Tobacco Taxes and Consumption

June 1993

Canada

Tobacco Taxes and Consumption

June 1993

Department of Finance Canada
Ministère des Finances Canada

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
Introduction i
Background ii
Main Findings iii
Conclusion vi

I INTRODUCTION 1

II. BACKGROUND 3
2.1 Introduction 3
2.2 General Tax Provisions 3
Federal Taxes 3
Provincial Taxes 5
2.3 The Price Structure of Tobacco 5
2.4 Domestic Consumption and Exports of Tobacco Products 6
Domestic Consumption 7
Exports of Tobacco Products 8
2.5 Federal Excise Revenues 8
2.6 Summary 8

III LITERATURE SURVEY 25
3.1 Introduction 25
3.2 Static Models 26
3.3 Partial Adjustment Models 27
3.4 State Adjustment Model 30
3.5 Rational Addiction Model 31
3.6 Summary 32

IV THE MODEL FOR DOMESTIC CONSUMPTION 33
4.1 Introduction 33
4.2 What Determines Demand 33
Data Periodicity 36
The Dependent Variable 37
The Explanatory Variables 38
4.3 Model Formulation 40
4.4 Econometric Approach 43
Choosing the Functional Form 43
Choosing the Appropriate Model 44
Threshold Variables 45
Other Considerations 45
4.6 Summary 46

V EMPIRICAL RESULTS FOR DOMESTIC CONSUMPTION 48
5.1 Introduction 48
5.2 The Variables 48

5.3 The Demand for Cigarettes 49
5.4 The Demand for Fine-Cut Tobacco 54
5.5 Tobacco Smuggling 60
5.6 Summary 62

VI THE PRICE SENSITIVITY OF YOUNGER CANADIANS 63

VII THE SUPPLY OF EXPORTED TOBACCO PRODUCTS 67
7.1 Introduction 67
7.2 The Economics of Smuggling 67
7.3 Model Development 72
The Natural Rate of Exports 73
Incorporating Smuggling Into The Demand For Exports 74
7.4 Empirical Results 76
The Natural Rate of Exports Model 76
The Smuggling Model 79
7.5 Potential Level of Tobacco Smuggling 83
7.6 Summary 87

VIII SOME IMPLICATIONS OF THE RESULTS 88
8.1 Introduction 88
8.2 The Events of 1991 and Federal Revenues 88
The Impact of the 1991 Federal Budget 88
Provincial Tax and Private Cost Increases 93
8.3 The Impact of Smuggling 94
8.4 Change In Overall Tobacco Consumption Since 1985 95

IX CONCLUSION 98

X BIBLIOGRAPHY 100

NOTES ON USAGE

The paper focuses on many aspects of the interaction between price, tax and consumption. In an effort to make the material more reader friendly, brief descriptions of the various terms associated with consumption which are used in the paper are provided below.

CONSUMPTION

Consumption refers to the total quantity of a specific product purchased by a consumer. The paper makes a distinction between legal and illicit tobacco (e.g. the legal tax-paid consumption of cigarettes and illicit cigarettes) and considers these as two different products.

LEGAL OR DOMESTIC CONSUMPTION

Legal or domestic consumption refers to the quantity of tax-paid tobacco purchased in Canada.

ILLICIT CONSUMPTION

Illicit consumption refers to the quantity of tobacco purchased in Canada which has either been illegally imported into Canada or obtained by some other illegal means and on which tax has not been paid.

EXPORTS

Exports refer to the quantity of tobacco which is manufactured in Canada and subsequently shipped to a foreign country, sold in duty-free shops, sold as ships' stores, or sold to diplomats on a tax-free basis.

DOMESTIC SHIPMENTS

Domestic shipments refer to the quantity of tobacco which is manufactured and sold tax-paid in Canada.

EXPENDITURES

Expenditures refer to the total value of a product purchased and is equivalent to multiplying the price of the product by the quantity sold.

DEMAND FOR CIGARETTES/FINE-CUT TOBACCO

The demand for cigarettes or fine-cut tobacco is equivalent to the fully-taxed domestic consumption of that product.

SMUGGLED TOBACCO

Smuggled tobacco is equivalent to the term illicit tobacco.

EXECUTIVE SUMMARY

Introduction

In the recent past, there have been significant changes in the level of tobacco taxes. Since 1980, federal excise levies (both the excise tax and the excise duty) have increased by over 550% while provincial levies have risen by more than 500%. These tax increases led to higher prices which, in turn, affected consumption. Since the total tax revenues received by both federal and provincial governments depend upon the rate of tax and the level of tax-paid consumption, policy makers should have an understanding of how taxes affect tobacco prices and the relationship between price and quantity consumed.

Complicating this analysis is the fact that tobacco products are sold in a variety of forms such as cigarettes, fine-cut tobacco (which includes tobacco sticks), cigars, pipe tobacco, chewing tobacco, snuff and plug. To a certain degree, consumers treat these products as substitutes for each other. However, the two that are the most closely related are cigarettes and fine-cut tobacco since the latter can be used to create a "very good" substitute for the former. Hence, the change in the price of one may well affect the consumption of the other.

The total quantity of tobacco products consumed in Canada is determined by two important decisions. First, an individual decides whether or not to smoke and, second, the smoker determines the quantity to be consumed. Studies have shown that over 75% of adult smokers made their initial decision to smoke before they turned 21. Other studies have found that teenagers are more sensitive to price changes than are adults. Given the habitual nature of smoking, price changes which deter teenagers from starting to smoke should have a greater, long-term effect on total consumption than the associated change in the quantity consumed by existing smokers.

During the latter half of the 1980's and continuing into the 1990's, the quantity of tobacco products exported from Canada increased dramatically. At the same time, there has been a large increase in the amount of illicit tobacco, particularly goods originating in Canada, seized by Customs at the border and inland by the RCMP. These recent trends suggest that smuggled tobacco has become an important substitute for the fully-taxed product.

The purpose of this evaluation is to examine the issues discussed above. Specifically, it will address the following questions:

- how do tax increases affect the demand for tobacco products?
- to what degree are fine-cut tobacco and cigarettes substitutes?
- are younger Canadians more price sensitive than older Canadians?

- and, to what extent have recent tax increases affected the market for smuggled tobacco products?

That is, the evaluation focuses on the interaction of taxes and tobacco consumption. Consequently, the evaluation does not consider such issues as the social costs of smoking; the health effects of smoking; the social costs of tobacco smuggling; or the notion of an optimal level of tax. The data used in the study covers the period beginning in 1968 and ending in 1991 and the findings are primarily based on these data.

Background

Cigarettes represent more than 90 per cent of total tobacco expenditures in Canada. From 1968 to 1981, tax-paid cigarette consumption (as proxied by domestic shipments) grew by 2.8 per cent per annum. However, since 1981, tax-paid cigarette consumption has declined steadily by an average of 5.2 per cent per annum. As this decline has coincided with important tax and price increases, there appears to be a correlation between the price and quantity of tax-paid cigarettes consumed.

Fine-cut tobacco (roll-your-own) comprises a large majority of the non-cigarette tobacco expenditures in Canada. In contrast to cigarettes, tax-paid fine-cut consumption declined slightly from 1968 to 1981 (2.9 per cent per annum), increased significantly between 1981 and 1988 (7.7 per cent per annum) and declined thereafter. The most recent decline coincides with significant federal and provincial tax increases on fine-cut tobacco. It is interesting to note that there appears to have been no correlation between price and tax-paid consumption prior to 1989. Instead, tax-paid consumption seems to have been affected by the real price differential between cigarettes and fine-cut tobacco. The higher this differential, the more likely were consumers to switch to fine-cut.

Tobacco products bear several taxes, both federal and provincial, including three product-specific levies and as many as two types of sales tax. Currently, taxes represent about 75% of the final price paid by consumers. Essentially, the higher the share of taxes in the final retail price, the greater the influence of a given percentage tax change on the retail price and, in turn, on the quantity consumed. The relationship between price and quantity changes is measured by the price elasticity of demand which is defined as the percentage change in consumption which would occur given a one per cent change in price. For example, a price elasticity of -0.4 would imply that a 10% increase in the price of cigarettes would lead to a 4% decline in consumption.

Many academic studies have attempted to determine the price elasticity for tobacco and for cigarettes in particular. A review of these studies provides useful insights into the type of analysis and relevant data necessary to estimate the current price elasticity of demand in Canada. The estimated initial effect of a change in price on consumption, or the short-run price elasticity of demand, ranges from -0.3 to -0.4 in Canadian studies and from -0.22 to -0.49 in U.S. studies. The estimated final effect of a price change on

consumption, or the long-run price elasticity of demand, falls between -0.57 and -1.5 in Canadian studies and -0.3 and -3.14 in U.S. studies. Such diverse results make it difficult to ascertain what price elasticity should be used in determining the final impact of a tax change on government revenues. Consequently, this paper develops a model which provides an elasticity estimate that takes into account current market conditions.

