

TWO EMPIRICAL STUDIES IN THE ECONOMICS  
OF ALCOHOL ABUSE

by

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### **ABSTRACT**

The issue of alcohol abuse has been studied by all the social sciences. This thesis examines two areas studied by economists. These are production losses caused by abuse and production returns to treatment.

There are three ways that alcohol abuse can have an adverse impact on the level of production. First, studies have shown that abuse has a detrimental impact on attendance and productivity. Secondly, drinking problems can become so acute that they render the abuser unemployable. Finally, alcohol abuse can cause premature mortality.

Chapter 2 estimates lost production due to alcohol abuse in British Columbia in 1979. The estimates are prepared according to alternative assumptions regarding unemployment; a full employment assumption and a replacement worker assumption. With the latter assumption, costs are restricted to losses from employed abusers (i.e., reduced efficiency and increased absenteeism). These factors are estimated to reduce the production of 50,000 workers by approximately 25 percent. This is estimated to have decreased 1979 production by almost \$200 million. Under the full employment

assumption, it is estimated that the production cost is about \$329 million. The increased cost results from 2,652 unemployable abusers (estimated cost, \$34 million) and the premature death of 800 individuals (estimated cost, \$95 million).

Chapter 3 develops two cost-benefit models to estimate production returns from treatment (i.e., one for each of the foregoing assumptions). Presumably, if the abuser quits drinking the production problems and their ensuing costs are eliminated. If a clinic is responsible for abuser sobriety, the elimination of future costs is a benefit of the treatment program.

As abusers, employers, and the government share the benefits of successful treatment, the models are adapted to distribute the costs and benefits among these three groups. In addition, chapter 3 presents an empirical application of the model. It examines 1985 production returns to in-patient treatment using data from the Dallas House program (Victoria, British Columbia).

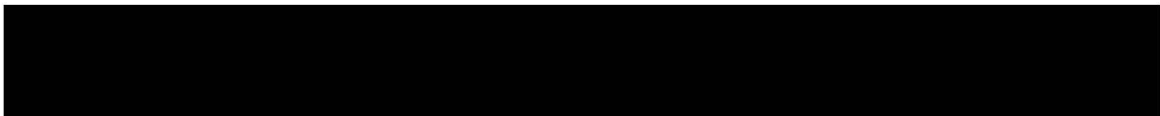
Each cost-benefit equation is estimated using sensitivity analysis and benefits are assessed with 108 variable combinations. The results indicate that, with both models, treatment produced a net production benefit for all three groups. This result was achieved because the government provides the majority of funding for the Dallas House treatment program. The benefits to employers, under many variable combinations, were not sufficient to offset total treatment

costs. This result differs from several previous studies which found that occupational treatment programs offer significant benefits to employers. The discrepancy is caused by the fact that previous studies implicitly assumed that all the production benefits of treatment accrue to employers.

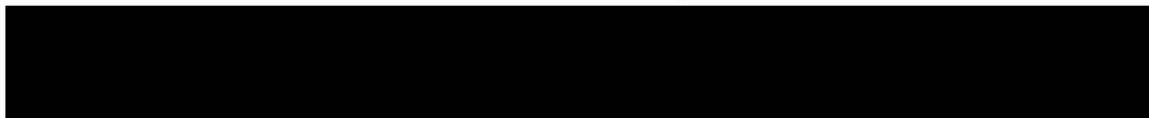
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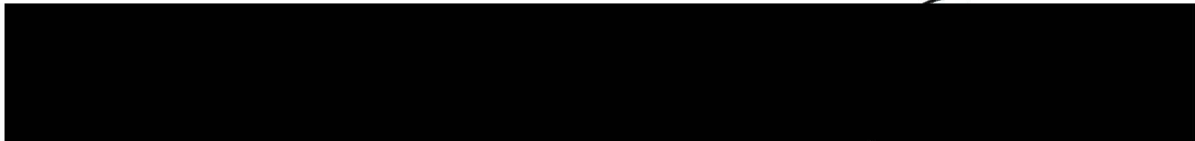
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## TABLE OF CONTENTS

	Page
Abstract . . . . .	ii
Table of Contents . . . . .	v
List of Tables . . . . .	vii
List of Figures . . . . .	ix
Acknowledgements . . . . .	x
Dedication . . . . .	xi
1. Introduction . . . . .	1
1.1 Overview of the Thesis . . . . .	1
1.2 Defining Alcohol Abuse . . . . .	4
1.3 Methodological Issues in Determining the Economic Cost of Alcohol Abuse . . . . .	7
Footnotes . . . . .	11
2. Lost Production Due to Alcohol Abuse . . . . .	12
2.1 Introduction . . . . .	12
2.2 Selective Review of the Literature . . . . .	16
2.3 Income and Occupational Status of the 'Average' Abuser . . . . .	22
2.4 Problems of Quantification . . . . .	25
2.5 Lost Production Due to Reduced Productivity and Absenteeism . . . . .	28
2.6 Lost Production of Unemployable Abusers . . . . .	44
2.7 Lost Production Due to Premature Mortality . . . . .	46
Footnotes . . . . .	59
3. Cost-Benefit Analysis of An Alcohol Treatment Program . . . . .	62
3.1 Introduction . . . . .	62
3.2 Purpose and Background of the Study . . . . .	64
3.3 Selective Review of the Literature . . . . .	67
3.4 Benefits of Treatment . . . . .	71
3.4.1 Model I (Assuming Full Employment) . . . . .	73
(a) Abuser Benefits . . . . .	74
(b) Employer Benefits . . . . .	76
(c) Government Benefits . . . . .	77
3.4.2 Model II (Assuming Worker Replacement) . . . . .	78
(a) Abuser Benefits . . . . .	80
(c) Employer Benefits . . . . .	80
(c) Government Benefits . . . . .	81

3.5	Cost of Treatment . . . . .	81
3.5.1	Model I (Assuming Full Employment) . . . . .	81
	(a) Abuser Costs . . . . .	82
	(b) Employer Costs . . . . .	82
	(c) Government Costs . . . . .	82
3.5.2	Model II (Assuming Worker Replacement) . . . . .	83
3.6	Estimating the Models . . . . .	83
3.6.1	Assumptions . . . . .	84
3.6.2	Sensitivity Analysis . . . . .	89
3.7	Results . . . . .	92
3.7.1	Model I (Assuming Full Employment) . . . . .	92
	(a) Abuser Benefits . . . . .	92
	(b) Employer Benefits . . . . .	93
	(c) Government Benefits . . . . .	93
3.8.2	Model II (Assuming Worker Replacement) . . . . .	93
	(a) Abuser Benefits . . . . .	94
	(b) Employer Benefits . . . . .	94
	(c) Government Benefits . . . . .	95
3.8	Conclusions and Implications . . . . .	95
	Footnotes . . . . .	98
4.	Summary . . . . .	100
	Bibliography . . . . .	105
	Appendix A: Variables Used in the Models in Chapter 3 . . . . .	109
	Appendix B: Model I: Results . . . . .	118
	Appendix C: Model II: Results . . . . .	127

## LIST OF TABLES

	Page
Table 1: Estimate of Job Efficiency Before and After Treatment . . . . .	33
Table 2: Number of Sickness Disability Cases . . . . .	33
Table 3: Employed Civilian Abusers in 1970 in the United States . . . . .	38
Table 4: Comparisons of Per Capita Consumption and Rates of Cirrhosis Mortality between the United States in 1970 and British Columbia in 1979 . . . . .	40
Table 5: Estimated Cost of Lost Production for Employed Male Abusers in British Columbia due to Absenteeism and Reduced Productivity 1979 . . . . .	42
Table 6: Estimated Cost of Lost Production for Employed Female Abusers in British Columbia due to Absenteeism and Reduced Productivity 1979 . . . . .	43
Table 7: Causes of Death in Canada in 1971 Related to Hazardous Drinking . . . . .	50
Table 8: Present Value of Lost Future Market Production due to Premature Mortality in 1979 for Male Abusers . . . . .	55
Table 9: Present Value of Lost Future Market Production due to Premature Mortality in 1979 for Female Abusers . . . . .	56
Table 10: Model I: Social Benefits . . . . .	119
Table 11: Model I: Abuser Benefits . . . . .	121
Table 12: Model I: Employer Benefits . . . . .	123
Table 13: Model I: Government Benefits . . . . .	125
Table 14: Model II: Social Benefits . . . . .	128

	Page
Table 15: Model II: Abuser Benefits . . . . .	130
Table 16: Model II: Employer Benefits . . . . .	132
Table 17: Model II: Government Benefits . . . . .	134

## LIST OF FIGURES

	Page
Figure 1: Age Distribution of Patients (1985) . . .	87
Figure 2: Age Distribution of Patients (1983-86) . .	88

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The author assumes complete and sole responsibility for errors and omissions.

**DEDICATION**

For Bonnie and Jennie; their love and support enrich my life.

## CHAPTER 1: INTRODUCTION

### 1.1 Overview of the Thesis

Alcohol abuse is recognized as one of the most pervasive and significant problems facing industrial societies. It is an immense problem with a myriad of diverse consequences for abusers, their acquaintances and the society in which they live. The breadth of the problem has attracted interest from all the social sciences. This thesis examines two areas studied by economists. These are production costs caused by alcohol abuse and production returns to treatment.

It should be recognized from the outset that lost production constitutes only one of the external costs attributable to alcohol abuse. Alcohol consumption causes many health problems and, therefore, leads to greater expenditures on medical services. It is also related to higher levels of crime and increased judicial costs. In addition to these "economic costs", alcohol abuse is responsible for higher divorce rates and causes pain and suffering for abusers and their families.

The costs of abuse can be placed in three mutually exclusive categories. The first is "intangible costs" and includes those consequences which cannot be objectively assigned a monetary value (e.g., pain and suffering). The second category results from problems which require higher levels of social expenditures (e.g., health problems). Expenditures on alcohol-related problems represent an economic cost

in that society must forgo alternative uses for the resources. The final category is forgone production attributable to alcohol abuse (i.e., lost production due to alcohol-induced productivity loss, unemployability and death).

Clearly a comprehensive approach would quantify all the economic costs of alcohol abuse, at any rate the last two categories of cost. However, there are a number of problems associated with estimating the value of the second category of costs. These are examined in Section 1.3. For now it suffices to point out that the cost of abuse results from problems caused by alcohol consumption. Although many problems are highly correlated with drinking, it can be quite difficult to establish the causal relationship or quantify the effect abuse has on problem incidence (e.g., homicide). Therefore, this thesis examines only the third category of costs, that is, the cost of lost production.

It should be noted that in this thesis lost production refers only to market production. Undoubtedly alcohol abuse also reduces non-market production (e.g., home repairs, housekeeping services, etc.). However, it is difficult to quantify the value of these services. In addition, the effect of abuse on non-market production has not been fully examined. Therefore, it would be difficult to place much confidence in an estimation of the value of lost non-market production. Conversely, the value of market production can be approximated from the labour market. In addition, the impact of abuse has been examined frequently in studies of occupational treatment programs.

Chapter 2 quantifies lost production due to alcohol abuse in British Columbia in 1979. The chapter examines three cost areas. The first is reduced productivity caused by increased absenteeism and decreased efficiency. The second is lost production caused by "unemployable abusers." These are individuals whose alcohol problem is so severe that they are unable to maintain gainful employment. The final cost area is lost production due to premature mortality in 1979. If an abuser dies, society loses the value of his/her future production. Therefore, it is reasonable to assign the present value of lost future production to the year of death.

Chapter 3 develops two cost-benefit models to estimate production returns to treatment. As mentioned previously, alcohol abuse causes problems which are responsible for lower market production. Presumably, if the abuser quits drinking these problems and ensuing costs would be eliminated. If treatment is responsible for the change in the abuser's drinking habits, the reduction in future costs is a benefit attributable to the treatment program. If the benefits of treatment exceed its costs, it is beneficial for society to fund the program.

Abusers, employers and the government share the benefits of successful treatment. Therefore, the cost-benefit models are adapted to distribute the costs and benefits of treatment among these three groups. In addition, Chapter 3 presents an empirical application of the models. It examines the production returns to an in-patient treatment program using data collected from Dallas House (Victoria,

B.C.) in 1985. Dallas House is a small in-patient treatment centre which treats an average of 137 patients a year.

It should be recognized that Dallas House does not collect background information on patients to permit a cost-benefit study of its treatment program. Consequently, the analysis relies heavily on expert approximations from empirical studies of similar in-patient treatment programs. Moreover, the objective is to provide an estimate of the minimum benefits of treatment. Hence, at certain points the study errs on the side of conservative benefit estimates. It also uses sensitivity analysis and assesses the benefits over a range of possible outcomes.<sup>1</sup>

The final chapter presents a brief summary of the thesis.

## **1.2 Defining Alcohol Abuse**

The term "alcoholism" pervades the literature. However, it is extremely difficult to derive a comprehensive or consensus definition of the term. There are several reasons why it is difficult to define alcoholism. First of all, abusers are prevalent in all cultures and are not homogeneous. They are represented in all economic, social, age and ethnic groups. Secondly, abusers exhibit considerable variability in their drinking practices, from occasional binges to constant inebriation. Thirdly, the problems caused by abuse can be the result of acute and/or chronic intoxication. Finally, the etiology of the behaviour is not known. Some contend that alcoholism is a disease, while others argue it is a psychological behaviour.

The controversy surrounding definitions of alcoholism has caused the term to lose favour with many authorities. For example, the World Health Organization now uses the phrase "alcohol dependence" which implies a physical and/or psychological addiction to ethanol. In order to circumvent any preconceived notions of alcoholism, this thesis uses the term alcohol abuse. However, the difficulty of definition still remains.

Researchers frequently select a definition of abuse which is compatible with the objective of their study. For example, researchers studying the effects of alcohol on cirrhosis of the liver might define abuse in terms of an average daily consumption of absolute alcohol in excess of 10 centilitres.<sup>2</sup> Obviously this definition would be inappropriate for other alcohol problems, such as impaired driving. In this case, abuse might be defined as driving with a blood alcohol level exceeding 0.08 mg/100 ml.<sup>3</sup>

The preceding examples show three important factors in establishing an operational definition of abuse. First, the definition relates drinking practices to the problem being studied. Secondly, the objective is to isolate those individuals whose drinking practices render them susceptible to the problem. Finally, the generality of the definition is a function of the relationship of the problem to alcohol consumption. In other words, a specific relationship allows the researcher to select a narrow definition of abuse (e.g., cirrhosis of the liver).

Unfortunately, a variety of drinking practices and alcohol-related problems can result in lower levels of production (e.g., both cirrhosis and alcohol-induced accidents can decrease production.) Therefore, the definition of abuse must be general so that it includes a variety of production problems resulting from alcohol consumption. On the other hand, if the definition is too general, most drinkers would be classified as abusers. The majority of drinkers have over-indulged on a particular occasion and have not been at their normal level of efficiency the next day. In the aggregate, this could constitute a significant economic cost. However, the concern of this thesis is with those individuals whose drinking causes recurring production problems. In other words, the objective is to select a definition which will restrict abuse to the most serious cases.

In this regard abuse will be said to occur when an individual's consumption of alcohol is responsible for frequent decreases in production. It should be recognized that, with this definition, abuse is not restricted to individuals with chronic drinking problems. If, for example, an individual dies in an alcohol-caused accident society would lose all of his/her future production. Obviously this constitutes a frequent decrease in production and would be classified as a production cost of abuse. It does not matter if the individual who died or caused the accident had a chronic drinking problem.

### **1.3 Methodological Issues in Determining the Economic Cost of Alcohol Abuse**

The economic cost of alcohol abuse can be viewed as the potential gain to society if the behaviour were eliminated.<sup>4</sup> As such, it is important to recognize that the external cost of abuse does not arise from the consumption of alcohol per se. Rather, the costs result from problems which are attributable to the abuser's drinking. Consequently, it is imperative that problems and alcohol abuse be causally related. If a problem is not caused by abuse, then eliminating the behaviour will not affect the problem's occurrence or its ensuing costs. Therefore, establishing a causal relationship between abuse and specific problems is a fundamental step in estimating the cost.

Previous attempts to estimate the cost of alcohol abuse have largely ignored the importance of causality. This has led to some methodological errors. The most frequently cited study is Berry and Boland (1977). In this study the authors noted that it was extremely difficult to establish a causal relationship between crime and alcohol abuse. However, they felt that ignoring alcohol's role in crime would be a serious deficiency. Consequently, they generated cost estimates based on empirical studies of the association between crime and alcohol use. For example, they used Shupe's 1954 study to conclude that 67 percent of the social costs of homicide were associated with the consumption of ethanol.

The authors warned that their estimate examined only the association between the variables and should not be construed to imply causality. However, they included these values in their general estimate of the cost of abuse. If society would benefit from the elimination of abuse then, in this particular case, the only means by which this would occur is through a reduction in crime. Therefore, if 67 percent of the economic cost of homicide is included as a cost of abuse, then the argument is ostensibly that eliminating alcohol abuse would result in a 67 percent decrease in the number of murders. The caveats of the authors failed to recognize that including the cost of crime implicitly assumed causality.

In addition to establishing a causal relationship, calculating the cost of abuse requires that the analyst estimate the impact that drinking has on problem incidence. For example, suppose that alcohol abuse is responsible for 50 percent of traffic accidents. If the behaviour were eliminated the number of accidents would be expected to decrease by 50 percent. Consequently, the analyst could estimate that half the costs of these accidents are attributable to alcohol abuse.<sup>5</sup>

With most alcohol-related problems, drinking is a single factor in a complex causal system. Consequently, estimating the incidence of a problem due to alcohol abuse can be a difficult task. As indicated in Shupe's 1954 study, a large number of homicides occur after the victim and/or suspect has been drinking. In many cases alcohol may have been a contributing factor. However, it is difficult to estimate how many homicides would have occurred in the absence of alcohol

consumption. Without this information it is difficult to estimate the cost of homicide attributable to alcohol abuse.

Researchers faced with this problem have two options. First of all, they can follow Berry and Boland's approach and estimate the cost of problems which are associated with alcohol abuse. This provides a comprehensive estimate which illustrates the diversity of alcohol-related problems. The United States National Research Council advocates this approach and states the following:

The first principle is that in identifying relevant costs of drinking, it is better to err on the side of inclusiveness rather than exclusiveness. Otherwise the scheme loses its value as a device for alerting us to potentially important aspects of the problem. The accounting scheme should include social as well as economic effects, collective as well as individual ones. It should include effects that are easily quantified as well as those that are not.<sup>6</sup>

The problem with this approach is that it subjects the analysis to methodological criticisms. The inclusion of the costs of crime and to a lesser extent medical costs, means that critics can argue that the approach has overestimated the cost of abuse. This criticism can undermine the integrity of the study and its conclusions.

The other option is to exclude those costs where it is difficult to determine the effect that abuse has on problem incidence. This approach means that the calculations underestimate the actual costs of alcohol abuse. This, too, may be criticized. However, on the principle that it is better to err on the side of conservatism, this approach is advocated as a means of protecting the credibility of the study.

Consequently, this thesis quantifies only the production costs of alcohol abuse. This issue has been examined in many occupational treatment programs and, based on these studies, it is reasonable to conclude that drinking is responsible for the lower productivity of abusers. Alcohol-related problems which require social expenditures are not addressed. In the future, when relationships are better understood, it may be possible to include these other economic costs and hence to derive a more comprehensive estimate of the cost of alcohol abuse.

**FOOTNOTES**

1. Economists frequently advocate the use of sensitivity analysis to deal with uncertainty. Under this approach, terms are varied over a range of expected values. The technique illustrates the sensitivity of results to alternative assumptions.
2. Most researchers agree that an average daily consumption of 10 centiliters of absolute alcohol increases the risk of contracting cirrhosis of the liver.
3. Under British Columbia law, impaired driving is defined as operating a vehicle with a blood alcohol level of 0.08 or greater.
4. The gain to society is net of the costs of controlling alcohol abuse.
5. This assumes that alcohol consumption does not influence the severity of the accident. If, for example, alcohol abuse was responsible for 60 percent of fatal crashes, then the costs would have to be calculated by accident category. Therefore, the cost of abuse would likely exceed 50 percent of the total costs of traffic accidents.
6. National Research Council, Alcohol and Public Policy: Beyond the Shadow of Prohibition, Moore and Gerstein ed. (Washington: National Academy Press, 1981) pp. 20.

## CHAPTER 2 LOST PRODUCTION DUE TO ALCOHOL ABUSE

### 2.1 Introduction

As stated in Chapter 1, alcohol abuse is said to occur when an individual's consumption of ethanol is responsible for frequent decreases in production. This definition is chosen to restrict the cost estimate to those individuals whose drinking causes serious and recurring production problems. However, it should be recognized that alcohol consumption can decrease the productivity of all drinkers. Even light drinkers may, on occasion, over-indulge and suffer from a hangover the next day. This could adversely effect job productivity and attendance. In the aggregate this might constitute a significant economic cost. However, it is difficult to quantify because few empirical studies have examined this issue. Therefore, this thesis restricts the estimate of the external production costs of alcohol abuse to the most serious cases.

The value of lost production is generally found to be the most significant economic cost of alcohol abuse. For example, Berry and Boland (1977) contended that lost production constituted over 46 percent of the total cost of alcohol abuse in the United States. This chapter examines specific problems caused by alcohol abuse and quantifies some of the adverse production consequences in monetary terms. It should be acknowledged that alcohol consumption may entail both costs and benefits for production. Studies have demonstrated, for example, that small amounts of alcohol can improve some individuals' performance. However, the concern of this study is with

the cost of abuse. The probably minor production benefits that might result from alcohol consumption will not be examined in this thesis.

There are many ways that alcohol abuse can have an adverse impact on production. Intoxification, or a hangover, can render a worker less productive through increased absenteeism and poorer work performance. Studies have shown that impaired workers are more prone to make mistakes, damage equipment, waste materials and cause accidents.<sup>2</sup> The deterioration of the abuser's work performance can create a burden on co-workers and, thereby, have a detrimental impact on morale. The problems caused by alcohol abuse can become so acute that they render the abuser unemployable. Finally, alcohol abuse can cause morbidity and premature mortality.

The fundamental question to be addressed in this chapter is; what would have been the potential gain in production in British Columbia if the problems caused by alcohol abuse in 1979 had been eliminated? The answer to this question depends importantly on the way in which unemployment is treated. On the one hand, it can be argued that the existence of unemployment means that many of the problems of alcohol abuse create no real production losses for society. If an individual dies prematurely or is unemployable because of alcohol abuse, then he/she can be replaced by an otherwise unemployed worker. Consequently, the death does not result in a social loss in production. On the other hand, it can be argued that in the absence of a drinking problem the abuser might be a successful entrepreneur and would create work for himself/herself and others.

Whether or not a correction for unemployment should be included in a cost benefit study is a controversial issue among economists. Some argue that the analysis should assume full employment. Otherwise, the cost of alcohol abuse is confused with the cost of the macro management policies of the government.<sup>3</sup> Others, however, argue that a full employment assumption is unrealistic in today's economy. They feel that, if unemployment is ignored, the analysis overstates the actual costs of the problem.

This is an important issue that is re-examined in Chapter 3. At this point it suffices to say that both arguments appear to have validity and should thus be incorporated into the analysis. The full employment assumption means that problems such as premature mortality and unemployability constitute an economic cost. It leads, in effect, to an estimate of the potential cost to society. With the less-than-full employment, or the replacement worker assumption, the cost of abuse is restricted to production losses caused by employed abusers. This latter assumption leads, therefore, to a lower bound estimate of the cost of abuse.

This chapter consists of eight sections. Section 2.2 examines previous attempts to estimate lost production attributable to alcohol abuse. The primary purpose of reviewing these studies is to critically evaluate their quantitative techniques with a view to defining an appropriate approach to the measurement of the cost of alcohol abuse. Researchers have attempted a variety of approaches to circumvent empirical difficulties associated with quantifying the

value of lost production. A 'good' approach recognizes three fundamental goals. First of all, it must quantify the effects of only those problems which can be reasonably attributed to alcohol abuse. Therefore, it is necessary to assert that alcohol abuse is causally related to the problem which decreases production. Secondly, the estimate should be comprehensive and attempt to assess the costs of all problems in which quantification is feasible. Finally, it is necessary to adopt a consistent basis of estimation. Thus in situations where alternative estimates are available, the analysis might be based on the most conservative alternative.

Section 2.3 examines the distribution of alcohol consumption among income/occupational classes. The value of lost production is an estimate of the difference between the abuser's actual and potential contribution to production. Quantifying this value requires an assessment of the adverse production consequences of alcohol abuse and an estimation of the value of the abuser's contribution to production. The majority of economists use the gross wage or salary of a worker as an approximate measure of a worker's contribution to production.<sup>4</sup> Therein lies the importance of establishing the occupational distribution of abusers. Obviously, if the distribution of abusers were skewed towards lower income occupations, then the costs would be less than if abuse were normally distributed. Determining the distribution of abusers among income classes is, therefore, fundamental if aggregate formulas are to be applied.

Section 2.4 examines specific production problems associated with alcohol abuse which are not quantified in this chapter. There are several reasons why some problems are not quantified in dollar terms. First of all, in some instances current knowledge does not permit a causal inference. Secondly, some forms of production, such as household services, are extremely difficult to value in market terms. Finally, some problems must be examined individually and it would be inappropriate to apply an aggregate formula. Obviously, empirical difficulties undermine quantification of these problems.

The next three sections (sections 2.5 - 2.7) examine specific production problems and provide estimates of their cost to the British Columbia economy in 1979. The first calculates the cost of absenteeism and reduced productivity of employed abusers. The second calculates the cost of those abusers whose alcohol problems are so acute that they are unemployable. The third estimates the value of lost potential production arising from premature mortality attributable to alcohol abuse. The final section, 2.8, summarizes the findings of the chapter.

## **2.2 Selective Review of the Literature**

There is an abundance of literature examining the adverse consequences of alcohol abuse on the level of production. These studies can be classified as being either microeconomic or macroeconomic in perspective. The microeconomic studies examine the cost of abuse to a firm or industry. Their primary goal is to illustrate the advantages of establishing alcohol rehabilitation

programs for employees. The macroeconomic studies adopt a broader perspective and attempt to derive a general estimate of the production costs to the economy as a whole. The primary concern in this chapter is with the latter. However, the microeconomic studies are beneficial in displaying the types of production problems caused by alcohol abuse. Consequently, a few of them are examined in more detail later in this chapter.

A few studies have attempted to generalize from microeconomic studies to estimate lost production due to alcohol abuse. The Alcoholism Foundation of British Columbia contended that abuse cost the province's industries approximately \$35 million in 1968.<sup>5</sup> This estimate was based upon a study by Gulf Oil of Canada which found that 3 percent of its employees abused alcohol and that the average abuser cost the company about \$1,300 a year.<sup>6</sup> The \$35 million estimate assumed that the costs and extent of abuse experienced by Gulf Oil were representative of the problem for all companies in British Columbia.

There are two main problems associated with this approach. First of all, studies have shown that the magnitude of alcohol abuse varies among occupations and industries.<sup>7</sup> The cost of abuse would vary, therefore, depending upon the company chosen as the basis for the calculations. Secondly, this method estimates the cost from production losses to the company. Costs borne by individuals and society are not included.

