THE FISCAL IMPACT OF A COMPREHENSIVE TOBACCO CONTROL PROGRAM IN ONTARIO

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Foreword

This project is a collaborative effort between the Ontario Tobacco Research Unit and the Ontario Medical Association and was funded by the OMA and the Ontario Ministry of Health and Long-Term Care. This report was reviewed by a panel of international experts on tobacco control consisting of the following individuals:

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This report incorporates the feedback and expertise of the expert panel. The first draft of the report was prepared by Andra Ghent under the direction of Roberta Ferrence at the Ontario Tobacco Research Unit and Ted Boadway at the Ontario Medical Association. The Ontario Medical Association released a related, non-technical policy paper, "Investing in Tobacco Control: Good Health Policy, Good Fiscal Policy" on December 2, 2003.

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Executive Summary

It has long been clear to the medical community that tobacco imposes an enormous physical and emotional toll on smokers and their loved ones. Tobacco use causes cardiovascular disease, respiratory disease, lung and other forms of cancer, low birth weight infants, and a myriad of other illnesses (U.S. Surgeon General, 2000). Tobacco use also complicates the course of some illnesses not directly caused by smoking and increases the risks of anesthesia when surgically treating any condition (Kotani et al., 1999; Schwilk et al., 1997). The result is that almost 12,000 people in Ontario die each year as a result of smoking (Luk and Single, 2003; Xie et al., 1996; Chief Medical Officer of Health, 1996), most of whom started smoking as teenagers and developed the habit that would kill them before they were able to make a fully rational decision about whether the health risks were justifiable (World Bank, 1999, ch.1).

While the human costs of smoking are enormous, the present report focuses primarily on how we can reduce the monetary costs of tobacco use. Studies from the mid-1990s indicate that smoking costs the Province of Ontario $3.7 billion, or almost 1% of GDP, including $1.1 billion in direct health care costs (Xie et al., 1996; Single et al., 1996; Choi and Pak, 1996). More recently, Harrison et al. (2003) used a more sophisticated technique to calculate the costs of tobacco to Newfoundland and Labrador. Their findings suggest that the costs to Ontario might be 50% higher than those estimated previously.

The government of Ontario bears a substantial portion of these costs in the form of higher health care costs and lower income and sales tax revenue. The magnitude of the monetary costs suggests that the Ontario government should consider investing more in tobacco control to reduce these costs. As such, one way to view tobacco control is as an investment, and one criterion that the government should consider when deciding to what level to fund a tobacco control program is the net present value of this investment.

To be effective, tobacco control must be comprehensive, sustained, and receive adequate funding. A thorough examination of the available evidence on tobacco control strategies and the international guidelines put forth by the Atlanta-based Centers for Disease Control demonstrated that a five-year comprehensive tobacco control program in Ontario must include increasing tobacco taxes, a provincial order requiring that all public places be smoke-free, funding and assistance for smoking cessation, intensive mass-media and community based public education campaigns, school-based programs, and marketing bans.

This paper investigates the net present value of the investment in the five year comprehensive program proposed in the Report to the Minister of Health (Ashley et al., 1999) and the report of the Ontario Tobacco Strategy Steering Committee (2002). That is, we investigate whether the fiscal benefits accruing to the provincial government in the form of reduced health care expenditures, as well as higher income and sales tax revenue, justify the investment. We also

assess the impact of the program on the government's tobacco tax revenue and examine the effect of the program on the Ontario tobacco industry and the Ontario macroeconomy.

Under our benchmark forecast of a 15% reduction in prevalence over five years, and including only health care savings as the benefit, we find that the net present value of the project to the Ontario Government is $900 million. For every $1 the province spends on tobacco control, it will save over $3 in public health care spending. When we included the changes in provincial sales tax, income tax, and tobacco tax revenue, the net present value of the project rose to $16 billion, and the fiscal benefit-cost ratio grew to over 28. The program will produce immediate gains in tobacco tax revenues and rapid reduction in smoking attributable costs due to pregnancy complications and cardiovascular disease. Furthermore, the program will prevent more than 3,000 premature deaths and obviate over 140,000 hospital days in the ten years following the program's inception.

To confirm the robustness of our conclusions, we performed four sensitivity analyses wherein we conducted the analysis with different discount rates and forecasts for the change in tobacco use. If the program achieved even a 10% reduction in consumption (corresponding to a 5% reduction in prevalence) over five years, the health care savings alone would justify investing in it. We also deliberated the source and directions of biases in our analysis and ascertained that most of the risks biased our estimates of the net present value downwards. Based on these considerations, we do not believe that any omitted factors could possibly change our conclusion that the project has a positive net present value and should thus be undertaken by the government.

We have demonstrated that comprehensive and vigorous tobacco control is a project that will save lives as well as save the Ontario Government money. There are many other reasons to implement a comprehensive tobacco control program, such as protecting non-smokers from ETS, reducing the pain and suffering to smokers and their loved ones, and increasing the quality of air. We focus on the monetary costs here to show that the Ontario Government's investment in tobacco control is fiscally responsible. There are many programs that have benefits for the citizens of Ontario, and clearly the provincial government cannot fund all good initiatives. In this case, the province is not forced to choose between social spending and responsible fiscal management – it can accomplish both goals through one policy.

I Introduction

It has long been clear to the medical community that tobacco imposes an enormous physical and emotional toll on smokers and their loved ones. Tobacco use causes cardiovascular disease, respiratory disease, lung and other forms of cancer, low birth weight infants, and a myriad of other illnesses (U.S. Surgeon General, 2000). Tobacco use also complicates the course of some illnesses not directly caused by smoking and increases the risks of anesthesia when surgically treating any condition (Kotani et al., 1999; Schwilk et al., 1997). Smokers are thus more likely to die prematurely as a result of preventable illnesses, face extended hospital stays, and experience a lower quality of life while they are alive. The result is that almost 12,000 people in Ontario die each year as a result of smoking (Luk and Single, 2003; Xie et al., 1996; Chief Medical Officer of Health, 1996), most of whom started smoking as teenagers and developed the habit that would kill them before they were able to make a fully rational decision about whether the health risks were justifiable (World Bank, 1999, ch.1).

While the human costs of smoking are enormous, the present report focuses primarily on how we can reduce the monetary costs of tobacco use. Xie et al. (1996) and Single et al. (1996) estimated that, in 1992, tobacco use cost the Province of Ontario $3.7 billion[1], or almost 1% of GDP, including $1.1 billion in direct health care costs. Choi and Pak (1996) found a similar cost of $3.6 billion for 1988. More recently, Harrison et al. (2003) used a more sophisticated technique to calculate the costs of tobacco to Newfoundland and Labrador. Their findings suggest that the costs to Ontario might be 50% higher than those estimated previously.

The government of Ontario bears a substantial portion of these costs in the form of higher health care costs and lower income and sales tax revenue. The magnitude of the monetary costs suggests that the Ontario government should consider investing in tobacco control to reduce these costs. As such, one way to view tobacco control is as an investment, and one criterion that the government should consider when deciding to what level to fund a tobacco control program is the net present value of this investment.

To be effective, tobacco control must be comprehensive, sustained, and receive adequate funding. The Report to the Minister of Health from Her Expert Panel on the Renewal of the Ontario Tobacco Strategy (Ashley et al., 1999; herein Report to the Minister of Health) outlines the elements of a successful program for Ontario. They include increasing tobacco taxes, a provincial order requiring that all public places be smoke-free, funding and assistance for smoking cessation, intensive mass-media and community based public education campaigns, school-based programs, and marketing bans. Following the Report to the Minister of Health, the Ontario Tobacco Strategy Steering Committee produced a detailed template of what such a program should look like (Ontario Tobacco Strategy Steering Committee (OTSSC), 2002). They based their recommendation on a thorough examination of the available evidence on tobacco control strategies and the international guidelines put forth by the Atlanta-based Centers for

[1] All figures are in Canadian dollars unless indicated otherwise.

Disease Control (CDC, 1999). They recently submitted an estimate of the annual costs for each of the components (OTSSC, 2003).

This paper investigates the net present value of the investment in the program proposed in the Report to the Minister of Health and OTSSC (2002). That is, we investigate whether the benefits accruing to the provincial government in the form of reduced health care expenditures, as well as higher income and sales tax revenue, justify the investment. We also assess the impact of the program on the government's tobacco tax revenue.

Section II reviews the main elements in a comprehensive program and some of the available evidence on the effectiveness of each of the measures. Section III examines the experience of other jurisdictions with comprehensive tobacco control programs, and we derive our forecast for the reduction in consumption from the program based on this evidence. Section IV provides an overview of the approach we use to calculate the net benefit to the Ontario government of implementing the program and details the costs of the program. Section V calculates the present discounted value of the savings to the provincial government from the reduction in tobacco-related illness based on various assumptions about reductions in prevalence and the discount rate as well as the change in tobacco tax revenue. Section VI summarizes the results to find the total effect of the program on the Ontario Government's fiscal position, discusses some possible biases in our estimates, and offers some caveats regarding the analysis. Finally, section VII offers recommendations based on the results.

II The Components of a Comprehensive Tobacco Control Strategy

The addictive nature of cigarettes may sometimes create the illusion that there is no remedy for the problem. We now have evidence on the effectiveness of several strategies to reduce tobacco use among adults and prevent tobacco uptake among youth. Tobacco is not an insurmountable or mysterious public health issue; rather, it is a problem that we know how to tackle. The OTSSC (2002) and the Report to the Minister of Health (1999) provide recent and relevant examinations of the evidence base for the measures in the program. As such, this section only briefly reviews the main elements of an effective comprehensive tobacco control program and the empirical evidence on the successes of these measures for the benefit of the reader unfamiliar with the above documents and to provide some background to our forecasts for the reductions in consumption.

II.1 Tax Increases

Traditionally, governments have implemented tobacco taxes to raise revenue and they continue to be an important source of revenue for governments. There is also strong agreement among researchers and the tobacco control community that tax increases have a major impact on tobacco use. In a recent *British Medical Journal* review of the worldwide experience with tobacco control, Jha and Chaloupka (1999) conclude, "[t]ax increases are the single most effective intervention to reduce demand for tobacco."

There is also a consensus that price elasticity for adult tobacco consumption is between –0.3 and –0.5 (Chaloupka and Wechsler, 1997; U.S. Surgeon General, 2000), with the estimates centered on –0.4. That is, a ten percent increase in the price of cigarettes results in a four percent decline in consumption of cigarettes. Certain groups of the population are more sensitive to price increase than others. In particular, researchers find that, in response to a 10% increase in the price, prevalence among youth and pregnant women declines by 7% (Chaloupka and Grossman, 1996; Ringel and Evans, 2001). Smokers in lower income brackets are also more responsive to price changes (U.S. Surgeon General, 2000; Chaloupka et al., 1999), suggesting that tobacco taxes are less regressive than often thought and may even be progressive in some instances (Gruber and Koszegi, 2002). Finally, there is some evidence than men have more elastic demands than women (Chaloupka and Warner, 1999; Stephens et al., 2001).

Some studies using the most recently available Canadian and US data are finding somewhat higher elasticities than the consensus estimates based on the body of literature to date. Gruber and Koszegi (2001) find price elasticities for the general population in the range of –0.62 to –0.8 while Gruber and Koszegi (2002) estimate a price elasticity of –0.66. A recent study from the National Bureau of Economic Research (Gruber, Sen, and Stabile, 2002) examines price elasticity of cigarettes in the Canadian provinces. They find that the elasticity of legal sales of cigarettes in Canada is –0.7. Due to smuggling facilitated by the tobacco industry in the early 1990s, legal sales of cigarettes in Canada may overstate the elasticity of consumption. After controlling for the effect of smuggling in three different ways, Gruber et al. (2002) find that the elasticity of cigarette consumption is tightly centred around –0.45 to –0.47.

Currently, cigarette prices in Ontario are significantly below those of all other provinces except Quebec and most adjacent U.S. states (Smoking and Health Action Foundation, 2003). As of April 2003, the price of a carton of cigarettes in Ontario is $9.28 below the average of the prices in adjacent jurisdictions; it is $14.37 below the average of the price of a carton in the other nine Canadian provinces. Because of this price differential, the homogeneity of the product within Canada, and weak enforcement of measures to combat inter-provincial smuggling, Ontario has become a source of smuggled cigarettes to other provinces. The Criminal Intelligence Service of Alberta recently identified Ontario as "the main source of illegal smokes in Alberta" (Rassel, 2003). A comprehensive tobacco control program would raise the tax on tobacco by $14.37 to raise the price of cigarettes in Ontario to the average price of the other nine provinces.

Some observers worry that this will create smuggling akin to that seen in the early 1990s. Readers should bear in mind that the smuggling of the early 1990s happened in large part because the tobacco industry facilitated the smuggling - smuggling is not inevitable. Despite the abetting of smuggling by the tobacco industry, tobacco taxes were a very effective tool to decrease cigarette consumption in Canada during that period - the effect of a 10% price increase was to decrease consumption by about 4.5% after controlling for the impact of smuggling (Gruber et al., 2002). Furthermore, total tobacco tax revenues rose at both the provincial and federal levels during the 1990s, indicating the tax increase was still an effective revenue generating strategy.