Main Findings

The Demand For Tobacco

Although the overall demand for tobacco is an aggregate of the demand for a variety of products, cigarettes and fine-cut tobacco together account for more than 95% of the total quantity consumed in Canada. Thus, most of the demand for tobacco can be explained by estimating a demand function for cigarettes and fine-cut tobacco. The actual quantity consumed may be influenced by a number of factors which include: own price; the price of substitutes; population; education; social class; cigarette advertising; anti-smoking publicity; health consequences; smoking bans; and the degree of addiction. Unfortunately, some of these factors cannot be observed while others cannot be quantified reliably. As a result, the models used in this study include variables reflecting own price, disposable income and the price of substitutes. With respect to the latter, the recent emergence of smuggled tobacco products is captured in the models by including the real level of tax as a proxy for the savings associated with switching from a legal to an illicit product.

The empirical results support several conclusions. First, the price elasticity of demand for tax-paid cigarettes changes through time. For example, in 1991, the observed short-run value is -0.9 -- that is, a 10% increase in the real price of cigarettes would lead to a 9% decline in consumption. This value is significantly higher than results reported in previous Canadian studies where estimates range from -0.3 to -0.4.

Second, the price elasticity of demand for cigarettes tends to be more inelastic in the long-run (-0.7) than in the short-run. This result could arise if smokers initially react to a price increase by either reducing the amount they smoke or quitting altogether. However, over time the habitual nature of tobacco consumption catches up with many of them and they return to their past consumption levels.

Third, there is a significant degree of substitutability between cigarettes and fine-cut tobacco. Since 1980, both price and tax increases have led to an increase in the real price differential between cigarettes and fine-cut tobacco. As a result, some smokers have switched from cigarettes to the cheaper alternative. In fact, it is estimated that a 10% increase in the price of cigarettes would lead to a 13% increase in the sales of tax-paid fine-cut tobacco.

The Price Sensitivity of Younger Canadians

One of the goals of tobacco taxation is to discourage younger people from taking up smoking. In the 1991 Federal Budget, the Minister of Finance, the Honourable Michael Wilson, stated that "our national strategy to reduce tobacco use addresses all aspects of the problem of tobacco consumption. In particular, it is aimed at discouraging young people from beginning to smoke. ... Studies show that tobacco taxes are particularly important in discouraging younger Canadians from smoking". Given this goal, an evaluation of tobacco taxation should try to ascertain whether younger Canadians are affected more than others by a tax increase. As tax increases affect individuals through the consequential change in the retail price, the question is whether younger Canadians have a higher price elasticity of demand than adults.

The question of whether tobacco price increases affect younger people more than adults has not been addressed in many studies. In order to gain some insight into the price sensitivity of younger Canadians, a simple analysis was carried out to determine how the proportion of smokers among teenagers and adults is affected by the real price of tobacco. In all cases, the results showed that younger Canadians are, indeed, more sensitive to price changes than adults. That is, recent tax increases have led to a reduction in the number of teenagers who start to smoke and this will have a long-term effect on total tobacco consumption.

Exports and Smuggling

The quantity of cigarettes and fine-cut tobacco exported from Canada increased very substantially between 1985 and 1991. For example, cigarette exports grew by over 440%. These increases in exports coincided with significant tax increases. There was also a large increase in the number of seizures of illicitly imported tobacco products indicating that smuggling had become a problem in Canada.

In an effort to account for the apparent substitution from tax-paid to smuggled tobacco products, the real level of taxes was included in the domestic consumption models. The empirical results indicate that the real level of taxes has had an important influence on tax-paid consumption over the last few years. However, the models provide only an indication of the reduction in tax-paid consumption caused by the substitution and not the consequential change to the level of smuggled tobacco products.

In order to assess the potential level of smuggled tobacco products, two additional models were developed to try to explain changes in Canadian tobacco exports over time. The first, the natural rate model, attempts to explain the supply of exported tobacco to legitimate markets to meet the demand created by Canadians travelling abroad. However, this model fails to explain the recent surge in the level of exports. A second model was therefore formulated which augments the supply to legitimate markets by incorporating variables which attempt to capture the influence of smuggling. Specifically, these variables include the real level of tobacco taxes in Canada, which should be proportional to the profits realized by smugglers, and a proxy for the expected cost of being caught smuggling.

The empirical results of this smuggling model reveal that a 10% increase in the level of real tobacco taxes in Canada would lead to at least a 10% increase in the level of tobacco exports -- an amount which would appear to be destined for the smuggling market. In addition, the results indicate that the level of smuggling is influenced by the expected cost of being caught. That is, an increase in either enforcement at the border (number of searches) or the associated level of fines would result in a reduction in the level of smuggled tobacco.

All of the models can be used to assess the implications of the market for smuggled tobacco on government revenues. For instance, it is found that the existence of the market for smuggled tobacco cost the federal government anywhere from $555 million to $695 million in foregone revenues in 1991. However, it is important to realize that these revenue losses could only be recovered by the total elimination of smuggling at prevailing tax rates, which would likely be impractical given the long border between Canada and the United States. In addition, increases in enforcement entail additional costs which would reduce the potential increase in revenues. Therefore, the revenue losses should not be viewed as revenues which could actually be realized.

Impact of Changes in 1991

The empirical results of the domestic consumption models can be used to determine the potential impact on tax-paid tobacco consumption of the significant tax increase announced in the February 1991 budget. The 3¢ per cigarette excise tax increase resulted in a 27% increase in total taxes which led to a 19% increase in the retail price. As a result, it is estimated that tax-paid cigarette consumption would fall by approximately 16% in the short-run and 12% in the long-run.

The significant increase in the level of federal taxes has led some smokers to switch to smuggled tobacco products. It is estimated that this substitution led to a potential short-run reduction in tax-paid cigarette consumption of 3.8%. However, it should be recognized that there are legal ways to increase one's consumption of tax-free cigarettes by taking advantage of the rules regarding duty-free importations -- each individual is able to import a carton of cigarettes tax-free after being out of the country for more than 48 hours. That is, smokers could spend more time outside of the country or encourage friends to bring them cigarettes on their return from a foreign trip. **These types of importations are legal and should not be attributed to smuggling.** Nevertheless, the influence of the tax variable in the domestic model might be capturing some of the increase in these legal importations.

The simulations are also used to estimate how tax-paid tobacco consumption and the associated federal revenues were affected by the 1991 budget. In fiscal year 1991/92, tax-paid cigarette consumption would fall by about 28 million cartons while tax-paid fine-cut tobacco would decline by 3.2 million 200 gram tins. As a result, the tax increase would provide an extra $945 million in revenues from cigarettes and $105 million from fine-cut tobacco in that fiscal year for a total revenue gain of $1,050 million. This compares with the original budget estimate of $1,300 million.

Federal revenues are also affected by changes in provincial taxes and private costs. For example, unanticipated increases in both these areas during 1991 led to a decline in tax-paid cigarette sales of 13.8 million cartons in fiscal year 1991/92. Similarly, there was also a decline in the sales of tax-paid fine-cut tobacco. These quantity reductions could not have been incorporated into the federal government's revenue forecast. As a result, there was an unanticipated loss in federal revenues from tobacco excise levies which amounted to $220 million in fiscal year 1991/92. That is, when all of the changes in 1991 are considered, it is estimated that the federal excise revenues from tobacco products were almost $470 million lower than expected -- $250 million because of a higher-than-expected quantity response and $220 million due to unanticipated changes in provincial taxes and private costs.

Conclusion

Recent increases in federal tobacco taxes complement the government's comprehensive strategy of reducing tobacco smoking in Canada. The empirical results indicate that an increase in the level of tax does lead to a reduction in tax-paid tobacco consumption. However, it also results in an increase in the market for illicit tobacco. On balance, federal tax increases since 1985 have resulted in a net decline in overall tobacco consumption in Canada.

TOBACCO TAXES AND CONSUMPTION

I INTRODUCTION

In the recent past, there have been significant changes in the level of tobacco taxes. From 1980 to 1991, the level of taxes, expressed in real terms[1], increased by 250 per cent for cigarettes and 520 per cent for fine-cut tobacco[2]. These tax increases led to higher prices which, in turn, changed consumption patterns. Since the total tax revenues received by both the federal and provincial governments depend upon both the rate of tax and the level of tax-paid consumption, an understanding of how taxes affect tobacco prices and the relationship between price and quantity changes is important for policy-makers.

Tobacco products are sold in a variety of forms including cigarettes, fine-cut tobacco, cigars, pipe tobacco, chewing tobacco, snuff and plug. To a certain degree, consumers treat these products as substitutes for each other. However, the two products that are the most closely related are cigarettes and fine-cut tobacco since the latter is a very good substitute for the former. Hence, a change in the relative price between cigarettes and fine-cut tobacco should have an influence on the consumption of both products.

