the public of the dangers of harmful alcohol use. It is likely that structural restrictions played the greatest part in the decline in the harmful use of alcohol. Indeed, evidence found in the literature shows that restricting access and, in particular, increasing the age limit regarding the purchase and consumption of alcohol are strategies that have a strong empirical support (Babor et al. 2003). When, in 2005, lowering the limit of the legal blood alcohol concentration when driving and the launching of an information campaign coincided with a sharp decline in road accidents, this confirmed the effectiveness of a policy combining structural and behavioural measures. The campaigns on alcohol prevention have been evaluated to demonstrate if and to what extent the dissemination of the prevention messages have changed awareness and attitudes of the population. The evaluation of the campaign “What’s the point? / Ça débouche sur quoi?” showed a high campaign-message recall rate, a high rate of social acceptance and a good understanding of the message (IPSO 2001). As to the « Drink or drive / Boire ou conduire » campaign, it was characterised by a high recall rate and an increased awareness of the risks associated with driving under the influence of alcohol (Institut für Verkehrssoziologie 2005).

The adopted methodology also has its limits. The relation between prevention expenditure and the reduction in prevalence in the region is positive, but the

[60] ROI=(520.3-21.8)/21.8=22.9

regression coefficient is based on a small sample – we had to use a re-sampling technique – and the coefficient margin of error is 14.4% (thus not significant in the usual sense). The Swiss health survey contains no retrospective questions regarding the pattern of past alcohol consumption; it is not possible, therefore, to build a statistical model based on individual data. Even though the evidence is not as strong as for tobacco and the margin of uncertainty is greater, the many converging indices make us feel comfortable with the idea that reinforcing the structural interventions combined with information and awareness campaigns have contributed to the decline of prevalence in excessive alcohol consumption between 1997 and 2007.

5.7 Conclusion

The decline in prevalence – from 5.99% to 5.14% (or a decrease of 14.2%) – is of the same magnitude as the reduction in smoking prevalence (-16.0%) during the same time span. It corresponds to about 55,000 fewer individuals with harmful alcohol use.

After taking into account the price effect, close to half (47.3%, ranging from 22.2% to 60.2%) of the change in prevalence is attributable to prevention. In other words, there would have been about 25,000 more affected individuals, if no prevention programmes had been implemented, with a range of possible values from about 11,500 to 31,500. This goal was achieved despite the fact that the price of alcohol declined and the access to alcohol was easier in 2007 given the increasing number of outlets at petrol stations.

The benefits of the prevalence reduction are substantial, as alcohol accounts for 9.0% of the total burden of disease in Switzerland. In 2007, alcohol consumption caused approximately 1,800 deaths after accounting for the protective effect of moderate consumption. In addition to excess mortality, one has also to consider disease-related disabilities and the higher risk of unemployment. In economic terms, the annual outcome of alcohol prevention is a reduction in the social cost of about CHF 500 million with a range of possible values from 250 to 650. For every franc spent on preventing alcohol harmful consumption, there is a return of 23 (between 11 and 29 when we consider uncertainty).

Our study shows that in cantons with higher prevention expenditure the decline in prevalence tends to be greater. We submit evidence that strategies based on information and education combined with structural interventions, are useful tools to reduce the harmful use of alcohol and are also economically efficient (benefits outweigh the costs). The prevention effort must be continued if the objectives of the 2008-2012 National Alcohol program are to be achieved, i.e. better knowledge of the risks, reduction of problematic consumption and lower prevalence of alcohol dependency.

6 Conclusions

Our research set out to answer two main questions: (1) Do the measures used in Switzerland for preventing tobacco use, harmful use of alcohol and road accidents work? and (2) Are they worth the money they cost?