Since the early 1990s, the federal government has also implemented a number of measures to combat smuggling. In April of 2001, the federal government instituted an export tax of $10 per carton for exports of up to 1.5% of a tobacco manufacturer's production and $22 per carton for exports above the 1.5% threshold. This tax is designed to prevent the type of smuggling seen in the early 1990s where Canadian tobacco exports to the U.S. increased dramatically only to be immediately smuggled back into Canada. The export tax substantially reduces the profitability of smuggling for tobacco manufacturers and thus acts as a disincentive for them to aid and abet smuggling. Because of the different tastes of Canadian and U.S. cigarettes, they are seen by smokers to be far from perfect substitutes so that smuggling between Canada and the U.S. is not a serious concern beyond that of Canadian exports destined for illegal reentry at a later date. Data from the COMMIT study indicates that few Canadians smoke U.S. brands and even fewer U.S. smokers smoke Canadian brands. The federal government has also established an anti-smuggling task force in cooperation with U.S. authorities. Finally, the federal government has launched legal action in both Canada and the U.S. to recoup its foregone tax revenues, making it clear to tobacco manufacturers that it will not be profitable to smuggle. For these reasons, the conditions that led to smuggling a decade ago no longer exist, and the likelihood of smuggling is very low, particularly if the Ontario government takes steps to ensure this.

The remaining concern is the Province of Quebec, where tobacco prices would be below those in Ontario. To maximize both the fiscal and health impact of the tax increase, the Ontario government should encourage Quebec to raise tobacco taxes and follow the guidelines set out by Scollo and Sweanor (2000). According to these evidence-based guidelines, the Ontario Government should

- *require sophisticated covert and overt tax markings on all tobacco products*
- *ensure that product markings allow detailed tracing of any products (including exports) through the distribution chain*
- *increase and enforce penalties for smuggling. Smuggling must be seen as a clear loss-making business in order to discourage it*
- *hold tobacco companies and their executives liable for any involvement in activities that contribute to smuggling.*

II.2 Smoke-Free Public Places

The primary motivation behind the push for smoke-free public places is to protect the health of non-smokers from Environmental Tobacco Smoke (ETS). However, this policy has also been found to decrease tobacco consumption and prevalence. For instance, Chaloupka and Saffer (1992) account for the endogeneity between the enactment of public place bans and reductions in cigarette sales. That is, they use an econometric technique that permits them to control for the fact that it is the jurisdictions where there is more anti-tobacco sentiment that are more likely to enact public place bans. They nevertheless find that "if every state had enforced a public place law…. cigarette sales would have been approximately 17 percent lower, on average."

Woodruff et al. (1993) find evidence that, even after accounting for demographic factors, smokers working in smoke-free workplaces are much more likely to quit than their counterparts in workplaces where smoking is allowed and that continuing smokers smoke less. They also ascertain that occasional smokers were 35% more likely to become regular smokers in workplaces with no restrictions than occasional smokers who worked in smoke-free workplaces.

Fichtenberg and Glantz (2002) similarly found that smoke-free workplaces reduced smoking prevalence by 3.8% and per employee cigarette consumption in affected workplaces by 29%. They posited that if all workplaces in the US and UK became smoke-free, per capita consumption would fall by 4.5 and 7.6 percent respectively. Other studies finding smoke-free public places successful in reducing consumption include Jha and Chaloupka (2000), Stephens et al. (1997, 2001), and Yurekli and Zhang (2000). Examining a slightly different issue, Chaloupka and Wechsler (1997) and Wakefield et al. (2000) find smoke-free public places effective in deterring young people from smoking.

Based on this evidence, the recommendation of the OTSSC, and the growing body of literature on the effects of ETS, a comprehensive tobacco control strategy requires that Ontario make all public places smoke-free.

II.3 Smoking Cessation Assistance

A common misconception is that nicotine is the most harmful ingredient in tobacco products. In fact, most of the damage caused by tobacco use comes from the delivery mechanism: the cigarette (Ontario Medical Association, 1999). Ideally, nicotine users could stop using nicotine altogether. Unfortunately, many nicotine users are unable to completely stop using it. However, smokers can quit smoking much more easily than they can give up nicotine and nicotine replacement therapy (NRT) is highly preferred to a continuation of smoking. The Ontario Medical Association (1999) reviewed dozens of published studies on the effectiveness of NRT and buproprion (brand name Zyban or Wellbutrin) and found that use of smoking cessation tools approximately doubles smoking cessation rates. In their independent review of the evidence, Raw et al. (1999) reach the same conclusion. More recently, Hughes et al. (2003) performed a

meta-analysis of NRT studies and found that over-the-counter NRT more than doubles the quit rate relative to patients given placebos. Unfortunately, the cost of smoking cessation therapy is similar to that of smoking and so there is currently little immediate economic incentive for a nicotine user in Ontario to switch from cigarettes to NRT or to commence buproprion treatment.

Other important tools in smoking cessation are interventions by the primary care team and community support programs. Based on a review of almost 20 years of evidence, Raw et al. (1998) recommend that the primary care team a) Ask patients whether they smoke, b) Advise all smokers to quit, c) offer Assistance if smokers indicate they are ready to quit, and d) Arrange follow up. In 2000, the American Medical Association issued a consensus statement endorsing a similar approach based on its review of over 6000 peer-reviewed articles on assessment and treatment of tobacco use. A report endorsed by the Optimal Therapy Initiative (2000) at the University of Toronto recommends similar treatment based on its review of the evidence. Fiore, Bailey, Cohen et al. (2000) found in their meta-analysis of 43 studies that minimal interventions (lasting 3 minutes or less) raised the odds of a smoker quitting by 30% relative to no intervention. Importantly, Raw et al. (1998) and Parrot et al. (1998) find clinical intervention to be a highly cost effective health care policy.

Since 1996, the Clinical Tobacco Intervention (CTI) Program has helped to educate and encourage Ontario physicians to assist patients with their smoking cessation efforts. CTI is an evidence-based program designed to recruit and mobilize physicians, pharmacists, and dentists to perform tobacco cessation and prevention interventions through the provision of educational programs, patient materials, ongoing support, and evaluation. CTI focuses on the minimal contact intervention approach (brief patient interventions lasting 3-5 minutes), and the five A's model of: Asking patients about their smoking status, Advising patients about the health risks, Assessing patients' readiness to quit, Assisting patients that are ready to quit, and Arranging follow up.

The comprehensive program delineated in OTSSC (2002) requires subsidization of NRT and buproprion, ensuring the availability of a range of primary care cessation services, enhancements to the Clinical Tobacco Intervention Program, as well as funding for cessation-specific mass media campaigns, cessation related research, and grants to community-based cessation programs.

II.4 Industry Advertising Ban and Education Programs

It is exceptionally difficult to convey the message that tobacco is neither socially acceptable to use nor a legitimate business if the province permits the tobacco industry to promote its product. While Canada no longer permits the tobacco industry to use mass media or billboards to market tobacco, restrictions on tobacco promotions are most effective when they are comprehensive (Saffer and Chaloupka, 1999). Currently, tobacco manufacturers still "advertise" through distinctive packaging and display cases in variety and department stores, bars, gas stations, and other sites of tobacco sales.

Recent econometric research posits that the effects of advertising are a function of the stock of advertising rather than the annual expenditure on advertising (Saffer and Chaloupka, 1999; Farrelly et al., 2001). That is, the effects of advertising are not felt in the year of the advertising; a consumer's perception of a product depends on the level of advertising, which is determined by the sum of all previous advertising expenditures. This implies that Ontario continues to suffer from the extensive mass media advertising by the tobacco industry of the last four decades despite the recent prohibition on this form of advertising.

To accelerate the depreciation of the tobacco industry's capital "stock" (i.e., the effects of their past advertising), mass media campaigns and school-based programs need to reiterate the messages that tobacco is harmful to smokers and non-smokers, that tobacco use is not glamorous, and that tobacco is exceptionally addictive. Stephens et al. (2001) suggest that an increase of $1 per capita in health education spending would be sufficient to induce a 20% decline in prevalence among men (but not women). Studies by Hu et al. (1995a, 1995b), Jha and Chaloupka (2000), and Saffer and Chaloupka (1999) similarly find that increased spending on anti-smoking advertising campaigns reduces tobacco use.

Based on the above, the program as outlined by the OTSSC (2002) involves eliminating display cases, requiring plain packaging, increased funding for the current mass media campaign, and funding for local advertising campaigns to support smoke-free workplaces, public places and homes.

III Evidence from Comprehensive Programs

Evidence from several jurisdictions has shown that comprehensive tobacco control works. While the evidence-based CDC guidelines are relatively recent, they draw upon the experience of U.S. states with comprehensive tobacco control, all of which have achieved dramatic reductions in consumption as a result of their tobacco control programs. In this section, we consider only the comprehensive programs that had reducing adult consumption as one of their primary aims. Our goal is to project the impact of the proposed program on per capita consumption. Programs intended mainly to reduce tobacco use by youth, such as the Florida program, are less relevant for our purposes.

III.1 California

In 1988, California enacted Proposition 99 and became the first U.S. state to implement a comprehensive tobacco control program. *Proposition 99* raised tobacco taxes by 25 cents per pack and earmarked 25% of the new tax revenue for state-sponsored tobacco control campaigns. The result has been a more than 50% decline in per capita cigarette consumption since the program's inception (California Department of Health Services, 2000; Campaign for Tobacco-

Free Kids, 2003a) and a 25% reduction in prevalence (California Department of Health Services, 2002a). The quit rate in California has risen from just over 2% of smokers annually in 1988 to almost 6% in 2000 (Hyland et al., 2002). In the first few years of the program, per capita consumption in California declined 50% faster than in the rest of the U.S (Pierce et al., 1999). Following the passage of Proposition 99, the rate of consumption decline tripled (Siegel et al., 2000). In the first five years of the program, per capita consumption fell 34% while prevalence declined 17% (California Department of Health Services, 2002a, 2002b).

California estimates that it saves over $3 for every $1 spent on tobacco consumption (California Department of Health Services, 2000). Fichtenberg and Glantz (2000) show that the program resulted in 33,000 fewer deaths from heart disease between 1989 and 1997. Fichtenberg and Glantz also reveal that cuts to the program's funding were associated with 8,300 more deaths from cardiovascular disease than if the program's initial aggressiveness had been maintained until 1997.

California achieved this success despite a program which did not include all of the elements evidence has since demonstrated are important to comprehensive tobacco control and without ever reaching the levels of funding recommended by the CDC. Smoking prevalence in California has declined much less dramatically since the program's funding was reduced and the tobacco industry increased its promotional expenditures (Pierce et al., 1998; California Department of Health Services, 2002a). California has maintained the reductions in prevalence it initially achieved as a result of the program and continues to see a slow decline in consumption.

III.2 Massachusetts

In 1992, Massachusetts approved the Massachusetts Tobacco Control Program. This program involved a tax increase and increased spending on a wide range of prevention and cessation programs. Tobacco consumption fell by 30% in the first five years of the program (Connolly and Robbins, 1998; Harris, 1999). Adult prevalence declined by 10% in the first five years of the program compared to no significant change in the remaining U.S. states excluding California (Biener, Harris, and Hamilton, 2000; Harris, 1999). Prevalence among pregnant women fell by 29% in the first year of the program and almost 50% in the first five years (Harris, 1999). The quit rate in Massachusetts almost tripled between 1992 and 2000 (Hyland et al., 2002). The program has reduced total health care spending by 0.3% (Harris, 1999). For every $1 the state of Massachusetts spends on tobacco prevention, it saves $2 in health care spending (Harris, 1999).

The program's first tax increase did not result in a sustained retail price increase because its effect on price was more than offset by an industry wide price reduction in 1993. This suggests that non-price measures can have a powerful impact on tobacco use since consumption fell in the absence of a real price increase. Unfortunately, in 2003 the program's funding was cut to just 13% of the CDC's recommended minimum (Campaign for Tobacco-Free Kids, 2003a),

suggesting that the program might not be able to achieve further reductions in prevalence in the coming years.

III.3 Oregon

In 1997, Oregon implemented *Ballot Measure 44*, which increased tobacco taxes and earmarked 10% of the revenues from the new tax to funding of public awareness and education programs. In the first two years of the program, per capita cigarette consumption fell by 11%, 5% more than had the program consisted of a tax increase alone (National Cancer Policy Board, 2000). Also in the first two years, the quit rate rose by almost 2 percentage points (Hyland et al., 2002). In the first five years of the program, per capita consumption fell 29% and prevalence declined by 12% (Oregon Department of Human Services, 2003).

Oregon continues to see results from its comprehensive program as its funding has not been significantly reduced since the program began. However, it is important to note that Oregon has not implemented all of the components in the CDC's Best Practices and meets only 50% of the minimum level of funding the CDC advises is necessary. The Oregon program would likely be still more successful if it were implementing all of the international best practices.