During the latter half of the 1980's and continuing into the 1990's, the quantity of tobacco products exported from Canada has increased dramatically. At the same time, there has been a large increase in the quantity of illicit tobacco products, including goods originating in Canada, seized by Customs at the border and inland by the RCMP. These recent trends suggest that smuggled tobacco products have become an important substitute for the legal product.

The total quantity of tobacco products consumed in Canada is determined by two important decisions. First, an individual decides whether or not to smoke and, second, the smoker determines the quantity to be consumed. Studies have shown that over 75% of adult smokers made their initial decision to smoke before they turned 21. Other studies have found that teenagers are more sensitive to price changes than are adults. Given the addictive nature of tobacco products, price changes which deter teenagers from starting to smoke should have a greater, long-term effect on total consumption than the associated change in the quantity consumed by existing smokers.

---

1. Through time, inflation reduces the real value of a dollar so that fewer goods and services can be acquired with that dollar. To account for the influences of inflation, economists express values in real terms by adjusting for changes in prices relative to a base year.

2. Fine-cut tobacco, which is also referred to as manufactured tobacco, is used by smokers to "roll" their own cigarettes either with a mechanical device or by hand. It should be noted that Statistics Canada includes "tobacco sticks" in their definition of fine-cut tobacco and this definition is adopted throughout the paper.

The purpose of this evaluation is to examine the issues discussed above. Specifically, it will address the following questions:

- *how do tax increases affect the demand for tobacco products?*
- *to what degree are fine-cut tobacco and cigarettes substitutes?*
- *are younger Canadians more price sensitive than older Canadians?*
- *and, to what extent have recent tax increases affected the market for smuggled tobacco products?*

To answer these questions, it is necessary to quantify the factors which determine the demand for tobacco products. That is, the evaluation focuses on the interaction of taxes and tobacco consumption. Consequently, the evaluation does not include such issues as the social costs of smoking; the health effects of smoking; the social costs of tobacco smuggling; or the notion of an optimal tax rate. The data used in the study cover the period beginning in 1968 and ending in 1991 and the findings are primarily based on these data.

Chapter II provides background data which illustrate the changes in the tobacco market. Chapter III contains a survey of the literature pertaining to the demand for tobacco. Chapter IV develops a model for tobacco demand in Canada and Chapter V presents the associated empirical results. Chapter VI assesses the price sensitivity of teenagers versus adults. Chapter VII sets out models which can be used to quantify the market for smuggled tobacco products and presents the associated empirical results. Chapter VIII assesses the consequences of selected tax changes on federal tax revenues based on the results presented in earlier chapters. The final chapter presents the conclusions.

II. BACKGROUND

2.1 Introduction

A useful starting point in evaluating tobacco taxes is to review the historical trends in consumption, prices and taxes. The purpose of this chapter is to provide this background information. To that end, section 2 gives a general description of the taxes which are applied to tobacco products by both the federal and provincial governments and highlights significant changes through time. Section 3 discusses the major components which make up the price of a carton of cigarettes and 200 grams of fine-cut tobacco. Section 4 describes movements in the legal consumption of cigarettes and fine-cut tobacco in Canada and notes recent changes in Canadian tobacco exports. The final section presents historical data on federal excise tax and duty revenues from various tobacco products.

2.2 General Tax Provisions

Unlike most goods purchased in Canada, tobacco products are subject to as many as five different commodity taxes. The federal government levies an excise duty and/or excise tax along with the goods and services tax (GST). All provincial/territorial governments impose a product-specific tax and, in some cases, include tobacco products in their sales tax base.

Federal Taxes

At the federal level, all forms of tobacco products sold in Canada are subject to an excise duty. In addition, an excise tax is applied to these products with the exception of raw leaf tobacco. Imported tobacco products also face customs duties based on the country of origin. Finally, all tobacco products are subject to the GST.[3]

Excise duties are levied under the Excise Act as fixed amounts per unit on tobacco products manufactured and sold in Canada. The duty is imposed on production and is payable by the manufacturer[4,5]. While on the surface it would seem that imported tobacco products escape the excise duty, it should be noted that imports are subject to a

---

3. Prior to January 1, 1991, tobacco products were subject to the federal sales tax.

4. The excise duty is levied on cigarettes and other tobacco products as they are produced. Prior to 1991, the duties were remitted to the government on a daily basis. However, since January 1991, manufacturers are allowed to remit the duties on a monthly basis.

5. In the case of raw leaf tobacco, the tax is payable by the tobacco packer.

customs duty which comprises the normal tariff[6] and a component, referred to as a customs duty offset, equivalent to the excise duty.

Excise taxes are imposed under the Excise Tax Act as fixed amounts per unit of tobacco product except for the excise tax on cigars which is ad valorem. Unlike excise duties, they are imposed on both domestically produced and imported tobacco products. In the case of domestic products, the tax is levied at the manufacturers' level at the time of sale. Imported products are taxed at the time of importation. The government generally receives the associated revenues on a semi-monthly basis or about three weeks after the time of sale.[7]

The federal government also imposes a sales tax on tobacco products under the Excise Tax Act. Prior to 1991, the federal sales tax (FST) was imposed on an ad valorem basis on the manufacturer's price including the federal excise duty or on the duty paid value of imported goods. In January 1991, the FST was replaced with the GST which is imposed at every stage in the production and distribution chain. As businesses are allowed to claim an input tax credit for the tax paid on their purchases, the GST is equivalent to a retail sales tax charged on sales to final consumers.

Over the last thirty years, the federal government has relied on three forms of tax to collect revenues from tobacco products -- sales taxes, excise taxes and excise duties. Over this period, the only major change to this structure has been the replacement of the 19% FST with the 7% GST. However, despite this change in the tax structure, the government ensured that the final price paid by consumers remained the same by adjusting the level of the excise tax. Consequently, the federal government neither gained nor lost revenues from tobacco products as a result of the change.

Of course, as Table 2.1* shows, the rates of tax have been changed many times in the last thirty years -- especially since 1980. Starting in April 1981, the government introduced a system of automatic indexation where the excise levies (taxes and duties) were adjusted annually based on changes in the consumer price index for tobacco

---

6. Under the Canada-U.S. Free-Trade Agreement, the tariffs applicable on tobacco products imported from the United States are being phased out.

7. Taxpayers whose average monthly excise tax liability is in excess of $1 million are required to make payments on a semi-monthly basis. Taxes due on transactions during the first 15 days of each month must be remitted by close of business on the last business day of the month while taxes collected during the remainder of the month must be remitted by close of business on the 15th day of the following month. This system of remittances was introduced in April 1988. Prior to that date, excise taxes were remitted monthly based on sales in the previous month.

* The tables and graphs discussed in this chapter are at the end of the chapter.

products.[8,9] The indexation system was abolished in the 1985 budget but not before the federal levies had risen by more than 55%. Since 1985, all subsequent changes have had to be approved by Parliament. As part of the federal government's comprehensive strategy of reducing tobacco smoking in Canada[10] and to raise additional revenues, Parliament has approved several significant tax increases since 1985. As a result, the total excise levies on cigarettes, for example, have increased by 318%.

Provincial Taxes

In all provinces, tobacco products are subject to a specific tax which is levied on a per unit basis. At the end of 1992, the level of tax on a carton of 200 cigarettes ranged from a low of $13.00 in Ontario to a high of $21.00 in British Columbia. In addition, all provinces other than Prince Edward Island, Alberta and British Columbia apply their retail sales tax to tobacco products. Moreover, there are differences in the provincial sales tax base. Newfoundland, Nova Scotia, New Brunswick and Québec include the federal GST in their base, while the other provinces do not. Recent provincial tobacco tax and sales tax rates are shown in Table 2.2.

As with the federal levies, provincial levies have risen considerably in recent years -- by over 500% since 1980. Moreover, it is interesting to note that the cumulative increase in the average provincial levy in Canada since 1968, as shown in Table 2.3, has been over 2,400% which is significantly higher than the almost 700% increase in the federal levies. In contrast, the increase in the general price level (CPI) over the same period was just over 330%. Consequently, the provincial share of the retail price increased from 12.4% in 1968 to 34.5% in 1991.

2.3 The Price Structure of Tobacco

It is clear that both federal and provincial taxes have increased significantly since 1968. However, consumers do not directly observe all of the taxes associated with tobacco products. Rather, they base their consumption decisions on the final price. Consequently, it is important to understand the relationship between tax and price changes. Figure 2.1 provides the composition of the average retail price of a carton of cigarettes in the month of December for each year from 1968 to 1991 in terms of federal taxes,

---

8. Initially, the levies were to be adjusted quarterly. However, industry concerns prompted a change to an annual system of indexation.