The analysis has shown there is indeed a high rate of return for every franc invested in such prevention efforts. But there are also several other important conclusions, that can be drawn from the research. In the following paragraphs we present some of the key lessons according to the following themes:

- a comparison and discussion of the return on investment (ROI) in the three prevention fields,
- a discussion of the general lessons regarding the three prevention fields,
- a discussion of some specific lessons in the single prevention fields,
- a discussion of the strengths and limitations of the economic evaluation,
- and finally some general conclusions.

Returns on Investment (ROI) in prevention: comparison and discussion of the main results

The three prevention fields selected for economic analysis present enormous suffering, a high number of premature deaths and considerable costs to society as a whole. Our analysis shows that public health efforts in terms of prevention and health promotion measures have been cost-saving in reducing the associated human and economic costs through the promotion of healthier lifestyles and environmental improvements.

For **road accidents**, between 1975 and 2007, the number of fatalities and severely injured strongly decreased as expenses in prevention increased by over 50% in real terms. The effect of all interventions was substantial. Taking into account the increase of the population, the increase of the number of vehicles in circulation and the general social and demographic trends which have contributed to a decline in the number and the severity of accidents, we estimate that between 1975 and 2007 road accident prevention measures prevented a total of 13,484 fatalities, 17,316 permanently disabled casualties, 98,861 severely injured, 82,822 moderately injured and 710,214 slightly injured. A total of CHF 72,816 million were avoided costs of which 19% are direct costs (material damages not considered), 41% production losses and 40% intangible costs. The ROI of all public prevention programmes, excluding investments in the safety of the road infrastructure, is estimated at CHF 9.43 for each franc invested. The ROI of all prevention measures, including investments in the safety of road infrastructure and expenses for private safety devices, is estimated at 1.57.

For **tobacco and alcohol**, between 1997 and 2007, the amount dedicated to prevention efforts systematically increased with a total of CHF 20,6 million for

tobacco, and CHF 19.5 million for alcohol in 2007. For tobacco over this period, the number of smokers was reduced by 5.3 percentage points, from 33.2% to 27.9% in 2007, which corresponds to a reduction of 343,000 smokers after adjustment for population growth. The decline in the number of smokers attributable to prevention activities other than tax increase is 143,000. This estimate can be considered as robust; it was confirmed using two differently designed econometric models. The decline in smoking prevalence generates significant health benefits, smoking being the single most common cause of disability-adjusted years of life lost (11.2% of all DALYs lost in Switzerland). In economic terms, the yearly outcome of tobacco prevention is a reduction in the societal cost of smoking-related diseases of close to CHF 800 million (the possible values range from 544 to 931 million). Each franc invested in smoking prevention thus results in a net benefit of 41.

Similarly, for alcohol, between 1997 and 2007, the proportion of the population having an excessive consumption of alcohol dropped from 6.0% to 5.1%. This corresponds to about 55,000 fewer individuals with harmful alcohol use. After taking into account the price effect, close to half (47.3%, ranging from 22.2% to 60.2%) of the change in prevalence is attributable to prevention. In other words, there would have been about 25,000 more affected individuals, if no prevention programmes had been implemented, with a range of possible values from 11,500 to 31,500. This goal has been achieved, despite the fact that the price of alcohol has dropped and access to alcohol is easier given the increasing numbers of outlets at petrol stations. Each franc invested in the prevention of harmful alcohol use thus results in a net benefit of 23.

The estimated ROI for each of these areas varies between 9.43 for public road accident prevention programmes, 23 for alcohol prevention and 41 for tobacco prevention. The ROIs were calculated from a societal perspective by comparing the costs of the prevention interventions with the accrued benefits in terms of the direct costs, production losses and intangible costs avoided. In each case, the estimations for benefits in terms of avoided costs were calculated on the basis of conservative assumptions.

A comparison of our results with those of Abelson et al. (2003) is particularly interesting given that we used the Australian research as a point of reference. As shown in Table 6-1, the estimated comparable ROI for road accident prevention in Switzerland (1.54) is only slightly lower than in Australia (1.77). The ROI estimated for tobacco prevention in Australia (49) is only slightly higher than in Switzerland (41). A comparison in the prevention field of alcohol is not possible as it was not considered in the Australian study. We may therefore conclude that our results appear to be reasonable or conservative estimates.