III.4 New Zealand

New Zealand has been on the leading edge of tobacco control among the OECD countries since it first publicized its intention to begin comprehensive tobacco control efforts in 1985. Between 1985 and 1998, New Zealand eliminated tobacco advertising, substantially raised taxes, and funded public information campaigns. The difference between New Zealand's programme and that of most of the U.S. states is that, rather than making a sudden change in tobacco policy, New Zealand gradually introduced the program elements. This factor makes it somewhat more difficult to evaluate the success of New Zealand's program. Nevertheless, between 1985 and 1998, New Zealand reduced per capita tobacco consumption by 45% and reduced prevalence by 17% (Laugesen and Swinburn, 1999). The program averted at least 1400 premature deaths between 1985 and 1996 (Laugesen and Swinburn, 1999).

Based on the consumption reductions achieved by three relevant U.S. state programs in their first five years of operation, our benchmark forecast is that adult consumption will decline by a total of 30% in Ontario over the five years of the program. To achieve this reduction, the funding needs to be sustained for five years as the evidence from California demonstrates. Results from the US COMMIT, where the program's effect on quit rates did not last beyond the years of intervention (Hyland et al., 2003) corroborates the need for sustained funding.

The benchmark forecast of 30% may be an underestimate since, of the three state programs we use for comparison, only Massachusetts achieved the CDC's required funding level. None of the

programs included all of the elements now recognized as international 'best practices' in tobacco control. To control for this possibility, we include in our analysis a scenario where consumption falls by 40%.

On the other hand, the 30% forecast may be an overestimate because of diminishing returns to tobacco control. The three U.S. comparison states initiated their programs when smoking was much more socially acceptable than it currently is in Ontario. It seems plausible that it is more expensive to induce cessation in the remaining "hard-core" smokers, those who continue to smoke despite substantial increases in the incentives to quit brought about by legislative changes in the last decade in Canada and Ontario. Indeed, Hyland et al. (2002) present evidence that comprehensive tobacco control programs are more effective at reducing prevalence among light and medium smokers than among heavy smokers. We consider an alternate case wherein consumption falls by only 20% to control for this risk to our estimates. We expect these two risks to balance each other out such that 30% is a reasonable midpoint for our projection for the reduction in consumption.

IV Calculating the Costs and Benefits of Tobacco Control

IV.1 Investment Valuation: the Concept of Net Present Value

The standard technique economists use to assess the value of an investment project is to compare the total value today of the future cash flows from the project to the total cost today of the project.[2] In this case, the future cash flows of the project consist of the reduction in health care costs and the increased income and sales tax revenue from increased productivity associated with a permanent reduction of smoking prevalence. Because a dollar received next year is not as valuable today as a dollar received today, economists **discount** future cash flows. If I have a dollar today, I can invest it so that next year it is worth 1*(1+r) where r is the annual interest rate. For example, suppose I had $100 that I invested at an interest rate of 5%. In a year, that $100 will be worth $105. Because I cannot invest the dollar until I receive it, the value today of a dollar received next year is 1/(1+r); if I received $1/(1+r) today, it would be worth $(1/(1+r))*(1+r)= $1 tomorrow so that $1/(1+r) is the correct valuation of $1 received next year. Returning to our example, if instead of investing $100 today, I wanted to make sure that I had $100 next year, I need only invest $100/(1.05) = $95.24 today. Repeating this process for year two, we would find that the value of a $1 received two years from now would be $1/$(1+r)^2$. So if I wanted to ensure that I had $100 two years hence, I need only invest $100/$(1.05)^2$= $90.70 today. This pattern would hold for any time period such that $1 received in period t would be worth $1/$(1+r)^t$ today. Of course, the value of any cash flows received far into the future is very small because of the discount factor and approaches 0 when time t is sufficiently large.

[2] Stephens et al. (2000) also use the NPV evaluation technique to assess the economic costs and benefits of a school-based smoking prevention program.

The value of all future cash flows from a project is the sum of the cash flows received in each period from the start of the accrual of benefits to the end of the benefits. In our case, a permanent reduction in prevalence entails a permanent reduction in health care costs and a permanent increase in productivity (and thus government taxes). The **Present Discounted Value (PDV)** of the cash flows from our project if it starts to pay off in period τ is

$$\text{PDV (Benefit)} = \sum_{t=\tau}^{\infty} \frac{(HealthCareCostDecreases(t) + TaxSavings(t))}{(1+r)^t}$$

This sum is thus our total benefit from the project. As the size of the relevant time period goes to 0 ($t \rightarrow 0$), interest gets compounded continuously such that the discount factor becomes e^{-rt} and the sum becomes an integral. Our formula for calculating the benefit from the program is then

$$\text{PDV (Benefit)} = \int_{\tau}^{\infty} (HealthCareCostDecreases(t) + TaxSavings(t))e^{-rt}\,\text{dt}$$

The total cost of the program can be calculated the same way except that the limits of integration are 0 and 5. While the government should continue to invest in tobacco control after year 5 of the program, future expenditures on tobacco control will result in new reductions in tobacco prevalence; only a negligible fraction of the costs of future programs can be attributed to the maintenance of previous gains in prevalence reduction. Table 1 reproduces the costs of each of the components of the tobacco control program. Since the annual cost of the project is $90 million, the PDV of the cost of the project is

$$\text{PDV (cost)} = \int_{0}^{5} 90e^{-rt}\,dt$$

The **Net Present Value** (NPV) of the program is PDV (benefit) – PDV (cost). If the NPV is negative, then the costs clearly outweigh the benefits, and the project should not be undertaken. Conversely, if the NPV is positive, the investment is profitable and should be undertaken.

While evaluating the PDV of the cost of the project is straightforward, the next subsection describes the approach we use to estimate the reductions in morbidity and mortality that will result in lower health care costs and higher income and sales tax revenue.

Table 1 - Cost of Program (Millions of 2003 $)

Component	Annual Cost	Total Cost, r=5%	Total Cost, r=7%	Total Cost, r=4%
Community Programs to Reduce Tobacco Use	$ 10.12	$ 44.77	$ 42.69	$ 45.86
Chronic Disease Programs to Reduce the Burden of Tobacco-Related Diseases	$ 9.84	$ 43.53	$ 41.51	$ 44.59
School Programs	$ 12.40	$ 54.86	$ 52.31	$ 56.19
Enforcement	$ 7.34	$ 32.47	$ 30.97	$ 33.26
Province-Wide Programs	$ 7.34	$ 32.47	$ 30.97	$ 33.26
Mass Media	$ 15.26	$ 67.53	$ 64.39	$ 69.17
Cessation Programs	$ 17.46	$ 77.24	$ 73.66	$ 79.12
Surveillance and Evaluation	$ 8.98	$ 39.73	$ 37.88	$ 40.69
Administration and Management	$ 1.32	$ 5.82	$ 5.55	$ 5.96
TOTAL	**$ 90.06**	**$ 398.42**	$ 379.94	$ 408.13

IV.2 The Relative Risk Methodology

Most of the studies in Canada have used a cost-of-illness approach to estimate the costs of smoking (Kaiserman, 1997; Choi and Pak, 1996; Single et al., 1996; Xie et al., 1996; Raynauld and Vidal, 1992; Luk and Single, 2003). This method consists of first establishing how much smoking raises both current and former smokers' risk of developing each smoking associated disease. These risks are called **relative risks** (RRs) with a RR of 1 corresponding to the case for a non-smoker. For instance, if the risk of a non-smoker developing lung cancer is 1 in 77, and the RR for a current smoker is 13, then the risk of current smoker developing lung cancer is 13*(1/77) ~ 1/6 or 1 in 6.

Table 2 contains the relative risk data we use in this study, which comes from Luk and Single (2003). Luk and Single (2003) derive their relative risk data from English et al.'s (1995) comprehensive meta-analysis of hundreds of studies on relative risks from tobacco use. The studies English et al. included had to meet stringent criteria such that the meta-analysis only includes studies that controlled for confounding factors, separated the risks of current and former smokers, and calculated age and sex-specific risks.

The advantage of using these data is their reliability; however, among the disadvantages is that over the last ten years, it has become clear that many diseases previously thought unrelated to tobacco use are in fact caused by tobacco. Luk and Single (2003) updated the tables based on some of the more recent medical literature, but it is likely that we are still missing some of the diseases linked with tobacco use. A further disadvantage is that this methodology ignores the additional health care use by smokers from illnesses not directly attributable to tobacco use. Smokers generally experience more complications in surgery such that they spend more time in hospital on average for all kinds of procedures. Smoking also weakens immune systems such that smokers are more likely to contract infections and spend more time recovering from them. Chaloupka and Warner (1999) cite work suggesting that inclusion of such indirect health care costs could raise estimates of the costs of smoking by 50% or more. Indeed, a recent study by Harrison et al. (2003) that includes these costs finds per capita costs of smoking in Newfoundland were 50% higher than previous estimates using the relative risk methodology.

Table 2 - Relative Risks

	Former smoker		Current smoker	
Disease	Male	Female	Male	Female
Lip & Oropharyngeal Cancer	1.76	1.76	4.55	4.55
Oesophageal Cancer	1.79	1.79	4.01	4.01
Stomach Cancer	1.11	1.11	1.41	1.41
Anal Cancer	1.83	1.83	3.18	3.18
Pancreatic Cancer	1.15	1.15	1.86	1.86
Laryngeal Cancer	2.86	2.86	7.48	7.48
Lung Cancer	6.75	5.07	13	11.4
Endometrial Cancer, 50+yr.		0.91		0.53
Vulvar Cancer		1.37		3.42
Penile Cancer	1.6		1.8	
Bladder Cancer	1.66	1.66	2.72	2.72
Renal Parenchymal Cancer	1.61	1.61	1.64	1.64
Renal Pelvic & Ureter Cancer	1.95	1.95	3.96	3.96
Parkinson's Disease	0.57	0.57	0.57	0.57
Ischaemic Heart Disease, Mortality <65yr.	1.59	1.59	2.58	2.58
Ischaemic Heart Disease, Mortality 65+yr.	1.12	1.12	1.54	1.54
Ischaemic Heart Disease, Morbidity <65yr.	1.32	1.32	3.51	3.51
Ischaemic Heart Disease, Morbidity 65+yr.	1.08	1.08	2.16	2.16
Pulmonary Circulatory Disease	6.7	6.7	9.8	9.8
Cardiac Dysrhythmias, Mortality, <65yr.	1.59	1.59	2.58	2.58
Cardiac Dysrhythmias, Mortality, 65+yr.	1.12	1.12	1.54	1.54
Cardiac Dysrhythmias, Morbidity, <65yr.	1.32	1.32	3.51	3.51
Cardiac Dysrhythmias, Morbidity, 65+yr	1.08	1.08	2.16	2.16
Stroke, <65yr.	1.3	1.3	3.12	3.12
Stroke, 65+yr.	1.15	1.15	1.65	1.65
Arterial Disease	1.82	1.82	2.54	2.54
Pneumonia & Influenza	1.29	1.29	1.47	1.47
COPD	6.7	6.7	9.8	9.8
Peptic Ulcer	1	1	6.8	6.8
Crohn's Disease	1.92	1.6	1.92	3.27
Ulcerative Colitis	1.71	1.71	0.63	0.63
Ectopic Pregnancy		1.27		1.46
Spontaneous Abortion		1		1.36
Haemorrhage		1		1.62
Hypertension in Pregnancy		1		0.78
Poor Fetal Growth		1		2.04
Premature Rupture Membranes		1		1.93
Congenital Anomalies (StillBirth)	1	1	1.33	1.33
Perinatal Conditions (StillBirth)	1	1	1.33	1.33
Effect of Maternal Hypertension	1	1	0.78	0.78
Effect of Prem Rupture Membr	1	1	1.93	1.93
Effect of Ectopic Pregnancy	1.27	1.27	1.46	1.46
Effect of Spontaneous Abortion	1	1	1.36	1.36
Effect of Placental Complications	1	1	1.62	1.62
Slow Fetal Grwth/Low Brthweight	1	1	2.04	2.04
SID Syndrome	1	1	2.76	2.76
Prophylactic Chemotherapy	6.75	5.07	13	11.4
Maintenance Chemotherapy	6.75	5.07	13	11.4
Chemotherapy Convalescence	6.75	5.07	13	11.4

Source: Luk and Single (2003)

Note: Relative Risks for Chemotherapy are assumed to be the same as those for lung cancer

Our reason for choosing the relative risk methodology is twofold. First, estimating all of the health care costs associated with smoking, instead of only those associated with smoking-related diseases, would require detailed data on physician, hospital, and drug use for smokers, former smokers, and non-smokers. Perhaps because of the limitations of existing data, a review of the literature found no work in which investigators have attempted to quantify the costs of smoking in Ontario using this more comprehensive methodology. Linking respondents to the newly available Canadian Community Health Survey (CCHS) with provincial administrative records of their health service utilization will hopefully enable researchers to reassess the costs to Ontario in the near future.