9. The increase on September 1, 1984, was based on the total consumer price index as recommended by the Task Force on Alcohol and Tobacco Tax Indexation.

10. The intitiative also included legislation to ban tobacco advertising and prohibit smoking in federally controlled workplaces. Moreover, publicity campaigns were launched which raised the public's awareness of the health hazards of smoking and tried to dissuade teenagers from smoking.

provincial taxes and private costs[11]. Specifically, the figure shows that, in nominal terms, the retail price has increased from approximately $4.50 in 1968 to just over $47.00 in 1991.

While Figure 2.1 provides a picture of how each of the retail price components has changed through time, it fails to illustrate the relative importance of these changes. Consequently, Figure 2.2 shows the contribution of each component to the ultimate percentage change in the retail price. With the exception of 1974, retail price changes in the 1970's were primarily caused by increasing private costs and provincial taxes. Since that time, changes in the retail price have largely been caused by federal and provincial tax increases.

An alternative way of considering the components of the final price is to calculate the share of the retail price which goes to either level of government in the form of taxes and the share received by the manufacturer, wholesaler and retailer. To that end, Figure 2.3 provides the composition of the retail price of cigarettes expressed as percentage shares. It is interesting to note that increases in provincial taxes and private costs during the 1970's led to a decline in the federal share from a high of 50.1% in 1968 to a low of 28.7% in 1984. Over the same period of time, the provincial share increased from 12.4% to 33.8% while the share of private costs remained fairly steady. The federal government significantly increased its taxes in 1985, 1989 and 1991 and this raised the federal share to 39.9%. In contrast, the private share declined to 25.6% while the provincial share increased marginally to 34.5%.

2.4 Domestic Consumption and Exports of Tobacco Products

Clearly, tax changes play a major role in changes to the retail price of cigarettes and other tobacco products[12]. For this reason, determining the impact of tax increases on total government revenues requires a good understanding of the relationship between the retail price and consumer demand. The purpose of this section is to look at what has happened to domestic consumption over time and to compare changes in quantities to the real price of tobacco and the real level of taxes. In addition, the emerging problem of tobacco smuggling is examined through a consideration of changes in Canadian tobacco exports.

---

11. Private costs comprise the manufacturer's price and associated distribution margins (i.e. retail and wholesale) and can be calculated by deducting all applicable taxes from the final retail price.

12. While Figures 2.1, 2.2 and 2.3 describe what has been happening to the price of cigarettes, a similar story can be developed for other tobacco products. Table A1.2 in Appendix 1 illustrates this point as it shows what has happened to the price structure of fine-cut tobacco through time.

Domestic Consumption

Cigarettes represent more than 90 per cent of total tobacco expenditures in Canada. As is shown in Figure 2.4, domestic shipments[13] of cigarettes grew by 2.8 per cent per annum, on average, between 1968 and 1981 and have declined fairly steadily at an average rate of 5.2 per cent per annum since then. The decline in domestic shipments during the 1980's coincided with important tax and price increases (see Table A1.3 in Appendix 1). Consequently, there appears to be a strong correlation between price and consumption.

Fine-cut tobacco comprises a large majority of the non-cigarette tobacco consumption in Canada. Figure 2.5 shows that domestic fine-cut tobacco consumption declined slightly between 1968 and 1981 (2.9 per cent per annum, on average), increased significantly between 1981 and 1988 (7.7 per cent per annum) and declined thereafter. The recent decline coincides with significant federal and provincial tax increases on fine-cut tobacco. Furthermore, with the exception of the last few years, there appears to be no correlation between price and domestic consumption. Instead, domestic consumption seems to be responsive to changes in the real price differential between cigarettes and fine-cut tobacco. The higher this differential, the more likely are consumers to switch to fine-cut.

The total domestic consumption of cigarettes should be closely related to the number of people who smoke. Just as the level of domestic shipments of cigarettes has declined, so also has the number of smokers. Figure 2.6 illustrates that the percentage of the population who smoke[14] decreased from approximately 50% in 1965 to 32% in 1989. This reduction is presumably due to factors such as price increases, smoking bans and anti-smoking publicity. The decrease is even more marked among younger people (Figures 2.7 and 2.8). For example, the proportion of teenaged females (i.e. between the ages of 15 and 19) who smoke declined from a high of 48% in 1974 to 24% in 1991. In contrast, the proportion of adult women who smoke dropped from 38% in 1974 to 31% in 1991.

---

13. There are no available data on the quantity of tobacco consumed. Therefore, domestic shipments are used as a proxy for domestic consumption. For a more detailed discussion see chapter IV.

14. Since smoking is not prevalent among people 14 years or younger, the total population to which the number of smokers is compared is limited to those aged 15 and over.

Exports of Tobacco Products

As Figure 2.9 demonstrates, the quantity of cigarettes exported from Canada[15] increased by over 540% from 1985 to 1991. A similar story is shown in Figure 2.10 which presents the level of exports of fine-cut tobacco. However, the increase in the level of exported fine-cut tobacco products between 1985 and 1991 is even greater than that recorded for cigarettes and is steepest in 1990 and 1991. This enormous increase in the level of exported tobacco products has coincided with the major tax increases recorded in the latter part of the 1980's and in 1991. In addition, Figure 2.11[16] shows that there has been a large increase in the seizures of illicitly imported tobacco products over the same period. These trends suggest that smuggled tobacco products have become a viable substitute for consumers and so any empirical analysis of tobacco demand must address the smuggling issue.

2.5 Federal Excise Revenues

Tax revenues are determined by the tax rate and the total tax-paid quantity consumed. Federal revenues from the excise duty and the excise tax on cigarettes and other tobacco products for fiscal years 1968-69 to 1991-92 are shown in Table 2.4. During the 1970's, nominal revenues from the excise levies increased steadily reflecting a 10% tax increase in 1974 and the growth in domestic cigarette consumption. Nevertheless, the nominal increase in collections was more than offset by inflation so that revenues actually declined by more than 3 per cent per annum in real terms over this period. Since 1980, however, federal excise revenues have increased rapidly, both in nominal and real terms, and this was particulary true in the latter part of the 1980's.. In fact, the revenues in fiscal year 1991-92 are more than 4 times greater, in nominal terms, than in fiscal year 1979-80.

2.6 Summary

The background information presented in this chapter has provided some useful insights. Tobacco products bear several taxes, both federal and provincial, including three product-specific levies, the GST, and, in most cases, a provincial sales tax. Over time, there have been significant increases in the level of tax on tobacco. For example, since 1980, the federal excise levies have increased by over 550% while provincial levies

---

15. Subsequent to the creation of the data set reported in this paper, Statistics Canada has revised its reporting of cigarette exports to include so called "contract" sales. These sales represent the exportation of cigarettes where the Canadian manufacturer is acting as an agent for a foreign firm. These contract sales have been excluded from the analysis in this paper.

16. The actual data are shown in Table A1.5 in Appendix 1.

have risen by more than 500%. Consequently, taxes now represent about 75% of the final price paid by consumers.

In the absence of backward shifting (i.e. of a tax increase resulting in a decline in producer prices)[17], the influence of a given percentage change in taxes on the retail price and, in turn, the quantity consumed increases with the share of taxes in the final retail price. Moreover, historical trends in domestic cigarette consumption show an important correlation between price and demand. Clearly, it is necessary to quantify how price changes affect the quantity demanded in order to provide reliable forecasts of government revenues.

Furthermore, a review of the historical levels of domestic fine-cut tobacco consumption and exported tobacco products reveals that the price of substitutes could be an important determinant of demand. Specifically, domestic fine-cut consumption appears to be strongly influenced by the relative price between fine-cut tobacco and cigarettes. Moreover, the dramatic increase in tobacco exports and the corresponding rise in seizures indicate that illicit tobacco products have become a viable substitute for their legal counterparts.

---

17. Theoretically, there is a point at which the share of taxes in the final retail price is so large that it makes it difficult for a tax change to be completely shifted backward onto the factors of production.