At this point, it may be helpful to discuss the correct interpretation of the ROIs we calculated. A ROI of 10 does *not* mean that for every franc invested in prevention, the national or cantonal government has a return of CHF 10 in terms of lower expenditures for public health or social welfare. The correct interpretation of a ROI of 10 is that the total social benefits, after the deduction of the costs of prevention, amount to CHF 10 for every franc invested. These social benefits include a reduction in medical

costs and other direct costs, which are in part covered for by the public funding, a reduction in productivity losses and intangible costs. Productivity losses correspond to a loss of national income due to the absence from work caused by illness and premature death. They are reflected in public finances only as far as they lead to losses in tax revenues. The reduced human suffering due to successful prevention, which is measured in the form of prevented intangible costs, does not appear at all in public finances, although it is probably the main objective of prevention measures.

It may also be useful to discuss the ROIs estimated for prevention programmes with the standards of economic evaluation applied in the curative heath care. The standard approach in economic evaluation of a new drug or medical device is to calculate

Table 6-1 Comparison of ROIs in three prevention fields (in million 2007 CHF)

	Road accidents Public prevention programmes 1975-2007	**Tobacco** Prevention focussing on behaviour 2007	**Alcohol harmful use** Prevention focussing on behaviour 2007
Costs of prevention	5'168	19	22
Benefits of prevention			
Direct medical costs	6'212	139	76
Direct non medical costs	4'138		16
Production losses	22'098	315	152
Intangible costs	21'476	342	277
Total prevented costs	53'924	796	520
ROI	**9.43** (7.6 – 11.3)	**41** (28 – 48)	**23** (11– 29)
ROI of all road accident interventions including private expenditures (Switzerland)	**1.54** (1,05 – 2,03)	**not relevant**	**not relevant**
ROI in study by Abelson et al. (2003) (Australia)[a]	**1.77**[b]	**49**	**no estimate**

The numbers in parenthesis represent the confidence interval of the ROI. The confidence interval is calculated by varying the coefficients of the prevention measures estimated in the effectiveness estimation by one standard error (a measure of the variability of the coefficient). This variation corresponds to a 68% probability range.

[a] *Note that the comparisons are limited by methodological differences between the studies and the type of prevention interventions considered.*

[b] *For a comparison of the ROI of the Australian and the Swiss road accident prevention studies: Considering the type of costs included, the appropriate comparison is with the ROI of all interventions, including private expenditures (first row of the table).*

its cost-effectiveness with respect to an existing health care procedure. The new drug or medical device is considered cost-effective if its additional costs are justified by a sufficiently high gain in health or quality of life of the patients treated. The new procedures in curative medicine are thus not expected to save costs, although they sometimes do. In the case of the prevention programmes evaluated we found that in comparison with standard treatment "no prevention" these measures are clearly cost-saving, as the direct medical costs prevented are higher than the costs of prevention in all of the three prevention fields. Furthermore, this difference is considerably higher if we include the prevented productivity losses. If we apply the standards used in the evaluation of curative medicine to the public health interventions we evaluated, we should conclude that they were a good investment as they were not only effective but also cost-saving.

Note also that we did not consider the effects of prevention on the future costs of health care expenditure which could possibly be incurred when people live longer. Although the consideration of these costs is sometimes proposed we believe that it would be odd to do so as the objective of public prevention and health promotion policies is a healthier and longer life for the population (see Richardson 2004).