Second, using the relative risk methodology provides a simple way of reclassifying an adult smoker's costs after he or she quits by simply moving that adult into the "Former Smoker" risk category. This reclassification is crude because former smokers have a wide distribution of risks, a distribution that depends on many factors including how long the individual smoked before quitting, how long it has been since he quit, and the age at cessation. The estimates should balance out on average. This simplification likely leads to an underestimate of the costs of smoking, as the relative risks associated with former smokers in table 2 are relatively high and probably correspond to those in the first few years after cessation. For instance, the decrease in the relative risk for myocardial heart infarction and stroke in table 2 corresponds to that of a smoker who has quit for 1-2 years (Lightwood and Glantz, 1997; Negri et al., 1994; Dobson et al., 1991); most studies find that the risk of myocardial infarction and stroke five years after cessation are similar to that of a non-smoker or only slightly elevated (Lightwood and Glantz, 1997; Negri et al., 1994; Kawachi et al., 1993; Dobson et al., 1991). Similarly, while the lung cancer risk for a former smoker remains considerably higher than that of a non-smoker, Becher et al. (1991) estimate that the relative risk for lung cancer after three years of cessation is less than a quarter of that for a smoker; the relative risk for lung cancer for a former smoker, approximately half that of a current smoker, is thus much more conservative as shown in table 2 (Luk and Single, 2003). Another study (Sobue et al., 1993) indicates that the relative risk for lung cancer as shown in table 2 approximately corresponds to that of a former smoker who smoked for 40-50 years and stopped 5 years earlier. The use of aggregate relative risk data is thus more likely to lead to an underestimate than an overestimate of the savings.

The relative risk methodology enables us to quantify some of the health effects from ETS. We are able to assess the impact of maternal smoking on infants and thus calculate the direct health care costs associated with more low birth weight infants and many other obstetric complications attributable to maternal smoking. However, we are not able to attach a numerical value to many of the health care costs from ETS due to spouses, coworkers, and other sources of exposure. To do so, we would require more detailed data on levels of exposure and the smoking status of spouses, workplaces, and family and friends.

V Health and Fiscal Impacts

This section estimates the health and fiscal benefits based on various assumptions about reductions in consumption, reductions in prevalence, and the discount rate. In section III we projected a 30% decline in consumption as a result of the program. Part of this decline in consumption will come from smokers quitting, and part of it will come from continuing smokers smoking less. In their review of the literature, Chaloupka et al. (2000) find that about half the decline in consumption comes from the reduction in prevalence, implying that the program will induce a 15% fall in prevalence. These reductions in tobacco use are what we call our benchmark model. We include two alternative smoking scenarios, one where consumption falls by 40% (and prevalence falls by 20%) and another where consumption falls by 20% and prevalence decreases by 10%. We perform our analysis based on 1997 data because of its availability. Details on data sources are in Appendix 1.

We use 5% as the nominal discount rate in the benchmark model. This is slightly higher than the average yield on a five-year Government of Ontario bond over the past two years, which is arguably the relevant borrowing rate for the government. We chose this rate based on the guidelines by the Treasury Board of Canada (1998), which stipulate that, "[i]t is appropriate to use the actual cost of borrowing when the analysis is from the narrow fiscal point of view of the government". In sensitivity analyses, we use 7% and 4% as discount rates. We assume a 2% inflation rate since this is the mid-point of the Bank of Canada's inflation target band of 1-3%.

V.1 Morbidity and Mortality Reductions

Until the current youth category reaches the age of the cohort in question, the reductions in morbidity and mortality will be that of a switching of X% of current smokers from the current to former smoker categories. After the current "youth" generation reaches that age, the annual reductions will be that of switching X% of smokers from the current to the never smoker category; that is, a straightforward elimination of X% of the mortality and morbidity associated with smoking. Reductions in youth prevalence result in greater annual savings because they eliminate the mortality and morbidity associated with former smokers.

For instance, suppose prevalence in all age categories falls by 15% today. We could calculate the reductions in morbidity and mortality in the 40-44 year old age group over each of the next 25 years as the reductions associated with 15% fewer current smokers net of the increase in morbidity and mortality from that 15% of current smokers becoming former smokers. From year 26 onwards, the reductions in morbidity and mortality in that age group come from a 15% decrease in youth prevalence; that is, simply the reduction in morbidity and mortality from 15% fewer current smokers. Appendices 2 and 3 contain the net reductions in mortality and morbidity by age group and gender for the benchmark scenario of a 15% reduction in prevalence.

Table 3 summarizes the reductions in mortality and morbidity as a result of the program. Assuming the program receives adequate funding over each of its five years so that the 15% reduction in prevalence is achieved, the program will prevent 1,200 premature deaths in Ontario in its first five years. Even years after the initial program is over, the program will continue to prevent premature mortality in Ontario. At the end of 10 years, the program will have saved over 5,000 lives in Ontario.

The corresponding reductions in morbidity will free up tens of thousands of hospital beds and slow down the pace of provincial health care spending. In the first five years of the program, the program will save over 60,000 hospital days. At the end of ten years, the program will have saved over 140,000 hospital days. These savings in hospital utilization will end up saving the province hundreds of millions of dollars, as discussed in the next sub-section.

V.2 Health Care Savings

The health care savings from reducing morbidity are calculated using the estimates for the reductions in morbidity and mortality in each adult age group from a decrease in prevalence of X%. Because most of the health care costs associated with smoking occur during and after middle age, the reduction in health care costs associated with reductions in youth prevalence are heavily discounted. Most of our savings come from reductions in adult prevalence.

We consider only the public portion of the health care savings from reductions in morbidity. To calculate the reductions in health care costs associated with obviating one hospital day, we follow the methodology of Luk and Single (2003) in assuming that reductions in smoke-related physician, ambulatory, home care, and drug costs are proportional to the reduction in hospital days. We derived the fraction of the smoke-attributable health care savings attributable to the public sector from the National Health Expenditure Trends, 1972-2002 database. Because of a lack of data on the public and private sector distribution of ambulatory and home care costs, we assumed these costs were all attributable to the public sector. Appendix 4 contains the annual total and public health care costs associated with smoking.

Under the benchmark model, the health care savings of the comprehensive program would be $1.3 billion, or more than three times the cost of the program. The sensitivity analyses in Table 4 show that the health care savings are sufficient to justify the investment under any reasonable assumptions one might make about the discount rate or reduction in prevalence. If the program achieved even a 5% reduction in prevalence, the program would pay for itself in the reduction of health care costs alone. However, reduced health care costs are only a portion of the program's fiscal benefits.

Table 3 - Cumulative Mortality and Morbidity Reductions

	15% Fall in Prevalence		*20% Fall in Prevalence*		*10% Fall in Prevalence*	
	Lives Saved	**Avoided Hosp. Days**	**Lives Saved**	**Avoided Hosp. Days**	**Lives Saved**	**Avoided Hosp. Days**
Year 5	1,177	61,156	1,569	81,541	785	40,771
Year 10	3,141	142,994	4,188	218,037	2,094	109,019
Year 15	5,109	266,683	6,812	355,577	3,406	177,789
Year 25	9,066	476,414	12,088	635,218	6,044	317,609
Year 50	19,649	1,040,541	26,199	1,387,389	13,100	693,694

Table 4 - Health Care Savings (Millions of $2003)

	Decrease In Prevalence	**Discount Rate**	**TOTAL**	**Program Cost**
Benchmark	*15%*	*5%*	***$ 1,300***	*$ 398*
Alternate Case A	20%	5%	**$ 1,733**	$ 398
Alternate Case B	10%	5%	**$ 867**	$ 398
Alternate Case C	15%	7%	**$ 700**	$ 380
Alternate Case D	15%	4%	**$ 2,103**	$ 408
"Breakeven" Prevalence Decline	5%	5%	**$ 433**	$ 398
"Breakeven" Discount Rate	15%	10%	**$ 365**	$ 354

Note: Assumes a 2% rate of inflation.

V.3 Higher Income and Sales Tax Revenues

This section estimates the increase in income and sales tax revenue from reductions in both morbidity and mortality. Tax revenue will increase because the productivity of Ontario residents will increase as workers spend less time in hospital, fewer Ontarians die prematurely and thus forgo income, and smokers waste less company time on smoke breaks. This will result in more output being produced and the government receiving more revenue as a result of its share of this output. We consider each of the three sources of higher income in turn.

Because of the lack of data available on effective provincial income and sales tax data by income earners, we impute the value of the provincial government's share from its 2003 budget (Ontario Ministry of Finance, 2003). Based on this budget, provincial personal income and sales tax revenue is 7.1% of Ontario GDP so that for every $100 of new income, the Ontario government receives approximately $7.10 in income and sales tax.

The first source of the increase in income is the value of the economic output created by time spent working instead of in hospital. While a day spent in hospital consumes society's resources, a day spent working creates new resources. We use average incomes to estimate the value of this productivity.

A larger component of the loss to the Ontario government comes from smokers dying early. For each smoker that dies prematurely, the government forgoes not only its share of that individual's income this year, but its share of the income of that individual for all future years as well. To value this, we assume that a man would usually live to 78 years and that a woman would ordinarily die at age 82 if he or she did not smoke. We also assume productivity grows at an annual rate of 1% so that the value of the lost income increases over time and the effective discount rate is r-1% where r is the real interest rate. As in the morbidity calculations, a reduction in prevalence will result in a permanent reduction in the loss of this income as a result of fewer premature deaths every year.

A word of caution is in order regarding these estimates. We have used average Ontario incomes by age and gender to calculate the value of the productivity increase from the reduction in morbidity. However, smokers are concentrated in lower income brackets implying that the average income of a smoker will not be equal to that of the average Ontarian. Our estimates of the income increase are likely to be upwardly biased for this reason. Because of the progressive nature of the income tax system, our attribution of the income tax portion is also upwardly biased. However, the regressive nature of sales tax will likely offset the upwards bias in the income tax. We have excluded the revenue the provincial government would receive in capital gains and corporate profits taxes to dampen the bias introduced by the use of average Ontario incomes.

Finally, smokers often need to smoke so frequently that they must use employer time to do so. Based on work conducted by the Conference Board of Canada, Health Canada (2002) estimates that in 1995, "the average cost [in 1995 dollars] to employers due to the decreased productivity of employees smoking in non-break periods" was $2,175 annually per smoking employee. In 2003 dollars, this amounts to $1.7 billion in lost productivity to the entire province of Ontario each and every year. To estimate this cost, the researchers assumed that smokers in Canada take an average of two cigarettes per day at undesignated break time and that each cigarette absorbs 15 minutes of productive time. To our knowledge, there are no clinical or observational studies conducted in Canada to verify this assumption. However, an observational study in Australia (Borland, Cappiello, and Owen, 1997) found that Australian smokers smoke an average of 1.34 cigarettes on undesignated breaks.[3] If Canadian smoking behaviour and the length of breaks parallels that of Australians, the Health Canada figures may be a slight overestimate.

A recent U.S. study confirms that reducing tobacco use does in fact increase workplace productivity, independent of the increased absenteeism of smokers. Halpern et al. (2001) measure current and former smokers hourly productivity using 10 different objective measures of productivity. Former smokers were more productive in 7 of the 10 categories and, on average, were 4.5% more productive. That is, if the work day (excluding lunch and designated breaks) is 7 hours, former smokers produce 19 minutes worth more output every day than smokers.

We assume that half of any reductions in consumption result in increased productivity. That is, we assume that a 30% decline in consumption will result in a 15% reduction in the productivity costs of smoke breaks estimated by the Conference Board. We chose not to assume that the decline in consumption will result in an equivalent decline in lost productivity for two reasons. First, as discussed above, the Conference Board may have made a slight overestimate in the number of cigarettes smoked per day. Second, while the Halpern et al. study addresses the issue of the effect of declining prevalence on workplace productivity, we have no firm data on the effect of a decline in cigarettes smoked per day in continuing smokers on productivity. We thus felt it was best to be conservative on this issue until future work examines this issue more carefully.

Using these assumptions, the program will result in a productivity increase with a PDV of almost $34 billion. The Ontario government's portion of this gain is about $2.4 billion. Appendix 5 contains details of the savings from each of the components as well as the savings under alternate assumptions about the declines in consumption, prevalence, and the discount rate.

[3] It is worth emphasizing that the Borland et al. study is based on questionnaires smokers themselves answered. To the extent that smokers underreport how much smoking interferes with their job, the study's findings about cigarettes smoked on the job may be downwardly biased.

V.4 Higher Tobacco Tax Revenue

The Ontario Ministry of Finance (2003) estimates that it will receive $1.26 billion in tobacco taxes for fiscal 2003-2004. The tobacco tax is an important source of revenue for the provincial government, and any fiscal analysis of the proposed plan needs to explore the impact on provincial tax revenues. While consumption of tobacco will fall under our plan, the total impact of the program will in fact be to raise the province's total tobacco tax revenue. We explore the impact of the program on total tobacco tax revenue under a variety of scenarios. To assess the impact, we assume that the first third of the total drop in consumption occurs in the first year of the program, with an equivalent drop in each of the next two years. While the full fall in consumption will not be achieved by year 3, we did this in the interest of getting a conservative estimate for the increase in tobacco tax revenue. Appendix 6 summarizes the results. Under the benchmark assumptions, the PDV of the increase in tobacco tax revenue will be $7.5 billion.