Table 2.1

Historical Federal Tax Rates On Selected Tobacco Products

	Excise Duty		Excise Tax		Sales Tax[1]
Effective Date	Cigarettes[2] $/1,000	Fine-cut Tobacco[3] $/kg	Cigarettes $/1,000	Fine-cut Tobacco[3] $/kg	All Products %
April 10, 1959	4.000	0.770	5.000	1.7600	11
January 1, 1967	4.000	0.770	5.000	1.7600	12
December 1, 1967	4.000	0.770	6.000	1.9800	12
November 19, 1974	5.000	1.100	6.000	1.9800	12
April 22, 1980	6.100	1.410	6.000	1.9800	12
April 1, 1981	6.289	1.454	6.186	2.0410	12
September 1, 1981	6.808	1.574	6.696	2.2097	12
September 1, 1982	7.857	1.816	7.728	2.5502	12
September 1, 1983	9.101	2.104	8.952	2.9542	12
September 1, 1984	9.547	2.207	9.390	3.0987	12
October 1, 1984	9.547	2.207	9.390	3.0987	13
May 24, 1985	9.547	2.207	19.390	5.9000	13
January 1, 1986	9.547	2.207	19.390	5.9000	14
February 27, 1986	10.120	2.339	20.544	6.2540	14
April 1, 1986	10.120	2.339	20.544	6.2540	15
February 19, 1987	10.525	2.433	21.376	6.5040	15
January 1, 1988	10.525	2.433	21.376	6.5040	18
April 27, 1989	27.475	15.333	21.376	11.3040	19
October 1, 1989	27.475	18.333	21.376	14.2540	19
January 1, 1991	27.475	18.333	21.776	15.2140	7
February 27, 1991	27.475	18.333	51.776	35.6480	7

Notes:

[1] The Goods and Services Tax (GST) replaced the Federal Sales Tax (FST) on January 1, 1991.

[2] Rates are for standard weight cigarettes -- i.e. weighing less than 1.361 grams.

[3] The excise tax and duty on fine-cut tobacco were levied on a per-pound basis prior to April 1, 1981. The statutory rates have been converted to a per-kilogram basis for comparison purposes.

Table 2.2

Provincial Tobacco Tax and Sales Tax Rates as of December 31, 1992
(per 200 cigarettes)

	Tobacco Tax ($)	Sales Tax (%)
Newfoundland	20.56	12
Prince Edward Island	18.00	n.a.
Nova Scotia	13.60	10
New Brunswick	13.60	11
Québec	13.76	8
Ontario	13.00	8
Manitoba	16.00	7
Saskatchewan	16.00	8
Alberta	14.00	n.a.
British Columbia	21.00	n.a.

n.a.: Stands for not applicable.

Table 2.3

Percentage Changes in Cigarette Excise Levies and the Total CPI Since 1968
(December over December)

Year	Federal Levies		Provincial Levies		Total CPI	
	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
1969	0.0	0.0	29.6	29.6	4.8	4.6
1970	0.0	0.0	0.0	29.6	1.3	6.2
1971	0.0	0.0	20.0	55.6	5.2	11.6
1972	0.0	0.0	1.2	57.4	4.9	17.1
1973	0.0	0.0	0.0	57.4	9.4	28.1
1974	10.0	10.0	0.0	57.4	12.3	43.8
1975	0.0	10.0	0.0	57.4	9.5	57.5
1976	0.0	10.0	57.6	148.1	5.9	66.8
1977	0.0	10.0	14.9	185.2	9.4	82.5
1978	0.0	10.0	26.6	261.1	8.4	97.9
1979	0.0	10.0	6.7	285.2	9.7	117.1
1980	10.0	21.0	6.3	309.3	11.2	141.4
1981	11.6	35.0	29.4	429.6	12.2	170.9
1982	15.4	55.9	25.9	566.7	9.2	195.9
1983	15.8	80.5	27.2	748.1	4.5	209.2
1984	4.9	89.4	8.3	818.5	3.8	220.9
1985	52.8	189.4	17.5	979.6	4.4	234.9
1986	6.0	206.6	15.8	1,150.0	4.2	249.6
1987	4.0	219.0	13.8	1,322.2	4.1	263.4
1988	0.0	219.0	12.6	1,501.9	4.0	277.7
1989	53.1	388.5	7.6	1,624.1	5.2	297.3
1990	0.0	388.5	19.3	1,957.4	5.0	317.1
1991	62.2	692.5	23.0	2,429.6	3.8	332.9

Table 2.4

Federal Government Revenues on Tobacco Products, 1968-69 to 1991-92

(Millions of dollars)

Fiscal Year	EXCISE DUTIES				EXCISE TAXES				TOTAL EXCISE TAXES AND DUTIES			
	Cigarettes	Fine-cut	Cigars	Total	Cigarettes	Fine-cut	Cigars	Total	Cigarettes	Fine-cut	Cigars	Total
1968-69	188.7	7.0	1.0	196.7	281.9	17.6	4.6	304.1	470.6	24.6	5.6	500.8
1969-70	186.0	6.8	1.1	193.9	272.9	18.1	4.8	295.8	458.9	24.9	5.9	489.7
1970-71	204.2	6.7	1.3	212.2	296.0	18.4	5.0	319.4	500.2	25.1	6.3	531.6
1971-72	213.2	7.0	1.2	221.4	306.2	18.9	4.9	330.0	519.4	25.9	6.1	551.4
1972-73	217.8	6.8	1.2	225.8	319.3	18.6	5.2	343.1	537.1	25.4	6.4	568.9
1973-74	226.4	6.8	1.2	234.4	345.6	24.5	5.7	375.8	572.0	31.3	6.9	610.2
1974-75	248.8	6.5	1.1	256.4	340.8	19.9	6.7	367.4	589.6	26.4	7.8	623.8
1975-76	292.3	8.6	0.9	301.8	347.0	17.0	5.5	369.5	639.3	25.6	6.4	671.3
1976-77	306.3	8.2	1.1	315.6	381.8	16.5	6.8	405.1	688.1	24.7	7.9	720.7
1977-78	320.5	7.9	0.9	329.3	341.2	32.0	5.5	378.7	661.7	39.9	6.4	708.0
1978-79	306.1	7.1	0.9	314.1	374.4	13.2	9.0	396.6	680.5	20.3	9.9	710.7
1979-80	324.0	6.3	0.9	331.2	374.1	13.0	6.5	393.6	698.1	19.3	7.4	724.8
1980-81	394.1	7.7	0.9	402.7	406.8	13.0	6.9	426.7	800.9	20.7	7.8	829.4
1981-82	454.0	7.9	1.0	462.9	385.1	12.3	6.2	403.6	839.1	20.2	7.2	866.5
1982-83	501.6	11.3	1.1	514.0	495.6	18.3	7.6	521.5	997.2	29.6	8.7	1,035.5
1983-84	524.3	14.5	1.1	539.9	508.1	21.3	7.1	536.5	1,032.4	35.8	8.2	1,076.4
1984-85	560.7	14.0	1.4	576.1	566.5	23.1	6.7	596.3	1,127.2	37.1	8.1	1,172.4
1985-86	580.0	15.2	1.9	597.1	1,010.7	43.5	9.6	1,063.8	1,590.7	58.7	11.5	1,660.9
1986-87	532.1	18.9	1.6	552.6	1,048.8	49.1	9.5	1,107.4	1,580.9	68.0	11.1	1,660.0
1987-88	537.1	18.9	1.6	557.6	1,190.7	60.2	10.2	1,261.1	1,727.8	79.1	11.8	1,818.7
1988-89	547.7	18.5	1.4	567.6	1,100.6	51.0	8.2	1,159.8	1,648.3	69.5	9.6	1,727.4
1989-90	1,171.1	121.7	1.8	1,294.6	735.9	56.8	8.5	801.2	1,907.0	178.5	10.3	2,095.8
1990-91	1,246.3	106.3	1.7	1,354.3	991.0	62.1	10.2	1,063.3	2,237.3	168.4	11.9	2,417.6
1991-92	1,014.0	112.5	5.2	1,131.7	1,967.9	192.0	20.4	2,180.3	2,981.9	304.5	25.6	3,312.0

Source: Public Accounts of Canada -- Vol. II - Part I, Details of Expenditures and Revenues.