One of the earliest attempts to calculate the macroeconomic cost of alcohol abuse was by Holtmann (1963) who adopted a different approach from other studies. Rather than calculating the cost of abuse in 1959, Holtmann estimated the present value of future economic losses expected to accrue from individuals who abused alcohol in that year. For example, in the absence of rehabilitation, he predicted that future unemployment for 1959 abusers would have a present value cost of \$23 billion.<sup>8</sup> This was calculated by summing expected losses from employment of 1959 abusers in successive years (i.e., 1959, 1960, 1961, etc.). Therefore, Holtman did not restrict the estimate to the cost of problems caused by alcohol abuse in an individual year.

Holtman attempted to calculate the value of lost production by summing the costs associated with unemployment, premature mortality and absenteeism caused by alcohol abuse. The different approach means that his estimation techniques are not really applicable for this study. His approach, however, is similar to that used to evaluate the benefits from alcohol treatment programs.

One of the few Canadian attempts to estimate the economic cost of alcohol abuse was made by Holmes (1976). Holmes attempted to calculate the costs and benefits of alcohol consumption for Ontario in 1971. In terms of lost production, Holmes examined only two aspects of the problem; the costs of absenteeism and industrial accidents. Holmes used a study by the Treasury Board Secretariat (1971) to calculate the cost of absenteeism due to alcohol abuse. This study contended that a problem drinker was absent about 17 days more per

year than a moderate drinker.<sup>9</sup> Holmes employed the Ledermann distribution model and determined that 5.78 percent of Ontario's total population consumed at least 10 centilitres of ethanol per day. He then assumed that the proportion of employed heavy drinkers was the same as in the total population. Thus he concluded that 177,215 employees abused alcohol. Holmes multiplied the number of abusers by 17 and the average daily salary and concluded that alcohol-induced absenteeism cost Ontario \$86,551,806 in 1971.<sup>10</sup>

Holmes' technique made three critical assumptions. The first was that the Ledermann formula was an appropriate technique for estimating the number of individuals who experienced work problems because of alcohol abuse. Secondly, the percentage of employed abusers was the same as in the general public. Finally, he assumed that the average wage represented the value of lost production and, therefore, that alcohol abuse was normally distributed through income groups. These assumptions were not supported with empirical evidence or by reviewing relevant literature. The first two are quite contentious. However, the most serious criticism of Holmes' study is that it ignored many important production costs of alcohol abuse. Problems such as premature mortality and reduced efficiency were not included in the analysis.

Pritchard (1967) attempted to estimate the value of lost production due to alcohol abuse in Australia in 1965. He examined the costs of premature mortality and unemployment caused by alcohol abuse. The main shortcoming in Pritchard's analysis is that he did

not attempt to quantify any of the costs associated with employed abusers. His estimate, therefore, ignored a significant component of the economic cost. A second problem with Pritchard's study is that it is difficult to determine the cause/effect relationship between alcohol abuse and unemployment (i.e., Did alcohol abuse cause the unemployment or did unemployment lead to the drinking problem?). Obviously this has an important impact on the cost estimate.

The most frequently cited study of the cost of abuse is Berry and Boland (1977). These authors calculated the value of lost production by estimating the impact that male abusers had on family income, and production losses caused by premature mortality and abuse by military personnel. The fundamental proposition of the first cost is that, because abusers are less productive, a problem drinker would earn less than his non-abusing counterpart. This implicitly assumes that the market mechanism corrects for the adverse consequences of abuse by reducing the incomes of problem drinkers.

This assumption simplifies the task of estimating the production costs of abuse because specific problems do not need to be quantified. It is not necessary to assess the cost of problems such as absenteeism, lower productivity, unemployment, accidents and mistakes because the market mechanism compensates for all of these phenomena. To evaluate this technique it must be determined if it is reasonable to assume that the market mechanism corrects for all the production problems of alcohol abuse by transferring the costs to the abuser in the form of reduced income.

There are three ways that alcohol abuse can lower incomes of problem drinkers. First of all, labour remuneration can decrease because of higher absenteeism rates. Secondly, poor work could lead to reduced promotion opportunities or demotion. Finally, severe alcohol problems can lead to dismissal. These factors will cause the abuser's income to be lower than his/her non-abusing counterpart.

Although empirical studies show that abusers earn less than non-abusers, there are several reasons why the market mechanism will fail to provide a complete correction for lost productivity. First of all, most employers provide some sick leave and, therefore, will share some of the costs of alcohol-induced absenteeism. Secondly, the abuser's wage rate may be determined by a contract rather than by his/her individual productivity. Finally, some workers may be able to conceal their drinking problem from their superiors. It appears that the market mechanism provides only a partial correction for the reduced productivity of abusers. Therefore, it appears that Boland and Berry's technique underestimates the actual losses caused by alcohol abuse.

This review has shown that quantifying the cost of alcohol abuse is difficult and all techniques are subject to some criticisms. In order to minimize such criticisms, this study adopts four principles in estimating the cost of alcohol abuse. First of all, it calculates only the cost of problems which can be reasonably attributed to alcohol abuse (i.e., where there is some corroborating evidence supporting a cause/effect relationship). Secondly, where

quantification is possible, the study attempts to provide a comprehensive estimate of the social cost (i.e., it does not estimate the cost to a single group such as employers or abusers). Thirdly, when alternative estimates are available, the analysis is based on a conservative alternative. Finally, sensitivity analysis is used as two results are presented (i.e., one for the replacement worker assumption, the other for full employment).

The quantification difficulties should not discourage attempts to estimate the cost of abuse. Our ability to quantify the benefits of treatment is dependent on estimating these costs (i.e., the benefits being the avoidance of future costs). There is a general consensus among health authorities that alcohol abuse is a neglected problem. Therefore, refinement of estimation techniques will facilitate the development of a cost-benefit study which uses an empirical basis to argue for increased funding for alcohol treatment programs.

### **2.3 Income and Occupational Status of the 'Average' Abuser**

Economists generally use the gross wage rate as a measure of labour's contribution to production.<sup>11</sup> The loss of production due to an affliction is calculated by multiplying the wage by the adverse consequences of the problem. If, for example, disease x causes workers to miss an average of two days work per year, then the annual production costs of x would be two days wages for each individual who contracted the disease. There are obvious pragmatic difficulties in

ascertaining the wage rate for each person who catches the disease. If, however, all individuals have an equal probability of catching x, then the aggregate cost could be calculated by multiplying the average two day earnings (before deductions) by the incidence of x. If, on the other hand, a particular group, such as blue collar workers, primarily catch disease x, an appropriate wage adjustment must be made.

Therefore, in calculating the production costs of alcohol abuse it is necessary to determine if the problem is normally distributed among workers or if particular occupational groups are more susceptible to alcohol problems. The evidence indicates that certain occupations and professions have higher rates of alcohol abuse. This is not the primary concern, but rather, the main issue is whether a particular occupational or income class has a more predominant problem with alcohol abuse.

Researchers have found that alcohol consumption is positively correlated with income but drinking problems are inversely related to income.<sup>12</sup> The latter relationship cannot be perceived as evidence that the distribution of abusers is skewed towards lower income occupations. As mentioned previously, an abuser bears some of the costs of his/her drinking problem. Therefore, the abuser receives less income than his/her non-abusing counterpart. In the absence of alcohol abuse, the problems would be eliminated and the two workers would receive comparable incomes. Thus the inverse relationship between income and alcohol abuse could simply reflect the fact that

the abuser bears part of the costs of his/her drinking problem.

Investigations at the work place indicate that abusers tend to be concentrated in lower income occupations. Trice and Roman (1972) contend that this finding is due to the fact that lower status abusers are more readily identified by company supervisors. The reasons for this phenomenon are discussed in more detail in Section 2.5. For now, it suffices to say that it is more difficult to identify a manager or professional with a drinking problem and the occupational mixture in company studies tends to be biased.

Studies from rehabilitation programs and Alcoholics Anonymous members indicate an even distribution across occupational status levels. In fact, some studies have found that more educated individuals in high-status positions are more prone to have drinking problems. Although abuse rates vary among specific occupations, it appears that problem drinkers are not concentrated in a social class. In a review of the literature Chadosoff et al (1961) stated:

...[the type of industry distribution] demonstrates the ubiquitousness of the alcoholic. An industry or occupational group may be absent or under-represented in a particular sample of alcoholics, but the deficiency is apparently compensated in another.<sup>13</sup>

The evidence of a negative correlation between income and alcohol abuse appears to be due to the impact of drinking on income, rather than due to a concentration of abusers in lower income occupations. It is reasonable to assume, therefore, that in the absence of alcohol problems the 'average' abuser would earn the

average wage or salary. Thus, in calculating lost market production due to alcohol abuse, it is assumed that the average earnings before deductions of a male (female), in a comparable age group, will represent the abusers potential contribution to production.

#### 2.4 Problems of Quantification

As mentioned previously, the primary difficulty in examining specific problems associated with alcohol abuse is that some alcohol-related problems are not readily quantified in monetary terms. Perhaps the most significant form of production loss which is not quantified is non-market production, such as household services. Services such as child care, cleaning, meal preparation and home repairs are extremely valuable, but it is very difficult to assign to them a dollar value because they are provided outside of the market. Economists have attempted a variety of techniques to quantify their value. However, the estimates exhibit considerable variability. The difficulty is compounded by the fact that few researchers have examined the effect that alcohol abuse has upon non-market production. For these reasons it was decided not to attempt to quantify the cost of abuse for non-market production. However, given the adverse consequences of abuse on market production, it seems reasonable to conclude that alcohol abuse entails a significant loss of household production for those families with a problem drinker.

It is extremely difficult to apply an aggregate formula for some problems caused by alcohol abuse. Studies have shown, for example,

that alcohol abusers are more prone to make mistakes because of their drinking. However, quantifying the cost of an error depends upon its consequences. If, for example, an intoxicated surgeon makes an error it could result in the death of the patient. On the other hand, a mistake by an assembly line worker might simply result in a trivial fault in the product. Obviously, the economic cost of mistakes due to alcohol abuse must be analyzed individually and empirical difficulties preclude the quantification of this cost.

A third problem in quantifying the cost of lost production due to alcohol abuse is that cause and effect are not always readily distinguished. It is possible, for example, that the abuser's poor work performance will lead to his/her dismissal. It is also possible that unemployed individuals are more prone to developing drinking problems. It is extremely difficult, therefore, to ascertain the amount of unemployment caused by alcohol abuse. Until research can determine the amount of unemployment due to drinking problems, it is not possible to quantify this cost.

Some problems due to alcohol abuse need further research before it will be possible to assign them a dollar value. For example, many researchers note that an abuser's job performance can have a detrimental impact on co-workers morale and, consequently, lowers their productivity. This phenomenon, however, needs further empirical investigation before quantification is possible. A study analyzing the productivity change in co-workers after an abuser's rehabilitation would facilitate quantifying this cost. However, to date, studies analyzing

this phenomenon tend to be extremely subjective in nature. Researchers contend that this is a very significant cost and it has been estimated that abuse lowers the productivity of non-abusers by as much as 10 percent. As mentioned previously, however, further empirical work is needed before one can place much confidence in this estimate.

A final obstacle encountered in quantifying the production costs of alcohol abuse is that some problems cannot be placed in mutually exclusive categories and the costs must be understated to avoid double counting. For example, studies have found that alcohol abusers are more prone to having accidents because of their drinking practices. This fact is a significant component of the higher absenteeism rate of abusers. It is also possible, however, that the abuser's accident will injure another individual. Thus, it would be desirable to compute the economic cost of accidents due to abuse independently. However, there are very few estimates of the proportion of an abuser's absenteeism due to accidents. Consequently, an estimate of the production costs of accidents due to alcohol abuse would double count the cost of absenteeism for abusers.

The inability to quantify many production costs of alcohol abuse does not undermine the usefulness of the estimate. Rather, it re-inforces the concept that the final figure should be perceived as a minimum estimate of the potential gain in production from eliminating alcohol abuse. Future research may provide more reliable data and facilitate quantification of the cost of more problems due to

abuse. Until such time, production problems which do not lend themselves to quantification can only be acknowledged in the analysis.

## **2.5 Lost Production Due to Reduced Productivity and Absenteeism**

Two of the most serious work problems caused by alcohol abuse are reduced efficiency and absenteeism. It appears that the occupational status of the abuser primarily determines which problem dominates (Trice and Roman, 1970). Professional and white-collar workers tend to report to work, even when they are not capable of performing their duties.<sup>14</sup> Blue-collar employees, on the other hand, resort to absenteeism when in this condition.<sup>15</sup>

Trice and Roman cited several reasons for this phenomenon. First of all, higher-income positions are not closely supervised and their work is frequently independent of other employees. Lower-income jobs, on the other hand, tend to be more inter-related and come under the scrutiny of company supervisors. Consequently, it is easier for a white-collar worker to fake job performance and conceal sporadic low productivity. Secondly, high-income workers have more freedom to leave the office to continue drinking or cover-up their condition. Trice and Roman stated:

Significantly, low-status respondents who had jobs which required travelling in the community, such as delivery men, truck drivers and garbage collectors, were more inclined to go to work and remain on the job because their job activities facilitated cover-up and on-the-job drinking.<sup>16</sup>

Another reason why high-income abusers report to work is to pre-

vent colleagues from detecting a drinking problem from their attendance record. Stamps (1965) noted that high-income abusers primarily relied on self cover-up, while low-income workers counted on co-workers and supervisors to conceal their problem with alcohol. High-income abusers tend to exercise controlled drinking, or abstinence, when with their associates.<sup>17</sup> In contrast, lower-income abusers reported they frequently got drunk with their co-workers.<sup>18</sup>

The different responses elicited by alcohol abuse among income groups partially explains the disparity in the estimates of alcohol-induced absenteeism. Mann (1952) contended that an abuser was absent twice as frequently as a non-abuser, while Cavalie (1956) indicated an abuser's absenteeism was nearly eight times higher.<sup>19</sup> Obviously, the estimate of alcohol-induced absenteeism will depend upon the occupational status of the sample. If the sample is dominated by the more readily identified blue-collar worker, then the absenteeism rate would overstate the true incidence for a 'typical' abuser.

In reality, there are three types of absenteeism associated with alcohol abuse. The first is 'attendance' absenteeism where the employee simply fails to report to work. The second is 'on-the-job' absenteeism, where the abuser is unable to perform his/her assigned tasks. Finally, there is 'partial' absenteeism where the worker inexplicably disappears from an assigned post. The last two entail significant economic costs. However, they are not included in company attendance records. This increases the difficulty of quantifying the adverse production consequences of alcohol abuse.

In order to circumvent this difficulty, researchers have combined the last two forms of absenteeism under the category of reduced productivity. One of the earliest attempts to quantify this in monetary terms was by Winslow et al (1966). The authors had an abuser's supervisor rate his/her job performance in terms of a proportion of his/her potential production. If, for example, an abuser was viewed to be operating at 75 percent of his potential, then the value of reduced productivity was estimated at 25 percent of his/her annual salary.

The technique employed by Winslow et al could facilitate quantification of reduced productivity. Their study, however, employed a small sample of 19 abusers and the results must be interpreted cautiously, especially given the subjective nature of the evaluative procedure. Consequently, it would be quite hazardous to generalize these results for all employed abusers in British Columbia. Future research along these lines, however, would be beneficial in determining the costs of alcohol abuse.

The Special Subcommittee on Alcohol and Narcotics (1970) attempted to estimate the cost of reduced productivity due to alcohol abuse in a report for the United States Senate. In order to quantify the costs, four state agencies and seven major companies with alcohol treatment program were contacted. The companies and state agencies reported that their research indicated that the average abuser's production was between 25 to 44 percent lower because of absenteeism and reduced efficiency.<sup>20</sup> The Subcommittee assumed the 25 percent

figure and contacted nine academic experts for their opinions. Seven experts felt that 25 percent was too conservative, while two felt it overstated the costs.<sup>21</sup>

Attributing the costs of absenteeism and reduced efficiency to alcohol abuse implicitly assumes that drinking is solely responsible for these problems. The Winslow et al study found that the costs of abusers were very similar to employees who experienced other difficulties, such as marital breakdowns and mental illness. It is possible that alcohol abusers are prone to problems and, in the absence of drinking, other problems would develop which would hinder their job performance. Therefore, the essential question in quantifying the costs is; what are the production consequences of rehabilitation?

Trice (1965) found that treatment improved job attendance, but, 'treated' abusers continued to have higher rates of absenteeism. These results are difficult to interpret. They could indicate that abusers are more susceptible to other problems and, therefore, that alcohol abuse was not solely responsible for the production problems. These results could also reflect the fact that not all 'treated' abusers are rehabilitated. Most treatment programmes consider a 40 percent success rate as good and, consequently, a significant number of 'treated' abusers will continue to have problems with alcohol. In aggregate data, therefore, 'treated' abusers would be expected to have higher rates of absenteeism.

The fact that a significant number of abusers continue to have drinking problems after treatment presents a dilemma for this study.

The difficulty is compounded by the fact that the majority of studies evaluating the production effects of treatment have been made by companies. The results of treatment are assessed by its effect on work performance. If the abuser becomes as productive as other workers, then he/she is viewed as being rehabilitated. If productivity increases to an acceptable level, then he/she is perceived as to be controlling his/her drinking. If there is no marked improvement in job performance, then it is assumed a drinking problem persists. Thus, the definition of rehabilitation in these studies assumes that production problems were caused by alcohol abuse.

Although these company studies cannot be employed to determine the net effect of rehabilitation, they can be used as corroborating evidence for a causal inference. If alcohol abuse is a cause of higher absenteeism and reduced efficiency, then rehabilitation would decrease the occurrence of these production problems. Given that treatment does help some abusers overcome their drinking problem, 'treated' abusers should exhibit an aggregate improvement in their job performance.

A study by Asma (1975) for the Illinois Bell Telephone Company attempted to evaluate the improvement in work performance resulting from treatment. The study evaluated job efficiency and absenteeism for 402 abusers five years before, and after, entering the company treatment program.<sup>22</sup> Overall, it was contended that 57 percent of the referrals were rehabilitated.<sup>23</sup> The following two tables display the improvement in efficiency and absenteeism after treatment.

TABLE 1

## ESTIMATE OF JOB EFFICIENCY BEFORE AND AFTER TREATMENT

	FIVE YEARS BEFORE		FIVE YEARS AFTER	
	EMPLOYEES	PERCENT	EMPLOYEES	PERCENT
POOR	112	28	51	12
FAIR	199	50	119	30
GOOD	91	22	232	58

Source: Fern E. Asma, 'Long Term Experience with Rehabilitation of Alcoholic Employees', Richard Williams ed. Occupational Alcoholism Programs, (Springfield; Charles C. Thomas, 1975), p. 190

TABLE 2

NUMBER OF SICKNESS DISABILITY CASES  
(MORE THAN SEVEN DAYS REPORTED ILLNESS)

	FIVE YEARS BEFORE	FIVE YEARS AFTER
WOMEN	229	75
MEN	433	281
TOTAL	662	356

Source: Ibid.

The results indicate that there was a significant improvement in attendance and efficiency after treatment. Asma noted, however, that the absenteeism rate among the 402 referrals was still higher than for employees who never developed problems with alcohol. It should be noted, however, that only 230 abusers were considered rehabilitated. The results from this study must be interpreted cautiously. The improvement in job performance could have resulted from fearing dismissal rather than from rehabilitation.

The fear of dismissal undoubtedly provides a strong motivation to improve job performance. However, case studies indicate that the primary effect of warnings and threats is a temporary improvement in performance.<sup>24</sup> In the absence of rehabilitation, the problems tend to re-occur. The fact that Asma's study analyzed performance for a ten year period shows that rehabilitation is the long term solution to alcohol problems. This is somewhat expected, because, if threatening the abuser was all that was required then, from a production standpoint, it would not be necessary to invest in treatment programs.

Studies evaluating the production benefits of treatment have found that it is far more effective than warning employees who abuse alcohol.<sup>25</sup> In Asma's study, 81 percent of the referrals had at least ten years' service with the company before entering treatment. These employees had valuable experience and knowledge and their termination would entail a significant loss for the firm. The cost of dismissing

these workers would be the expense of training their replacements.<sup>26</sup> In Asma's study, 255 referrals retained their jobs in the future, and this was estimated to have saved the company \$459,000 in retraining costs alone.<sup>27</sup>

The empirical evidence indicates that treatment improves the attendance and job efficiency of abusers. This supports the hypothesis that alcohol abuse is a cause of the reduced productivity of problem drinkers. The question still remains, however, as to whether alcohol abuse is solely responsible for these production problems. Current knowledge cannot resolve this question and, therefore, it must be determined if assigning the production costs of abusers to their drinking problem is a reasonable assumption.

In Asma's study, 57 percent of the referrals no longer experienced these production problems after treatment. The remaining 43 percent continued to have higher rates of absenteeism and lower efficiency. The question then arises; is it reasonable to assume that 57 percent of the abusers no longer had a drinking problem? If, for example, treatment usually eliminated alcohol abuse by 90 percent, then it would appear that some of the reduced productivity of abusers was not related to their drinking. If, on the other hand, treatment eliminated alcohol abuse by 57 percent, then it would be 'possible' that drinking was entirely responsible for production problems.

Baekeland (1977) critically reviewed twenty years of literature on the effectiveness of treatment methods. His primary finding was that the patient's characteristics were the most important factors for

successful treatment. If abusers were highly motivated, e.g., fearing the loss of a job or spouse, their prognosis was good. Baekeland reported that the success rate for such individuals varied between 32.4 and 68 percent. The 57 percent success rate in Asma's study falls in this range. By no means does this constitute proof that alcohol abuse is solely responsible for these production problems. It appears, however, that attributing reduced productivity to alcohol abuse is not an unreasonable assumption.

There have been very few British Columbian or Canadian studies quantifying the costs of reduced productivity due to alcohol abuse. Consequently, it will be necessary to generalize from studies conducted in the United States. It is assumed that an abuser's absenteeism and reduced efficiency caused by drinking lowers his/her production by 25 percent. This was the conservative estimate adopted by the Special Subcommittee on Alcohol and Narcotics in a report for the United States Senate. Although the extent of alcohol abuse may vary between British Columbia and the United States, it seems reasonable to assume that the consequences of abuse are similar.

It is also necessary to estimate the number of employed abusers in British Columbia in 1979 to quantify the costs. This presents a significant difficulty and some studies have advocated a wide range. The Special Subcommittee report, for example, assumed that between 4 and 8 percent of federal civil servants abused alcohol in 1970. The cost of reduced productivity was, therefore, estimated to be between \$285 and \$570 million.<sup>28</sup>

The report for the United States Senate made several simplifying assumptions in estimating the extent of alcohol abuse. First of all, it assumed that the age distribution of federal civil servants was not an important factor. As mentioned previously, work problems caused by alcohol abuse are progressive in nature and generally occur after ten to twenty years of heavy drinking. Consequently, the age distribution is an important determinant of the magnitude of alcohol abuse at work.

A second assumption in the report was that the sex of federal civil servants was not an important factor. Abuse rates are higher for men, particularly in labour force participants. In Asma's study, 23 percent of the abusers were women. This could be the result of a bias against classifying women as alcohol abusers. However, Presnall (1976) stated:

In the NCA (National Council on Alcoholism) calculations the ratio between male and female alcoholic employees was calculated at 5:1. In the general population it was generally accepted that there was a ratio higher than 5:1 for females. But in business and industry employed female populations the evidence pointed to a high rate of voluntary job termination on the part of women . . . . Fear of social pressure, plus the greater freedom of women to choose not to work were thought to be causative of lower prevalence. New data now available supports a revision of the male/female employed alcoholism ratio to 3.5:1.<sup>29</sup>

Presnall attempted to estimate the number of employed civilian abusers in the United States in 1970. To accomplish this, he examined numerous company and government studies on the prevalence of alcohol abuse. Over all Presnall contended that 4.94 percent of employed

workers abused alcohol and that the average age was between 40 and 44.<sup>30</sup> The following table presents his estimate of abuse prevalence by age and sex.

**TABLE 3**  
**EMPLOYED CIVILIAN ABUSERS IN 1970 IN THE UNITED STATES**

AGE GROUP	% OF EMPLOYED MALES WHO ABUSE ALCOHOL	NUMBER OF EMPLOYED MALE ABUSERS	% OF EMPLOYED FEMALES WHO ABUSE ALCOHOL	NUMBER OF EMPLOYED FEMALE ABUSERS
19	1.7	15,309	0.5	3,853
20-24	3.2	123,608	0.9	28,212
25-29	5.5	274,729	1.6	33,058
30-34	7.5	337,936	2.1	34,256
35-39	9.2	405,677	2.6	45,257
40-44	10.0	479,554	2.9	60,490
45-49	9.3	442,114	2.7	60,180
50-54	6.7	282,844	2.0	40,841
55-59	2.3	81,015	0.7	11,946
60-64	1.8	42,871	0.5	5,411
<b>TOTAL</b>	<b>6.49</b>	<b>2,485,657</b>	<b>1.74</b>	<b>323,504</b>

Source: Lewis F. Presnall, Occupational Alcoholism Problems, presented at conference on Occupational Alcoholism for Union and Management, Bayshore Inn, Vancouver, B.C., Oct. 19, 1970, p. 6

In deriving these figures Presnall adopted the floor estimate approach of the NCA. This technique stresses that the estimate of abuse prevalence must be sufficiently conservative so that "on the basis of all known data it would be improbable that the actual percentage of alcoholism would fall below that level".<sup>31</sup> Thus, Presnall's estimate is a conservative prediction of abuse in the United States in 1970. The question for this study is whether these estimates could be employed in British Columbia. In addressing this issue Presnall stated:

It would be presumptuous to assume that our findings were entirely applicable to occupational populations in Canada... Nevertheless, the estimation formula should be useful in making Canadian assessments, particularly in view of the 'floor estimate concept'.<sup>32</sup>

In order to assess the applicability of Presnall's estimates to British Columbia, this study examines two commonly employed measures of alcohol abuse (see Table 2.3). The Ledermann formula contends that the proportion of heavy drinkers is lognormally distributed by per capita consumption. Consequently, it appears that the percentage of heavy drinkers in British Columbia in 1979 was higher than in the United States in 1970 (i.e., the data base used for Presnall's estimates). Mortality rates from cirrhosis of the liver are perceived as indicating the prevalence of long term drinking problems. Once again the data indicates a more serious alcohol abuse problem in British Columbia. Given the conservative approach of Presnall's study, it would appear that his percentage estimates are be a very conservative estimate of employed abusers in British Columbia in 1979.

**TABLE 4**  
**COMPARISONS OF PER CAPITA CONSUMPTION AND**  
**RATES OF CIRRHOSIS MORTALITY BETWEEN THE**  
**UNITED STATES IN 1970 AND BRITISH COLUMBIA IN 1979**

	ANNUAL PER CAPITA (15 YEARS AND OLDER) CONSUMPTION OF ABSOLUTE ALCOHOL (LITRES)	RATES OF CIRRHOSIS OF LIVER MORTALITY (PER 100,000 INDIVIDUALS)
United States (1970)	9.7	14.0
British Columbia (1979)	12.6	17.2

Source: Christopher Smith and Robert Hanham, Alcohol Abuse; Geographical Perspectives, (Pennsylvania; Commercial Printing Ltd., 1982), p. 21

Statistics Canada, Control and Sale of Alcoholic Beverages (63-202) Causes of Death (84-203) Intercensal Annual Estimates of Population (91-519)

Applying Presnall's estimation formula to British Columbia data indicates that 4.35 percent of employed persons between the ages of 20 and 64 abused alcohol in 1979. The following formula is used to calculate the value of lost production due to reduced productivity and absenteeism:

$$(1) \quad LP = \sum_{n=1}^5 AAE_n RPF NA_n$$

where:

LP = lost production;  
n = age category (see table 3.8);  
AAEn = average annual male (female) pre-tax earnings per male  
(female) earner in age group n;  
NA<sub>n</sub> = number of male (female) abusers in age group n; and  
RPF = reduced productivity factor from alcohol abuse.