The tobacco tax revenue is the most significant and most immediate component of the total fiscal benefits. It thus provides an immediate financing mechanism for the program until the province sees the reductions in health care costs and increases in provincial sales and income tax revenue. In the medium term (10 years), the other fiscal benefits of the program justify the provincial investment in the program. The tobacco tax revenues are best seen as providing the short-term funds to invest in the project.

V.5 Macroeconomic Impacts[4]

Some commentators might worry that we have ignored the effect of any decline in the tobacco industry on government tax revenues. This section explains why any shift in resources away from the tobacco industry will likely be negligible or have a neutral to slightly positive macroeconomic impact.

First, it is important to get an accurate measure of how important the Ontario tobacco industry is to the Ontario economy. Ninety-three percent of the direct employment in the tobacco industry is in Brant, Elgin, Norfolk, and Oxford Counties (KPMG, 2002). This concentration of the industry in a small geographical area and population often leads to an exaggerated public impression of the industry's overall contribution to Ontario's macro-economy. Readers should bear in mind that tobacco is a tiny industry relative to the Ontario economy. In 2001, the industry generated $157 million in value-added annually to the economy of Ontario (KPMG, 2002) or 0.035% of Ontario's 2001 GDP. Even if one includes the industry's estimates of the indirect value-added of $ 356 million (KPMG, 2002), the total value-added of the industry is only 0.12% of Ontario's 2001 GDP.

[4] While we do not consider it here because it is not relevant for the case of Ontario, jurisdictions doing similar analyses may need to consider the effect of any change in the CPI resulting from a tobacco tax increase on the jurisdiction's fiscal situation.

It is also important that analysts not link the fortunes of the Ontario tobacco industry too closely with tobacco consumption in Ontario. Tobacco is a global commodity such that only a small portion of the Ontario tobacco industry's production is consumed in Ontario. As of 2001, 50% of Canada's tobacco production (the vast majority of which is produced in Ontario) is exported to other countries (Agriculture and Agri-Food Canada, 2003). Consumption of the remaining 50% is distributed across the Canadian provinces with Ontario consuming slightly over 1/3rd of the total (Deloitte and Touche, 1995). Thus, just over 1/6th of the Ontario tobacco industry's output is consumed in Ontario. This implies that a 30% reduction in consumption in Ontario will result in at most a 5% drop in the demand for the Ontario tobacco crop rather than a 30% reduction.

Furthermore, the worldwide demand for tobacco continues to increase such that, as Warner (2000) asserts… "[g]lobally, therefore, the 'transitional costs' of successful tobacco control involves less rapid expansion of the tobacco industry, rather than dire economic straits attributable to its contraction." In the face of growing international demand, any contraction in the Ontario tobacco industry must result from the higher cost structure of Ontario tobacco growers relative to tobacco farmers in other parts of the world. If Ontario had a comparative advantage in tobacco production, we would see the Ontario tobacco industry grow despite our tobacco control efforts. A decline implies that Ontario's resources would be more productive if used in another industry. The long-term deterioration in the Ontario tobacco industry thus reflects this industry's higher cost structure, not the success Canada has had in reducing tobacco consumption.

It would also be misleading to assume that any modest decline in industry output resulting from the program would translate into declines in aggregate output. Any decrease in domestic tobacco consumption would result in either increased spending on other goods and services or increases in savings; the money smokers previously spent on tobacco would not disappear into a black hole. Nor would the resources previously used in tobacco production vanish never to be used again – either other industries would expand, or personal savings would rise, such that a decrease in tobacco consumption represents a redistribution of resources rather than any reduction in the productive capacity of Ontario. If savings rose, the effect would likely be stimulatory (Collins and Lapsley, 2003) as there would be more funds available for investment that is crucial for growth. If there were a contraction in the tobacco industry, there would be a transition period while resources were shifted out of the tobacco industry and other industries were able to increase production to meet a rise in the demand for their product. Resources from the tobacco industry would not lay idle indefinitely. The issue is then one of how long resources would lay idle, and the value of those resources, rather than a matter of simply eliminating the economic value of the industry.

Most studies find that the macroeconomic impact of a decline in the tobacco industry will be either slightly beneficial or neutral. In their seminal work, Warner and Fulton (1994) designed a computer simulation of the Michigan economy for 1992-2005 with and without the tobacco product sales. They found that a tobacco-free Michigan would have had 5,600 more jobs in 1992 with the net job gains declining to 1,500 by 2005. In another U.S. study, Warner and his

colleagues (1996) considered the effect of a doubling of the downward rate of decline in U.S. tobacco consumption and found that it would result in net employment gains in every one of the non-tobacco growing regions. Warner and his colleagues did find that such a decline would result in fewer jobs in the tobacco growing southeastern region but that these declines would be more than offset by increases in employment in the rest of the U.S. Readers should bear in mind that, at the time of Warner's analysis, the U.S. tobacco region employed almost 100 times more workers than its Canadian counterpart, such that it would be inaccurate to extrapolate from Warner's results to suggest that a decline in tobacco consumption would result in job losses in Ontario. It would be more accurate to think of Brant, Elgin, Norfolk, and Oxford counties as the tobacco-growing region of Ontario than of Ontario as the tobacco-growing region of Canada. Research reported by the World Bank (1999) found that the elimination of all domestic tobacco consumption in Canada would result in a 0.1% *increase* in employment.

At least one study (Irvine and Sims, 1997) has found that a 20% decline in cigarette consumption would result in a net reduction in employment and output in Canada. However, the key assumption generating that result was that the Government of Canada would reduce public spending in response to declining tobacco revenues because they did not assume any change in the tax rate on cigarettes. In the analysis presented above, total tobacco tax revenues rose as a result of a higher tax rate. Importantly, Irvine and Sims (1997) found that GDP at factor cost and total employment would rise if the government did not reduce its expenditures.

VI Net Fiscal Benefit to the Government of Ontario, Discussion, and Directions for Future Research

Figures 1-3 summarize the discussion to this point by graphically comparing the total costs of the program to its fiscal benefits; Table 5 provides a numerical summary. In all cases, the fiscal benefits from reductions in health care costs or increases in income and sales tax taken separately clearly justify the province of Ontario's investment in a vigorous and comprehensive tobacco control program. The fiscal benefits from the health care savings alone will result in savings of almost $3 for every $1 spent on the program in the benchmark model. Excluding the value of the tobacco tax revenue, the project's net present value rises to $3.3 billion. Including the increase in tobacco tax revenue, the fiscal benefits outweigh the costs by a factor of over 28 under the benchmark model. More conservative assumptions put this ratio at 19, while using a discount rate of 4% yields a fiscal benefit/cost ratio of over 40.

There are several caveats to the analysis presented here, some of which relate to pragmatic issues surrounding our calculation of the benefits and some that concern the conceptual framework we have adopted. First, limitations of the data and simplifications to make the analysis tractable introduce imprecision into our analysis that may bias our results upwards or downwards. Table 6 highlights some of these simplifications. However, as we show below, it is highly unlikely that any bias in these estimates would alter our conclusions.

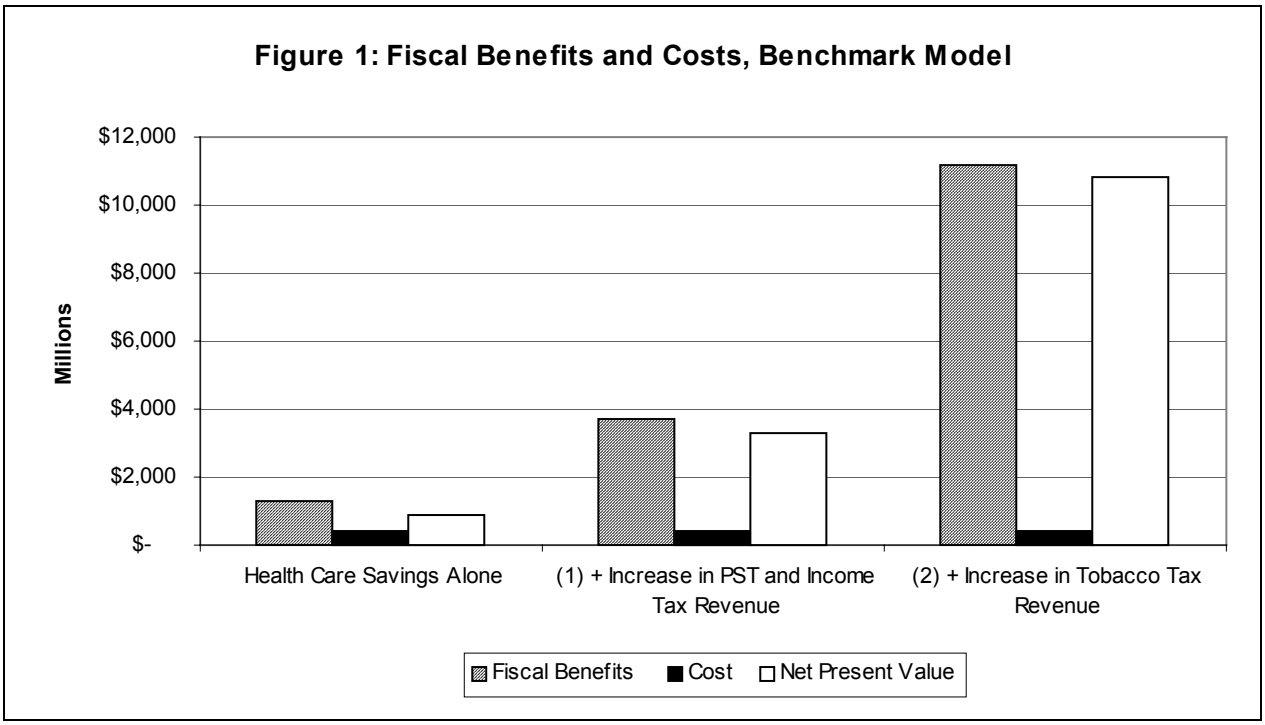
Figure 1: Fiscal Benefits and Costs, Benchmark Model
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$-
Millions
Health Care Savings Alone
(1) + Increase in PST and Income Tax Revenue
(2) + Increase in Tobacco Tax Revenue
Fiscal Benefits
Cost
Net Present Value

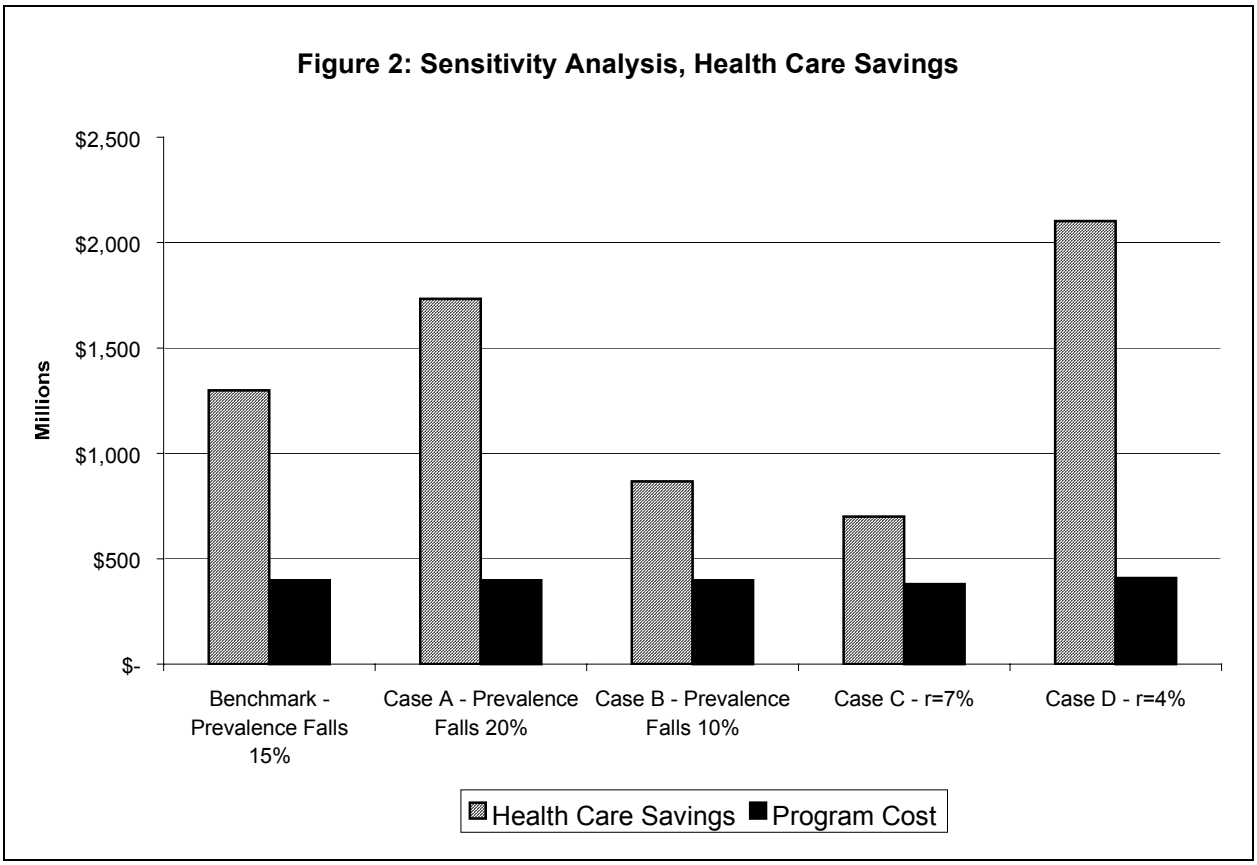
Figure 2: Sensitivity Analysis, Health Care Savings
$2,500
$2,000
$1,500
$1,000
$500
$-
Millions
Benchmark - Prevalence Falls 15%
Case A - Prevalence Falls 20%
Case B - Prevalence Falls 10%
Case C - r=7%
Case D - r=4%
Health Care Savings
Program Cost