Figure 2.1

Composition of the Retail Price of Cigarettes (Carton of 200)

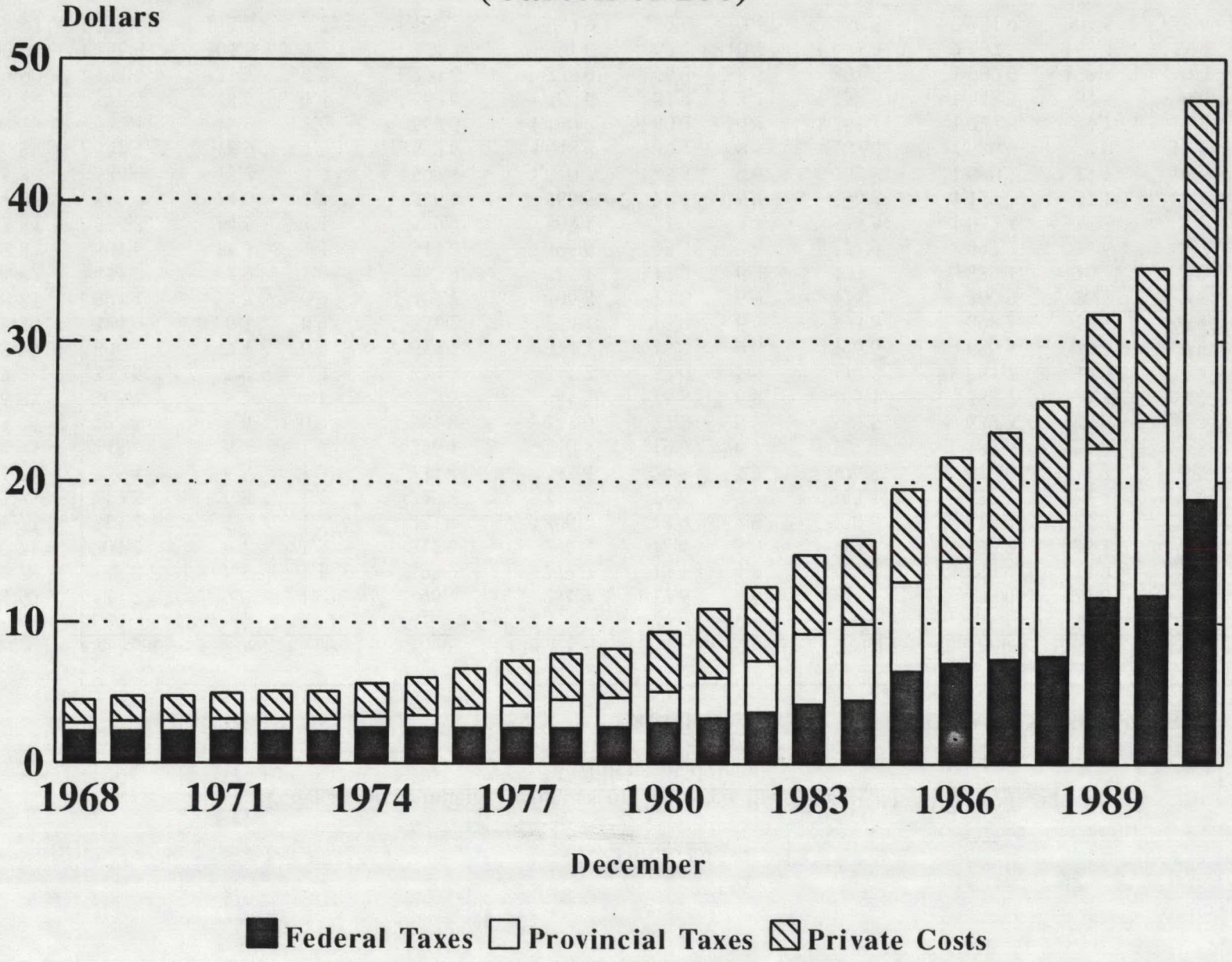


Figure 2.2

Contributions to the Percentage Change in the Retail Price of Cigarettes

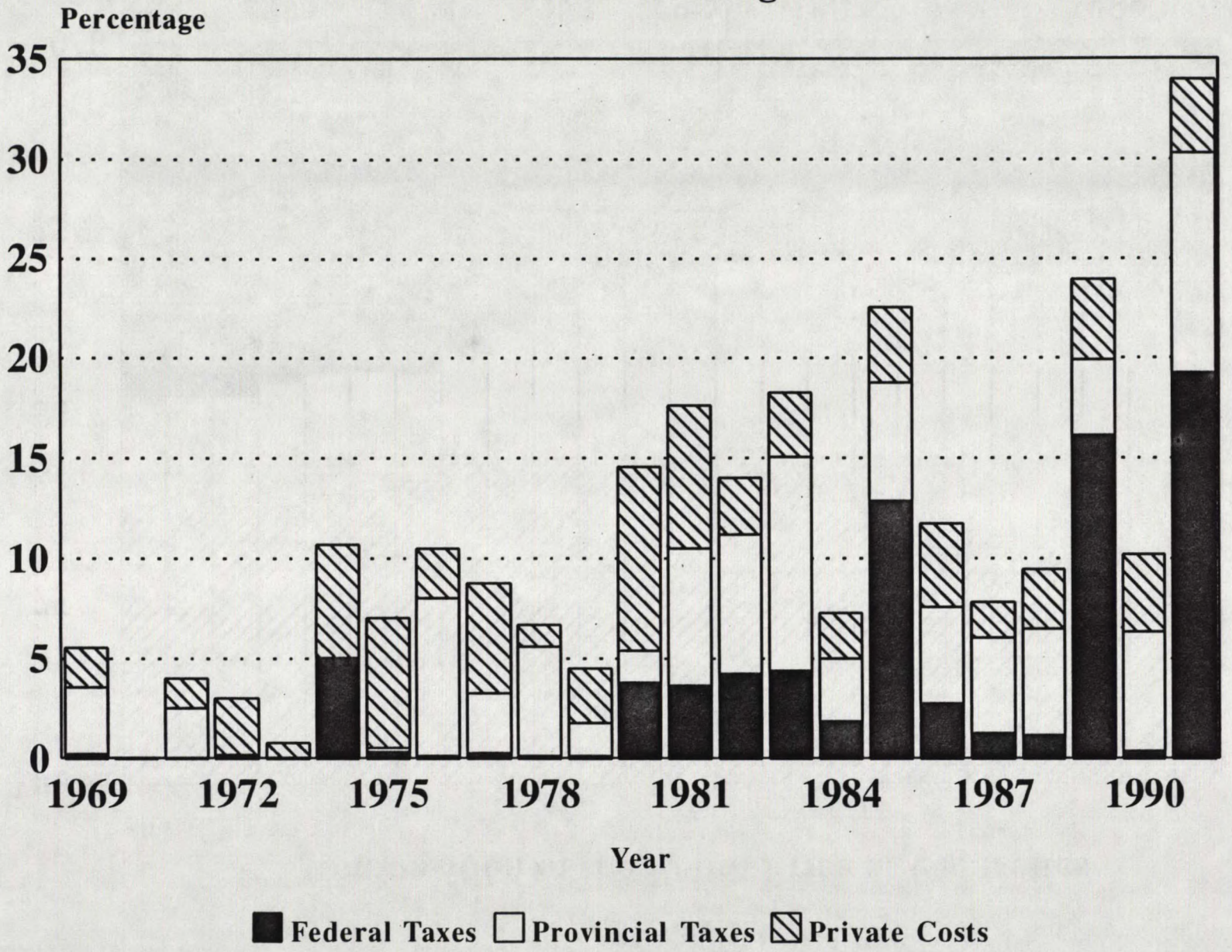


Figure 2.3

Composition of the Retail Price of Cigarettes

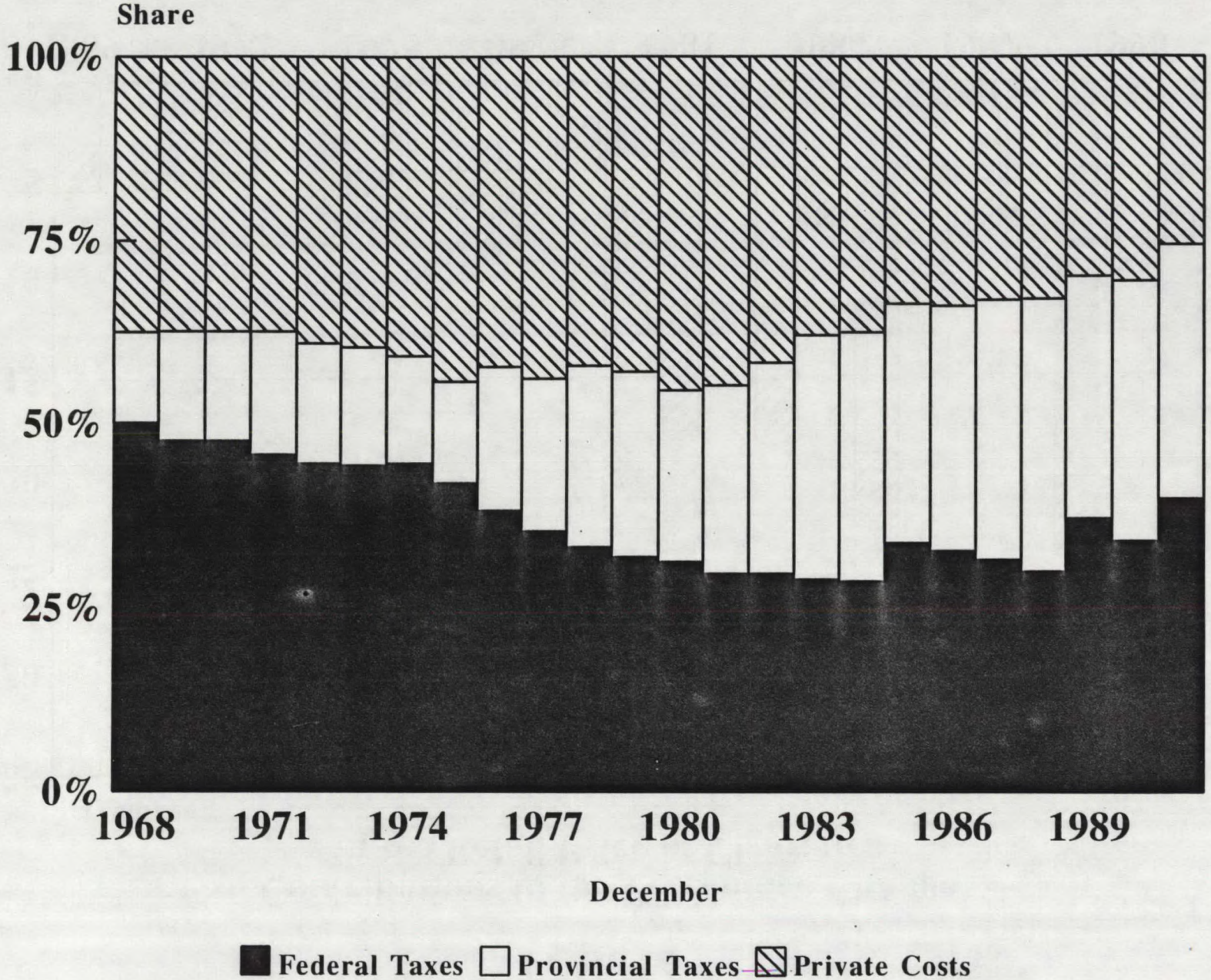