General lessons and relevant policy implications with regard to the three thematic areas

- This research has demonstrated the potential benefits of preventions measures and shown that they can deliver good value for money for society as a whole. This does not mean, however, that each specific prevention measure can deliver the same value for money. For planning, it is therefore important to refer to existing evidence on the cost-effectiveness of individual interventions and consider how well the evidence relates to the specificities of the context for which it is planned before adopting the intervention.
- The introduction of new prevention interventions may have a high ROI even in prevention fields with a long history of successful prevention efforts and where additional improvements to health may appear difficult to achieve. This certainly applies to the road accident prevention measures introduced in 2005 (lower maximum blood alcohol level, possibility for the police to test for blood alcohol level without prior indication of intoxication, tightening of sanctions, etc.) for which we estimate a ROI of 8.06.
- The results show that information and education measures have contributed considerably to the reduction of road accidents, tobacco consumption and excessive alcohol consumption. Structural prevention combined with behavioural interventions (e.g. compulsory use of safety devices, education programmes and control activity by traffic police) play a major role in the large reduction of severe road accident casualties.

Specific lessons and relevant policy implications for each of the three thematic areas

Road Accidents

- Measures aimed at safer behaviour on the road yield a higher return than investment in road infrastructure and safety devices, which by far represent the biggest part of safety expenditure.
- The crucial role of increased safety-belt wearing in the reduction of road accident casualties is an important example of how successful prevention of road accidents is often a combination of technical progress and regulation (introduction of technically improved safety-belts, compulsory safety-belts on new cars since 1971), laws imposing a change of behaviour (compulsory safety-belt wearing first introduced from 1976 to 1977 and then permanently in 1981), traffic-police controls enforcing the laws, improved driver education and continuous information programmes. The initially strong political opposition to compulsory safety-belt wearing appears bizarre today, if we consider its huge effect in reducing road accident casualties in Switzerland over the past 30 years and the fact that safety-belt wearing is today felt as an almost natural behaviour by most car occupants.
- However, the availability of data on the amount of resources spent on road accident prevention and how they are spent is limited. A systematic collection of this kind of information should thus be encouraged in order to allow the coordination and evaluation of future road accident prevention measures.
- Overall the analysis shows the importance of public prevention programmes in the substantial reduction of road casualties during the period between 1975 and 2007. The case of road accident prevention in Switzerland thus appears to be an example of a highly successful prevention strategy.

Tobacco

- The resources for advertising and promotion of tobacco products are several multiples of those available for prevention activities. This presents a significant challenge to public health and prevention efforts in particular. Despite this, prevention efforts are showing a return on the investment and therefore should not be reduced in the years to come.
- Prevention activities other than tax on cigarettes have proven to be effective in reducing smoking consumption and prevalence. Our study submits strong evidence showing that tax on cigarettes is not the only effective tool to curb the smoking epidemic, but so are strategies based on information and education. Prevention efforts should not be reduced in the years to come: smoking prevalence remains high in Switzerland when compared with rates observed in other developed countries.
- Initiation and cessation rates are key determinants of change in smoking prevalence. Our research shows that *prevention programmes are more effective in*

terms of inducing smokers to consider quitting than in terms of convincing young people not to start smoking. Adolescents and young adults are highly receptive to tobacco advertising and less sensitive to prevention messages based on health risks. Anti-smoking messages have not been successful in countering the favourable image of smoking, which reduces the perception of risk (Slovic 2001). Tobacco advertising thus undermines prevention efforts. The key to the success of reducing smoking prevalence in the future is to achieve a significant lower initiating rate amongst the young. The goal will not be achieved by solely raising tobacco risks perception without changing the (positive) image of smoking. The perception of smoking as a normal behaviour has to be reversed. Currently based on four pillars (taxing tobacco products, providing information about risks, helping smokers to quit, protection from second-hand smoke), prevention policy should be supplemented by a comprehensive ban of all forms of cigarette promotion and advertising.

Alcohol

- Our study shows that in cantons with higher prevention expenditure the decline in prevalence tends to be greater.
- The prevention effort must be continued if the objectives of the 2008-2012 National Alcohol program are to be achieved, i.e. better knowledge of the risks, reduction of problematic consumption and lower prevalence of alcohol dependency.