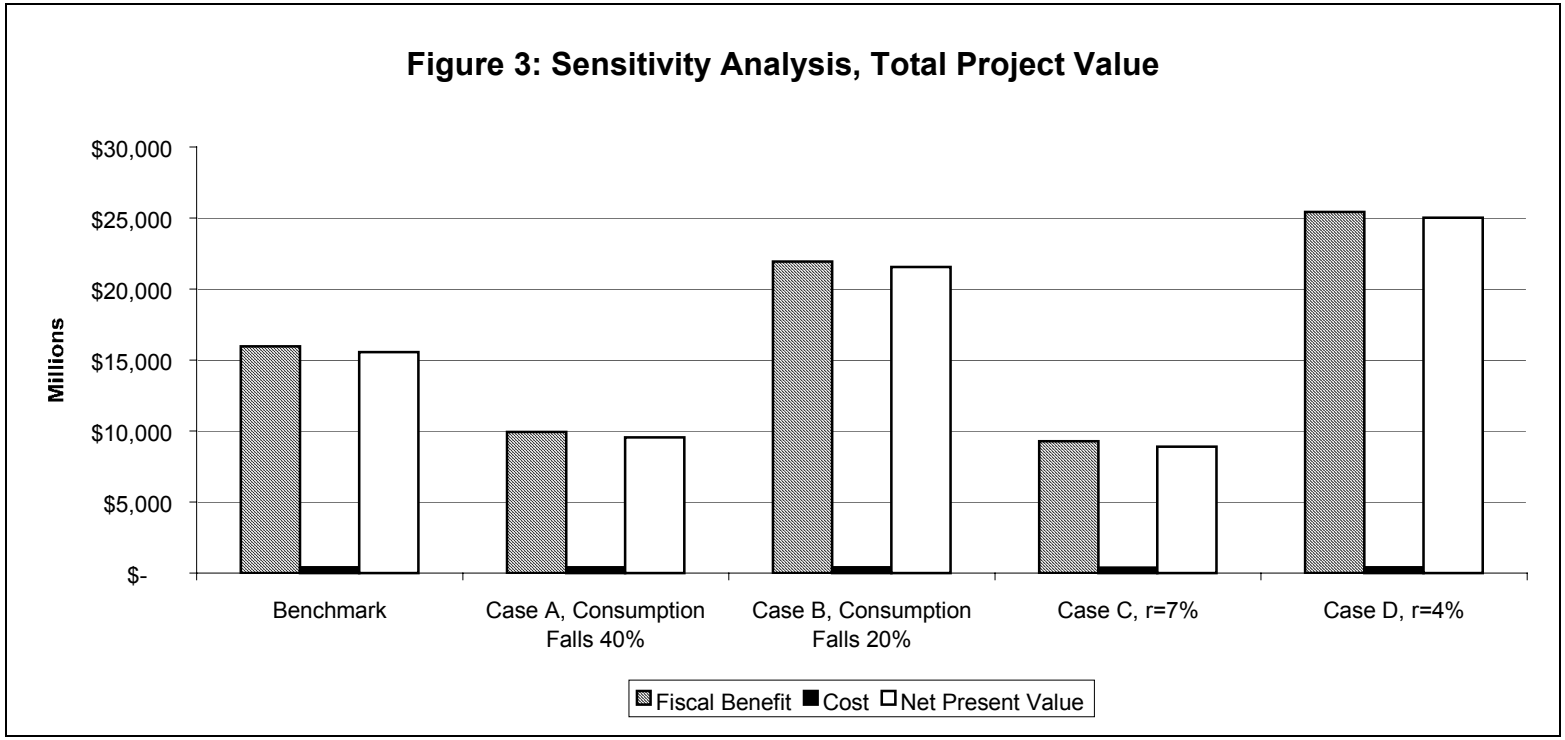
Figure 3: Sensitivity Analysis, Total Project Value
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
Millions
Benchmark
Case A, Consumption Falls 40%
Case B, Consumption Falls 20%
Case C, r=7%
Case D, r=4%
Fiscal Benefit
Cost
Net Present Value

Table 5 - Net Present Value of Project (in millions of 2003$)

	Decrease In Prevalence	Decrease in Consumption	Discount Rate	Fiscal Benefit (Millions of 2003$)	Cost (Millions of 2003$)	Net Present Value (Millions of 2003$)	Fiscal Benefit/ Cost
Benchmark	*15%*	*30%*	*5%*				
(1) Health Care Savings Alone				$ 1,300	$ 398	$ 902	**3.26**
(2) (1) + Increase in PST and Income Tax Revenue				$ 3,694	$ 398	$ 3,296	**9.28**
(3) (2) + Increase in Tobacco Tax Revenue				$ 11,194	$ 398	$ 10,796	**28.11**
Alternate Case A	20%	40%	5%				
(1) Health Care Savings Alone				$ 1,733	$ 398	$ 1,335	**4.35**
(2) (1) + Increase in PST and Income Tax Revenue				$ 4,926	$ 398	$ 4,528	**12.37**
(3) (2) + Increase in Tobacco Tax Revenue				$ 8,263	$ 398	$ 7,865	**20.75**
Alternate Case B	10%	20%	5%				
(1) Health Care Savings Alone				$ 867	$ 398	$ 468	**2.18**
(2) (1) + Increase in PST and Income Tax Revenue				$ 2,463	$ 398	$ 2,064	**6.19**
(3) (2) + Increase in Tobacco Tax Revenue				$ 14,126	$ 398	$ 13,727	**35.48**
Alternate Case C	15%	30%	7%				
(1) Health Care Savings Alone				$ 700	$ 380	$ 320	**1.84**
(2) (1) + Increase in PST and Income Tax Revenue				$ 1,783	$ 380	$ 1,403	**4.70**
(3) (2) + Increase in Tobacco Tax Revenue				$ 7,244	$ 380	$ 6,864	**19.08**
Alternate Case D	15%	30%	4%				
(1) Health Care Savings Alone				$ 2,103	$ 408	$ 1,695	**5.16**
(2) (1) + Change in Sales and Income Tax Revenue				$ 7,203	$ 408	$ 6,795	**17.66**
(3) (2) + Change in Tobacco Tax Revenue				$ 16,489	$ 408	$ 16,081	**40.43**

Note: Assumes a 2% rate of inflation and a 1% productivity growth rate.

Table 6 - Sources of Possible Bias in Estimate of Benefits

(1) Source	(2) Direction of Bias	(3) Affected Components	(4) Value of (3), Millions of 2003 $	(5) (3) as a % of Benefits (Excluding Tobacco Tax Revenue) in Benchmark Model
Exclusion of Many Illnesses due to ETS	Downwards	All Health Care Savings	$ 1,300	35.19%
	Downwards	Tax Revenue from Decreased Morbidity	$ 7	0.18%
	Downwards	Tax Revenue from Decreased Mortality	$ 287	7.76%
Total			$ 1,594	
Exclusion of Higher Use of Social Services by Children and Adults Born Low-BirthWeight	Downwards	No Included Component		
Control Group for Relative Risk Data exposed to ETS	Downwards	All Health Care Savings	$ 1,300	35.19%
	Downwards	Tax Revenue from Decreased Morbidity	$ 7	0.18%
	Downwards	Tax Revenue from Decreased Mortality	$ 287	7.76%
Total			$ 1,594	
Use of Average Canadian Incomes Instead of Average Canadian Smoker's *Incomes*	Upwards	Tax Revenue from Decreased Morbidity	$ 7	0.18%
	Upwards	Tax Revenue from Decreased Mortality	$ 287	7.76%
Total			$ 294	
Exclusion of Smoker's Higher Risks from Illnesses not Directly Associated with Tobacco Use	Downwards	All Health Care Savings	$ 1,300	35.19%
	Downwards	Tax Revenue from Decreased Morbidity	$ 7	0.18%
	Downwards	Tax Revenue from Decreased Mortality	$ 287	7.76%
Total			$ 1,594	

Perhaps most importantly, our analysis fails to consider most of the health care costs associated with environmental tobacco smoke (ETS). While we have considered some of the costs associated with birth complications from smoking during pregnancy, there are many other illnesses associated with ETS that we have not considered. This was done largely because of the lack of availability of good data on exposure to ETS and a widely accepted methodology for incorporating these costs. What we do know is that these costs exist and are sizable. ETS is a known or suspected cause of lung cancer, coronary heart disease, nasal sinus cancer, and several respiratory diseases in children (Ontario Tobacco Research Unit, 2001; California Environmental Protection Agency, 1997). The California Environmental Protection Agency (1997) estimates that cardiovascular disease and lung cancer caused by ETS kill between 4,560 and 7,800 Californians annually and that childhood respiratory disease due to ETS uses 78,6000 to 188,700 physician office visits. Aligne and Stoddard (1997) estimate that, in the US, the annual medical costs of parental ETS amount to US$5 billion. If ETS is responsible for similar numbers of per capita morbidity and mortality in Ontario, our estimates for the reductions in health care costs would be much higher.

Aside from the medical costs, parental ETS results in greater student absenteeism (Gilliland et al., 2003) and may cause developmental disorders that result in poorer academic performance while the student is in school. While it is exceptionally difficult to attach a number to these types of costs, they clearly reduce future productivity and result in greater expenditure on educational resources for lower results.

Closely associated with these types of costs are the expenses connected with the developmental problems low birth weight babies experience later in life. The U.S. Treasury (1998) estimates that low birth weight infants are 50% more likely to need to repeat a grade. While our study accounts for the savings in medical costs from reducing the number of low birth weight infants, we do not consider the reduction in educational costs from this outcome, nor do we consider the increase in productivity from fewer developmentally challenged children. This is likely to be a significant source of savings as fewer children will need to repeat grades, need special education, and children will become more productive from any given educational expenditure. Although we have not calculated the number of low-birth weight babies attributable to tobacco use, one U.S. study suggests that 1 in 7 low birth weight deliveries resulted from smoking during pregnancy (Oklahoma State Department of Health, 2000). This ratio is likely to be lower in Ontario because of our lower smoking prevalence, though clearly a significant percentage of Ontario's more than 6000 annual low birth weight deliveries result from smoking. Chaloupka and Warner (1999) cite evidence that inclusion of "the long-term intellectual and physical consequences of smoking-related low-birth-weight disabilities implied a tax of $4.80 [US] per pack in 1991!" We can unambiguously conclude that the omission of these savings biases our results downwards.

A further source of bias is our relative risk data. As discussed in Section IV, the relative risk data come from a meta-analysis of studies published in the 1980s and first half of the 1990s. Unfortunately, the risks ETS pose were not clearly understood by most of the researchers at the time and it is unclear that the control group (non-smokers) was completely unexposed to tobacco

use. Most people were likely exposed to ETS either through their work or home given attitudes prevailing about ETS at the time. Because the control group was not completely free of the toxin under study, the relative risk data is likely to be downwardly biased and use of this data will tend to underestimate the savings.

Finally, we have used average Ontario incomes to assess the income and sales tax savings from smoking cessation programs. However, smokers have lower average incomes than most Ontarians and using average Ontarian incomes will lead to an overestimate of the savings. While it is difficult to assess how much this might bias our results, the affected components constitute less than 8% of the fiscal savings (excluding increases in tobacco tax revenue) under the benchmark model. Therefore, this bias does not materially alter our results.

Aside from these smaller problems, our approach to the problem merits additional discussion. We have focused on assessing the fiscal costs and benefits for the Ontario government. We have not considered all of the economic benefits accruing to the Ontario government. Adopting a complete economic approach requires an evaluation of all of the outcomes of the program, even those results that might seem more difficult to quantify. The Ontario government surely puts some value on saving the lives of Ontarians and the quality of those lives. The very fact that the Ontario government spends any money on health care demonstrates that it does attach some measurable value to life that can be measured in dollars. If we were assessing the full economic impact of the study, we would need to have some dollar value for how much the Ontario government values a year of life adjusted by the quality of that year of life. Our exclusion of any inherent value of life should not be read to imply that the Ontario government puts a value of $0 on a quality-adjusted life year but rather that we have simply addressed a different question, that of the fiscal impact of the program. If we had adopted the economic approach, our estimation of the benefits would rise substantially since we would have included benefits from each quality-adjusted life year saved as a result of the program.