Figure 2.4

Domestic Shipments of Cigarettes, Real Price and Real Taxes, 1968 to 1991 (1986 Dollars)

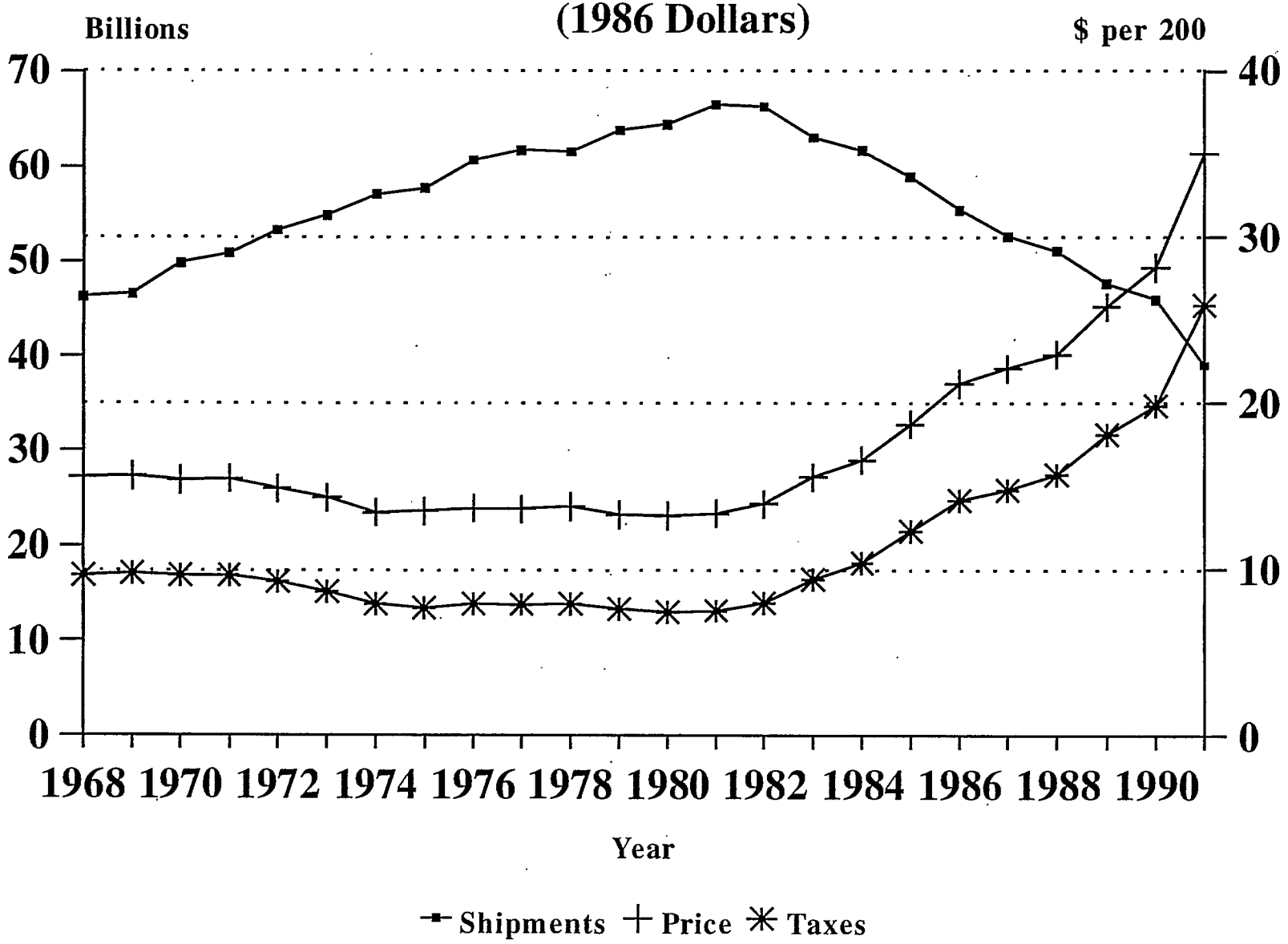
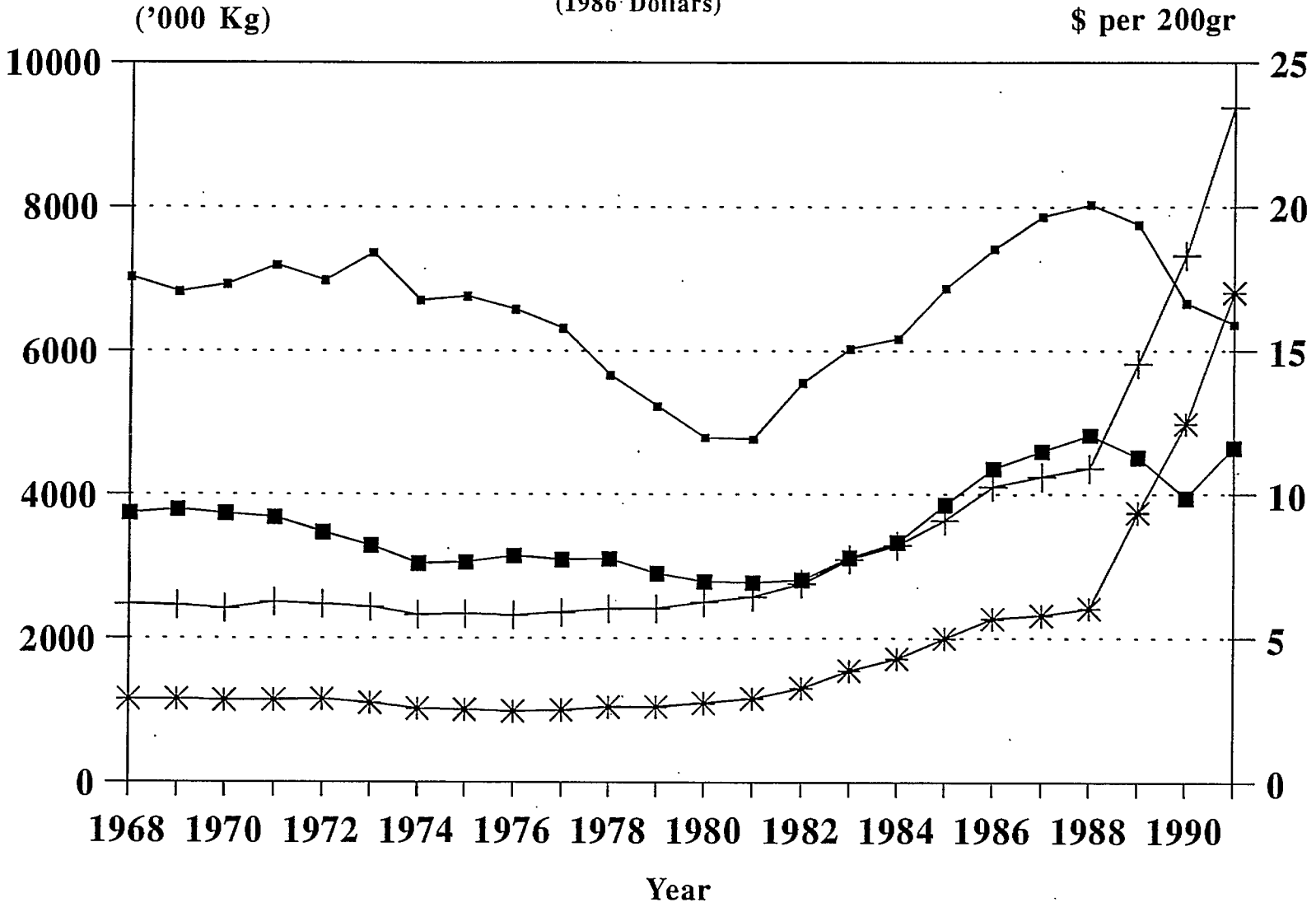


Figure 2.5

Domestic Shipments of Fine-Cut Tobacco, Real Price, Taxes and Savings*, 1968 to 1991

(1986 Dollars)



* Price differential relative to cig.