Strengths of the research

- The main strength of this research is that for the first time in Switzerland an economic evaluation in this field was carried out using a common methodological framework. The three CBA studies are based on a comprehensive evaluation of the available Swiss data on prevention efforts and health outcomes over a period ranging from 10 (alcohol and tobacco) to 33 years (road accidents). A detailed calculation of the prevention costs and benefits has enabled us to calculate the ROI of a package of prevention measures – and, in some cases, of single measures as well.
- The use of a common methodology contributes to the comparability of the road accident and the alcohol and tobacco studies. These similarities include the use of the same cost categories on the benefit side (direct costs, production losses, intangible costs), the application of the DALY approach for the calculation of the health related life years gained due to prevention, a common valuation of a DALY at CHF 50,400 and the use of the same discount rate of 2% for costs and benefits.
- The organisation of the research project, which included four common workshops with the participation of a Scientific Advisory Board, contributed considerably to the quality of the study. The members of the Scientific Advisory Board also delivered important comments and inputs to the single project and synthesis reports.

Limitations of the research

- Despite the use of a common methodology the comparability of the results between the three selected prevention fields is limited due to variation in the quality and availability of data. For instance, estimations of the effectiveness of prevention interventions were deeply constrained by the availability of suitable data; a different statistical procedure was applied to estimate the effectiveness of road accident prevention compared with that used for the effectiveness of tobacco and alcohol prevention. Another example is the difference between the period covered by the study – it varied between 33 years for road accidents and 10 years for alcohol and tobacco.
- Furthermore, not all costs avoided due to successful prevention interventions could be considered. For example, in the case of road accident prevention the material damages of the vehicles were not included but were considered, however, in the sensitivity analysis.
- In a federalist political system, the delivery of prevention interventions is supplied by a range of different providers operating at different levels. This is particularly true in Switzerland. Accurate data on expenditure is therefore not always readily available, making the link between expenditure and benefits a difficult challenge. Additional efforts were therefore necessary in order to calculate expenditures (e.g. researcher prompted cantonal survey for alcohol and tobacco).
- The application of the DALY approach leads to an underestimation of the intangible benefits of prevention in all the three prevention fields. This is because the DALY weights are based on expert judgments which do not consider psychosocial effects of morbidity, and because existing DALY weights are poorly tailored to capture the quality of life lost due to accident injuries. These weaknesses are widely recognized and are one of the reasons for a major WHO project currently in progress which is aimed at developing a new DALY framework. Our decision to use DALYs in order to translate the reduction of morbidity obtained by prevention measures into health-related life years saved therefore leads to a conservative estimate of the ROI.
- Our research assumes causality in the absence of rigorous effectiveness data with regard to the three individual prevention programmes. However, this problem is well recognised and a recurrent theme in the methodological debate. As yet the issue remains a continuing challenge to economists, since demonstrating a direct causal link between the effectiveness of a bundle of prevention measures that are applied in a natural, non clinical setting is difficult to establish.

In view of the relatively scarce data available on prevention measures a number of assumptions needed to be made on the magnitude of some prevention measures and their costs (e.g. on the expenditure on structural measures for road safety). Every effort was therefore taken to counterbalance the use of evidence based judgments and increase the robustness of the work. Of these, most importantly, was the applied use of the lower bound for benefits and the upper bound for costs, thereby

tending to *underestimate the benefits* and *overestimate the costs* of prevention; the overall result is *a conservative estimate of the ROI*.

General Conclusions

Over the past years, prevention interventions in Switzerland in the fields of road accident, tobacco and alcohol have shown a considerable return for the money invested. In each case, this research has shown that prevention efforts have provided good value for money. Certainly, we cannot assume that what happened in the past will automatically apply to the future, but it seems plausible that well designed prevention measures may indeed show a considerable ROI in the future.

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