The following two tables display the results of these calculations for both sexes:

TABLE 5

ESTIMATED COST OF LOST PRODUCTION FOR EMPLOYED MALE ABUSERS IN BRITISH COLUMBIA  
DUE TO ABSENTEEISM AND REDUCED PRODUCTIVITY 1979

AGE CATEGORY	NUMBER OF EMPLOYED MALES	% WHO ABUSE ALCOHOL	NUMBER OF EMPLOYED MALE ABUSERS	ANNUAL AVERAGE MALE EARNINGS PER MALE EARNER (\$)	ESTIMATED COST OF REDUCED PRODUCTIVITY AND ABSENTEEISM (\$)
1 (20-24)	151,463	3.2	4,847	9,807	11,883,632
2 (25-34)	210,983	6.4	13,500	16,463	55,562,625
3 (35-44)	140,361	9.6	13,475	19,542	65,832,113
4 (45-54)	107,055	8.1	8,671	19,134	41,477,729
5 (55-64)	65,026	2.1	1,366	17,250	5,890,875
TOTAL	674,888	6.20	41,859		180,646,974

Source: Lewis Presnall, Occupational Alcoholism Problems, presented at Conference on Occupational Alcoholism for Union and Management, Bayshore Inn, Vancouver, B.C., Oct. 19, 1970, p. 6

Statistics Canada; Earnings of Men and Women (13-577)

TABLE 6

ESTIMATED COST OF LOST PRODUCTION FOR EMPLOYED FEMALE ABUSERS IN BRITISH COLUMBIA  
DUE TO ABSENTEEISM AND REDUCED PRODUCTIVITY 1979

AGE CATEGORY	NUMBER OF EMPLOYED FEMALES	% WHO ABUSE ALCOHOL	NUMBER OF EMPLOYED FEMALE ABUSERS	ANNUAL AVERAGE FEMALE EARNINGS PER FEMALE EARNER (\$)	ESTIMATED COST OF REDUCED PRODUCTIVITY AND ABSENTEEISM (\$)
1 (20-24)	108,488	0.9	976	6,947	1,695,068
2 (25-34)	151,088	1.8	2,720	8,914	6,061,520
3 (35-44)	100,536	2.7	2,714	9,127	6,192,670
4 (45-54)	76,680	2.4	1,840	9,030	4,153,800
5 (55-64)	46,576	0.6	279	8,829	615,823
TOTAL	483,368	1.76	8,529		18,718,881

Source: Lewis Presnall, Occupational Alcoholism Problems, presented at Conference on Occupational Alcoholism for Union and Management, Bayshore Inn, Vancouver, B.C., Oct. 19, 1970, p. 6

Statistics Canada; Earnings of Men and Women (13-577)

The results suggest that 50,488 workers in British Columbia in 1979 were alcohol abusers. Overall, it is contended that reduced productivity due to alcohol abuse cost the province \$199,365,855 in lost potential production. As mentioned in section 2.1, lost production from employed abusers represents the total production cost of alcohol abuse with the replacement worker assumption. The next two sections estimate additional losses associated with the full employment model.

## **2.6 Lost Production of Unemployable Abusers**

Researchers have found that alcohol abusers have higher unemployment rates. Swint and Nelson (1977) reported that studies estimate that unemployment among alcohol abusers ranges between 15 and 25 percent. These statistics, however, must be interpreted cautiously. It is possible that drinking problems were responsible for the abuser's dismissal and, therefore, that alcohol abuse caused the unemployment. It is also possible, however, that the consequences of unemployment were responsible for the alcohol abuse. Unemployment increases the time available for alcohol consumption and the psychological effects of not being able to obtain employment could be conducive to developing a drinking problem.

It is not possible, at the present time, to ascertain the amount of unemployment caused by alcohol abuse. This study, therefore, does not attempt to calculate the value of lost production due to alcohol induced unemployment. Instead, it attempts to estimate the cost of

'unemployable' abusers. An 'unemployable' abuser is one whose problem with alcohol is so acute that he has little, if any, chance of obtaining a job. The most obvious examples of this condition are skid road abusers. These individuals are physically addicted to ethanol and, regardless of the economic situation, they are unable to obtain gainful employment.

Studies have indicated that approximately 5 percent of all abusers are unemployable because of chronic alcohol problems (e.g., Ray (1978)). Therefore, 95 percent of abusers can be considered as being employable. These 'employable' abusers can be placed into one of three categories. First of all, there are employed abusers. Secondly, there is the group seeking employment. Finally, there are those abusers who are potentially employable but, for some reason, are not in the labour force. To calculate the total number of 'unemployable' abusers it would be necessary to estimate the number of problem drinkers in these three categories.

Calculating the number of 'employable' abusers in these categories presents some difficulties. These problems can be circumvented if it is assumed that in the absence of severe alcohol problems, 'unemployable' abusers would experience the same employment rate as 'employable' abusers. This implicitly assumes that the labour force participation rate and unemployment rate for rehabilitated unemployable abusers would be the same as for 'employable' abusers. This would understate the actual employment potential for rehabilitated 'unemployable' abusers because some of the unemployment,

and the decision to leave the labour force, for the 'employable' group is probably related to their drinking.

In the previous section it was estimated that 50,388 abusers were employed in British Columbia in 1979. If this represents 95 percent of potentially employed abusers, then 2,652 'unemployable' abusers might have been employed except for their drinking problem. This is a minimum estimate for two reasons. First, the estimate of the number of employed abusers was calculated with Presnall's floor estimate approach. Secondly, the actual number of unemployable abusers is 5 percent of the total number of alcohol abusers. If these 2,652 individuals would have earned the average gross wage or salary, then the cost of 'unemployable' abusers is estimated at \$34,330,140 in 1979.

### **2.7: Lost Production Due to Premature Mortality**

Alcohol abuse can cause many health problems and some British Columbians died in 1979 because of their alcohol consumption. Presumably, if abuse were eliminated these deaths would have been prevented and the deceased abusers would have lived a normal life expectancy. This represents an economic cost because in the absence of drinking problems society would have continued to benefit from these individuals' market production.

Calculating the cost of premature mortality in 1979 requires that the analyst derive three estimates. First of all, one must estimate how many individuals died in 1979 because of their drinking

problem. Secondly, it is necessary to estimate their anticipated life expectancy if they had not abused alcohol. Finally, the present value of future production resulting from the increase in longevity must be calculated.

Lost production due to premature mortality differs from the other cost calculations in this chapter because the benefits of eliminating abuse accrue over time. A future benefit is not as valuable to society because it is not available for immediate consumption or investment. Consequently, future benefits are discounted to convert them to their present value. There is considerable debate among economists over the appropriate discount rate. In order to circumvent this controversy, the present value of lost production is calculated with 8, 10, and 12 percent discount rates.<sup>33</sup>

Previous studies which have quantified the production cost of premature mortality have estimated the number of deaths by examining the differences in mortality rates between abusers and non-abusers. This implicitly assumes that the increased probability of mortality among abusers is attributable only to their alcohol consumption. However, some of the mortality of abusers could be related to other factors, such as living conditions (e.g., pneumonia). Therefore, a superior methodological approach would be to examine specific mortality data and restrict the cost estimate to those cases where the analyst is confident that the death is causally related to alcohol abuse.

It should be recognized that this approach is facilitated by the fact that the deaths have occurred prior to the analysis. Therefore, the researcher knows how many deaths occurred because of specific causes (e.g., in 1979, 445 British Columbians died from cirrhosis of the liver).<sup>34</sup> Given these data, the analyst must then determine the proportion of deaths which can be reasonably attributed to alcohol abuse. The task is more difficult when examining lost production due to a decreased life expectancy for living abusers (e.g., when examining the benefits of treatment). In this case, the analyst must predict the decreased annual probability of future deaths through the elimination of alcohol abuse. As specific mortality data are not available, the analyst must estimate increased life expectancy from differences in mortality rates.

Both approaches are used in this thesis. This chapter uses specific mortality data to calculate lost production resulting from premature mortality in British Columbia in 1979. The next chapter uses differences in mortality rates to estimate the benefits of an increased life expectancy caused by successful treatment.

This thesis uses a study by Ouellet et al (1977) to determine the number of deaths in British Columbia due to alcohol abuse. The study was made for the Department of National Health and Welfare and attempted to calculate the amount of premature mortality in Canada attributable to smoking and hazardous drinking. In order to establish a causal relationship between premature mortality and these risk factors, the authors reviewed all causes of death in the International

Classification of Diseases (ICD). They then examined the epidemiological evidence to determine which causes of death were actually related to the risk factors.

The relationship between alcohol consumption and specific causes of death varied from a spurious association to a causal relationship. In determining a causal relationship the authors had used main considerations; "i) the strength and specificity of the association, ii) the biological plausibility of the observed association".<sup>35</sup> The following table displays the types of deaths the authors felt were related to alcohol abuse.

TABLE 7

## CAUSES OF DEATH IN CANADA IN 1971 RELATED TO HAZARDOUS DRINKING

CATEGORY	CAUSE OF DEATH (ICD)	NUMBER OF DEATHS
I (QUASI- CERTAIN)	Cirrhosis of the liver (571)	2,204
	Cancer of larynx (161)	184
	Cancer of the oral cavity and pharynx (140-149)	364
	Cancer of esophagus (150)	311
	Accidents - motor vehicle traffic (E 810-825)	5,793
	Accidents - falls (E 880-887)	607
	Accidents - fires (E 890-899)	652
	Alcoholism and Alcoholic psychosis (291 and 303)	483
II (PROBABLE)	Accidents (other than in I) (E 800-809, E 826-879, E 900-929)	3,472
	Suicide (950-959)	2,716
	Pneumonia (480-486)	1,128
	Peptic Ulcers (531-533)	344
	Gastritis and Duodenitis (535)	23
	Metabolic disorders (260-279)	292
I & II	TOTAL	18,898

Source: B.L. Ouellet et al., Premature Mortality Attributable to Smoking and Hazardous Drinking in Canada, (Ottawa; Department of National Health and Welfare, 1977), Volume I, p. 7

The authors calculated the relative risk and attributable fraction for all causes of death that they were reasonably certain that drinking was a causal factor (i.e., Category 1 in Table 7). The attributable fraction determines the percentage of deaths from a particular cause due to alcohol abuse. Every estimate of the attributable fraction was tested with a 95 percent confidence interval and the probable range was presented.

The authors had several difficulties in determining the attributable fraction due to alcohol abuse. One problem was defining and determining the extent of problem drinking in the context of a specific cause of death. They stated:

In defining a threshold level after which increased alcohol use constitutes a high risk we are faced with a problem. For certain diseases, a long-term heavy consumption of alcohol is important while for other causes of death, such as accidents, we are dealing with more immediate risk situations where impairment resulting from a heavy acute (versus chronic) use of alcohol represents a high rate.<sup>36</sup>

In those instances where heavy long-term consumption was the critical factor, epidemiological studies were examined to determine the threshold of increased risk. For example, it was asserted that individuals whose average daily consumption of ethanol exceeded 10 centilitres were at risk of contracting cirrhosis of the liver. The authors then used the Ledermann formula to determine the extent of problem drinking. The difference in consumption between the sexes was determined by studies in Canada and the United States.

Where acute intoxication was the critical factor, such as traffic accidents, the authors employed a number of Canadian and international studies to determine the population at risk. When international studies had to be used, the authors were careful to establish that there were no significant cultural differences between the countries and that the alcohol abuse problem between the two countries was comparable. It was not possible for the authors to remove the influence of all possible risk factors in causing a death. Therefore, for some causes of death the attributable fraction may overstate the actual role of alcohol abuse. The conservative approach in establishing which causes of death were actually related to alcohol abuse, however, means that Ouellet's study probably understates the amount of premature mortality caused by alcohol abuse. Alcohol probably was a causal factor in some suicides, for example, but none of these deaths were attributed to hazardous drinking.

The Ouellet study also presented estimates of potential years of life lost due to alcohol abuse. If an abuser died at age 40 then the authors concluded that 30 years of potential life were lost. This figure permits an estimation of the average age of individuals who died from a particular cause due to alcohol abuse. For example, from the study it can be determined that the average male abuser who died from cirrhosis of the liver was 54 years old. Thus, if we assume he might have lived and worked to age 65, society lost 11 years of his production.<sup>37</sup>

The value of lost potential market production due to premature mortality is calculated by applying the results of Ouellet's study to provincial mortality data. This probably understates the amount of premature mortality in British Columbia in 1979 attributable to alcohol abuse for three reasons. First of all, Ouellet's study adopted a very conservative approach. Secondly, British Columbia has the most serious provincial problem with alcohol abuse and Ouellet made a national study.<sup>38</sup> Therefore, the percentage of deaths by a particular cause due to hazardous drinking is probably higher in British Columbia. Finally, Ouellet's study examined alcohol abuse in 1971 and the empirical evidence indicates that the problem increased significantly in the 1970's. Since the number of problem drinkers has increased, it seems likely that the percentage of deaths due to alcohol abuse has also increased.

The evidence does indicate that the 'best' estimates in Ouellet's study tend to understate the actual amount of premature mortality due to alcohol abuse. For example, the study contends that 65.5 percent of male cirrhosis deaths were due to alcohol abuse. The mortality data, however, reports that about 74 percent of male cirrhosis deaths in British Columbia in 1979 were caused by alcohol abuse.<sup>39</sup>

The following formula is employed to calculate the present value of lost future market production due to premature mortality caused by alcohol abuse:

$$PVL Px = \sum_{y=b}^{65} \frac{Wy (1+c)^{(y-b)} P(S)y P(L)y}{(1+r)^{(y-b)}} NCx$$

where:

- PVL Px = present value of lost production of males (females) due to premature mortality in 1979 caused by x attributable to alcohol abuse;
- b = average age of death of a male (female) abuser from x;
- y = year;
- Wy = average annual gross earnings of a male (female) age y;
- P(S)y = probability that a non-abusing male (female) will survive year y;
- P(L)y = probability that a non-abusing male (female) age y will be in the labour force;
- r = discount rate;
- c = annual percentage increase in productivity for a male (female) non-abuser;<sup>40</sup>
- NCx = number of male (female) deaths from x due to alcohol abuse.

The following two tables show the results of the analysis. Both the discount rate and the attributable fraction are varied with sensitivity analysis.<sup>41</sup>

TABLE 8: PRESENT VALUE OF LOST FUTURE MARKET PRODUCTION  
DUE TO PREMATURE MORTALITY IN 1979 FOR MALE ABUSERS

CAUSE OF DEATH	PERCENT DUE TO ALCOHOL ABUSE	NUMBER OF DEATHS DUE TO ALCOHOL ABUSE	DISCOUNT RATE (%)	LOST PRODUCTION (\$ 000)
(1) Cirrhosis of the liver	54.0	154	8	19,270
	54.0	154	10	17,887
	54.0	154	12	16,678
	65.5	187	8	23,373
	65.5	187	10	21,696
	65.5	187	12	20,229
	75.0	214	8	26,763
	75.0	214	10	24,843
	75.0	214	12	23,163
(2) Cancer of the oral cavity, pharynx, and esophagus	16.1	23	8	1,734
	16.1	23	10	1,652
	16.1	23	12	1,577
	21.7	30	8	2,337
	21.7	30	10	2,226
	21.7	30	12	2,126
	27.2	38	8	2,929
	27.2	38	10	2,790
	27.2	38	12	2,664
(3) Motor Vehicle Accidents	32.1	163	8	40,991
	32.1	163	10	34,000
	32.1	163	12	28,915
	38.2	194	8	48,781
	38.2	194	10	40,461
	38.2	194	12	28,195
	44.0	223	8	56,187
	44.0	223	10	46,604
	44.0	223	12	39,635
(4) Accidental Falls and Fires	13.5	35	8	6,760
	13.5	35	10	5,925
	13.5	35	12	5,226
	28.0	72	8	14,022
	28.0	72	10	12,288
	28.0	72	12	10,922
	42.0	108	8	21,032
	42.0	108	10	18,432
	42.0	108	12	16,383
(5) Alcoholism and Alcohol Psychosis	100.0	58	8	7,578
	100.0	58	10	6,921
	100.0	58	12	6,363

**TABLE 9**  
**PRESENT VALUE OF LOST FUTURE MARKET PRODUCTION**  
**DUE TO PREMATURE MORTALITY IN 1979 FOR FEMALE ABUSERS**

CAUSE OF DEATH	PERCENT DUE TO ALCOHOL ABUSE	NUMBER OF DEATHS DUE TO ALCOHOL ABUSE	DISCOUNT RATE (%)	LOST PRODUCTION (\$ 000)
(1) Cirrhosis of the liver	65.7	105	8	3,253
	65.7	105	10	3,006
	65.7	105	12	2,791
	74.5	119	8	3,688
	74.5	119	10	3,409
	74.5	119	12	3,165
	81.6	131	8	4,040
	81.6	131	10	3,734
	81.6	131	12	3,466
(2) Motor Vehicle Accidents	32.1	69	8	5,425
	32.1	69	10	4,524
	32.1	69	12	3,867
	38.2	82	8	6,456
	38.2	82	10	5,384
	38.2	82	12	4,062
	44.0	94	8	7,437
	44.0	94	10	6,201
	44.0	94	12	5,301
(3) Accidental Falls and Fires	9.9	17	8	968
	9.9	17	10	843
	9.9	17	12	746
	23.1	39	8	2,258
	23.1	39	10	1,968
	23.1	39	12	1,741
	36.5	62	8	3,568
	36.5	62	10	3,109
	36.5	62	12	2,751
(4) Alcoholism and Alcohol Psychosis	100.0	19	8	700
	100.0	19	10	635
	100.0	19	12	579

It is contended that alcohol abuse was responsible for between 642 and 948 deaths in British Columbia in 1979. In terms of lost market production, these deaths cost the economy between \$66,782,000 and \$130,234,000. The 'best' estimates suggest that 800 people died because of alcohol abuse and this resulted in \$94,988,000 of lost potential production.<sup>42</sup> It should be remembered that this is a very conservative estimate and includes only lost market production. The death of 800 individuals represents large social costs which cannot be quantified. These deaths undoubtedly caused considerable pain and suffering for family members and acquaintances. They also result in losses of non-market production. It should be emphasized that quantifying lost production due to premature mortality is not an attempt to value life, but rather, quantifies one of the external costs that the deaths impose on society.

## **2.8 Summary**

With the replacement worker assumption, the cost of alcohol abuse is restricted to production losses from employed abusers. It has been estimated that in 1979 over 50,000 workers in British Columbia were alcohol abusers. Productivity from these individuals is estimated to be 25 percent less than their non-abusing counterparts. This decrease in production is due to poorer work performance and increased absenteeism. Overall, it is estimated that in 1979 alcohol abuse in the work force decreased production in British Columbia by almost \$200 million using a conservative basis of estimation.

In terms of "potential" production, the cost is considerably higher. Under the full employment assumption, it is estimated that the potential production cost of alcohol abuse in 1979 is about \$329 million. The increased cost resulted from 2,652 "unemployable" abusers (estimated cost, \$34 million) and the premature death of 800 individuals (estimated cost, \$95 million).

It should be recognized that the production costs of alcohol abuse are distributed among abusers, employers and the government. Abusers bear some of the costs because they earn less than their non-abusing counterparts. However, the market mechanism does not provide a complete correction and employers also share part of the costs. The government loses corporate and income taxes from forgone production. Therefore, it too shares some of the costs. The distribution of costs is examined in the next chapter, which estimates the costs and benefits of treatment.

## FOOTNOTES

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4. In effect they assume that workers are paid the value of their marginal product.
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6. Ibid
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8. A.G. Holtmann, 'Estimating the Demand for Public Health: The Alcoholism Case', Public Finance, volume 19, 1964, p. 355
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16. Ibid, p. 138

17. Ibid, p. 132
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19. Ibid, p. 135
20. Special Subcommittee on Alcohol and Narcotics, Substantial Cost Savings from the Establishment of Alcoholism Program for Federal Civilian Employees, report for U.S. Senate (Washington; U.S. Government Printing Office, Oct. 1970), p. 9
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22. Fern E. Asma, 'Long Term Experience with Rehabilitation of Alcoholic Employees', Richard Williams ed., Occupational Alcoholism Programs, (Springfield; Charles C. Thomas, 1975), p. 188
23. Ibid, p. 189
24. Lewis Presnall, Occupational Alcoholism Problems, presentation at Conference on Occupational Alcoholism for Union and Management, Bayshore Inn, Vancouver, B.C., Oct. 19, 1976, p. 11
25. Judith Groeneveld et al., The Alcoholism Treatment Program at Canadian National Railways, (Toronto; The Alcoholism and Drug Addiction Research Foundation, 1984)
26. There would be additional costs if the union filed a grievance over the dismissal.
27. Ministry of Health, Alcohol and Drug Commission, Employee Assistance Programs, p. 4
28. Special Subcommittee on Alcohol and Narcotics, Substantial Cost Savings, p. 11
29. Lewis Presnall, Occupational Alcoholism Problems, p. 4
30. Ibid, p. 5
31. Ibid, p. 3
32. Ibid
33. These discounts rates are recommended for public sector appraisals in British Columbia (Environmental and Land Use Committee Secretariat, Guidelines for Benefit-Cost Analysis, 1977).

34. Statistics Canada, Cause of Death (84-203)
35. B.L. Ouellet et al., Premature Mortality Attributable to Smoking and Hazardous Drinking in Canada, Volume I, (Ottawa; Department of National Health and Welfare, 1977), p. 6
36. Ibid, p. 18
37. In order to be consistent with the next chapter, lost production is calculated to age 65. However, it is noted that the Ouellet et al study calculated potential years of life lost to age 70.
38. As indicated earlier, the most common measures to estimate the magnitude of alcohol abuse are per capita consumption and cirrhosis rates. British Columbia traditionally has the highest values for these statistics among the ten provinces. Therefore, most experts feel that British Columbia has the most serious problem with alcohol abuse.
39. Statistics Canada, Causes of Death (84-203)
40. See Appendix A, item 6 for an explanation of how the increase in productivity is calculated.
41. Ouellet et al, tested the attributable fraction with a 95 percent confidence interval. This range and the discount rate are varied with sensitivity analysis.
42. This thesis uses Ouellet's "best estimate" and a 10 percent discount rate as being indicative of the cost of premature mortality. As demonstrated, the approach is conservative and has underestimated the actual premature mortality due to alcohol abuse. Therefore, it is felt that it is not necessary to use the lower bound estimate to provide a more conservative calculation.

## CHAPTER 3 COST-BENEFIT ANALYSIS OF AN ALCOHOL TREATMENT PROGRAM

### 3.1 Introduction

Society has a limited amount of resources and alternative projects must compete for funding. Decision-makers must frequently choose between projects which have different goals and objectives. Cost-benefit analysis can facilitate the decision-making process by two means. First of all, it can be employed to evaluate the desirability of a specific project or program. If the benefits exceed the cost, then it is advantageous to fund the project. Secondly, since outcomes are converted to a common dollar unit, cost-benefit analysis can be employed in principle to compare the returns from alternative projects or programs.

In recent years, an increasing number of researchers have attempted to devise cost-benefit models to evaluate alcohol treatment programs. Schramm (1980) cites two reasons for the interest in this analytical technique. First, social apathy towards the problem has led government decision-makers to allocate a disproportionate share of public funding to higher profile health problems. Therefore, it has been hoped that if more objective criteria are employed, government would increase its funding for alcohol treatment programs. Secondly, it has been hoped that the knowledge of returns from treatment would encourage private sector companies to establish occupational treatment programs.

As with most health applications of cost-benefit analysis, the benefit of treatment is the avoidance of future costs. The problems caused by alcohol abuse are responsible for lower production, higher medical costs and increases in premature mortality, crime and traffic accidents. Alcohol abuse also causes pain and suffering for the abuser, his family and friends. Presumably if the abuser stops drinking, these problems and their ensuing costs decrease. If treatment is responsible for the change in the abuser's drinking habits, the reduction in future costs is a benefit attributable to the treatment program.

There are however, several empirical difficulties associated with estimating the benefits of treatment. First of all, some consequences of abuse are difficult to express in monetary terms (eg., pain and suffering). Secondly, it is difficult to establish the causal relationship between certain problems and alcohol abuse (eg., crime). Finally, the nature of the relationship must be such that the analyst can predict the impact that eliminating excessive drinking has on the incidence of problems. For these reasons the models in this chapter restrict the benefits of treatment to the avoidance of future production costs.

This restriction means that the models will underestimate the benefits of treatment. This will not undermine the study's usefulness, provided that treatment is found to produce a net benefit. Since benefits are understated, the actual returns from treatment will be higher than predicted. Therefore, if other projects

with even higher returns do not remain unfunded, it is in society's interest to fund the program. If, however, treatment costs are found to be greater than measured production benefits the results are inconclusive. Overall net benefits may or may not be positive. The proper interpretation of such a finding is that production benefits alone are insufficient to justify program expenditures.

### **3.2 Purpose and Background of the Study**

This chapter examines two cost-benefit models to evaluate an alcohol treatment program. The models are designed to identify the distribution of benefits and costs among abusers, their employers and the government. Alcohol abuse creates costs for all three groups and similarly all three benefit from successful treatment. While most treatment programs receive their funding from a single source, it is possible that the benefits from a single funding source would not be sufficient to exceed treatment costs. However, in the aggregate the program could still produce a net social benefit. Obviously this has important implications for the amount of resources allocated to treat alcohol abuse.

The models presented in this chapter are refined from previous work done in the field. The previous studies are reviewed in the next section. For now it suffices to say that most of the previous models have primarily addressed the issue on a theoretical basis. By contrast, the analysis here also includes an empirical case study. It examines the economic returns from an in-patient treatment program

based on data from Dallas House (Victoria, B.C.) in 1985. Dallas House is a non-profit society which runs a small in-patient alcohol treatment program which treats an average of 137 patients a year.<sup>1</sup>

Dallas House treats patients with alcohol and related drug dependences. It is a co-educational program and has a maximum capacity of 12 patients. The clinic has a "12 step" recovery program and operates on a 28 day rotation. Patients are referred to the clinic through a variety of individuals and organizations (eg., doctors, employers and other treatment programs). Thus the clinic treats a cross-section of abusers from different social and economic classes.

Treatment primarily consists of individual counselling and group therapy. In the private counselling sessions, the patient and the therapist jointly decide on the issues they will discuss. The emphasis, however, is on helping the abuser find alternative means to deal with problems and stress. The clinic also provides educational sessions which examine the detrimental impact that abuse has on the mental and physical well-being of the patient. Another objective of these sessions is to illustrate the relationship between the abuser's lifestyle and his/her drinking problem.

The clinic offers 2 1/2 days of family counselling. The goal is to educate family members about the problem of alcohol abuse and to enable them to assist with the abuser's recovery. After completing the program the patient is encouraged to join a support group, such as Alcoholics Anonymous.