Some commentators (Raynauld and Vidal, 1992; Warner, Hodgson, and Carroll, 1999) argue that completeness of the fiscal impact assessment requires subtracting the health care costs the provincial government would save from smokers dying earlier than other Ontarians. The argument is that a smoker who quits smoking, or a person that never starts, will die of some illness not caused with smoking but one that nevertheless involves medical treatment covered by the province. Routine visits to physicians and other non-life threatening medical costs are also likely to be higher on average for nonsmokers because of their longer life spans. While this argument is technically correct, it is not one taken into account by most health care cost/benefit studies on other types of health interventions. It also seems to imply that the optimal health care expenditure by the province is $0. Finally, it is an argument that the court dismissed in at least one U.S. settlement case (Zeger et al., 1997) and which the tobacco industry has distanced itself from (Fairclough, 2001) because it appears incompatible with what we regard as basic human values. Nevertheless, we have included an analysis including the “death benefit” in appendix 7. Including the “death benefit” does not alter our main conclusion that the fiscal benefits of the program exceed the costs.

Future research should focus on conducting economic analyses of the impact of these programs rather than simply the fiscal impacts. This will give a broader perspective on the issue of why tobacco control is important from an economic perspective, albeit one that is perhaps somewhat more difficult to explain in the political forum.

There is also a need to use better methodologies to take into account all of the health care costs associated with smoking in Ontario and elsewhere. We could substantially improve our estimates of the direct health care costs of smoking by using econometric techniques that match smokers to similar non-smokers. To do this, researchers would need survey data containing information on smoking status and past smoking as well as records on health service utilization. Recent work by Harrison et al. (2003) and Johnson et al. (2003) takes excellent steps in this direction. In the longer term, it would be helpful to develop a microsimulation model to find the impacts on health outcomes and fiscal spending as a function of the time from which a smoker stops smoking, the duration of his or her habit, and other socio-demographic variables.

VII Recommendations and Conclusion

We have examined the fiscal costs and benefits for the Government of Ontario of a comprehensive tobacco control program using standard investment and cost/benefit analysis. Under our benchmark forecast of a 15% reduction in prevalence, and including only health care savings as the benefit, we find that the net present value of the project to the Ontario Government is $900 million. For every $1 the province spends on tobacco control, it will save over $3 in public health care spending. When we included the changes in provincial sales tax, income tax, and tobacco tax revenue, the net present value of the project rose to $16 billion, and the fiscal benefit-cost ratio grew to over 12. The program will produce immediate gains in tobacco tax revenues and rapid reduction in smoking attributable costs due to pregnancy complications and cardiovascular disease. Furthermore, the program will prevent more than 3,000 premature deaths and obviate over 140,000 hospital days in the ten years following the program's inception.

We performed four sensitivity analyses wherein we conducted the analysis with different discount rates and forecasts for the change in tobacco use. In all scenarios, the total fiscal benefit-cost ratio was above 19, and the health care savings alone justified the cost of the project. If the program achieved even a 10% reduction in consumption over five years, the health care savings alone would justify investing in it. We also deliberated the source and directions of biases in our analysis and ascertained that most of the risks biased our estimates of the net present value downwards. Based on these considerations, we do not believe that any omitted factors could possibly change our conclusion that the project has a positive net present value and should thus be undertaken by the government.

We have demonstrated that tobacco control is a project that will save lives as well as save the Ontario Government money. We must reiterate that these costs are only the most measurable of

the costs associated with smoking. There are many other reasons to implement a comprehensive tobacco control program, such as protecting non-smokers from ETS, reducing the pain and suffering to smokers and their loved ones, and increasing the quality of air. We focus on the monetary costs here not to minimize the other less tangible costs; we do so only to show that the Ontario Government's investment in tobacco control is fiscally responsible. Presumably, the Ontario government assigns some value to these costs as its agent of the public, such that there are more reasons the government should undertake the project than those presented here. There are many programs that have benefits for the citizens of Ontario and clearly the provincial government cannot fund all good initiatives. In this case, the province is not forced to choose between social spending and responsible fiscal management – it can accomplish both goals through one policy.

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Appendices

Appendix 1 – Data

Health Care Data
Health Care data on Days Stay by ICD-9 Code are from the Hospital Morbidity Database of the Canadian Institute for Health Information (CIHI), courtesy of the Central East Health Information Partnership.

Mortality data are from the Health Indicators Database (1999), Statistics Canada.
Health Care data on the share of public and private expenditure by category come from the Canadian Institute for Health Information's National Health Expenditure Trends, 1975-2002 database.

To calculate the death benefit, we use average per capita annual Ontario Government Health Expenditures for 2001 by age and gender from Table 10C of *Health Expenditures in Canada by Age and Sex* (2001), Health Canada.

Population Data
Ontario Population by age and gender comes from CANSIM II table 051-0001 - Estimates of population, by age group and sex, Canada, provinces and territories, annual (Persons).

Income Data
Income data is based on 1997 data and covers all income-earners in Ontario by age and gender was obtained by a special request to Statistics Canada. Statistics Canada calculated the average incomes for each broad age group (age 20-24, 25-34, 35-44, 45-54, 55-65, 65+) based on data from the 1997 Survey of Labour Income Dynamics (SLID). Average income was obtained by dividing total income for all income-earners by the population in that category.

Employment Rate Data
For the calculation of lost productivity due to smoking, we use employment rates for the year 2000 from CANSIM II table 282-0002 - Labour force survey estimates (LFS), by sex and detailed age group, annual.

Appendix 2 - Calculation of Mortality Reductions, Benchmark

TOTAL MORTALITY DUE TO MALE ADULT SMOKING (age 20 +)													
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
M-Current	3	5	10	25	47	78	128	208	262	406	530	371	536
#of M -Current	129886	139348	176394	178779	155227	111419	89600	66477	42743	32441	26632	12179	8686
M-Former	1	1	2	6	14	40	73	131	288	548	732	788	1394
#of M- Former	74947	77999	107592	116544	125321	143805	126973	102589	114093	107890	90041	63799	56273
Deaths per MF-Former	0	0	0	0	0	0	0	0	0	0	0	0	0
Fire Deaths	0	1	1	1	1	0	0	1	0	0	0	0	0
Reductions in Mortality if Male Adult Prevalence Fell by 15%													
Lower Current Mort	0	1	2	4	7	12	19	31	39	61	80	56	*80*
Increase in Former Mort	0	0	1	1	3	5	8	13	16	25	32	23	32
Total Mortality Reduction	**0**	**1**	**1**	**3**	**5**	**7**	**12**	**19**	**23**	**36**	**47**	**33**	**48**
TOTAL MORTALITY DUE TO Female ADULT SMOKING (age 20 +)													
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
F-Current	11	14	16	25	38	54	78	109	191	216	254	203	582
#of F-Current	104952	115057	134019	146119	118738	95412	75012	53884	39158	40826	26616	14625	12302
F-Former	2	3	4	6	14	23	38	62	119	163	292	348	919
#of F- Former	74432	85913	112627	122186	119519	108048	97843	70181	66896	63072	59055	49093	52895
Deaths per F-Former	0	0	0	0	0	0	0	0	0	0	0	0	0
Fire Deaths	0	0	0	0	0	0	0	0	1	0	1	*1*	2
Reductions in Mortality if Female Adult Prevalence Fell by 15%													
Lower Current Mort	2	2	2	4	6	8	12	16	29	32	38	31	88
Increase in Former Mort	1	1	1	1	2	3	4	7	10	16	20	16	32
Total Mortality Reduction	**1**	**2**	**2**	**3**	**4**	**5**	**8**	**9**	**18**	**17**	**19**	**15**	**56**

Appendix 3 - Calculation of Adult Morbidity Reductions

STEP 1 - Reduction in Hosp. Days from Males Quitting													
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-59	70-74	75-79	80+
Male Hosp. Days Current	505	712	1589	2377	3227	4439	7393	9548	12605	13310	16668	10664	11116
Drop in Hosp. - 20% Fall in Prev.	101	142	318	475	645	888	1479	1910	2521	2662	3334	2133	2223
Drop in Hosp. - 15% Fall in Prev.	76	107	238	356	484	666	1109	1432	1891	1996	2500	1600	1667
Drop in Hosp. - 10% Fall in Prev.	51	71	159	238	323	444	739	955	1261	1331	1667	1066	1112
STEP 2 - Increase in Hospital Days from More Formers													
# of Male Current	129886	139348	176394	178779	155227	111419	89600	66477	42743	32441	26632	12179	8686
20% of Current	25977	27870	35279	35756	31045	22284	17920	13295	8549	6488	5326	2436	1737
15% of Current	19483	20902	26459	26817	23284	16713	13440	9972	6411	4866	3995	1827	1303
10% of Current	12989	13935	17639	17878	15523	11142	8960	6648	4274	3244	2663	1218	869
Hospital Days per former	0.00564	0.00528	0.00621	0.00659	0.00822	0.01427	0.02804	0.04996	0.09507	0.16177	0.24490	0.33293	0.52499
Rise in Hosp. Days - 20%	147	147	219	236	255	318	502	664	813	1050	1304	811	912
Rise in Hosp. Days - 15%	110	110	164	177	191	238	377	498	610	787	978	608	684
Rise in Hosp. Days - 10%	73	74	110	118	128	159	251	332	406	525	652	405	456
STEP 3 - NET REDUCTION IN HOSPITAL DAYS, MALE													
20% cut in prevalence	-46	-5	99	240	390	570	976	1245	1708	1612	2029	1322	1311
15% cut in prevalence	-34	-4	74	180	293	427	732	934	1281	1209	1522	991	983
10% cut in prevalence	-23	-2	49	120	195	285	488	623	854	806	1015	661	656

STEP 1 - Reduction in Hospital Days from Females Quitting													
	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-59	70-74	75-79	80+
Female Hosp. Days Current	1112	1389	2201	3045	3706	5510	6223	9264	12051	15120	17206	13960	19561
20% cut in prevalence	222	278	440	609	741	1102	1245	1853	2410	3024	3441	2792	3912
15% Cut	167	208	330	457	556	827	934	1390	1808	2268	2581	2094	2934
10% Cut	111	139	220	305	371	551	622	926	1205	1512	1721	1396	1956
STEP 2 - Increase in Hospital Days from More Formers, Females													
# of Female Current	104952	115057	134019	146119	118738	95412	75012	53884	39158	40826	26616	14625	12302
20% of Current	20990	23011	26804	29224	23748	19082	15002	10777	7832	8165	5323	2925	2460
15% of Current	15743	17259	20103	21918	17811	14312	11252	8083	5874	6124	3992	2194	1845
10% of Current	10495	11506	13402	14612	11874	9541	7501	5388	3916	4083	2662	1462	1230
Hospital Days per former	0.00246	0.00297	0.00374	0.00498	0.00790	0.01465	0.02062	0.04391	0.07518	0.10694	0.18938	0.27599	0.58881
Rise in Hosp. Days - 20%	52	68	100	146	188	279	309	473	589	873	1008	807	1449
Rise in Hosp. Days - 15%	39	51	75	109	141	210	232	355	442	655	756	605	1086
Rise in Hosp. Days - 10%	26	34	50	73	94	140	155	237	294	437	504	404	724
STEP 3 - NET REDUCTION IN HOSPITAL DAYS, FEMALE													
20% cut in prevalence	171	209	340	463	554	823	935	1379	1821	2151	2433	1985	2464
15% Cut	128	157	255	348	415	617	701	1035	1366	1613	1825	1489	1848
10% Cut	85	105	170	232	277	411	468	690	911	1075	1217	992	1232

Appendix 4 - Smoke Attributable Health Care Costs, 1997

	in 2003 Dollars	% Public Sector	Public Sector Cost
Smoke Attributable Hospital Costs	$ 483,142,298	0.8617	$ 416,323,718
Smoking Attributable Physician Fees	$ 230,697,333	0.9933	$ 229,151,661
Smoking Attributable Ambulance Cost	$ 27,002,716	1	$ 27,002,716
Smoking Attributable Home Care Cost	$ 79,042,495	1	$ 79,042,495
Smoking Attributable Drug Costs	$ 246,877,742	0.306	$ 75,544,589
TOTAL	**$ 1,066,762,584**		**$ 827,065,179**
Smoke Attributable Hospital Days	511,105		
Public Sector Savings from Reduction in 1 hospital day:	**$ 1,618**		

Source: Luk and Single (2003) and author's calculations

Appendix 5 - Increase in Sales and Income Tax Revenue (Millions)

	Decrease In Prevalence	Decrease in Consumption	Discount Rate	Productivity Increase From: Lower Morbidity (Fewer Days Spent in Hospital)	Lower Mortality	Fewer Smoke Breaks on Company Time	Total	ONTARIO SALES AND INCOME TAX PORTION OF TOTAL
Benchmark	*15%*	*30%*	*5%*	*$ 93*	*$ 4,039*	*$ 29,591*	*$ 33,723*	*$ 2,394*
Alternate Case A	20%	40%	5%	$ 124	$ 5,389	$ 39,454	$ 44,967	$ 3,193
Alternate Case B	10%	50%	5%	$ 62	$ 2,691	$ 19,727	$ 22,480	$ 1,596
Alternate Case C	15%	30%	7%	$ 40	$ 1,282	$ 13,934	$ 15,255	$ 1,083
Alternate Case D	15%	30%	4%	$ 210	$ 10,635	$ 60,983	$ 71,829	$ 5,100

Note: Assumes a 1% annual productivity growth rate and a 2% inflation rate.