It should be recognized that Dallas House does not collect sufficient background information on its patients to allow a complete cost-benefit study of its treatment program, as would be ideal. For example, the clinic does not know the incomes of former patients. More importantly, the clinic does not conduct follow-up investigations to determine its success rate or changes in the patients' situation since treatment.

It is conceivable that the required information could have been obtained through a survey of former patients. However, this approach was abandoned for two reasons. First of all, it proved to be very difficult to locate many former patients. This meant that the results would have to be generalized from a small sample of respondents. Secondly, many social scientists feel it is inappropriate to rely on survey data from abusers. One of the strongest traits of alcohol abusers is denial of a drinking problem. Therefore, unsuccessfully treated abusers might minimize their current drinking or the detrimental impact it has on their lives. On the other hand, reformed abusers might tend to overstate the benefits of their sobriety. Consequently, even if a sufficient number of former patients could be located, the results of the survey would be questionable.

Obviously, the best approach would be to estimate the benefits for patients treated at Dallas House with objective assessments of their work performance and absenteeism before and after treatment (eg., job evaluations). However, because of recidivism this would

require periodic evaluation over several years. Consequently, it is not a practical alternative for this thesis.

Because of these difficulties, it is necessary to use two data bases to calculate the benefits of treatment. When possible, the study uses information supplied by Dallas House. When the required data were not available, the study uses results from empirical studies of similar treatment programs. Therefore, the study is not a cost-benefit analysis of Dallas House per se. Rather, it is an evaluation of an in-patient treatment program using data supplied by Dallas House. Although this reduces the confidence in the findings, two principles are adopted that should bolster the credibility of the analysis. First, at certain points the study will err on the side of conservative benefit estimates, thereby understating the actual production returns to treatment. Secondly, at other points the study will employ sensitivity analysis and assess the benefits over a range of possible outcomes.

### **3.3 Selective Review of the Literature**

There are two types of economic evaluations of alcohol treatment programs. The first type uses implicit economic criteria to illustrate the benefits of treatment (eg., reduced absenteeism or decreased labour turnover). Benefits comprise the difference between employee performance before and after treatment. These studies do not attempt to quantify the value of the benefits, but rather present data which have economic implications. Examples of this type of study are

Thorpe and Perret (1959), Franco (1960), Asma et al. (1971) and Dunne (1977).

The second type of evaluation uses explicit economic criteria and cost-benefit models to assess the economic returns to treatment. This latter, more comprehensive, approach differs in three fundamental ways from the first type of study. First of all, the analysis is carried one step further as benefits are quantified in monetary terms. Secondly, the analysis is extended beyond the immediate follow-up investigation, with future benefits being estimated. Finally, treatment costs are included in the analysis since the purpose is to estimate the net benefit of treatment.

The prototype for these latter models was Fein's (1958) study on mental illness. Fein estimated the future costs of mental illness and viewed the benefits of treatment as the avoidance of these costs. The majority of studies in this vein have examined the benefits of treatment from the employers' perspective. The purpose has been to evaluate occupational treatment programs. Examples of this type of study are Schramm (1977), Hertzman and Montague (1977), Swint et al. (1978) and Trice et al. (1978). It should be mentioned that these studies do not include empirical application of models; they simply outline models or methodological issues associated with conducting a cost-benefit analysis of occupational treatment programs.

There are two main problems associated with cost-benefit models used to evaluate alcohol treatment programs. The first, as pointed out by Schramm (1980), is that the models require very specific and

hard-to-collect data. Consequently, it is frequently necessary to rely on expert approximations. The second problem is that estimating future benefits requires some simplifying assumptions.

Swint et al. (1978) have developed one of the more comprehensive models to evaluate an occupational treatment program. Their model examines four costs which can be averted by successful treatment. These are employee replacement costs together with production losses caused by lower productivity, premature mortality and earlier dismissal. It should be recognized that the last two costs are only applicable if the firm cannot, or does not, replace the abusing employee. If the firm replaces the abuser, and if the new worker is as productive as the former employee, then premature mortality or earlier dismissal would only impose replacement costs on the firm.

It should also be recognized that the model implicitly assumes that the rehabilitated abuser will remain with the firm (i.e., the benefits of increased productivity are estimated over the abuser's working lifetime). If, for example, the reformed abuser accepted employment with another company, the firm would no longer receive the benefits of his/her sobriety.

A final problem with the Swint et al. model is that it implicitly assumes that all production benefits accrue to the employer. Alcohol abuse has been found to lower abusers' income (i.e., due to higher absenteeism rates). If the abuser is successfully treated, job attendance is expected to return to normal levels. Therefore, some of the production benefits are transferred to

the abuser in the form of higher labour remuneration. In addition, government derives benefits through higher taxes.<sup>2</sup> Consequently, production benefits are distributed among all three groups. The Swint et al model, therefore, overestimates the return to employers.

Although the focus of most of the literature has been on occupational treatment programs, some studies have examined the benefits from the social perspective. Swint and Nelson (1977) developed such a model. However, because of data problems, their model examined only the avoidance of production costs and did not attempt to quantify benefits such as reduced crime, traffic accidents or medical costs.

Swint and Nelson examined increases in production caused by decreases in mortality and unemployment and better work performance and attendance. These benefits were estimated with three separate equations. In addition, they presented an empirical application of their model. However, it should be recognized that the case study was based on hypothetical data. Although, the clinic had not been established, the sponsor provided the authors with projected cost estimates.

The focus on social benefits avoids some of the problems associated with evaluating occupational treatment programs. For example, it is not necessary to assume that an abuser will remain with the same company. A reformed abuser will be more productive and, from the social perspective, it does not matter whether current or future employers receive this benefit.

However, examining treatment from the social perspective does not circumvent the problem of a replacement worker. Premature mortality and early dismissal will not impose a social cost if the abuser is replaced by an unemployed individual. This will be examined in more detail in the next section. For now it suffices to say that in order to deal with this problem in this thesis, two models are used to estimate the production benefits of treatment.

### **3.4 Benefits of Treatment**

This section examines two models to estimate the benefits of treatment. The first model estimates production benefits with an assumption of full employment. The second model estimates production benefits with an assumption that the abuser can be replaced by an unemployed individual.

With the full employment assumption, alcohol abuse can lower productivity by three means. First of all, employed abusers are less productive because of higher absenteeism and poorer work performance. Secondly, the drinking problem may force the abuser to leave the labour force. Finally, alcohol abuse can cause premature mortality so that society loses the abuser's future production. The benefit of treatment is the avoidance of these future costs for those individuals who are successfully treated.

With the replacement assumption, the only production cost of alcohol abuse results from the lower productivity of employed

abusers. Departure from the labour force or premature mortality do not impose social costs because the abuser is replaced by an otherwise unemployed individual.<sup>3</sup> Therefore, the production benefit of treatment is restricted to successfully treated abusers whose future employment status does not depend on their rehabilitation. In other words, they would have continued to be employed despite their drinking problem and the benefit of successful treatment is simply increased productivity (ie., better work performance and attendance).

Whether the existence of unemployment should be recognized in a cost-benefit analysis is a controversial issue (see section 2.1). Some analysts (e.g., Weisbrod (1961)) argue that a program's benefits should be calculated independently of the performance of the economy or the macroeconomic policies of the government. They feel that unemployment is a separate problem and should not be allowed to obscure the resource allocation benefits of eliminating a health problem, such as alcohol abuse. On the other hand it can be argued that the full employment assumption is unrealistic in today's economy; if the fact of unemployment is ignored, the program's benefits will be overstated.

Since both arguments appear to have validity, it was decided to include two models in this thesis, one for each assumption. The full employment assumption provides an estimate of the potential production benefits of treatment. The replacement worker assumption provides a lower-bound estimate of the production benefits of treatment.

### 3.4.1 Model I (Assuming Full Employment)

The following model is used to calculate the aggregate benefits of treatment provided in any calendar year using the full employment assumption:<sup>4</sup>

$$(1) \quad PVSPB = \sum_{y=b}^{65} \frac{P(ST)_y \cdot n \cdot (MP_y - MPay)}{(1+r)^{y-b}}$$

where:

PVSPB = present value of society's production benefits;  
 y = year;  
 b = mean age at which a male (female) abuser enters treatment;  
 P(ST)<sub>y</sub> = probability that treatment remains successful in year y;  
 n = number of male (female) abusers treated in the sample year;  
 MP<sub>y</sub> = value of market production in year y for a non-abusing male (female);  
 MPay = value of market production in year y for an abusing male (female); and  
 r = discount rate.

Further:

$$(2) \quad MP_y = W_y (1+c)^{y-b} P(S)_y P(L)_y$$

where:

W<sub>y</sub> = mean annual gross wage for a non-abusing male (female) age b + y;  
 c = annual percentage increase in productivity for a male (female) non abuser;  
 P(S)<sub>y</sub> = probability that a non-abusing male (female) will survive year y; and  
 P(L)<sub>y</sub> = probability that a non-abusing male (female) age y will be in the labour force.

and:

$$(3) \quad MPay = W_y (1+c)^{y-b} (1-RPF) P(Sa)_y P(La)_y$$

where:

- RPF = reduced productivity factor of abuse;  
 P(Sa)y = probability that an abusing male (female) will survive year y;  
 P(La)y = probability that an abusing male (female) age y will be in the labour force;  
 and other terms are as indicated in equation (2).

Returning to equation (1),  $P(ST)y.n$  will provide an estimate of the number of abusers who continue to benefit from treatment through year y.<sup>5</sup>  $(MPy - MPay)$  provides an estimate of the increase in production for a rehabilitated abuser in year y. Therefore, summing the discounted benefits over the abusers' working lifetimes will yield the present value of aggregate future production benefits of treatment.

As mentioned previously, abusers, employers and the government all benefit separately from the production gains of successful treatment. Abusers benefit through higher incomes. Employers benefit through increased labour productivity not reflected in increased labour remuneration. The government benefits from higher tax revenue. The following sub-sections examine the production benefits accruing to each group.

**(a) Abuser Benefits**

The production benefits of successful treatment that accrue to abusers are in the form of increased income through higher wages. It should also be recognized that this is only one benefit to the

abuser. He/she also has a decreased probability of premature mortality, better health, and the elimination of family and personal problems caused by his/her drinking. These intangible benefits, however, are not measured in this thesis.

The following formula is used to calculate the abusers' share of the production benefits of treatment:

$$(4) \quad PVAPB = \sum_{y=b}^{65} \frac{P(ST)y^n [MPy(1 - TR) - MPay \frac{(1 - RIF)}{(1 - RPF)} (1 - TRa)]}{(1 + r)^n (y - b)}$$

where:

PVAPB = present value of abuser's income benefits;  
 TR = income tax rate for individual earning;  
 $\frac{Wy(1 + c)}{(y - b)}$   
 RIF = reduced income factor;  
 TRa = income tax rate for individual earning  
 $\frac{Wy(1 + c)}{(y - b)} (1 - RIF)$ ;  
 and other terms are as defined previously.

As mentioned previously, abusers generally earn lower wages. However, the employer bears some of the costs of the drinking problem. The term  $(1 - RPF)$ , included in  $MPay$  (see equation (3)), yielded the net effect of abuse on productivity. The factor  $RIF$  estimates the amount by which drinking lowers the abuser's gross income. Therefore, dividing  $MPay$  by  $(1 - RPF)$  and multiplying it by  $(1 - RIF)$  will provide an estimate of gross earnings for an abuser. Since income tax is progressive in nature, it is necessary to calculate the tax rate for the expected income of abusers and those individuals who benefit from treatment.<sup>6</sup>

**(b) Employer Benefits**

In terms of lost production, employers benefit from successful treatment if the abuser's production increases by more than his/her wage.<sup>7</sup> However, it should also be recognized that employers also benefit from not having to replace abusers who die or leave the labour force because of a drinking problem. Replacing a worker entails search and training costs for the firm. These costs are avoided if the abuser is successfully treated. However, since these avoided costs are not "production costs", they will not be quantified in this thesis.

The following formula is used to calculate the production benefits for employers:

$$(5) \quad PVEPB = \sum_{y=b}^{65} \frac{P(ST)y \quad n \quad MPay \frac{(RPF - RIF)}{(1 - RPF)} (1-CTR)}{(y - b)(1 + r)}$$

where:

PVEPB = present value of employers' production benefits;  
 CTR = corporate income tax rate;  
 and the other terms are as indicated previously

The term RPF is the percentage decrease in production due to alcohol abuse. The term RIF is the percentage decrease in the abuser's gross wage due to alcohol abuse. Therefore, (RPF - RIF) is the percentage difference between lower production and lower wages. As long as RPF is greater than RIF, then eliminating alcohol abuse increases production more than it increases the abuser's wage. However, like abusers, the benefit to employers is estimated after deducting taxes owing to the government (i.e., (1-CTR)).

The model implies that employers do not receive any of the production benefits resulting from a decrease in premature mortality or higher labour force participation. This results from the assumption that non-abusers are paid the value of their marginal product (see section 4.6.1). If the abuser dies, or leaves the labor force, the employer would no longer have to pay the abuser more than the value of his/her production. As this is the production cost to the firm, these factors do not impose future costs on the employer (e.g., premature mortality ends the production cost of abuse for employers). If non-abusing workers are paid the value of their marginal product, then all the production benefits associated with the decrease in mortality and higher labour force participation are transferred in the form of labour remuneration.

**(c) Government Benefits**

The higher incomes earned by successfully treated abusers and their employers increase income tax revenue for the government. In addition, eliminating abuse lowers medical and judicial costs and decreases traffic accidents and social assistance payments. However, since the focus of the thesis is on production, the only benefit which will be quantified is the increased income tax revenue. The following formula estimates the government's production benefit:

$$(6) \quad PVGPB = \sum_{y=b}^{65} \frac{P(ST)y^n (MPy(TR) - MPay \frac{(1 - RIF)}{(1 - RPF)} (TRa))}{(1 + r)(y - b)} + PVEPBy \frac{CTR}{(1 - CTR)}$$

where:

PVGPB = present value of the government's production benefits;  
 PVEPBy = present value of employers' benefits in year y;  
 and the other terms are as indicated previously.

As stated, tax benefits to the government are composed of increases in personal and corporate income taxes. The term

$\frac{PVEPBy}{(1-CTR)}$  is designed to estimate the employers' contribution to

increased tax revenue. Dividing PVEPBy by (1-CTR) provides an estimate of the annual discounted increase in gross income accruing to employers (i.e., the increase in production after eliminating higher wages earned by reformed abusers). Multiplying this by the corporate income tax rate yields an estimate of employers' taxes.

The term in the brackets in equation (6) calculates the increase in personal income tax. The only difference between this and the equation used to estimate abuser benefits is that MPy and MPay are multiplied by the tax rate rather than one minus the tax rate. It should be noted that since income tax is shared, both the federal and provincial governments will receive these benefits.

It should also be noted that because the social benefits are distributed between these three groups. The government benefits could also be calculated from the following identity:

$$(7) \quad PVGPB = PVSPB - PVAPB - PVEPB$$

### 3.4.2 Model II (Assuming Worker Replacement)

As mentioned previously, with the replacement assumption the only social production cost of alcohol abuse results from the lower

production of employed abusers. Premature mortality or other departure from the labour force does not impose social costs because the abuser could be replaced by an unemployed non-abuser. Therefore, the benefit of treatment is simply the increase in productivity for those individuals who would have been employed in spite of their drinking problem.

The following formula estimates the aggregate economic benefits of treatment (PVSPB<sup>1</sup>):

$$(8) \quad PVSPB^1 = \sum_{y=b}^{65} \frac{P(ST)_y \cdot n \cdot MPay^1}{(1+r)^y}$$

where:

$$(9) \quad MPay^1 = RPF \cdot Wy \cdot (1+c)^{y-b} \cdot P(Sa)_y \cdot P(La)_y \cdot (1-Uy)$$

$Uy$  = unemployment rate for male (female) age  $y$ ;  
and other terms are as indicated previously.

As with the first model,  $P(ST)_y \cdot n$  estimates the number of abusers who benefit from treatment.  $P(Sa)_y \cdot P(La)_y \cdot (1-Uy)$  estimates the probability that these individuals would have continued to be employed if they had not been successfully treated. Finally,  $RPF \cdot Wy \cdot (1+c)^{y-b}$  estimates the decrease in production caused by alcohol abuse. Therefore, it also represents the potential gain to society if the abuser is successfully treated.

One of the fundamental differences between Models I and II is that the distribution of benefits will not satisfy the following identity:

$$(10) \quad PVSBP^1 = PVABP^1 + PVEBP^1 + PVGPB^1$$

This is because the abuser would still benefit from a decrease in premature mortality and job loss. The additional benefit to the abuser, however, does not constitute an economic benefit. It represents a cost of treatment to those individuals who would have replaced him/her. As such, from the aggregate economic perspective, it is merely a transfer of income between two groups.

**(a) Abuser Benefits**

The abuser's benefit is not equal in the two models because the replacement model includes the probability that the abuser could be unemployed. It should be recognized that the unemployment rate is not varied between abusers and non-abusers. This is because the difference in employment is captured by a lower labour force participation rate for abusers (item 11, Appendix A). The following formula is used to estimate abuser benefits:

$$(11) \quad PVAPB^1 = \sum_{y=b}^{65} \frac{P(ST)y^n (MPy^1(1 - TR) - MPay^1 \frac{(1 - RIF)(1 - TRa)}{RPF})}{(1 + r)^{(y - b)}}$$

where:

$$(12) \quad MPy^1 = Wy(1 + c)^{(y - b)} P(S)y P(L)y (1 - Uy);$$

and other terms are as indicated previously.

Because equation (9) contains the term RPF instead of (1-RPF), equations (11), (12) and (13) include the term  $\frac{1}{RPF}$  rather than  $\frac{1}{(1-RPF)}$  (see Model 1; (a) Abusers Benefits).

**(b) Employer Benefits**

The following formula is used to calculate the employer benefits:

$$(13) \quad PVEPB^1 = \sum_{y=b}^{65} \frac{P(ST)y \cdot n \cdot MPay^1 \cdot \frac{(RPF - RIF)}{RPF} \cdot (1-CTR)}{(1+r)(y-b)}$$

where all terms have been defined previously.

### (c) Government Benefits

The benefit to the government is estimated with the following formula:

$$(14) \quad PVGPB^1 = \sum_{y=b}^{65} \frac{P(ST)y \cdot n \cdot [MPay^1 \cdot \frac{1}{RPF} (TR) - MPay^1 \cdot \frac{RIF}{RPF} (TRa)]}{(1+r)(y-b)} + PVEPB^1 y \cdot \frac{CTR}{(1-CTR)}$$

where all terms have been defined previously.

Because of the progressive nature of income tax it is necessary to examine the difference in taxes at both income levels.

### 3.5 Cost of Treatment

The model is designed to examine an in-patient treatment program. There are two cost components of in-patient treatment programs. The first is resource expenditures (RRE) incurred by the clinic. The second component is the opportunity cost of treatment. Society must forgo the value of abusers' production during the treatment period and this represents an opportunity cost.

#### 3.5.1 Model I (Assuming Full Employment)

The aggregate cost of treatment is as follows:

$$(15) \quad TC = RRE + n \cdot \underline{(MPab)} \cdot d$$

where:

365

TC = treatment cost;  
 RRE = real resource expenditures;  
 d = number of days in the program;  
 and other terms are as indicated previously.

Treatment occurs over a period less than one year so that the

costs do not need to be discounted to present value.

**(a) Abuser Costs**

The abusers' share of treatment cost is as follows:

$$(16) \quad TC_a = RRE_a + n \frac{(MP_a b)}{365} d \frac{(1-RIF)}{(1-RPF)} (1-TR_a)$$

where:

$TC_a$  = treatment cost for abusers;  
 $RRE_a$  = abusers' share of resource expenditures;  
 and other terms are as indicated previously.

**(b) Employer Cost**

The employers' share of treatment costs is as follows:

$$(17) \quad TC_e = RRE_e + n \frac{(MP_a b)}{365} d \frac{(RIF - RPF)}{(1-RPF)} (1-CRT)$$

where:  $TC_e$  = treatment cost for employers;  
 $RRE_e$  = employers' share of real resource expenditure;  
 and other terms are as indicated previously.

It should be noted that, for employers, the opportunity cost of treatment can be a negative cost. If drinking lowers the abuser's production more than his/her wage then, when the abuser is absent from work, the decrease in remuneration (RIF) is less than the decrease in production (RPF). Consequently, the term (RIF-RPF) is negative. The implication is that the production cost of abuse is greater than the decrease in the abuser's wages. This is somewhat expected because the employer bears some of the cost of the abuser's drinking problem.

**(c) Government Costs**

The government's share of treatment cost is estimated as follows:

$$(18) \quad TC_g = RRE_g + \frac{n(MP_a d)}{365} \frac{1}{(1-RPF)} ([1-RIF] TR + [RIF-RPF] CTR)$$

Where:

TCg = government's share of treatment cost;  
 RREg = government's share of real resource expenditure;  
 and other terms are as indicated previously.

Once again, the government's share of treatment costs can be estimated as follows:

$$(19) \quad TCg = TC - TCa - TCe$$

### 3.5.2 Model II (Assuming Worker Replacement)

Since it is assumed that employers would not choose to replace abusers during the treatment period, there is little difference between the two models. One exception is that the term MPab is adjusted for the probability that the abuser is unemployed at the time of treatment. Consequently, in Model II,  $MPab^1$  is substituted for MPab. In addition, the term  $\frac{1}{RPF}$  is substituted for  $\frac{1}{(1-RPF)}$  (see equation (12)).

## 3.6 Estimating the Models

The next two sections present an empirical application of the models just described. The purpose is to calculate the economic return accruing to an in-patient treatment program using 1985 data from Dallas House. In that year the clinic treated 129 patients (82 men and 47 women). The 1985 financial statement indicates that the clinic's total expenditure (RRE) was \$278,197.

As mentioned previously, Dallas House does not collect all the information required for an empirical application of the models. Consequently, some terms must be estimated with expert approximations. This is accomplished through an examination of the

empirical literature on alcohol abuse and other treatment programs. Where the literature indicates a significant range in outcomes, values are varied with sensitivity analysis.

Information on the measurement of all variables is included in Appendix A. This section focuses on assumptions and terms varied with sensitivity analysis. The purpose is to elaborate on issues that require more explanation than is contained in Appendix A.

### **3.6.1 Assumptions**

Obviously estimating future production requires some assumptions. For example, it is assumed that the rehabilitated abuser would have the same attributes as a non-abuser. In other words, the problems which led to lower productivity are caused by the abuser's drinking. Therefore, if the abuser is successfully treated, the problems would be eliminated and the abuser's future production would increase to expected levels. This assumption is supported by evaluations of occupational treatment programs which have found significant improvements in job performance and attendance after treatment (e.g., Asma, 1975).

It is also assumed that a non-abuser's gross wage represents the value of his/her marginal product. In other words, the future wage approximates the value of future production. This is a common assumption in cost-benefit analysis. However, because of wage differentials, it means that the benefits must be independently calculated for both sexes.

As mentioned previously, Dallas House does not have background

information regarding patient incomes. Therefore, it is assumed that in the absence of a drinking problem, the patient would have earned the mean wage, adjusted for age and sex. Dallas House treats a cross section of society and, therefore, this is not an unreasonable assumption. Furthermore, as indicated in the last chapter, alcohol abuse has been found to be normally distributed among income groups. Therefore the analysis is, at least, indicative of treating a "typical" abuser.

Clearly the age of the patients is an important determinant of the benefits of treatment. The younger the patient, the more years society benefits from the increased production associated with his/her sobriety. Consequently, it was necessary to examine the age of patients treated at Dallas House in 1985. The age distribution was examined for both sexes because of wage rate differentials.

The analysis found a significant range in patients' ages (ie., from 17 years to 70 years). The range created an analytical difficulty because the calculations would have to be done by individuals or by narrow age bands. In addition, with sensitivity analysis the benefits are calculated with 108 possible variable combinations for each model. Therefore, it was decided to examine the age distribution to see if it would be reasonable to calculate the benefits of treatment with the mean age for each sex. This implicitly assumes that calculating the benefits for the mean age is representative of the benefits for all abusers. In other words, the smaller benefit in treating older patients is offset by the higher

return from younger patients.

It was hoped that the patients' ages would be normally distributed. However, a chi-square test rejected this proposition. Figure 1 compares the age distribution of patients treated in 1985 with normal distributions. As can be seen, the distributions are skewed right and younger patients are over-represented in the sample.

Since younger patients are overrepresented, use of the mean age would underestimate the returns from treatment. However, since the objective is to provide a minimum estimate of the benefits of treatment, use of the mean age may be justified. At the same time, it simplifies the calculations significantly. However, before accepting this approach it was decided to examine the age distribution for several years to ensure that 1985 was representative of a "typical" age distribution.

Figure 2 examines the age distribution for all patients treated since 1983. The results indicate that extending the period did not alter the nature of the distribution (i.e., skewed right). Consequently, it appears that using the mean age may be justified as providing a conservative estimate of the benefits of the treatment program.

The personal income tax rate is determined from the 1985 tax table. This thesis makes two assumptions to calculate this rate. First of all, it is assumed that employment is the only source of income. Secondly, it is assumed that employed individuals have \$10,000 in personal deductions. The latter assumption means that

FIGURE 1: AGE DISTRIBUTION OF PATIENTS (1985)

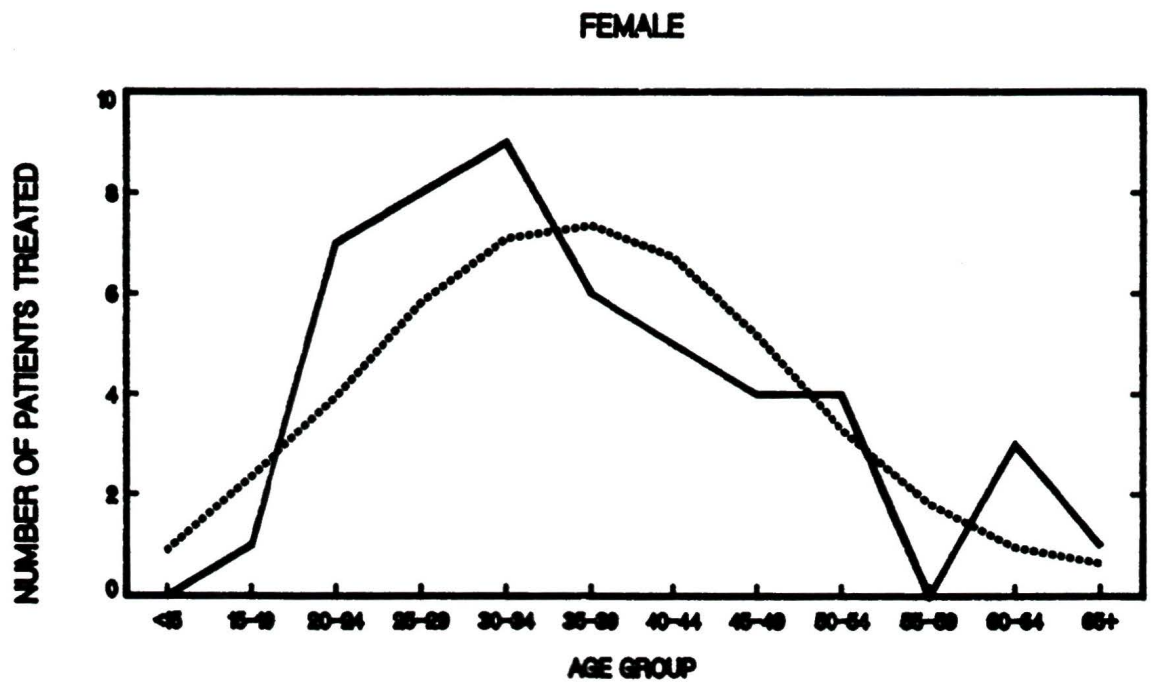
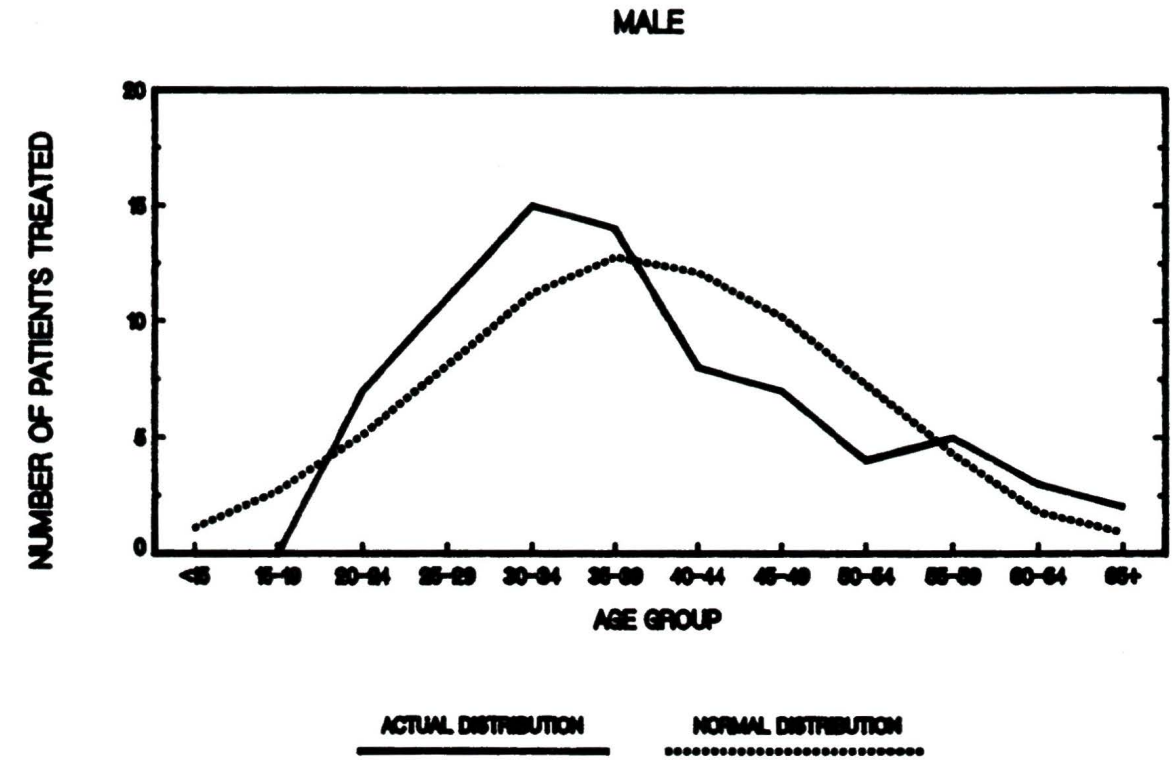
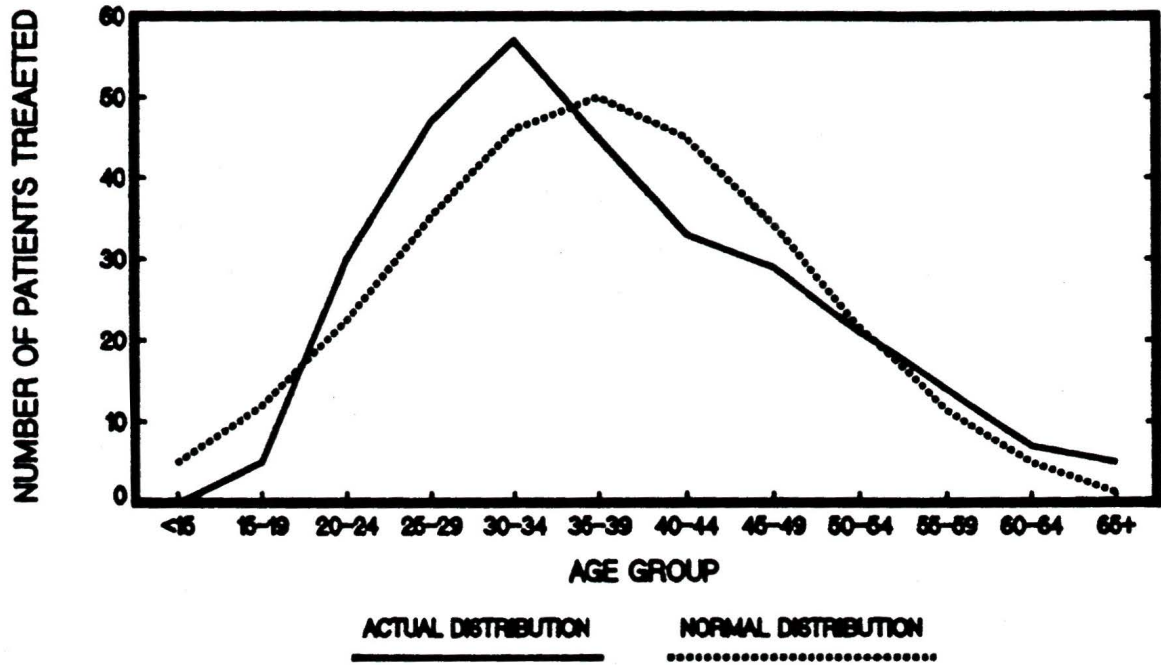
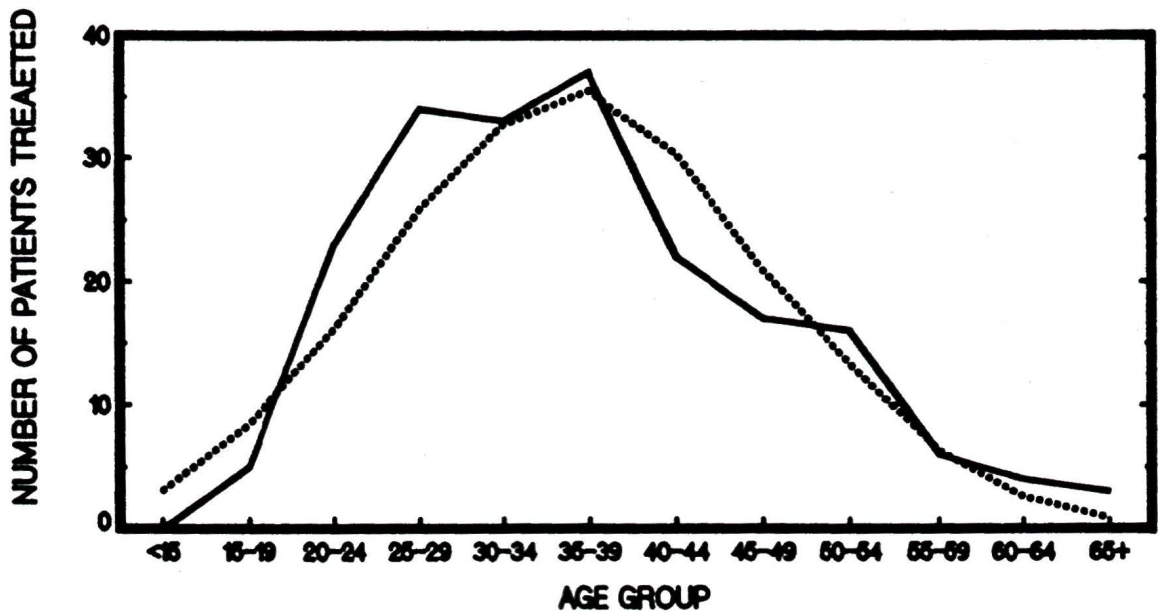


FIGURE 2: AGE DISTRIBUTION OF PATIENTS (1983-86)

MALE



FEMALE



patients had \$5,860 in deductions in addition to their personal exemption (e.g., for their spouse, children, charitable donations, pension contributions, etc.).

Clearly, without detailed financial information from the patients, it is impossible to derive a precise estimate of individual income tax rates. However, it should be recognized that these assumptions affect only the distribution of benefits, not the estimation of the economic return to treatment.

### **3.6.2 Sensitivity Analysis**

There are several difficulties in determining the success rate of treatment. First of all, social scientists and program evaluators frequently disagree on what constitutes successful treatment. Most feel that the goal of treatment is sobriety and that the success rate can be measured by the percentage of patients who quit drinking. However, others contend that abstinence does not guarantee a good life adjustment. They feel that treatment must be assessed by multifactorial outcome measures rather than simply examining alcohol intake.

A second problem in estimating the success rate is caused by recidivism. Abusers are prone to relapse and the success rate will decrease on an annual basis. Since the benefit of treatment is the reduction of future costs, the success rate should decrease with time because of recidivism. Although previous cost-benefit models have assumed a constant success rate, a declining rate is used in this study (see Item 19, Appendix A).

A final problem in estimating the program's success rate is caused by autonomous recovery. Studies have shown that abusers can overcome their drinking problem without clinical intervention. Therefore, some "successfully treated" abusers might have stopped drinking even if they had not received treatment. Consequently, it would be inappropriate to contend that in the absence of treatment all the patients would have continued to have a drinking problem. The success rate is, therefore, reduced to exclude those patients who, it is estimated, would have experienced autonomous recovery anyway (see Item 18, Appendix A).

As mentioned previously, Dallas House has not conducted follow-up investigations of its former patients. Consequently, the success rate must be estimated by the probability that a patient quit drinking because of clinical intervention. The probability that a patient benefited from treatment in year  $y$  is as follows:

$$(20) \quad P(ST)y = (1-P(AR)y) \cdot (1-P(R)y)$$

where:

$P(ST)y$  = the probability that treatment remains successful in year  $y$ ;

$P(AR)y$  = the probability that the patient would have experienced autonomous recovery in year  $y$ ; and

$P(R)y$  = the probability of recidivism in year  $y$ .

Obviously with this equation the success rate is determined by the probability that the patient would not have relapsed (ie.,  $1-P(R)y$ ). However, the success rate is discounted to exclude those patients who would have experienced autonomous recovery (ie.,

1-P(AR)y). Appendix A provides a description of how each variable is calculated. These are probabilities based on Baekeland's (1977) review of 20 years of literature on treatment programs. Furthermore, because of variability in reported results, both probabilities are varied with sensitivity analysis.

As discussed in the previous chapter, an abuser's wage is not indicative of the value of his/her production. Although an abuser's wage tends to be lower than that of his non-abusing counterpart, the employer bears some of the costs of the drinking problem (eg., lower productivity caused by poor work performance). The previous chapter estimated that alcohol abuse lowers production by about 25 percent. However, sensitivity analysis is employed to examine the benefits over a range of values for the reduced productivity factor (RPF) (see Item 9, Appendix A).

The goal of cost-benefit analysis is to convert outcomes to a common unit for comparative purposes. The benefit of treatment is the reduction of future costs. However, the costs of the treatment program are incurred when the patient enters treatment. Obviously it would be inappropriate to compare these values directly. A future benefit is not as valuable because it is not available for immediate consumption or investment. Consequently, future benefits must be discounted to present value terms. There is a debate among economists over the appropriate discount rate. To circumvent this controversy, this thesis uses sensitivity analysis and calculates the present value of future benefits with discount rates of 8, 10 and 12 percent (see

Item 4, Appendix A), as recommended for public sector appraisals in British Columbia (Environment and Land Use Committee, 1977).

The nominal corporate tax rate, as specified in the Income Tax Act is 46 percent. However, the actual percentage paid depends on the financial performance of the company. Consequently, the effective corporate tax rate is between 0 and 46 percent. Therefore, both rates are used to indicate the range of possible outcomes (see Item 16, Appendix A).

### **3.7 Results**

The results of the analysis are reported in Appendix B (Model I) and Appendix C (Model II). The following sub-sections present an overview of the findings.

#### **3.7.1 Model I (Assuming Full Employment)**

The social benefits of treatment are reported in table 10 in Appendix B. The model estimates that the net benefit of treatment, in present value terms, ranged from \$1,287,372 to \$4,616,141. The mean net benefit estimate is \$2,643,870. Obviously this model finds that the production benefits are more than sufficient to justify expenditures on the treatment program.

##### **(a) Abuser Benefits**

Production benefits of treatment accruing to abusers are reported in table 11 in Appendix B. The model estimates that net

benefits range from \$978,723 to \$2,335,696. The mean net benefit estimate is \$1,573,970. The analysis indicates that, with most variable combinations, the abuser is the primary recipient of the production benefits of treatment.

**(b) Employer Benefits**

Production benefits accruing to employers are reported in table 12 in Appendix B. The model estimates that net benefits range from \$88,861 to \$1,663,815. The mean net benefit estimate is \$552,174. Benefits accruing to employers exhibit the greatest variation. In addition, with 32 variable combinations the total benefits to employers are not sufficient to offset the clinic's operating costs. These issues are discussed in more detail in section 3.8 (Conclusions and Implications).

**(c) Government Benefits**

Production benefits to the government are reported in table 13 in Appendix B. The model estimates that net benefits range from \$144,092 to \$1,381,984. The mean net benefit estimate is \$517,725. In assessing the relative position of the net benefits to the government it should be noted that, unlike most treatment programs, Dallas House receives the majority of its funding from government grants (i.e., grants constitute approximately 90 percent of the resource expenditures by the clinic).

**3.7.2 Model II (Assuming Worker Replacement)**

The social benefits of treatment are reported in table 14 in Appendix C. This model estimates that the net benefit of treatment

range from \$687,774 to \$3,019,913. The mean net benefit estimate is \$1,624,555. Although the net benefit estimates are lower with the replacement worker assumption, model II still finds that the production benefits are more than sufficient to justify expenditures on the program.

**(a) Abuser Benefits**

Production benefits to abusers are reported in table 15 in Appendix C. The net benefit estimates range from \$905,279 to \$2,161,495 and have a mean value of \$1,456,424. In several variable combinations the benefit to abusers exceeds the social benefits. This is because benefits resulting from increased life expectancy and labour force participation still accrue to the abuser. However, from the social perspective, this represents a transfer of benefits from unemployed workers who would have replaced the abusers if they had not been successfully treated.

**(b) Employer Benefits**

Production benefits to employers are reported in table 16 in Appendix C. The model estimates that employers' net benefits range from \$82,301 to \$1,541,482. The mean net benefit estimates is \$331,396. Benefit estimates for employers do not change much with model II. This is because in models I and II the employer does not receive the benefits associated with an increase in life expectancy or labour force participation (see section 3.4.1 Employer Benefits). The slight difference in benefit estimates is due to the fact that model II accounts for the possibility of unemployment.

### (c) Government Benefits

Production benefits to the government are reported in table 17 in Appendix C. The model estimates that government net benefits range from \$24,997 to \$1,032,105. The mean net benefit estimate is \$311,396.

### 3.8 Conclusions and Implications

The models presented in this chapter have demonstrated methods of estimating the production benefits of an in-patient treatment program. A conservative approach was adopted and a minimum estimate of the benefits of treatment was derived. In addition, the models have outlined techniques for distributing costs and benefits among abusers, employers and the government.

The empirical case study of the in-patient treatment program has produced the following findings. First, the analysis found that aggregate production benefits exceed treatment costs, even with the replacement worker assumption. Given the conservative assumptions underlying these models, it is reasonable to assert on the basis of the client profile and cost of Dallas House's program that in-patient treatment offers a net benefit to society.

The analysis also found that treatment offers a net benefit for each of the three groups. However, this result was primarily attributable to the fact that the clinic receives most of its funding from government grants. If this were an occupational treatment program (i.e., where the employer must offset the total costs of

treatment), the results would have been considerably different. For example, in model I the production benefits to employers would not offset total treatment costs in 50 variable combinations.

It should also be noted that the estimated production benefits accrue to both present and future employers. Schramm (1980) states that, on average, workers change employers every six years. Changing employers would have a significant impact on the benefits accruing to the firm which paid for treatment. If the benefit period is restricted to six years then, in model I, the maximum benefit to the employer is \$579,797.

As mentioned previously, a finding that production benefits do not exceed treatment cost should not be interpreted as meaning that treatment results in an overall net cost. Savings in other areas, such as replacement and training costs, could offset apparent losses. However, one implication would be that the reliance on occupational programs to treat abusers may not be sufficient. Employers could find that dismissing abusers is the most cost efficient means of addressing the problem.

The analysis also found that the abuser was the primary recipient of the production benefits of treatment. However, economic circumstances may inhibit his/her ability to pay for treatment. It should be recognized that the reason why the abuser benefits from treatment is because his/her income is lower than that of a non-abuser. It should also be noted that the benefits of treatment result after successful treatment. Therefore, if the abuser has

primary responsibility for treatment costs, expenditures on rehabilitation programs would likely be lower than socially desirable levels.<sup>8</sup>

It would seem reasonable to expect the government to absorb the majority of treatment costs. The production benefits accruing to government are sufficient to offset these costs.<sup>9</sup> In addition, the government receives significant benefits through reduced expenditures on alcohol-related problems (e.g., criminal justice and medical expenditures). The government also benefits from lower expenditures on social programs (e.g., welfare and unemployment insurance).

Previous studies have found that treatment offers significant benefits to employers. However, these studies have employed some contentious assumptions. In particular they have assumed that the increase in production resulting from eliminating abuse will accrue entirely to the employer who pays for the treatment. The present analysis has found that the benefits are distributed among several groups. Therefore, all three groups should contribute to the cost of treatment.

## FOOTNOTES

1. Based on the clinic's records for the period 1983 to 1986. In 1985 Dallas House treated 129 patients.
2. The government also may benefit from reduced social support payments if the rehabilitated abuser is able to continue working. However, the models in this study are explicitly restricted to estimating the increase in production resulting from successful treatment. Taxes are included to determine the government's share of the increase in production. On the other hand, income assistance programs are government expenditures on an alcohol-related problem (i.e., unemployment). Therefore, like judicial and medical costs, a potential reduction in social assistance payments is not quantified in this thesis.
3. There are, of course, premature hiring and training costs. These do not constitute production losses per se. Consequently, they are not quantified in this thesis, but are simply noted as an intangible benefit (to the extent that they are avoided).
4. The expression is written in the given form because mean values are used in the estimation of MPy and MPay (see section 3.6.1 and Appendix A item 5).
5. See equation (20) for a more detailed explanation.
6. Given the round order magnitude of the TR and TRa terms, it was not considered worthwhile to fine tune the estimates by taking account of further small deductions from gross pay that accrue to governments (e.g., UIC premiums).
7. This benefit is calculated for all future employers. The benefit to the employer at the time of treatment depends on how long the reformed abuser remains with the firm.
8. One reason why abusers might be reluctant to assume the majority of treatment costs is that individuals can be risk averse. The probability of successful treatment is estimated to range from 25 to 40 percent. Therefore, the probability that an abuser will not benefit from successful treatment could be as high as 75 percent.
9. There is a concern that if the government examines only its share of production benefits, treatment programs would still be funded at less than socially desirable levels (e.g., the government might use its resources for a project which yields it a higher return but offers less social benefits). Therefore, the recommendation that the government supply the majority of

the funding is based on the assumptions that it will examine treatment benefits from the social perspective and that it should intervene because individuals' risk aversion may inhibit an optimal solution.

#### CHAPTER 4: SUMMARY

In competitive conditions the market mechanism balances the costs and benefits of a private good to determine price and a socially satisfactory quantity of consumption and output. However, in the case of alcohol, the market mechanism fails to determine the optimal level of consumption because alcohol consumption imposes external costs on third parties. Specifically, the market mechanism does not take into account the loss in social welfare resulting from problems caused by alcohol abuse. The economic rationale for taxing alcohol products is to correct for the failure of the market mechanism and incorporate external costs in the price. However, current taxation policies are primarily designed to raise government revenue and their role in a comprehensive alcohol policy is, at best, a secondary concern.

Economists could help to develop a comprehensive taxation policy by estimating the loss in social welfare resulting from alcohol abuse. Unfortunately, it is extremely difficult to calculate all the external costs of abuse. Some problems cannot be objectively assigned a monetary value (e.g., a divorce caused by abuse). Other problems are difficult to relate causally to alcohol consumption (e.g., crime). Consequently, this thesis concentrates on quantifying only production losses attributable to alcohol abuse, one category of external cost. It should also be said that the thesis does not take into account the fact that abusers presumably derive some individual

benefits from their alcohol consumption.

The manner by which unemployment is treated has a significant impact on the estimate of lost production. If one assumes that the abuser who dies prematurely or cannot work because of excessive drinking could be replaced at work by an unemployed individual, then the estimate of lost production is restricted to losses from employed abusers (e.g., reduced productivity and job attendance). If, on the other hand, one assumes that the economy is at full employment, production losses from premature mortality and unemployability are also included in the cost estimate. There is a considerable debate among economists as to the appropriate way to treat unemployment. In order to circumvent this controversy, this thesis calculates lost production according to both assumptions.

Experts contend that alcohol abuse reduces the productivity of employed abusers by about 25 percent. It is estimated that in 1979 there were over 50,000 employed abusers in British Columbia. This is estimated to have cost the province's economy about \$200 million in lost production under the replacement worker assumption. Under the full employment assumption, the cost estimate is increased to \$329 million. The higher cost was attributed to 2,652 unemployable abusers (estimated cost, \$34 million) and the premature death of 800 individuals (estimated cost, \$95 million).

The magnitude of production losses displays the need to examine ways of reducing the external costs of alcohol abuse. Chapter 3 examines one possible solution and evaluates the efficiency of an

in-patient treatment program. The analysis finds that rehabilitation increased the value of production more than the cost of treatment. Alternative use of the replacement and full employment assumptions does not alter this finding. Rather, these assumptions and sensitivity analysis influenced merely the value of the benefit estimate (e.g., net benefits are estimated to be between \$687,000 and \$4,616,000).

While the analysis finds that in-patient treatment is a worthwhile endeavor, informed decision-makers require studies of alternative means to reduce the costs. It could be the case that other types of treatment or prevention programs are more cost efficient ways of reducing the external costs of alcohol abuse (e.g., out-patient treatment or educational programs). Unfortunately, evaluation of other ways to reduce the costs of abuse is beyond the scope of this thesis.

Chapter 3 also examines the distribution of production benefits among abusers, employers, and the government. Based on the funding distribution of Dallas House's program, each of these three groups appears to benefit from treatment with abusers securing the greatest gain. However, if this had been an occupational treatment program the results would have been considerably different. The analysis indicates that, with many variable combinations, the production benefits to employers are insufficient to offset total treatment costs. This result differs from those of previous studies which have found that treatment offers significant benefits to employers. The

primary reason for the discrepancy is that the previous studies assume that employers receive all the production benefits resulting from successful treatment.

The implication of the benefit distribution is that all three groups should share treatment costs. Costs could be shared in accordance with the distribution of benefits. However, this may pose some practical difficulties for the abuser. The benefit to the abuser is an increase in future income and he/she may not be able to pay for treatment at its outset. One possible solution to this problem would be to allow the abuser to defer his/her contribution until after treatment (e.g., with a payroll deduction scheme). However, a difficulty with this approach is that only 25 to 40 percent of patients are successfully treated and the majority of abusers do not receive an increase in future income. Individual abusers might not be willing to assume the risks of successful treatment and, consequently, expenditures on rehabilitation programs might be less than socially desirable.

Given that risk aversion on the part of individuals could prevent an optimal solution, a case may be made that the government should intervene and provide the majority of the funding for treatment programs. Its production benefits were sufficient to offset total treatment costs. In addition, the government is the primary beneficiary of reduced external costs not included in this analysis (e.g., reduced medical and criminal justice costs). However, the Government of British Columbia does not provide much funding for

alcohol treatment programs. According to the Public Accounts, in fiscal 1985/86, the Province spent about \$10 million on grants to treatment programs. This represents only 0.4 percent of the Ministry of Health's total expenditure in that year.

One issue which has not been addressed is whether the alcohol industry should also share some of the treatment costs. Although it does not benefit from successful treatment, it profits from the sale of alcohol to abusers. In addition, it promotes consumption through advertising. Therefore, it too might have some responsibility for the external costs of alcohol abuse.

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**APPENDIX A: Variables Used in the Models in Chapter 3**

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This Appendix describes the source and method of calculation for each variable included in the empirical application of the models. More details on terms varied with sensitivity analysis are included in section 4.6.2.

(1) Year (y):

- o The year is initially equal to mean age at treatment and increases incrementally until age 65

(2) Mean age at which a male (female) abuser enters treatment (b):

- o For males the mean age at treatment is 39. For females the mean age at treatment is 37

Source: Dallas House

(3) Number of male (female) abusers treated in 1985 (n):

- o 82 men and 47 women were treated at Dallas House in 1985

Source: Dallas House

(4) Discount rate (r):

- o This thesis uses discount rates of 8, 10 and 12 percent. The mean value (10%) is included as it is the benchmark rate recommended for British Columbia.

Source: Environment and Land Use Committee Secretariat, Guidelines for Benefit Cost Analysis, Province of British Columbia, Victoria, 1977.

(5) Mean annual gross wage for a non-abusing male (female) age y (Wy):

- o Data on mean earnings of men and women was available only for 1982. To circumvent this difficulty the following steps were taken:
  - (i) the 1982 wages for men and women were converted to 1985 dollars using the Consumer Price Index (for each age group);
  - (ii) the productivity factor (c) was used to estimate the increase in earnings from 1982 to 1985 (see (6)).

Source: Statistics Canada; Earnings of Men and Women (13-577)  
 Statistics Canada; The Consumer Price Index (62-002)

6. Annual percentage increase in productivity for a male (female) non abuser (c):

- o Estimated by the change in real wages between 1967 and 1982. The following formula is used:

$$Y (1 + c)^{15} = X$$

Where:

Y = 1967 wages in 1982 dollars

X = 1982 wages

The results indicate that the annual increase in productivity (wages) for men is 1.205 percent and 2.388 percent for women. Note: Swint and Nelson (1977) assumed an annual increase in productivity of 3 percent. Therefore, this approach provides a more conservative estimate.

Sources: Statistics Canada: Earnings of Men and Women (13-577)

Statistics Canada: The Consumer Price Index (62-002)

7. Probability that a non-abusing male (female) will survive year y(P(S)y):

- o The Life Tables provide an estimate that a male (female) age x will survive the year. Thus the probability that an abuser will survive year y is as follows:

$$P(S)y = P(S)b P(S)_{b+1} \dots P(S)y$$

Where:

P(S)b = annual probability that a non-abusing male (female) age b will survive to age b+1.

Source: Statistics Canada; Life Tables, 84-532

8. Probability that a non-abusing male (female) age y would be in the labour force (P(L)y):

- o Examined labour force participation by age and sex in 1985

Source: Statistics Canada, The Labour Force, (71-001)

9. Reduced Productivity Factor (RPF):

- o Estimates of lower productivity due to absenteeism and lower output of alcohol abuser range from 20 to 30 percent. This thesis uses sensitivity analysis and benefits are calculated at 20, 25 and 30 percent. The mean value was included because it was the estimate used in the previous chapter.