Appendix 6 - Change in Tobacco Tax Revenue

	Decrease in Consumption	Discount Rate	Tax Increase	Cartons (Millions)	Increase In Revenue From Tax Increase (Millions)	Existing Provincial Tax	Decrease in Revenue From Existing Tax (Millions)	Net Change in Tax Revenue (Millions)
Benchmark								
Year 1	10%	5%	$ 14.37	65.7	$ 921	$17.20	$ (122)	$ 798
Year 2	20%	5%	$ 14.37	58.4	$ 779	$17.20	$ (233)	$ 546
Year 3 Onwards	30%	5%	$ 14.37	51.1	$ 12,640	$17.20	$ (6,484)	$ 6,156
TOTAL					$ 14,340		$ (6,840)	**$ 7,500**
Alternate Case A								
Year 1	13%	5%	$ 14.37	63.51	$ 890	$17.20	$ (159)	$ 731
Year 2	26%	5%	$ 14.37	54.02	$ 720	$17.20	$ (303)	$ 417
Year 3 Onwards	40%	5%	$ 14.37	43.8	$ 10,835	$17.20	$ (8,646)	$ 2,189
TOTAL					$ 12,445		$ (9,108)	*$ 3,337*
Alternate Case B								
Year 1	7%	5%	$ 14.37	67.89	$ 952	$17.20	$ (86)	$ 866
Year 2	14%	5%	$ 14.37	62.78	$ 837	$17.20	$ (163)	$ 674
Year 3 Onwards	20%	5%	$ 14.37	58.4	$ 14,446	$17.20	$ (4,323)	$ 10,123
TOTAL					$ 16,235		$ (4,572)	*$ 11,663*
Alternate Case C								
Year 1	10%	7%	$ 14.37	65.7	$ 912	$17.20	$ (121)	$ 791
Year 2	20%	7%	$ 14.37	58.4	$ 756	$17.20	$ (226)	$ 530
Year 3 Onwards	30%	7%	$ 14.37	51.1	$ 8,503	$17.20	$ (4,362)	$ 4,141
TOTAL					$ 10,171		$ (4,709)	*$ 5,461*
Alternate Case D								
Year 1	10%	4%	$ 14.37	65.7	$ 925	$17.20	$ (123)	$ 802
Year 2	20%	4%	$ 14.37	58.4	$ 790	$17.20	$ (237)	$ 554
Year 3 Onwards	30%	4%	$ 14.37	51.1	$ 16,282	$17.20	$ (8,352)	$ 7,930
TOTAL					$ 17,998		$ (8,712)	*$ 9,286*

Appendix 7 – The Death Benefit

Some critics would argue that a complete fiscal analysis should consider the "savings" to the Provincial Government from smokers dying earlier. The argument is that a smoker who quits smoking, or a person that never starts, will die of some illness not caused with smoking but one that nevertheless involves medical treatment covered by the province. Routine visits to physicians and other non-life threatening medical costs are also likely to be higher on average for nonsmokers because of their longer life spans.

To address this concern, we include in this section the increase in lifetime health care costs from the reduction in mortality engendered by the program. We calculated the number of reductions in premature mortalities in each age group and then estimated the increase in health care costs from the longer life span using average annual health care costs by age group and gender and multiplying those costs by the increase in years spent alive in each age category. For instance, the cost to the government of preventing a 35 year old man from dying prematurely, would be an additional five years worth of average 35-40 year old health care costs + five years worth of average 40-44 year old health care costs and so forth up to age 78. Because average health care expenditures include those due to current smoking, using averages may lead to an overestimate of a former smoker's costs.

The results of this analysis do not change our conclusion that the program has a positive net present value. In most cases, the health care savings alone still justify investment in the project. One notable exception is the scenario in which we use a 4% nominal discount rate. Because the increase in health care spending from less premature mortality occurs many years into the future, the use of a low discount rate substantially raises the value of the death benefit such that, in this circumstance, the program's cost to the government is justified only once we include the income and sales tax increases.

Appendix 7 - Inclusion of the Death Benefit

	Decrease in Prevalence	Decrease in Consumption	Discount Rate	Fiscal Benefit (Millions of 2003$)	Cost (Millions of 2003$)	Net Present Value (Millions of 2003$)	Fiscal Benefit/Cost
Benchmark	*15%*	*30%*	*5%*				
(1) Health Care Savings Alone				$ 1,300	$ 398	$ 902	**3.26**
(2) (1) - Death Benefit				$ 514	$ 398	$ 116	**1.29**
(3) (2) + Increase in PST and Income Tax Revenue				$ 2,909	$ 398	$ 2,511	**7.31**
(4) (3) + Increase in Tobacco Tax Revenue				$ 10,409	$ 398	$ 10,010	**26.14**
Alternate Case A	20%	40%	5%				
(1) Health Care Savings Alone				$ 1,733	$ 398	$ 1,335	**4.35**
(2) (1) - Death Benefit				$ 685	$ 398	$ 287	**1.72**
(3) (2) + Increase in PST and Income Tax Revenue				$ 3,878	$ 398	$ 3,480	**9.74**
(4) (3) + Increase in Tobacco Tax Revenue				$ 7,215	$ 398	$ 6,817	**18.12**
Alternate Case B	10%	20%	5%				
(1) Health Care Savings Alone				$ 867	$ 398	$ 468	**2.18**
(2) (1) - Death Benefit				$ 343	$ 398	$ (55)	**0.86**
(3) (2) + Increase in PST and Income Tax Revenue				$ 1,939	$ 398	$ 1,541	**4.87**
(4) (3) + Increase in Tobacco Tax Revenue				$ 13,603	$ 398	$ 13,204	**34.16**
Alternate Case C	15%	30%	7%				
(1) Health Care Savings Alone				$ 700	$ 380	$ 320	**1.84**
(2) (1) - Death Benefit				$ 456	$ 380	$ 76	**1.20**
(3) (2) + Increase in PST and Income Tax Revenue				$ 1,539	$ 380	$ 1,159	**4.05**
(4) (3) + Increase in Tobacco Tax Revenue				$ 7,000	$ 380	$ 6,620	**18.44**
Alternate Case D	15%	30%	4%				
(1) Health Care Savings Alone				$ 2,103	$ 408	$ 1,695	**5.16**
(2) (1) - Death Benefit				$ (10)	$ 408	$ (417)	**(0.02)**
(3) (2) + Increase in PST and Income Tax Revenue				$ 5,090	$ 408	$ 4,683	**12.48**
(4) (3) + Increase in Tobacco Tax Revenue				$ 14,377	$ 408	$ 13,969	**35.25**

Appendix 8 – Economic Rationale for Tobacco Control

To some, the reasons why the government should intervene in markets to reduce tobacco use are obvious and need no explanation. Others may worry that government intervention through taxes and regulations may reduce welfare through its distortion of private decisions. While economists are far from monolithic in their views on the appropriate role for government in a market economy, most agree that governments should intervene in private markets if there is extensive market failure. Does smoking qualify as such a situation?

It seems logical to assume, and economic theory usually does, that if 1) smokers are fully aware of the consequences of their actions, and 2) they bear the full costs of smoking to themselves and to others, smokers choose to smoke because it maximizes their lifetime utility even if smoking is addictive. If 1) and 2) hold, by choosing to spend their money on tobacco, smokers are revealing that they get more satisfaction from smoking tobacco than from anything else they could spend their money on. It follows that government intervention would reduce individual welfare since it would distort the individual's decision towards choosing some good from which he or she receives less utility.

Are smokers fully informed about the health and addiction risks of their actions? An overview of the evidence on smokers in industrialized countries suggests that they "are generally aware of their increased risks of disease, but that they judge the size of these risks to be smaller and less well-established than do nonsmokers" (World Bank, 1999, ch. 3). Research by Peck et al. (2000) shows that if just 3% of global smokers are uninformed, there would be a net welfare gain from a 10% price increase. Peck et al. (2000) further estimate that, depending on the assumptions used in their model, only 3% to 23% of smokers worldwide would need to be uninformed about the risks for tobacco to engender a global welfare loss. While these results may not be directly applicable to the Canadian case because of the greater availability of information on tobacco in developed countries than in developing countries, the findings do suggest that tobacco use probably involves a net welfare loss in Canada.

It is still more concerning that teenagers may not be able to process this information properly, and evidence shows that they underestimate their ability to become addicted (World Bank, 1999, ch.3; Peck et al., 2000). The vast majority of smokers start before the age of 20 (Laux, 2000; World Bank, 1999, ch. 1), and very few of them plan to be smokers for any significant period of time. The reality is that most smokers would like to quit after they start but either find themselves unable to or find it exceptionally addictive. This contradiction indicates that, for most people, smoking is not fully rational behaviour consistent with consumer sovereignty. Most current smoking is not the result of an individual fully deciding to smoke based on an individual assessment of the lifetime costs and benefits. Some might argue that the appropriate way to address the market failure resulting from youth smoking is to target tobacco policies to preventing youth from obtaining tobacco. Unfortunately, measures to prevent youth from gaining access to tobacco have not proven themselves to be effective and are difficult to enforce (World Bank, 1999, ch. 6).

The second premise that must hold for government intervention to decrease welfare is that smokers internalize all of the costs and benefits of tobacco use. Economists call a situation in which an individual does not internalize the full consequences of his or her consumption or production behaviour an **externality**. An obvious example is the use of cars because the user of the car does not bear all the consequences of air pollution himself.

Smoking involves at least two types of externalities: interpersonal and intra-personal. Interpersonal externalities are the costs smokers impose on other people. Such costs include health care costs in publicly funded health care systems such as Canada's and the health effects of ETS. Aside from the externality due to ETS, the limited Canadian work on the subject suggests that smokers may cover their share of the direct health care costs through tobacco taxes (Raynauld and Vidal, 1992). However, it is more difficult to get an accurate measure of the externality due to ETS since many of these costs involve long-term developmental costs (see section VI of this report) and it is more difficult to quantify some of health care costs due to ETS than it is to obtain health care costs from first-hand smoking. One obvious way to reduce the welfare loss from this market failure is to ban smoking in public places. While this will not completely eliminate ETS, it will reduce the extent of the externality. The Canadian study (Raynauld and Vidal, 1992) on the issue of interpersonal externalities did not consider the value of foregone provincial sales and income tax. Finally, the economic value of pain and suffering that smokers impose on friends and family members[5] could be quantified, at least in theory, and likely exceeds the sum of these other interpersonal externalities.

The second type of externality arising from smoking is the intra-personal externality. These are future costs of smoking that the smoker does not internalize because of time-inconsistent behaviour. Gruber and Koszegi (2001) cite evidence from the psychology literature that consumers choose different discount rates between time periods that are further away than between this time period and the next. That is, a smoker will tend to discount next year less heavily relative to this year than he will the year after next relative to next year. The result is that when the smoker reaches next year, the decision he chose to make last year is no longer optimal because he now has a different discount rate for the next period than he did last year. Time-inconsistency thus implies that there is an intra-personal externality where the smoker today imposes costs on his future self that he does not fully internalize in his decision-making process. For smoking, time-inconsistency results in smokers not acting in their own best welfare, instead requiring an external mechanism to force them to choose the consumption path that will yield them the highest lifetime utility. While the theoretical nature of this work makes it difficult to attach a precise figure to the intra-personal externality from smoking, Gruber and Koszegi (2001) show that, in terms of life years lost and using a discount rate of 4%, the cost of a pack of cigarettes is US$30.45 or about 100 times the size of the interpersonal externalities estimated in the US literature.

[5] Some would argue that the economic decision making unit is the family, not the individual, such that only the pain and suffering of friends can rightly be considered externalities.

Gruber and Mullainathan (2002) corroborate the theoretical work of Gruber and Koszegi (2001) by using separate U.S. and Canadian survey data on smokers' subjective well-being. They find that smokers report greater well-being *after* a tobacco tax increase, indicating that tobacco control policies improve welfare. This finding implies that smokers do in fact need an external mechanism to behave optimally.

In summary, the evidence reveals that the conditions that must hold for government intervention to reduce welfare do not hold for tobacco. First, people usually start smoking before they can make a rational decision about whether it is in their own best interest. Second, there is ample evidence that either young adults are not fully informed about the addictive potential of tobacco or they cannot accurately estimate their own risk of becoming addicted. Third, the presence of interpersonal externalities that are not yet fully quantified and substantial intra-personal externalities indicate that leaving tobacco consumption up to individual choice will not yield the highest levels of utility for either smokers or non-smokers.