Source: Swint and Nelson (1977)

10. Probability that an abusing male (female) will survive year  $y$   $P(S_a)y$ :

- o Generally, cost-benefit studies of alcohol abuse use life tables compiled by Pearl (1926). However, due to the age of the publication, more recent statistics are used in this thesis. Sundby (1967) has compiled age specific mortality rates for abusers (i.e., increased risk of mortality for age groups). For example, a 39 year old male abuser is 2.25 times more likely to die than his non-abusing counterpart. The probability that a 39 year old non-abusing male would die before the age of 40 is 0.00212. Therefore, the probability that a 39 year old male abuser would die before the age of 40 is 0.00477 (i.e.,  $0.00212 \times 2.25$ ). In other words, the probability of survival is 0.99533. Using this approach it is possible to derive life tables for abusers. The formula used in term 7 ( $(PS)y$ ), is then applied to the abusers' lifetable.

11. Probability that a male (female) abuser age  $y$  would be in the labour force  $P(L_a)y$ :

- o It is recognized that abusers' drinking problems can be so acute that they are unable to seek employment. Swint and Nelson (1977) assumed that unemployment among abusers was 4 percent higher than among non-abusers. This is a conservative estimate and is used in this thesis. However, rather than increasing the unemployment rate, this thesis decreases the labour force participation rate. This is to reflect lower employment rates for abusers in Model I (i.e., Model I assumes full employment).

Source: Swint and Nelson (1977), Statistics Canada; The Labour Force, (71-001)

## 12. Reduced Income Factor (RIF);

- o Berry and Boland (1977) examined the impact of abuse on an abuser's wage. The values vary according to age. The results of Berry and Boland's study are used in this thesis.

Source: Berry and Boland (1977)

## 13. Personal income tax rate for non-abusers (TR):

- o An employed non-abuser is estimated to earn  $Wy(1+c)^{(y-b)}$ . It is assumed that he (she) has \$10,000 in deductions. The tax rate is then calculated from the 1985 tax table (Federal and Provincial taxes are included).

$$\text{(i.e. } \frac{\text{Taxes Owning}}{\text{Gross Income}} = \text{the tax rate)}$$

Source: 1985 Tax Guide

## 14. Personal income tax for abusers (TRa);

- o An employed abuser is estimated to earn  $Wy(1+c)(y-b)(1-RIF)$ . It is assumed that he (she) has \$10,000 in deductions. The tax rate is then calculated from the 1985 tax table.

Source: 1985 Tax Guide

## 15. Corporate Tax Rate (CTR):

- o The nominal corporate tax rate is 46 percent. However, the actual tax paid depends on the profitability of the firm (i.e., the rate is between 0 and 46 percent). Therefore, this thesis uses sensitivity analysis and assesses taxes over the range of possible outcomes.

Source: Statistics Canada, Corporation Taxation Statistics, (61-208)

## 16. Unemployment Rate (Uy):

- o The unemployment rate varies by age and sex. However, the higher unemployment among abusers is captured by a lower labour force participation rate. Therefore, the unemployment rate is not varied for abusers and non-abusers.

Source: Statistics Canada, The Labour Force (71-001)

17. Resource Expenditure (RRE, RREa, RREe, RREg):

- o In 1985 resource expenditures by the clinic were \$278,197. Total revenue was \$275,958 (i.e., a deficit of \$2,239). In addition, \$885 was raised from membership, donations and sundry items. This creates a slight difficulty (i.e.,  $RRE = RREa + RREe + RREg$ ). To circumvent this problem, revenue from each group is increased on a pro-rated basis (i.e., increased proportionately to offset total expenditures). This results are as follows:

$$RRE = 278,197$$

	<u>Actual</u>	<u>Pro-rated*</u>
RREg	246,465	249,264
RREe	0	0
<u>RREa</u>	<u>28,608</u>	<u>28,933</u>
Total	275,073	278,197

\*Pro-rated figures are used in this thesis.

Source: Dallas House

18. Probability of Autonomous Recovery (P(AR)y):

- o Baekeland's 1977 review of treatment found that depending on the patient's characteristics there was a 2 - 15 percent probability of autonomous recovery. This range is used in this thesis.

Source: Baekeland (1977)

19. Relapse Rate (P(R)y):

- o The relapse rate is defined in terms of those individuals who are not successfully treated. The Baekeland (1975) review of 30 inpatient treatment programs indicated that the success rate varied between 25 and 40 percent. The benefits of treatment are assessed assuming success rates of 25, 32.5 and 40 percent. The relapse rate should increase with time. Selzer and Holloway (1957) found that 95 percent of abusers who relapse do so in the first year. Therefore, assuming a 25 percent success rate,

71.25 percent of patients would be expected to relapse in the first year. Of the remaining 3.76 percent who are expected to relapse, it is assumed that half of them will resume drinking in the next year (e.g., the second year relapse rate is .73125). This process is continued for the entire period of analysis or until the relapse rate is equal to 75 percent.

Source: Baekeland (1977)

Selzer and Holloway (1957)

20. Present Value of Society's Production Benefits; Model I (PVSPB):
  - o as calculated by equation 1.
21. Value of Market Production in Year  $y$  for an Abusing Male (Female); Model I (M Pay):
  - o as calculated by equation 3.
22. Present Value of Abuser's Income Benefits; Model I (PVAPB):
  - o as calculated by equation 4.
23. Present Value of Employers' Production Benefits; Model I (PVEPB):
  - o as calculated by equation 5.
24. Present Value of Governments' Production Benefits; Model I (PVGPB):
  - o as calculated by equation 6.
25. Present Value of Society's Production Benefits; Model II (PVSPB<sup>1</sup>):
  - o as calculate by equation 8.
26. Value of Market Production in Year  $y$  for an Abusing Male (Female); Model II (M Pay<sup>1</sup>):
  - o as calculated by equation 9.
27. Present Value of Abusers' Income Benefits; Model II (PVAPB<sup>1</sup>):
  - o as calculated by equation 11.

28. Value of Market Production in Year  $y$  for a Non-Abusing Male (Female); Model II ( $MPy^1$ ):
- o as calculated by equation 12.
29. Present Value of Employers' Production Benefits; Model II ( $PVEPB^1$ ):
- o as calculated by equation 13.
30. Present Value of Governments' Production Benefits; Model II ( $PVGPB^1$ ):
- o as calculated by equation 14.
31. Total Treatment Cost; Model I (TC):
- o as calculated by equation 15.
32. Treatment Cost for Abusers; Model I ( $TCa$ ):
- o as calculated by equation 16.
33. Treatment Cost for Employers; Model I ( $TCe$ ):
- o as calculated by equation 17.
34. Treatment Cost for Government; Model I ( $TCg$ ):
- o as calculated by equation 18.
35. Total Treatment Costs; Model II ( $TC^1$ ):
- o as calculated by equation 15, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RPF)}$  and  $MPab^1$  for  $MPab$ .
36. Treatment Costs for Abusers; Model 2 ( $TCa^1$ ):
- o as calculated by equation 16, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RPF)}$  and  $MPab^1$  for  $MPab$ .

28. Value of Market Production in Year  $y$  for a Non-Abusing Male (Female); Model II ( $MPy^1$ ):
- o as calculated by equation 12.
29. Present Value of Employers' Production Benefits; Model II ( $PVEPB^1$ ):
- o as calculated by equation 13.
30. Present Value of Governments' Production Benefits; Model II ( $PVGPB^1$ ):
- o as calculated by equation 14.
31. Total Treatment Cost; Model I (TC):
- o as calculated by equation 15.
32. Treatment Cost for Abusers; Model I ( $TCa$ ):
- o as calculated by equation 16.
33. Treatment Cost for Employers; Model I ( $TCe$ ):
- o as calculated by equation 17.
34. Treatment Cost for Government; Model I ( $TCg$ ):
- o as calculated by equation 18.
35. Total Treatment Costs; Model II ( $TC^1$ ):
- o as calculated by equation 15, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RPF)}$  and  $MPab^1$  for  $MPab$ .
36. Treatment Costs for Abusers; Model 2 ( $TCa^1$ ):
- o as calculated by equation 16, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RPF)}$  and  $MPab^1$  for  $MPab$ .

37. Treatment Costs for Employers; Model II ( $TCe^1$ ):

o as calculated by equation 17, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RPF)}$  and  $MPab^1$  for  $MPab$ .

38. Treatment Costs for Government; Model II ( $TCg^1$ ):

o as calculated by equation 18, substituting the term  $\frac{1}{RPF}$  for  $\frac{1}{(1-RRF)}$  and  $MPab^1$  for  $MPab$ .

39. Probability that Treatment Remains Successful in Year  $y$  ( $P(ST)y$ ):

o as calculated by equation 20.

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**APPENDIX B: MODEL 1; Results**

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TABLE 10: MODEL I; SOCIAL BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVSPB	TC	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	1,731,171	443,799	1,287,372
0.12	0.150	0.20	0.750	0.46	1,731,171	443,799	1,287,372
0.12	0.020	0.20	0.750	0.00	1,804,650	443,799	1,360,851
0.12	0.020	0.20	0.750	0.46	1,804,650	443,799	1,360,851
0.10	0.150	0.20	0.750	0.00	1,975,330	443,799	1,531,531
0.10	0.150	0.20	0.750	0.46	1,975,330	443,799	1,531,531
0.12	0.150	0.25	0.750	0.00	2,025,358	433,099	1,592,259
0.12	0.150	0.25	0.750	0.46	2,025,358	433,099	1,592,259
0.10	0.020	0.20	0.750	0.00	2,067,153	443,799	1,623,354
0.10	0.020	0.20	0.750	0.46	2,067,153	443,799	1,623,354
0.12	0.020	0.25	0.750	0.00	2,109,478	433,099	1,676,379
0.12	0.020	0.25	0.750	0.46	2,109,478	433,099	1,676,379
0.12	0.150	0.20	0.675	0.00	2,231,461	443,799	1,787,662
0.12	0.150	0.20	0.675	0.46	2,231,461	443,799	1,787,662
0.08	0.150	0.20	0.750	0.00	2,291,121	443,799	1,847,322
0.08	0.150	0.20	0.750	0.46	2,291,121	443,799	1,847,322
0.10	0.150	0.25	0.750	0.00	2,303,929	433,099	1,870,830
0.10	0.150	0.25	0.750	0.46	2,303,929	433,099	1,870,830
0.12	0.020	0.20	0.675	0.00	2,326,859	443,799	1,883,060
0.12	0.020	0.20	0.675	0.46	2,326,859	443,799	1,883,060
0.12	0.150	0.30	0.750	0.00	2,319,545	422,400	1,897,145
0.12	0.150	0.30	0.750	0.46	2,319,545	422,400	1,897,145
0.08	0.020	0.20	0.750	0.00	2,408,061	443,799	1,964,262
0.08	0.020	0.20	0.750	0.46	2,408,061	443,799	1,964,262
0.10	0.020	0.25	0.750	0.00	2,408,665	433,099	1,975,566
0.10	0.020	0.25	0.750	0.46	2,408,665	433,099	1,975,566
0.12	0.020	0.30	0.750	0.00	2,414,306	422,400	1,991,906
0.12	0.020	0.30	0.750	0.46	2,414,306	422,400	1,991,906
0.10	0.150	0.20	0.675	0.00	2,548,624	443,799	2,104,825
0.10	0.150	0.20	0.675	0.46	2,548,624	443,799	2,104,825
0.12	0.150	0.25	0.675	0.00	2,617,572	433,099	2,184,473
0.12	0.150	0.25	0.675	0.46	2,617,572	433,099	2,184,473
0.10	0.150	0.30	0.750	0.00	2,632,527	422,400	2,210,127
0.10	0.150	0.30	0.750	0.46	2,632,527	422,400	2,210,127
0.10	0.020	0.20	0.675	0.00	2,667,814	443,799	2,224,015
0.10	0.020	0.20	0.675	0.46	2,667,814	443,799	2,224,015
0.08	0.150	0.25	0.750	0.00	2,662,970	433,099	2,229,871
0.08	0.150	0.25	0.750	0.46	2,662,970	433,099	2,229,871
0.12	0.020	0.25	0.675	0.00	2,719,339	433,099	2,286,240
0.12	0.020	0.25	0.675	0.46	2,719,339	433,099	2,286,240
0.12	0.150	0.20	0.600	0.00	2,731,851	443,799	2,288,052
0.12	0.150	0.20	0.600	0.46	2,731,851	443,799	2,288,052
0.10	0.020	0.30	0.750	0.00	2,750,177	422,400	2,327,777
0.10	0.020	0.30	0.750	0.46	2,750,177	422,400	2,327,777
0.08	0.020	0.25	0.750	0.00	2,795,847	433,099	2,362,748
0.08	0.020	0.25	0.750	0.46	2,795,847	433,099	2,362,748
0.12	0.020	0.20	0.600	0.00	2,849,068	443,799	2,405,269
0.12	0.020	0.20	0.600	0.46	2,849,068	443,799	2,405,269
0.08	0.150	0.20	0.675	0.00	2,958,839	443,799	2,515,040
0.08	0.150	0.20	0.675	0.46	2,958,839	443,799	2,515,040
0.10	0.150	0.25	0.675	0.00	2,981,167	433,099	2,548,068
0.10	0.150	0.25	0.675	0.46	2,981,167	433,099	2,548,068
0.12	0.150	0.30	0.675	0.00	2,988,872	422,400	2,566,472
0.12	0.150	0.30	0.675	0.46	2,988,872	422,400	2,566,472

TABLE 10: MODEL I; SOCIAL BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVSPB	TC	NET BENEFIT
0.08	0.150	0.30	0.750	0.00	3,034,818	422,400	2,612,418
0.08	0.150	0.30	0.750	0.46	3,034,818	422,400	2,612,418
0.08	0.020	0.20	0.675	0.00	3,110,674	443,799	2,666,875
0.08	0.020	0.20	0.675	0.46	3,110,674	443,799	2,666,875
0.10	0.020	0.25	0.675	0.00	3,107,926	433,099	2,674,827
0.10	0.020	0.25	0.675	0.46	3,107,926	433,099	2,674,827
0.10	0.150	0.20	0.600	0.00	3,121,919	443,799	2,678,120
0.10	0.150	0.20	0.600	0.46	3,121,919	443,799	2,678,120
0.12	0.020	0.30	0.675	0.00	3,111,818	422,400	2,689,418
0.12	0.020	0.30	0.675	0.46	3,111,818	422,400	2,689,418
0.08	0.020	0.30	0.750	0.00	3,183,632	422,400	2,761,232
0.08	0.020	0.30	0.750	0.46	3,183,632	422,400	2,761,232
0.12	0.150	0.25	0.600	0.00	3,195,075	433,099	2,761,976
0.12	0.150	0.25	0.600	0.46	3,195,075	433,099	2,761,976
0.10	0.020	0.20	0.600	0.00	3,268,476	443,799	2,824,677
0.10	0.020	0.20	0.600	0.46	3,268,476	443,799	2,824,677
0.12	0.020	0.25	0.600	0.00	3,329,199	433,099	2,896,100
0.12	0.020	0.25	0.600	0.46	3,329,199	433,099	2,896,100
0.10	0.150	0.30	0.675	0.00	3,395,343	422,400	2,972,943
0.10	0.150	0.30	0.675	0.46	3,395,343	422,400	2,972,943
0.08	0.150	0.25	0.675	0.00	3,450,000	433,099	3,016,901
0.08	0.150	0.25	0.675	0.46	3,450,000	433,099	3,016,901
0.10	0.020	0.30	0.675	0.00	3,548,037	422,400	3,125,637
0.10	0.020	0.30	0.675	0.46	3,548,037	422,400	3,125,637
0.08	0.020	0.25	0.675	0.00	3,610,881	433,099	3,177,782
0.08	0.020	0.25	0.675	0.46	3,610,881	433,099	3,177,782
0.08	0.150	0.20	0.600	0.00	3,626,557	443,799	3,182,758
0.08	0.150	0.20	0.600	0.46	3,626,557	443,799	3,182,758
0.10	0.150	0.25	0.600	0.00	3,640,039	433,099	3,206,940
0.10	0.150	0.25	0.600	0.46	3,640,039	433,099	3,206,940
0.12	0.150	0.30	0.600	0.00	3,658,198	422,400	3,235,798
0.12	0.150	0.30	0.600	0.46	3,658,198	422,400	3,235,798
0.08	0.020	0.20	0.600	0.00	3,813,288	443,799	3,369,489
0.08	0.020	0.20	0.600	0.46	3,813,288	443,799	3,369,489
0.10	0.020	0.25	0.600	0.00	3,807,187	433,099	3,374,088
0.10	0.020	0.25	0.600	0.46	3,807,187	433,099	3,374,088
0.12	0.020	0.30	0.600	0.00	3,809,330	422,400	3,386,930
0.12	0.020	0.30	0.600	0.46	3,809,330	422,400	3,386,930
0.08	0.150	0.30	0.675	0.00	3,917,887	422,400	3,495,487
0.08	0.150	0.30	0.675	0.46	3,917,887	422,400	3,495,487
0.08	0.020	0.30	0.675	0.00	4,111,087	422,400	3,688,687
0.08	0.020	0.30	0.675	0.46	4,111,087	422,400	3,688,687
0.10	0.150	0.30	0.600	0.00	4,158,159	422,400	3,735,759
0.10	0.150	0.30	0.600	0.46	4,158,159	422,400	3,735,759
0.08	0.150	0.25	0.600	0.00	4,213,757	433,099	3,780,658
0.08	0.150	0.25	0.600	0.46	4,213,757	433,099	3,780,658
0.10	0.020	0.30	0.600	0.00	4,345,898	422,400	3,923,498
0.10	0.020	0.30	0.600	0.46	4,345,898	422,400	3,923,498
0.08	0.020	0.25	0.600	0.00	4,425,918	433,099	3,992,819
0.08	0.020	0.25	0.600	0.46	4,425,918	433,099	3,992,819
0.08	0.150	0.30	0.600	0.00	4,800,956	422,400	4,378,556
0.08	0.150	0.30	0.600	0.46	4,800,956	422,400	4,378,556
0.08	0.020	0.30	0.600	0.00	5,038,541	422,400	4,616,141
0.08	0.020	0.30	0.600	0.46	5,038,541	422,400	4,616,141

TABLE 11: MODEL I; ABUSER BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVAPB	TCa	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	1,154,264	175,541	978,723
0.12	0.150	0.20	0.750	0.46	1,154,264	175,541	978,723
0.12	0.150	0.25	0.750	0.00	1,154,264	175,541	978,723
0.12	0.150	0.25	0.750	0.46	1,154,264	175,541	978,723
0.12	0.150	0.30	0.750	0.00	1,154,264	175,541	978,723
0.12	0.150	0.30	0.750	0.46	1,154,264	175,541	978,723
0.12	0.020	0.20	0.750	0.00	1,201,510	175,541	1,025,969
0.12	0.020	0.20	0.750	0.46	1,201,510	175,541	1,025,969
0.12	0.020	0.25	0.750	0.00	1,201,510	175,541	1,025,969
0.12	0.020	0.25	0.750	0.46	1,201,510	175,541	1,025,969
0.12	0.020	0.30	0.750	0.00	1,201,510	175,541	1,025,969
0.12	0.020	0.30	0.750	0.46	1,201,510	175,541	1,025,969
0.10	0.150	0.20	0.750	0.00	1,310,538	175,541	1,134,997
0.10	0.150	0.20	0.750	0.46	1,310,538	175,541	1,134,997
0.10	0.150	0.25	0.750	0.00	1,310,538	175,541	1,134,997
0.10	0.150	0.25	0.750	0.46	1,310,538	175,541	1,134,997
0.10	0.150	0.30	0.750	0.00	1,310,538	175,541	1,134,997
0.10	0.150	0.30	0.750	0.46	1,310,538	175,541	1,134,997
0.10	0.020	0.20	0.750	0.00	1,369,273	175,541	1,193,732
0.10	0.020	0.20	0.750	0.46	1,369,273	175,541	1,193,732
0.10	0.020	0.25	0.750	0.00	1,369,273	175,541	1,193,732
0.10	0.020	0.25	0.750	0.46	1,369,273	175,541	1,193,732
0.10	0.020	0.30	0.750	0.00	1,369,273	175,541	1,193,732
0.10	0.020	0.30	0.750	0.46	1,369,273	175,541	1,193,732
0.12	0.150	0.20	0.675	0.00	1,487,792	175,541	1,312,251
0.12	0.150	0.20	0.675	0.46	1,487,792	175,541	1,312,251
0.12	0.150	0.30	0.675	0.00	1,487,792	175,541	1,312,251
0.12	0.150	0.30	0.675	0.46	1,487,792	175,541	1,312,251
0.12	0.150	0.25	0.675	0.00	1,491,876	175,541	1,316,335
0.12	0.150	0.25	0.675	0.46	1,491,876	175,541	1,316,335
0.08	0.150	0.20	0.750	0.00	1,511,701	175,541	1,336,160
0.08	0.150	0.20	0.750	0.46	1,511,701	175,541	1,336,160
0.08	0.150	0.25	0.750	0.00	1,511,701	175,541	1,336,160
0.08	0.150	0.25	0.750	0.46	1,511,701	175,541	1,336,160
0.08	0.150	0.30	0.750	0.00	1,511,701	175,541	1,336,160
0.08	0.150	0.30	0.750	0.46	1,511,701	175,541	1,336,160
0.12	0.020	0.20	0.675	0.00	1,549,093	175,541	1,373,552
0.12	0.020	0.20	0.675	0.46	1,549,093	175,541	1,373,552
0.12	0.020	0.25	0.675	0.00	1,549,093	175,541	1,373,552
0.12	0.020	0.25	0.675	0.46	1,549,093	175,541	1,373,552
0.12	0.020	0.30	0.675	0.00	1,549,093	175,541	1,373,552
0.12	0.020	0.30	0.675	0.46	1,549,093	175,541	1,373,552
0.08	0.020	0.20	0.750	0.00	1,586,151	175,541	1,410,610
0.08	0.020	0.20	0.750	0.46	1,586,151	175,541	1,410,610
0.08	0.020	0.25	0.750	0.00	1,586,151	175,541	1,410,610
0.08	0.020	0.25	0.750	0.46	1,586,151	175,541	1,410,610
0.08	0.020	0.30	0.750	0.00	1,586,151	175,541	1,410,610
0.08	0.020	0.30	0.750	0.46	1,586,151	175,541	1,410,610
0.10	0.150	0.20	0.675	0.00	1,690,743	175,541	1,515,202
0.10	0.150	0.20	0.675	0.46	1,690,743	175,541	1,515,202
0.10	0.150	0.30	0.675	0.00	1,690,743	175,541	1,515,202
0.10	0.150	0.30	0.675	0.46	1,690,743	175,541	1,515,202
0.10	0.150	0.25	0.675	0.00	1,695,822	175,541	1,520,281
0.10	0.150	0.25	0.675	0.46	1,695,822	175,541	1,520,281

TABLE 11: MODEL I; ABUSER BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVAPB	TCa	NET BENEFIT
0.10	0.020	0.20	0.675	0.00	1,766,976	175,541	1,591,435
0.10	0.020	0.20	0.675	0.46	1,766,976	175,541	1,591,435
0.10	0.020	0.25	0.675	0.00	1,766,976	175,541	1,591,435
0.10	0.020	0.25	0.675	0.46	1,766,976	175,541	1,591,435
0.10	0.020	0.30	0.675	0.00	1,766,976	175,541	1,591,435
0.10	0.020	0.30	0.675	0.46	1,766,976	175,541	1,591,435
0.12	0.150	0.20	0.600	0.00	1,821,321	175,541	1,645,780
0.12	0.150	0.20	0.600	0.46	1,821,321	175,541	1,645,780
0.12	0.150	0.25	0.600	0.00	1,821,321	175,541	1,645,780
0.12	0.150	0.25	0.600	0.46	1,821,321	175,541	1,645,780
0.12	0.150	0.30	0.600	0.00	1,821,321	175,541	1,645,780
0.12	0.150	0.30	0.600	0.46	1,821,321	175,541	1,645,780
0.12	0.020	0.20	0.600	0.00	1,896,676	175,541	1,721,135
0.12	0.020	0.20	0.600	0.46	1,896,676	175,541	1,721,135
0.12	0.020	0.25	0.600	0.00	1,896,676	175,541	1,721,135
0.12	0.020	0.25	0.600	0.46	1,896,676	175,541	1,721,135
0.12	0.020	0.30	0.600	0.00	1,896,676	175,541	1,721,135
0.12	0.020	0.30	0.600	0.46	1,896,676	175,541	1,721,135
0.08	0.150	0.20	0.675	0.00	1,952,036	175,541	1,776,495
0.08	0.150	0.20	0.675	0.46	1,952,036	175,541	1,776,495
0.08	0.150	0.30	0.675	0.00	1,952,036	175,541	1,776,495
0.08	0.150	0.30	0.675	0.46	1,952,036	175,541	1,776,495
0.08	0.150	0.25	0.675	0.00	1,958,471	175,541	1,782,930
0.08	0.150	0.25	0.675	0.46	1,958,471	175,541	1,782,930
0.08	0.020	0.20	0.675	0.00	2,048,694	175,541	1,873,153
0.08	0.020	0.20	0.675	0.46	2,048,694	175,541	1,873,153
0.08	0.020	0.25	0.675	0.00	2,048,694	175,541	1,873,153
0.08	0.020	0.25	0.675	0.46	2,048,694	175,541	1,873,153
0.08	0.020	0.30	0.675	0.00	2,048,694	175,541	1,873,153
0.08	0.020	0.30	0.675	0.46	2,048,694	175,541	1,873,153
0.10	0.150	0.20	0.600	0.00	2,070,949	175,541	1,895,408
0.10	0.150	0.20	0.600	0.46	2,070,949	175,541	1,895,408
0.10	0.150	0.25	0.600	0.00	2,070,949	175,541	1,895,408
0.10	0.150	0.25	0.600	0.46	2,070,949	175,541	1,895,408
0.10	0.150	0.30	0.600	0.00	2,070,949	175,541	1,895,408
0.10	0.150	0.30	0.600	0.46	2,070,949	175,541	1,895,408
0.10	0.020	0.20	0.600	0.00	2,164,679	175,541	1,989,138
0.10	0.020	0.20	0.600	0.46	2,164,679	175,541	1,989,138
0.10	0.020	0.25	0.600	0.00	2,164,679	175,541	1,989,138
0.10	0.020	0.25	0.600	0.46	2,164,679	175,541	1,989,138
0.10	0.020	0.30	0.600	0.00	2,164,679	175,541	1,989,138
0.10	0.020	0.30	0.600	0.46	2,164,679	175,541	1,989,138
0.08	0.150	0.20	0.600	0.00	2,392,372	175,541	2,216,831
0.08	0.150	0.20	0.600	0.46	2,392,372	175,541	2,216,831
0.08	0.150	0.25	0.600	0.00	2,392,372	175,541	2,216,831
0.08	0.150	0.25	0.600	0.46	2,392,372	175,541	2,216,831
0.08	0.150	0.30	0.600	0.00	2,392,372	175,541	2,216,831
0.08	0.150	0.30	0.600	0.46	2,392,372	175,541	2,216,831
0.08	0.020	0.20	0.600	0.00	2,511,237	175,541	2,335,696
0.08	0.020	0.20	0.600	0.46	2,511,237	175,541	2,335,696
0.08	0.020	0.25	0.600	0.00	2,511,237	175,541	2,335,696
0.08	0.020	0.25	0.600	0.46	2,511,237	175,541	2,335,696
0.08	0.020	0.30	0.600	0.00	2,511,237	175,541	2,335,696
0.08	0.020	0.30	0.600	0.46	2,511,237	175,541	2,335,696

TABLE 12: MODEL I; EMPLOYER BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVEPB	TCe	NET BENEFIT
0.12	0.150	0.20	0.750	0.46	85,765	-3,096	88,861
0.12	0.020	0.20	0.750	0.46	91,184	-3,096	94,280
0.10	0.150	0.20	0.750	0.46	104,709	-3,096	107,805
0.12	0.150	0.20	0.675	0.46	110,670	-3,096	113,766
0.10	0.020	0.20	0.750	0.46	111,840	-3,096	114,936
0.12	0.020	0.20	0.675	0.46	117,736	-3,096	120,832
0.08	0.150	0.20	0.750	0.46	130,362	-3,096	133,458
0.10	0.150	0.20	0.675	0.46	135,318	-3,096	138,413
0.12	0.150	0.20	0.600	0.46	135,629	-3,096	138,724
0.08	0.020	0.20	0.750	0.46	139,878	-3,096	142,974
0.12	0.020	0.20	0.600	0.46	144,289	-3,096	147,384
0.10	0.020	0.20	0.675	0.46	144,583	-3,096	147,679
0.12	0.150	0.20	0.750	0.00	158,824	-5,733	164,557
0.10	0.150	0.20	0.600	0.46	165,927	-3,096	169,023
0.08	0.150	0.20	0.675	0.46	168,660	-3,096	171,756
0.12	0.020	0.20	0.750	0.00	168,860	-5,733	174,593
0.10	0.020	0.20	0.600	0.46	177,325	-3,096	180,421
0.08	0.020	0.20	0.675	0.46	181,025	-3,096	184,121
0.10	0.150	0.20	0.750	0.00	193,905	-5,733	199,638
0.08	0.150	0.20	0.600	0.46	206,959	-3,096	210,055
0.12	0.150	0.20	0.675	0.00	204,944	-5,733	210,677
0.10	0.020	0.20	0.750	0.00	207,111	-5,733	212,844
0.12	0.020	0.20	0.675	0.00	218,030	-5,733	223,763
0.08	0.020	0.20	0.600	0.46	222,173	-3,096	225,269
0.08	0.150	0.20	0.750	0.00	241,411	-5,733	247,144
0.12	0.150	0.25	0.750	0.46	244,626	-8,873	253,499
0.10	0.150	0.20	0.675	0.00	250,588	-5,733	256,321
0.12	0.150	0.20	0.600	0.00	251,164	-5,733	256,897
0.12	0.020	0.25	0.750	0.46	255,792	-8,873	264,665
0.08	0.020	0.20	0.750	0.00	259,033	-5,733	264,766
0.12	0.020	0.20	0.600	0.00	267,201	-5,733	272,934
0.10	0.020	0.20	0.675	0.00	267,746	-5,733	273,479
0.10	0.150	0.25	0.750	0.46	282,152	-8,873	291,025
0.10	0.020	0.25	0.750	0.46	296,256	-8,873	305,130
0.10	0.150	0.20	0.600	0.00	307,272	-5,733	313,005
0.08	0.150	0.20	0.675	0.00	312,334	-5,733	318,067
0.12	0.150	0.25	0.675	0.46	316,164	-8,873	325,037
0.10	0.020	0.20	0.600	0.00	328,380	-5,733	334,113
0.12	0.020	0.25	0.675	0.46	329,675	-8,873	338,549
0.08	0.150	0.25	0.750	0.46	331,160	-8,873	340,033
0.08	0.020	0.20	0.675	0.00	335,232	-5,733	340,965
0.08	0.020	0.25	0.750	0.46	349,282	-8,873	358,155
0.10	0.150	0.25	0.675	0.46	365,166	-8,873	374,040
0.08	0.150	0.20	0.600	0.00	383,257	-5,733	388,990
0.10	0.020	0.25	0.675	0.46	382,243	-8,873	391,116
0.12	0.150	0.25	0.600	0.46	385,770	-8,873	394,643
0.12	0.020	0.25	0.600	0.46	403,559	-8,873	412,433
0.08	0.020	0.20	0.600	0.00	411,431	-5,733	417,164
0.12	0.150	0.30	0.750	0.46	403,487	-14,651	418,138
0.12	0.020	0.30	0.750	0.46	420,399	-14,651	435,049
0.08	0.150	0.25	0.675	0.46	429,186	-8,873	438,059
0.10	0.150	0.25	0.600	0.46	445,712	-8,873	454,585
0.08	0.020	0.25	0.675	0.46	451,137	-8,873	460,010
0.12	0.150	0.25	0.750	0.00	453,011	-16,432	469,443

TABLE 12: MODEL I; EMPLOYER BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVEPB	TCe	NET BENEFIT
0.10	0.150	0.30	0.750	0.46	459,595	-14,651	474,246
0.10	0.020	0.25	0.600	0.46	468,229	-8,873	477,102
0.12	0.020	0.25	0.750	0.00	473,688	-16,432	490,120
0.10	0.020	0.30	0.750	0.46	480,673	-14,651	495,324
0.08	0.150	0.25	0.600	0.46	524,047	-8,873	532,920
0.12	0.150	0.30	0.675	0.46	519,672	-14,651	534,322
0.10	0.150	0.25	0.750	0.00	522,504	-16,432	538,936
0.08	0.150	0.30	0.750	0.46	531,958	-14,651	546,609
0.12	0.020	0.30	0.675	0.46	541,615	-14,651	556,265
0.08	0.020	0.25	0.600	0.46	552,991	-8,873	561,864
0.10	0.020	0.25	0.750	0.00	548,623	-16,432	565,055
0.08	0.020	0.30	0.750	0.46	558,686	-14,651	573,337
0.12	0.150	0.25	0.675	0.00	585,488	-16,432	601,920
0.10	0.150	0.30	0.675	0.46	592,546	-14,651	607,197
0.12	0.020	0.25	0.675	0.00	610,510	-16,432	626,942
0.08	0.150	0.25	0.750	0.00	613,259	-16,432	629,691
0.10	0.020	0.30	0.675	0.46	619,903	-14,651	634,554
0.12	0.150	0.30	0.600	0.46	635,856	-14,651	650,507
0.08	0.020	0.25	0.750	0.00	646,818	-16,432	663,250
0.12	0.020	0.30	0.600	0.46	662,831	-14,651	677,481
0.10	0.150	0.25	0.675	0.00	676,234	-16,432	692,666
0.08	0.150	0.30	0.675	0.46	686,546	-14,651	701,197
0.10	0.020	0.25	0.675	0.00	707,857	-16,432	724,289
0.12	0.150	0.25	0.600	0.00	714,388	-16,432	730,820
0.08	0.020	0.30	0.675	0.46	721,248	-14,651	735,899
0.10	0.150	0.30	0.600	0.46	725,496	-14,651	740,147
0.12	0.020	0.25	0.600	0.00	747,332	-16,432	763,764
0.10	0.020	0.30	0.600	0.46	759,133	-14,651	773,784
0.12	0.150	0.30	0.750	0.00	747,198	-27,131	774,329
0.12	0.020	0.30	0.750	0.00	778,516	-27,131	805,647
0.08	0.150	0.25	0.675	0.00	794,788	-16,432	811,220
0.10	0.150	0.25	0.600	0.00	825,392	-16,432	841,824
0.08	0.020	0.25	0.675	0.00	835,438	-16,432	851,870
0.08	0.150	0.30	0.600	0.46	841,134	-14,651	855,785
0.10	0.150	0.30	0.750	0.00	851,102	-27,131	878,233
0.10	0.020	0.25	0.600	0.00	867,091	-16,432	883,523
0.08	0.020	0.30	0.600	0.46	883,809	-14,651	898,460
0.10	0.020	0.30	0.750	0.00	890,135	-27,131	917,266
0.08	0.150	0.25	0.600	0.00	970,457	-16,432	986,889
0.12	0.150	0.30	0.675	0.00	962,355	-27,131	989,486
0.08	0.150	0.30	0.750	0.00	985,107	-27,131	1,012,238
0.12	0.020	0.30	0.675	0.00	1,002,990	-27,131	1,030,121
0.08	0.020	0.25	0.600	0.00	1,024,057	-16,432	1,040,489
0.08	0.020	0.30	0.750	0.00	1,034,604	-27,131	1,061,735
0.10	0.150	0.30	0.675	0.00	1,097,307	-27,131	1,124,438
0.10	0.020	0.30	0.675	0.00	1,147,969	-27,131	1,175,100
0.12	0.150	0.30	0.600	0.00	1,177,512	-27,131	1,204,643
0.12	0.020	0.30	0.600	0.00	1,227,464	-27,131	1,254,595
0.08	0.150	0.30	0.675	0.00	1,271,382	-27,131	1,298,513
0.08	0.020	0.30	0.675	0.00	1,335,644	-27,131	1,362,775
0.10	0.150	0.30	0.600	0.00	1,343,512	-27,131	1,370,643
0.10	0.020	0.30	0.600	0.00	1,405,802	-27,131	1,432,933
0.08	0.150	0.30	0.600	0.00	1,557,656	-27,131	1,584,787
0.08	0.020	0.30	0.600	0.00	1,636,684	-27,131	1,663,815

TABLE 13: MODEL I; GOVERNMENT BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVGPB	TC	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	418,083	273,991	144,092
0.12	0.150	0.25	0.750	0.00	418,083	273,991	144,092
0.12	0.150	0.30	0.750	0.00	418,083	273,991	144,092
0.12	0.020	0.20	0.750	0.00	434,280	273,991	160,289
0.12	0.020	0.25	0.750	0.00	434,280	273,991	160,289
0.12	0.020	0.30	0.750	0.00	434,280	273,991	160,289
0.10	0.150	0.20	0.750	0.00	470,887	273,991	196,896
0.10	0.150	0.25	0.750	0.00	470,887	273,991	196,896
0.10	0.150	0.30	0.750	0.00	470,887	273,991	196,896
0.10	0.020	0.20	0.750	0.00	490,769	273,991	216,778
0.10	0.020	0.25	0.750	0.00	490,769	273,991	216,778
0.10	0.020	0.30	0.750	0.00	490,769	273,991	216,778
0.12	0.150	0.20	0.750	0.46	491,142	271,354	219,788
0.12	0.020	0.20	0.750	0.46	511,956	271,354	240,602
0.08	0.150	0.20	0.750	0.00	538,009	273,991	264,018
0.08	0.150	0.25	0.750	0.00	538,009	273,991	264,018
0.08	0.150	0.30	0.750	0.00	538,009	273,991	264,018
0.12	0.150	0.20	0.675	0.00	538,725	273,991	264,734
0.12	0.150	0.30	0.675	0.00	538,725	273,991	264,734
0.12	0.150	0.25	0.675	0.00	540,208	273,991	266,217
0.12	0.020	0.20	0.675	0.00	559,736	273,991	285,745
0.12	0.020	0.25	0.675	0.00	559,736	273,991	285,745
0.12	0.020	0.30	0.675	0.00	559,736	273,991	285,745
0.10	0.150	0.20	0.750	0.46	560,083	271,354	288,729
0.08	0.020	0.20	0.750	0.00	562,877	273,991	288,886
0.08	0.020	0.25	0.750	0.00	562,877	273,991	288,886
0.08	0.020	0.30	0.750	0.00	562,877	273,991	288,886
0.10	0.020	0.20	0.750	0.46	586,040	271,354	314,686
0.10	0.150	0.20	0.675	0.00	607,292	273,991	333,301
0.10	0.150	0.30	0.675	0.00	607,292	273,991	333,301
0.10	0.150	0.25	0.675	0.00	609,112	273,991	335,121
0.10	0.020	0.20	0.675	0.00	633,093	273,991	359,102
0.10	0.020	0.25	0.675	0.00	633,093	273,991	359,102
0.10	0.020	0.30	0.675	0.00	633,093	273,991	359,102
0.12	0.150	0.25	0.750	0.46	626,468	266,432	360,036
0.12	0.150	0.20	0.675	0.46	632,999	271,354	361,645
0.08	0.150	0.20	0.750	0.46	649,058	271,354	377,704
0.12	0.150	0.20	0.600	0.00	659,366	273,991	385,375
0.12	0.150	0.25	0.600	0.00	659,366	273,991	385,375
0.12	0.150	0.30	0.600	0.00	659,366	273,991	385,375
0.12	0.020	0.25	0.750	0.46	652,176	266,432	385,744
0.12	0.020	0.20	0.675	0.46	660,030	271,354	388,676
0.08	0.020	0.20	0.750	0.46	682,032	271,354	410,678
0.12	0.020	0.20	0.600	0.00	685,191	273,991	411,200
0.12	0.020	0.25	0.600	0.00	685,191	273,991	411,200
0.12	0.020	0.30	0.600	0.00	685,191	273,991	411,200
0.08	0.150	0.20	0.675	0.00	694,469	273,991	420,478
0.08	0.150	0.30	0.675	0.00	694,469	273,991	420,478
0.08	0.150	0.25	0.675	0.00	696,741	273,991	422,750
0.10	0.150	0.25	0.750	0.46	711,239	266,432	444,807
0.10	0.150	0.20	0.675	0.46	722,562	271,354	451,209
0.08	0.020	0.20	0.675	0.00	726,748	273,991	452,757
0.08	0.020	0.25	0.675	0.00	726,748	273,991	452,757
0.08	0.020	0.30	0.675	0.00	726,748	273,991	452,757

TABLE 13: MODEL I; GOVERNMENT BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVGPB	TC	NET BENEFIT
0.10	0.150	0.20	0.600	0.00	743,698	273,991	469,707
0.10	0.150	0.25	0.600	0.00	743,698	273,991	469,707
0.10	0.150	0.30	0.600	0.00	743,698	273,991	469,707
0.10	0.020	0.25	0.750	0.46	743,136	266,432	476,703
0.10	0.020	0.20	0.675	0.46	756,256	271,354	484,902
0.12	0.150	0.30	0.750	0.46	761,794	261,511	500,283
0.10	0.020	0.20	0.600	0.00	775,417	273,991	501,426
0.10	0.020	0.25	0.600	0.00	775,417	273,991	501,426
0.10	0.020	0.30	0.600	0.00	775,417	273,991	501,426
0.12	0.150	0.20	0.600	0.46	774,901	271,354	503,548
0.12	0.020	0.30	0.750	0.46	792,397	261,511	530,887
0.12	0.020	0.20	0.600	0.46	808,103	271,354	536,750
0.12	0.150	0.25	0.675	0.46	809,532	266,432	543,100
0.08	0.150	0.25	0.750	0.46	820,108	266,432	553,676
0.08	0.150	0.20	0.675	0.46	838,143	271,354	566,789
0.12	0.020	0.25	0.675	0.46	840,571	266,432	574,138
0.08	0.150	0.20	0.600	0.00	850,928	273,991	576,937
0.08	0.150	0.25	0.600	0.00	850,928	273,991	576,937
0.08	0.150	0.30	0.600	0.00	850,928	273,991	576,937
0.08	0.020	0.25	0.750	0.46	860,413	266,432	593,981
0.10	0.150	0.30	0.750	0.46	862,394	261,511	600,883
0.08	0.020	0.20	0.750	0.46	880,955	271,354	609,601
0.10	0.150	0.20	0.600	0.46	885,043	271,354	613,689
0.08	0.020	0.20	0.600	0.00	890,620	273,991	616,629
0.08	0.020	0.30	0.600	0.00	890,620	273,991	616,629
0.08	0.020	0.25	0.600	0.00	890,624	273,991	616,633
0.10	0.020	0.30	0.750	0.46	900,231	261,511	638,720
0.10	0.150	0.25	0.675	0.46	920,180	266,432	653,747
0.10	0.020	0.20	0.600	0.46	926,472	271,354	655,118
0.10	0.020	0.25	0.675	0.46	958,707	266,432	692,275
0.12	0.150	0.30	0.675	0.46	981,408	261,511	719,898
0.12	0.150	0.25	0.600	0.46	987,984	266,432	721,552
0.08	0.150	0.30	0.750	0.46	991,158	261,511	729,647
0.08	0.150	0.20	0.600	0.46	1,027,226	271,354	755,872
0.12	0.020	0.30	0.675	0.46	1,021,111	261,511	759,601
0.12	0.020	0.25	0.600	0.46	1,028,964	266,432	762,531
0.08	0.020	0.30	0.750	0.46	1,038,795	261,511	777,284
0.08	0.150	0.25	0.675	0.46	1,062,343	266,432	795,911
0.08	0.020	0.20	0.750	0.46	1,079,878	271,354	808,524
0.08	0.020	0.25	0.750	0.46	1,111,049	266,432	844,617
0.10	0.150	0.30	0.600	0.46	1,112,053	261,511	850,542
0.10	0.150	0.25	0.600	0.46	1,123,378	266,432	856,946
0.10	0.020	0.30	0.675	0.46	1,161,159	261,511	899,648
0.10	0.020	0.25	0.600	0.46	1,174,279	266,432	907,847
0.12	0.150	0.30	0.750	0.46	1,201,022	261,511	939,511
0.12	0.020	0.30	0.600	0.46	1,249,824	261,511	988,314
0.08	0.150	0.30	0.675	0.46	1,279,305	261,511	1,017,794
0.08	0.150	0.25	0.600	0.46	1,297,338	266,432	1,030,906
0.08	0.020	0.30	0.675	0.46	1,341,144	261,511	1,079,634
0.08	0.020	0.25	0.600	0.46	1,361,690	266,432	1,095,258
0.10	0.150	0.30	0.600	0.46	1,361,714	261,511	1,100,203
0.10	0.020	0.30	0.600	0.46	1,422,086	261,511	1,160,575
0.08	0.150	0.30	0.675	0.46	1,567,450	261,511	1,305,939
0.08	0.020	0.30	0.600	0.46	1,643,495	261,511	1,381,984

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**APPENDIX C: MODEL 2; Results**

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TABLE 14: MODEL II; SOCIAL BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVSPB'	TC'	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	1,090,717	402,943	687,774
0.12	0.150	0.20	0.750	0.46	1,090,717	402,943	687,774
0.12	0.020	0.20	0.750	0.00	1,130,165	402,943	727,222
0.12	0.020	0.20	0.750	0.46	1,130,165	402,943	727,222
0.10	0.150	0.20	0.750	0.00	1,218,256	402,943	815,313
0.10	0.150	0.20	0.750	0.46	1,218,256	402,943	815,313
0.10	0.020	0.20	0.750	0.00	1,266,110	402,943	863,167
0.10	0.020	0.20	0.750	0.46	1,266,110	402,943	863,167
0.12	0.150	0.25	0.750	0.00	1,363,396	394,794	968,602
0.12	0.150	0.25	0.750	0.46	1,363,396	394,794	968,602
0.08	0.150	0.20	0.750	0.00	1,378,488	402,943	975,545
0.08	0.150	0.20	0.750	0.46	1,378,488	402,943	975,545
0.12	0.150	0.20	0.675	0.00	1,403,996	402,943	1,001,053
0.12	0.150	0.20	0.675	0.46	1,403,996	402,943	1,001,053
0.12	0.020	0.25	0.750	0.00	1,412,706	394,794	1,017,912
0.12	0.020	0.25	0.750	0.46	1,412,706	394,794	1,017,912
0.08	0.020	0.20	0.750	0.00	1,437,525	402,943	1,034,582
0.08	0.020	0.20	0.750	0.46	1,437,525	402,943	1,034,582
0.12	0.020	0.20	0.675	0.00	1,445,152	402,943	1,042,209
0.12	0.020	0.20	0.675	0.46	1,445,152	402,943	1,042,209
0.10	0.150	0.25	0.750	0.00	1,522,820	394,794	1,128,026
0.10	0.150	0.25	0.750	0.46	1,522,820	394,794	1,128,026
0.10	0.150	0.20	0.675	0.00	1,569,588	402,943	1,166,645
0.10	0.150	0.20	0.675	0.46	1,569,588	402,943	1,166,645
0.10	0.020	0.25	0.750	0.00	1,582,637	394,794	1,187,843
0.10	0.020	0.25	0.750	0.46	1,582,637	394,794	1,187,843
0.10	0.020	0.20	0.675	0.00	1,631,668	402,943	1,228,725
0.10	0.020	0.20	0.675	0.46	1,631,668	402,943	1,228,725
0.12	0.150	0.30	0.750	0.00	1,636,076	386,647	1,249,429
0.12	0.150	0.30	0.750	0.46	1,636,076	386,647	1,249,429
0.12	0.020	0.30	0.750	0.00	1,695,247	386,647	1,308,600
0.12	0.020	0.30	0.750	0.46	1,695,247	386,647	1,308,600
0.12	0.150	0.20	0.600	0.00	1,717,275	402,943	1,314,332
0.12	0.150	0.20	0.600	0.46	1,717,275	402,943	1,314,332
0.08	0.150	0.25	0.750	0.00	1,723,110	394,794	1,328,316
0.08	0.150	0.25	0.750	0.46	1,723,110	394,794	1,328,316
0.12	0.150	0.25	0.675	0.00	1,759,284	394,794	1,364,490
0.12	0.150	0.25	0.675	0.46	1,759,284	394,794	1,364,490
0.08	0.150	0.20	0.675	0.00	1,777,669	402,943	1,374,726
0.08	0.150	0.20	0.675	0.46	1,777,669	402,943	1,374,726
0.12	0.020	0.20	0.600	0.00	1,780,139	402,943	1,377,196
0.12	0.020	0.20	0.600	0.46	1,780,139	402,943	1,377,196
0.08	0.020	0.25	0.750	0.00	1,796,906	394,794	1,402,112
0.08	0.020	0.25	0.750	0.46	1,796,906	394,794	1,402,112
0.12	0.020	0.25	0.675	0.00	1,818,940	394,794	1,424,146
0.12	0.020	0.25	0.675	0.46	1,818,940	394,794	1,424,146
0.10	0.150	0.30	0.750	0.00	1,827,384	386,647	1,440,737
0.10	0.150	0.30	0.750	0.46	1,827,384	386,647	1,440,737
0.08	0.020	0.20	0.675	0.00	1,854,283	402,943	1,451,340
0.08	0.020	0.20	0.675	0.46	1,854,283	402,943	1,451,340
0.10	0.020	0.30	0.750	0.00	1,899,164	386,647	1,512,517
0.10	0.020	0.30	0.750	0.46	1,899,164	386,647	1,512,517
0.10	0.150	0.20	0.600	0.00	1,920,921	402,943	1,517,978
0.10	0.150	0.20	0.600	0.46	1,920,921	402,943	1,517,978

TABLE 14: MODEL II; SOCIAL BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVSPB'	TC'	NET BENEFIT
0.10	0.150	0.25	0.675	0.00	1,967,179	394,794	1,572,385
0.10	0.150	0.25	0.675	0.46	1,967,179	394,794	1,572,385
0.10	0.020	0.20	0.600	0.00	1,997,227	402,943	1,594,284
0.10	0.020	0.20	0.600	0.46	1,997,227	402,943	1,594,284
0.10	0.020	0.25	0.675	0.00	2,039,586	394,794	1,644,792
0.10	0.020	0.25	0.675	0.46	2,039,586	394,794	1,644,792
0.08	0.150	0.30	0.750	0.00	2,067,732	386,647	1,681,085
0.08	0.150	0.30	0.750	0.46	2,067,732	386,647	1,681,085
0.12	0.150	0.30	0.675	0.00	2,105,994	386,647	1,719,347
0.12	0.150	0.30	0.675	0.46	2,105,994	386,647	1,719,347
0.12	0.150	0.25	0.600	0.00	2,146,593	394,794	1,751,799
0.12	0.150	0.25	0.600	0.46	2,146,593	394,794	1,751,799
0.08	0.020	0.30	0.750	0.00	2,156,288	386,647	1,769,641
0.08	0.020	0.30	0.750	0.46	2,156,288	386,647	1,769,641
0.08	0.150	0.20	0.600	0.00	2,176,849	402,943	1,773,906
0.08	0.150	0.20	0.600	0.46	2,176,849	402,943	1,773,906
0.12	0.020	0.30	0.675	0.00	2,182,728	386,647	1,796,081
0.12	0.020	0.30	0.675	0.46	2,182,728	386,647	1,796,081
0.12	0.020	0.25	0.600	0.00	2,225,173	394,794	1,830,379
0.12	0.020	0.25	0.600	0.46	2,225,173	394,794	1,830,379
0.08	0.150	0.25	0.675	0.00	2,228,479	394,794	1,833,685
0.08	0.150	0.25	0.675	0.46	2,228,479	394,794	1,833,685
0.08	0.020	0.20	0.600	0.00	2,271,040	402,943	1,868,097
0.08	0.020	0.20	0.600	0.46	2,271,040	402,943	1,868,097
0.08	0.020	0.25	0.675	0.00	2,317,853	394,794	1,923,059
0.08	0.020	0.25	0.675	0.46	2,317,853	394,794	1,923,059
0.10	0.150	0.30	0.675	0.00	2,354,383	386,647	1,967,736
0.10	0.150	0.30	0.675	0.46	2,354,383	386,647	1,967,736
0.10	0.150	0.25	0.600	0.00	2,401,151	394,794	2,006,357
0.10	0.150	0.25	0.600	0.46	2,401,151	394,794	2,006,357
0.10	0.020	0.30	0.675	0.00	2,447,503	386,647	2,060,856
0.10	0.020	0.30	0.675	0.46	2,447,503	386,647	2,060,856
0.10	0.020	0.25	0.600	0.00	2,496,534	394,794	2,101,740
0.10	0.020	0.25	0.600	0.46	2,496,534	394,794	2,101,740
0.12	0.150	0.30	0.600	0.00	2,575,912	386,647	2,189,265
0.12	0.150	0.30	0.600	0.46	2,575,912	386,647	2,189,265
0.08	0.150	0.30	0.675	0.00	2,666,503	386,647	2,279,856
0.08	0.150	0.30	0.675	0.46	2,666,503	386,647	2,279,856
0.12	0.020	0.30	0.600	0.00	2,670,208	386,647	2,283,561
0.12	0.020	0.30	0.600	0.46	2,670,208	386,647	2,283,561
0.08	0.150	0.25	0.600	0.00	2,721,061	394,794	2,326,267
0.08	0.150	0.25	0.600	0.46	2,721,061	394,794	2,326,267
0.08	0.020	0.30	0.675	0.00	2,781,424	386,647	2,394,777
0.08	0.020	0.30	0.675	0.46	2,781,424	386,647	2,394,777
0.08	0.020	0.25	0.600	0.00	2,838,800	394,794	2,444,006
0.08	0.020	0.25	0.600	0.46	2,838,800	394,794	2,444,006
0.10	0.150	0.30	0.600	0.00	2,881,382	386,647	2,494,735
0.10	0.150	0.30	0.600	0.46	2,881,382	386,647	2,494,735
0.10	0.020	0.30	0.600	0.00	2,995,841	386,647	2,609,194
0.10	0.020	0.30	0.600	0.46	2,995,841	386,647	2,609,194
0.08	0.150	0.30	0.600	0.00	3,265,273	386,647	2,878,626
0.08	0.150	0.30	0.600	0.46	3,265,273	386,647	2,878,626
0.08	0.020	0.30	0.600	0.00	3,406,560	386,647	3,019,913
0.08	0.020	0.30	0.600	0.46	3,406,560	386,647	3,019,913

TABLE 15: MODEL II; ABUSER BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVAPB'	TCa'	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	1,069,357	164,078	905,279
0.12	0.150	0.20	0.750	0.46	1,069,357	164,078	905,279
0.12	0.150	0.25	0.750	0.00	1,069,357	164,078	905,279
0.12	0.150	0.25	0.750	0.46	1,069,357	164,078	905,279
0.12	0.150	0.30	0.750	0.00	1,069,357	164,078	905,279
0.12	0.150	0.30	0.750	0.46	1,069,357	164,078	905,279
0.12	0.020	0.20	0.750	0.00	1,113,092	164,078	949,014
0.12	0.020	0.20	0.750	0.46	1,113,092	164,078	949,014
0.12	0.020	0.25	0.750	0.00	1,113,092	164,078	949,014
0.12	0.020	0.25	0.750	0.46	1,113,092	164,078	949,014
0.12	0.020	0.30	0.750	0.00	1,113,092	164,078	949,014
0.12	0.020	0.30	0.750	0.46	1,113,092	164,078	949,014
0.10	0.150	0.20	0.750	0.00	1,213,971	164,078	1,049,893
0.10	0.150	0.20	0.750	0.46	1,213,971	164,078	1,049,893
0.10	0.150	0.25	0.750	0.00	1,213,971	164,078	1,049,893
0.10	0.150	0.25	0.750	0.46	1,213,971	164,078	1,049,893
0.10	0.150	0.30	0.750	0.00	1,213,971	164,078	1,049,893
0.10	0.150	0.30	0.750	0.46	1,213,971	164,078	1,049,893
0.10	0.020	0.20	0.750	0.00	1,268,315	164,078	1,104,237
0.10	0.020	0.20	0.750	0.46	1,268,315	164,078	1,104,237
0.10	0.020	0.25	0.750	0.00	1,268,315	164,078	1,104,237
0.10	0.020	0.25	0.750	0.46	1,268,315	164,078	1,104,237
0.10	0.020	0.30	0.750	0.00	1,268,315	164,078	1,104,237
0.10	0.020	0.30	0.750	0.46	1,268,315	164,078	1,104,237
0.12	0.150	0.20	0.675	0.00	1,378,362	164,078	1,214,284
0.12	0.150	0.20	0.675	0.46	1,378,362	164,078	1,214,284
0.12	0.150	0.30	0.675	0.00	1,378,362	164,078	1,214,284
0.12	0.150	0.30	0.675	0.46	1,378,362	164,078	1,214,284
0.12	0.150	0.25	0.675	0.00	1,382,149	164,078	1,218,071
0.12	0.150	0.25	0.675	0.46	1,382,149	164,078	1,218,071
0.08	0.150	0.20	0.750	0.00	1,400,029	164,078	1,235,951
0.08	0.150	0.20	0.750	0.46	1,400,029	164,078	1,235,951
0.08	0.150	0.25	0.750	0.00	1,400,029	164,078	1,235,951
0.08	0.150	0.25	0.750	0.46	1,400,029	164,078	1,235,951
0.08	0.150	0.30	0.750	0.00	1,400,029	164,078	1,235,951
0.08	0.150	0.30	0.750	0.46	1,400,029	164,078	1,235,951
0.12	0.020	0.20	0.675	0.00	1,435,107	164,078	1,271,029
0.12	0.020	0.20	0.675	0.46	1,435,107	164,078	1,271,029
0.12	0.020	0.25	0.675	0.00	1,435,107	164,078	1,271,029
0.12	0.020	0.25	0.675	0.46	1,435,107	164,078	1,271,029
0.12	0.020	0.30	0.675	0.00	1,435,107	164,078	1,271,029
0.12	0.020	0.30	0.675	0.46	1,435,107	164,078	1,271,029
0.08	0.020	0.20	0.750	0.00	1,468,874	164,078	1,304,796
0.08	0.020	0.20	0.750	0.46	1,468,874	164,078	1,304,796
0.08	0.020	0.25	0.750	0.00	1,468,874	164,078	1,304,796
0.08	0.020	0.25	0.750	0.46	1,468,874	164,078	1,304,796
0.08	0.020	0.30	0.750	0.00	1,468,874	164,078	1,304,796
0.08	0.020	0.30	0.750	0.46	1,468,874	164,078	1,304,796
0.10	0.150	0.20	0.675	0.00	1,566,171	164,078	1,402,093
0.10	0.150	0.20	0.675	0.46	1,566,171	164,078	1,402,093
0.10	0.150	0.30	0.675	0.00	1,566,171	164,078	1,402,093
0.10	0.150	0.30	0.675	0.46	1,566,171	164,078	1,402,093
0.10	0.150	0.25	0.675	0.00	1,570,875	164,078	1,406,797
0.10	0.150	0.25	0.675	0.46	1,570,875	164,078	1,406,797

TABLE 15: MODEL II; ABUSER BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVAPB'	TCa'	NET BENEFIT
0.10	0.020	0.20	0.675	0.00	1,636,703	164,078	1,472,625
0.10	0.020	0.20	0.675	0.46	1,636,703	164,078	1,472,625
0.10	0.020	0.25	0.675	0.00	1,636,703	164,078	1,472,625
0.10	0.020	0.25	0.675	0.46	1,636,703	164,078	1,472,625
0.10	0.020	0.30	0.675	0.00	1,636,703	164,078	1,472,625
0.10	0.020	0.30	0.675	0.46	1,636,703	164,078	1,472,625
0.12	0.150	0.20	0.600	0.00	1,687,367	164,078	1,523,289
0.12	0.150	0.20	0.600	0.46	1,687,367	164,078	1,523,289
0.12	0.150	0.25	0.600	0.00	1,687,367	164,078	1,523,289
0.12	0.150	0.25	0.600	0.46	1,687,367	164,078	1,523,289
0.12	0.150	0.30	0.600	0.00	1,687,367	164,078	1,523,289
0.12	0.150	0.30	0.600	0.46	1,687,367	164,078	1,523,289
0.12	0.020	0.20	0.600	0.00	1,757,122	164,078	1,593,044
0.12	0.020	0.20	0.600	0.46	1,757,122	164,078	1,593,044
0.12	0.020	0.25	0.600	0.00	1,757,122	164,078	1,593,044
0.12	0.020	0.25	0.600	0.46	1,757,122	164,078	1,593,044
0.12	0.020	0.30	0.600	0.00	1,757,122	164,078	1,593,044
0.12	0.020	0.30	0.600	0.46	1,757,122	164,078	1,593,044
0.08	0.150	0.20	0.675	0.00	1,807,842	164,078	1,643,764
0.08	0.150	0.20	0.675	0.46	1,807,842	164,078	1,643,764
0.08	0.150	0.30	0.675	0.00	1,807,842	164,078	1,643,764
0.08	0.150	0.30	0.675	0.46	1,807,842	164,078	1,643,764
0.08	0.150	0.25	0.675	0.00	1,813,800	164,078	1,649,722
0.08	0.150	0.25	0.675	0.46	1,813,800	164,078	1,649,722
0.08	0.020	0.20	0.675	0.00	1,897,223	164,078	1,733,145
0.08	0.020	0.20	0.675	0.46	1,897,223	164,078	1,733,145
0.08	0.020	0.25	0.675	0.00	1,897,223	164,078	1,733,145
0.08	0.020	0.25	0.675	0.46	1,897,223	164,078	1,733,145
0.08	0.020	0.30	0.675	0.00	1,897,223	164,078	1,733,145
0.08	0.020	0.30	0.675	0.46	1,897,223	164,078	1,733,145
0.10	0.150	0.20	0.600	0.00	1,918,370	164,078	1,754,292
0.10	0.150	0.20	0.600	0.46	1,918,370	164,078	1,754,292
0.10	0.150	0.25	0.600	0.00	1,918,370	164,078	1,754,292
0.10	0.150	0.25	0.600	0.46	1,918,370	164,078	1,754,292
0.10	0.150	0.30	0.600	0.00	1,918,370	164,078	1,754,292
0.10	0.150	0.30	0.600	0.46	1,918,370	164,078	1,754,292
0.10	0.020	0.20	0.600	0.00	2,005,092	164,078	1,841,014
0.10	0.020	0.20	0.600	0.46	2,005,092	164,078	1,841,014
0.10	0.020	0.25	0.600	0.00	2,005,092	164,078	1,841,014
0.10	0.020	0.25	0.600	0.46	2,005,092	164,078	1,841,014
0.10	0.020	0.30	0.600	0.00	2,005,092	164,078	1,841,014
0.10	0.020	0.30	0.600	0.46	2,005,092	164,078	1,841,014
0.08	0.150	0.20	0.600	0.00	2,215,656	164,078	2,051,578
0.08	0.150	0.20	0.600	0.46	2,215,656	164,078	2,051,578
0.08	0.150	0.25	0.600	0.00	2,215,656	164,078	2,051,578
0.08	0.150	0.25	0.600	0.46	2,215,656	164,078	2,051,578
0.08	0.150	0.30	0.600	0.00	2,215,656	164,078	2,051,578
0.08	0.150	0.30	0.600	0.46	2,215,656	164,078	2,051,578
0.08	0.020	0.20	0.600	0.00	2,325,573	164,078	2,161,495
0.08	0.020	0.20	0.600	0.46	2,325,573	164,078	2,161,495
0.08	0.020	0.25	0.600	0.00	2,325,573	164,078	2,161,495
0.08	0.020	0.25	0.600	0.46	2,325,573	164,078	2,161,495
0.08	0.020	0.30	0.600	0.00	2,325,573	164,078	2,161,495
0.08	0.020	0.30	0.600	0.46	2,325,573	164,078	2,161,495

TABLE 16: MODEL II; EMPLOYER BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVEBP'	TCe'	NET BENEFIT
0.12	0.150	0.20	0.750	0.46	79,435	-2,866	82,301
0.12	0.020	0.20	0.750	0.46	84,450	-2,866	87,316
0.10	0.150	0.20	0.750	0.46	96,960	-2,866	99,827
0.12	0.150	0.20	0.675	0.46	102,528	-2,866	105,395
0.10	0.020	0.20	0.750	0.46	103,556	-2,866	106,422
0.12	0.020	0.20	0.675	0.46	109,042	-2,866	111,909
0.08	0.150	0.20	0.750	0.46	120,680	-2,866	123,547
0.10	0.150	0.20	0.675	0.46	125,305	-2,866	128,171
0.12	0.150	0.20	0.600	0.46	125,621	-2,866	128,488
0.08	0.020	0.20	0.750	0.46	129,477	-2,866	132,343
0.12	0.020	0.20	0.600	0.46	133,634	-2,866	136,501
0.10	0.020	0.20	0.675	0.46	133,874	-2,866	136,740
0.12	0.150	0.20	0.750	0.00	147,102	-5,308	152,410
0.10	0.150	0.20	0.600	0.46	153,648	-2,866	156,515
0.08	0.150	0.20	0.675	0.46	156,135	-2,866	159,001
0.12	0.020	0.20	0.750	0.00	156,389	-5,308	161,697
0.10	0.020	0.20	0.600	0.46	164,192	-2,866	167,058
0.08	0.020	0.20	0.675	0.46	167,565	-2,866	170,432
0.10	0.150	0.20	0.750	0.00	179,556	-5,308	184,864
0.08	0.150	0.20	0.600	0.46	191,590	-2,866	194,456
0.12	0.150	0.20	0.675	0.00	189,867	-5,308	195,175
0.10	0.020	0.20	0.750	0.00	191,770	-5,308	197,078
0.12	0.020	0.20	0.675	0.00	201,930	-5,308	207,238
0.08	0.020	0.20	0.600	0.46	205,654	-2,866	208,520
0.08	0.150	0.20	0.750	0.00	223,482	-5,308	228,790
0.12	0.150	0.25	0.750	0.46	226,682	-8,216	234,898
0.10	0.150	0.20	0.675	0.00	232,046	-5,308	237,354
0.12	0.150	0.20	0.600	0.00	232,632	-5,308	237,940
0.08	0.020	0.20	0.750	0.00	239,772	-5,308	245,080
0.12	0.020	0.25	0.750	0.46	237,022	-8,216	245,238
0.12	0.020	0.20	0.600	0.00	247,471	-5,308	252,779
0.10	0.020	0.20	0.675	0.00	247,914	-5,308	253,222
0.10	0.150	0.25	0.750	0.46	261,425	-8,216	269,641
0.10	0.020	0.25	0.750	0.46	274,480	-8,216	282,696
0.10	0.150	0.20	0.600	0.00	284,534	-5,308	289,842
0.08	0.150	0.20	0.675	0.00	289,139	-5,308	294,447
0.12	0.150	0.25	0.675	0.46	292,990	-8,216	301,206
0.10	0.020	0.20	0.600	0.00	304,059	-5,308	309,367
0.12	0.020	0.25	0.675	0.46	305,488	-8,216	313,704
0.08	0.150	0.25	0.750	0.46	306,776	-8,216	314,992
0.08	0.020	0.20	0.675	0.00	310,306	-5,308	315,614
0.08	0.020	0.25	0.750	0.46	323,543	-8,216	331,759
0.10	0.150	0.25	0.675	0.46	338,343	-8,216	346,560
0.08	0.150	0.20	0.600	0.00	354,796	-5,308	360,104
0.12	0.150	0.25	0.600	0.46	357,399	-8,216	365,615
0.10	0.020	0.25	0.675	0.46	359,549	-8,216	367,765
0.12	0.020	0.25	0.600	0.46	373,953	-8,216	382,169
0.08	0.020	0.20	0.600	0.00	380,840	-5,308	386,148
0.12	0.150	0.30	0.750	0.46	373,929	-13,566	387,495
0.12	0.020	0.30	0.750	0.46	389,573	-13,566	403,139
0.08	0.150	0.25	0.675	0.46	397,586	-8,216	405,802
0.10	0.150	0.25	0.600	0.46	412,974	-8,216	421,190
0.08	0.020	0.25	0.675	0.46	417,893	-8,216	426,109
0.12	0.150	0.25	0.750	0.00	419,782	-15,215	434,997

TABLE 16: MODEL II; EMPLOYER BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVEBP'	TCe'	NET BENEFIT
0.10	0.150	0.30	0.750	0.46	425,889	-13,566	439,455
0.10	0.020	0.25	0.600	0.46	433,818	-8,216	442,034
0.12	0.020	0.25	0.750	0.00	438,930	-15,215	454,145
0.10	0.020	0.30	0.750	0.46	445,406	-13,566	458,971
0.08	0.150	0.25	0.600	0.46	485,464	-8,216	493,680
0.12	0.150	0.30	0.675	0.46	481,607	-13,566	495,173
0.10	0.150	0.25	0.750	0.00	484,120	-15,215	499,335
0.08	0.150	0.30	0.750	0.46	492,872	-13,566	506,438
0.12	0.020	0.30	0.675	0.46	501,933	-13,566	515,499
0.08	0.020	0.25	0.600	0.46	512,244	-8,216	520,460
0.10	0.020	0.25	0.750	0.00	508,297	-15,215	523,512
0.08	0.020	0.30	0.750	0.46	517,608	-13,566	531,174
0.12	0.150	0.25	0.675	0.00	542,574	-15,215	557,789
0.10	0.150	0.30	0.675	0.46	549,094	-13,566	562,659
0.12	0.020	0.25	0.675	0.00	565,718	-15,215	580,933
0.08	0.150	0.25	0.750	0.00	568,104	-15,215	583,319
0.10	0.020	0.30	0.675	0.46	574,424	-13,566	587,990
0.12	0.150	0.30	0.600	0.46	589,285	-13,566	602,851
0.08	0.020	0.25	0.750	0.00	599,153	-15,215	614,368
0.12	0.020	0.30	0.600	0.46	614,272	-13,566	627,837
0.10	0.150	0.25	0.675	0.00	626,562	-15,215	641,777
0.08	0.150	0.30	0.675	0.46	636,105	-13,566	649,671
0.12	0.150	0.25	0.600	0.00	661,850	-15,215	677,065
0.10	0.020	0.25	0.675	0.00	665,831	-15,215	681,046
0.08	0.020	0.30	0.675	0.46	668,221	-13,566	681,787
0.10	0.150	0.30	0.600	0.46	672,298	-13,566	685,864
0.12	0.020	0.25	0.600	0.00	692,505	-15,215	707,720
0.10	0.020	0.30	0.600	0.46	703,443	-13,566	717,009
0.12	0.150	0.30	0.750	0.00	692,461	-25,122	717,583
0.12	0.020	0.30	0.750	0.00	721,431	-25,122	746,553
0.08	0.150	0.25	0.675	0.00	736,270	-15,215	751,485
0.10	0.150	0.25	0.600	0.00	764,767	-15,215	779,982
0.08	0.020	0.25	0.675	0.00	773,876	-15,215	789,091
0.08	0.150	0.30	0.600	0.46	779,339	-13,566	792,905
0.10	0.150	0.30	0.750	0.00	788,684	-25,122	813,806
0.10	0.020	0.25	0.600	0.00	803,366	-15,215	818,581
0.08	0.020	0.30	0.600	0.46	818,834	-13,566	832,400
0.10	0.020	0.30	0.750	0.00	824,825	-25,122	849,947
0.08	0.150	0.25	0.600	0.00	899,008	-15,215	914,223
0.12	0.150	0.30	0.675	0.00	891,865	-25,122	916,987
0.08	0.150	0.30	0.750	0.00	912,726	-25,122	937,848
0.12	0.020	0.30	0.675	0.00	929,506	-25,122	954,628
0.08	0.020	0.25	0.600	0.00	948,600	-15,215	963,815
0.08	0.020	0.30	0.750	0.00	958,534	-25,122	983,656
0.10	0.150	0.30	0.675	0.00	1,016,840	-25,122	1,041,962
0.10	0.020	0.30	0.675	0.00	1,063,749	-25,122	1,088,871
0.12	0.150	0.30	0.600	0.00	1,091,269	-25,122	1,116,391
0.12	0.020	0.30	0.600	0.00	1,137,540	-25,122	1,162,662
0.08	0.150	0.30	0.675	0.00	1,177,973	-25,122	1,203,095
0.08	0.020	0.30	0.675	0.00	1,237,447	-25,122	1,262,569
0.10	0.150	0.30	0.600	0.00	1,244,997	-25,122	1,270,119
0.10	0.020	0.30	0.600	0.00	1,302,673	-25,122	1,327,795
0.08	0.150	0.30	0.600	0.00	1,443,220	-25,122	1,468,342
0.08	0.020	0.30	0.600	0.00	1,516,360	-25,122	1,541,482

TABLE 17: MODEL II; GOVERNMENT BENEFITS

r	P(AR)	RPF	P(R)	CTR	PVGPB'	TCg'	NET BENEFIT
0.12	0.150	0.20	0.750	0.00	297,346	272,349	24,997
0.12	0.150	0.25	0.750	0.00	297,346	272,349	24,997
0.12	0.150	0.30	0.750	0.00	297,346	272,349	24,997
0.12	0.020	0.20	0.750	0.00	307,106	272,349	34,757
0.12	0.020	0.25	0.750	0.00	307,106	272,349	34,757
0.12	0.020	0.30	0.750	0.00	307,106	272,349	34,757
0.10	0.150	0.20	0.750	0.00	328,190	272,349	55,841
0.10	0.150	0.25	0.750	0.00	328,190	272,349	55,841
0.10	0.150	0.30	0.750	0.00	328,190	272,349	55,841
0.10	0.020	0.20	0.750	0.00	339,762	272,349	67,413
0.10	0.020	0.25	0.750	0.00	339,762	272,349	67,413
0.10	0.020	0.30	0.750	0.00	339,762	272,349	67,413
0.08	0.150	0.20	0.750	0.00	366,043	272,349	93,694
0.08	0.150	0.25	0.750	0.00	366,043	272,349	93,694
0.08	0.150	0.30	0.750	0.00	366,043	272,349	93,694
0.12	0.150	0.20	0.750	0.46	365,013	269,907	95,106
0.08	0.020	0.20	0.750	0.00	379,975	272,349	107,626
0.08	0.020	0.25	0.750	0.00	379,975	272,349	107,626
0.08	0.020	0.30	0.750	0.00	379,975	272,349	107,626
0.12	0.020	0.20	0.750	0.46	379,045	269,907	109,138
0.12	0.150	0.20	0.675	0.00	382,699	272,349	110,350
0.12	0.150	0.30	0.675	0.00	382,699	272,349	110,350
0.12	0.150	0.25	0.675	0.00	383,574	272,349	111,225
0.12	0.020	0.20	0.675	0.00	395,350	272,349	123,001
0.12	0.020	0.25	0.675	0.00	395,350	272,349	123,001
0.12	0.020	0.30	0.675	0.00	395,350	272,349	123,001
0.10	0.150	0.20	0.750	0.46	410,786	269,907	140,878
0.10	0.150	0.20	0.675	0.00	422,735	272,349	150,386
0.10	0.150	0.30	0.675	0.00	422,735	272,349	150,386
0.10	0.150	0.25	0.675	0.00	423,770	272,349	151,421
0.10	0.020	0.20	0.750	0.46	427,976	269,907	158,069
0.10	0.020	0.25	0.675	0.00	432,742	272,349	160,393
0.10	0.020	0.20	0.675	0.00	437,742	272,349	165,393
0.10	0.020	0.30	0.675	0.00	437,742	272,349	165,393
0.12	0.020	0.30	0.600	0.00	438,595	272,349	166,246
0.12	0.150	0.20	0.600	0.00	468,051	272,349	195,702
0.12	0.150	0.25	0.600	0.00	468,051	272,349	195,702
0.12	0.150	0.30	0.600	0.00	468,051	272,349	195,702
0.08	0.150	0.20	0.750	0.46	468,845	269,907	198,937
0.08	0.150	0.20	0.675	0.00	471,879	272,349	199,530
0.08	0.150	0.30	0.675	0.00	471,879	272,349	199,530
0.12	0.150	0.20	0.675	0.46	470,038	272,349	197,689
0.08	0.150	0.25	0.675	0.00	473,122	272,349	200,773
0.12	0.020	0.20	0.600	0.00	483,595	272,349	211,246
0.12	0.020	0.25	0.600	0.00	483,595	272,349	211,246
0.08	0.020	0.20	0.675	0.00	489,752	272,349	217,403
0.08	0.020	0.25	0.675	0.00	489,952	272,349	217,603
0.08	0.020	0.30	0.675	0.00	489,952	272,349	217,603
0.12	0.020	0.20	0.675	0.46	488,238	269,907	218,330
0.08	0.020	0.20	0.750	0.46	490,270	269,907	220,363
0.12	0.150	0.25	0.750	0.46	490,446	265,350	225,096
0.12	0.020	0.25	0.750	0.46	509,014	265,350	243,664
0.10	0.150	0.20	0.600	0.00	517,279	272,349	244,930
0.10	0.150	0.25	0.600	0.00	517,279	272,349	244,930

TABLE 17: MODEL II; GOVERNMENT BENEFITS (CONTINUED)

r	P(AR)	RPF	P(R)	CTR	PVGPB'	TCg'	NET BENEFIT
0.10	0.150	0.30	0.600	0.00	517,279	272,349	244,930
0.10	0.150	0.20	0.675	0.46	529,476	272,349	257,127
0.10	0.020	0.20	0.600	0.00	535,721	272,349	263,372
0.10	0.020	0.25	0.600	0.00	535,721	272,349	263,372
0.10	0.020	0.30	0.600	0.00	535,721	272,349	263,372
0.10	0.020	0.20	0.675	0.46	551,782	269,907	281,875
0.10	0.150	0.25	0.750	0.46	550,885	265,350	285,535
0.12	0.150	0.20	0.600	0.46	575,062	272,349	302,713
0.08	0.150	0.20	0.600	0.00	577,714	272,349	305,365
0.08	0.150	0.25	0.600	0.00	577,714	272,349	305,365
0.08	0.150	0.30	0.600	0.00	577,714	272,349	305,365
0.10	0.020	0.25	0.750	0.46	573,579	265,350	308,229
0.12	0.020	0.20	0.600	0.46	597,432	272,349	325,083
0.08	0.020	0.20	0.600	0.00	599,929	272,349	327,580
0.08	0.020	0.25	0.600	0.00	599,929	272,349	327,580
0.08	0.020	0.30	0.600	0.00	599,929	272,349	327,580
0.08	0.150	0.20	0.675	0.46	604,883	269,907	334,976
0.12	0.150	0.30	0.750	0.46	615,878	260,793	355,085
0.08	0.150	0.25	0.750	0.46	627,371	265,350	362,021
0.08	0.020	0.20	0.675	0.46	632,493	272,349	360,144
0.12	0.150	0.25	0.675	0.46	633,158	272,349	360,809
0.12	0.020	0.30	0.750	0.46	638,964	260,793	378,171
0.10	0.150	0.20	0.600	0.46	648,165	272,349	375,816
0.12	0.020	0.25	0.675	0.46	655,580	272,349	383,231
0.08	0.020	0.25	0.750	0.46	655,585	265,350	390,235
0.10	0.020	0.20	0.600	0.46	675,588	272,349	403,239
0.10	0.150	0.30	0.750	0.46	690,985	260,793	430,192
0.10	0.150	0.25	0.675	0.46	711,989	272,349	439,640
0.10	0.020	0.30	0.750	0.46	719,182	260,793	458,389
0.08	0.150	0.20	0.600	0.46	740,920	272,349	468,571
0.10	0.020	0.25	0.675	0.46	739,024	272,349	466,675
0.08	0.020	0.20	0.600	0.46	775,115	272,349	502,766
0.12	0.150	0.25	0.600	0.46	772,502	272,349	500,153
0.08	0.150	0.30	0.750	0.46	785,897	260,793	525,104
0.12	0.150	0.30	0.675	0.46	792,957	269,907	523,050
0.12	0.020	0.25	0.600	0.46	802,147	265,350	536,797
0.08	0.150	0.25	0.675	0.46	811,806	272,349	539,457
0.08	0.020	0.30	0.750	0.46	820,901	260,793	560,108
0.12	0.020	0.30	0.675	0.46	822,923	272,349	550,574
0.08	0.020	0.25	0.675	0.46	845,935	272,349	573,586
0.10	0.150	0.25	0.600	0.46	869,072	265,350	603,722
0.10	0.150	0.30	0.675	0.46	890,481	272,349	618,132
0.10	0.020	0.25	0.600	0.46	905,269	272,349	632,920
0.10	0.020	0.30	0.675	0.46	927,067	272,349	654,718
0.12	0.020	0.30	0.600	0.46	961,863	272,349	689,514
0.12	0.150	0.30	0.600	0.46	970,035	269,907	700,127
0.08	0.150	0.25	0.600	0.46	991,258	260,793	730,465
0.08	0.150	0.30	0.675	0.46	1,013,747	265,350	748,396
0.08	0.020	0.25	0.600	0.46	1,036,285	272,349	763,936
0.08	0.020	0.30	0.675	0.46	1,059,178	272,349	786,829
0.10	0.150	0.30	0.600	0.46	1,089,978	260,793	829,185
0.10	0.020	0.30	0.600	0.46	1,134,951	272,349	862,602
0.08	0.150	0.30	0.600	0.46	1,241,595	272,349	969,246
0.08	0.020	0.30	0.600	0.46	1,297,455	265,350	1,032,105

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