Figure 2.6

Smokers as a Share of the Total Canadian Population Aged 15 and Over

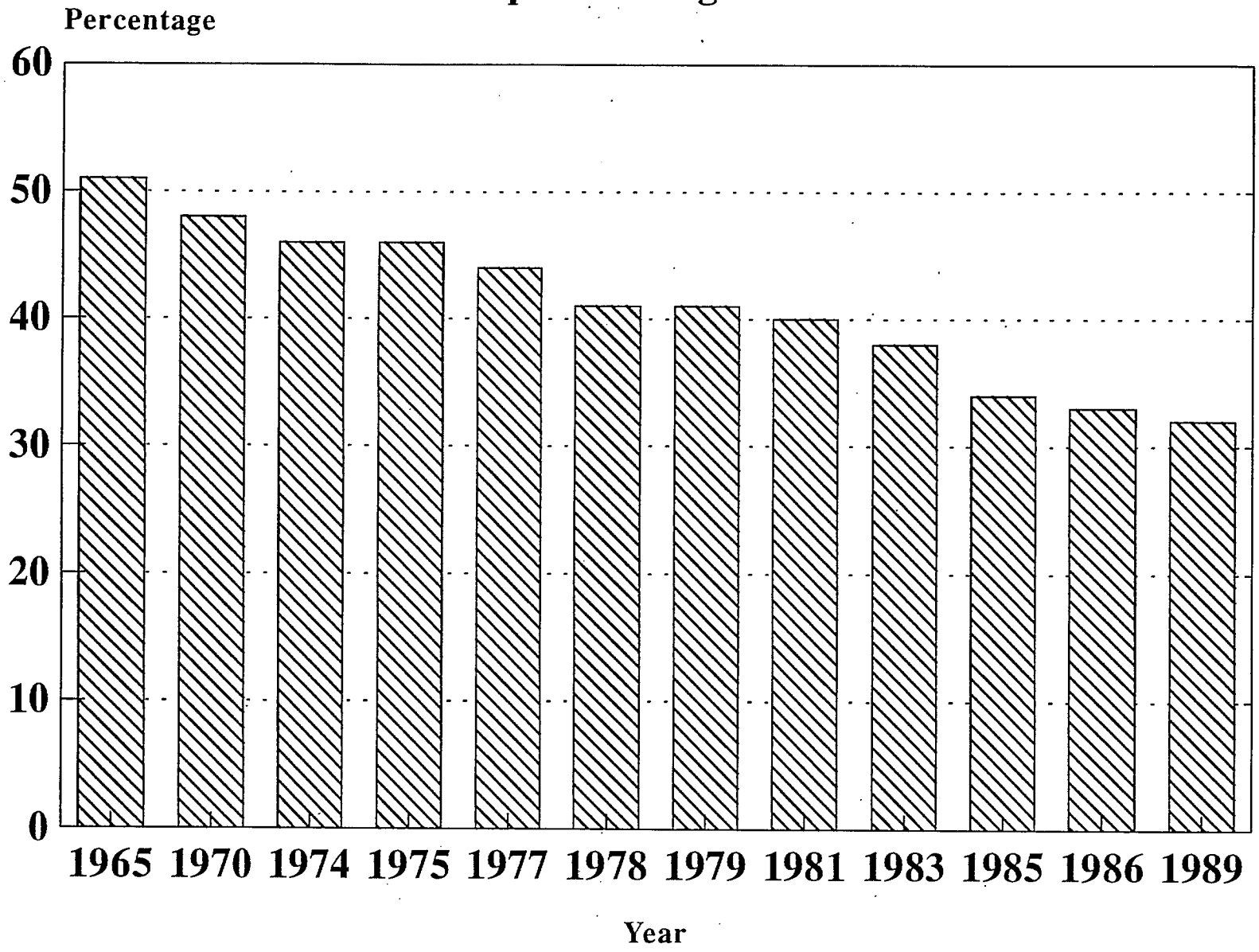


Figure 2.7

The Proportion of Male Teenagers and Adults Who Smoke

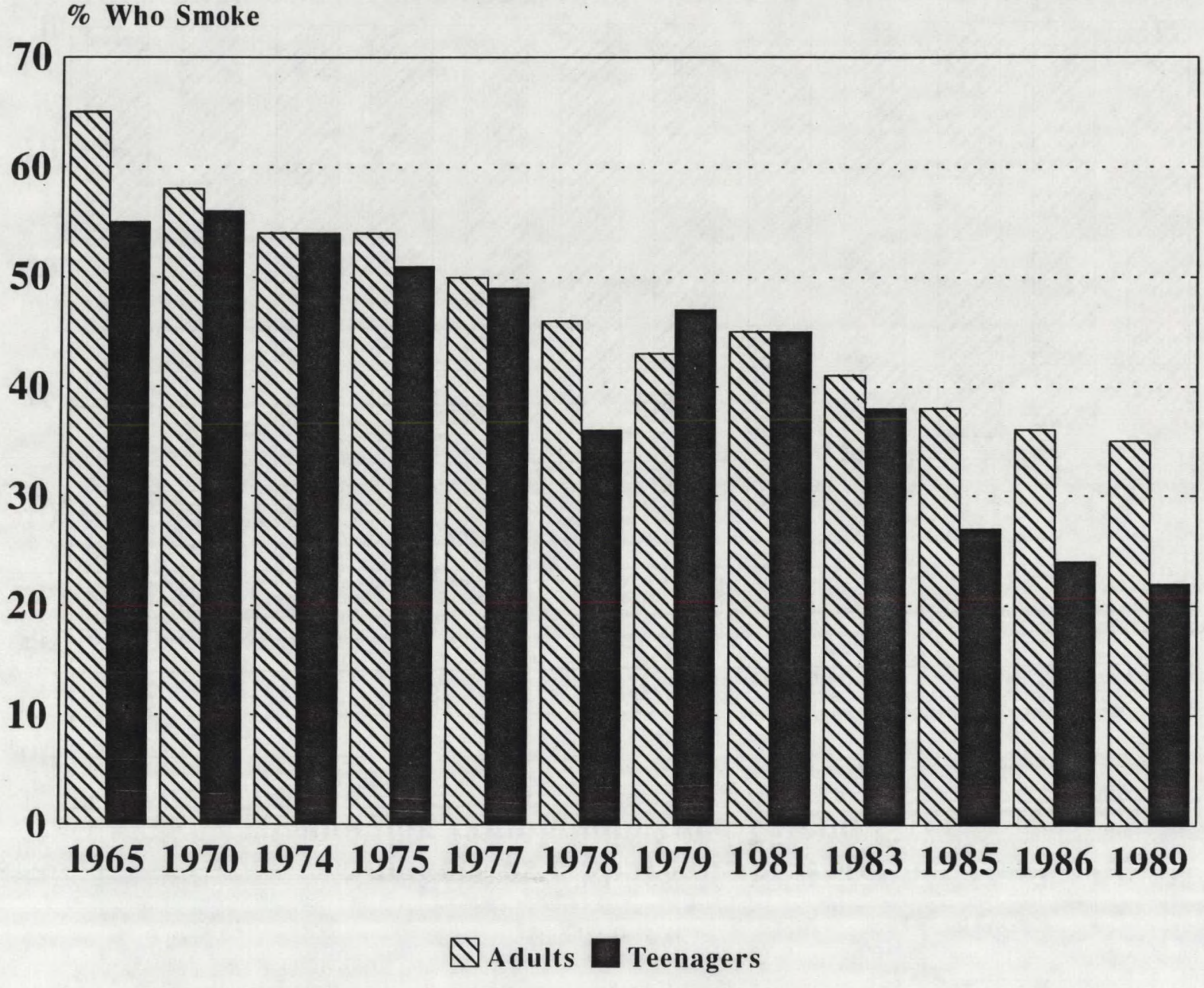


Figure 2.8

The Proportion of Female Teenagers and Adults Who Smoke

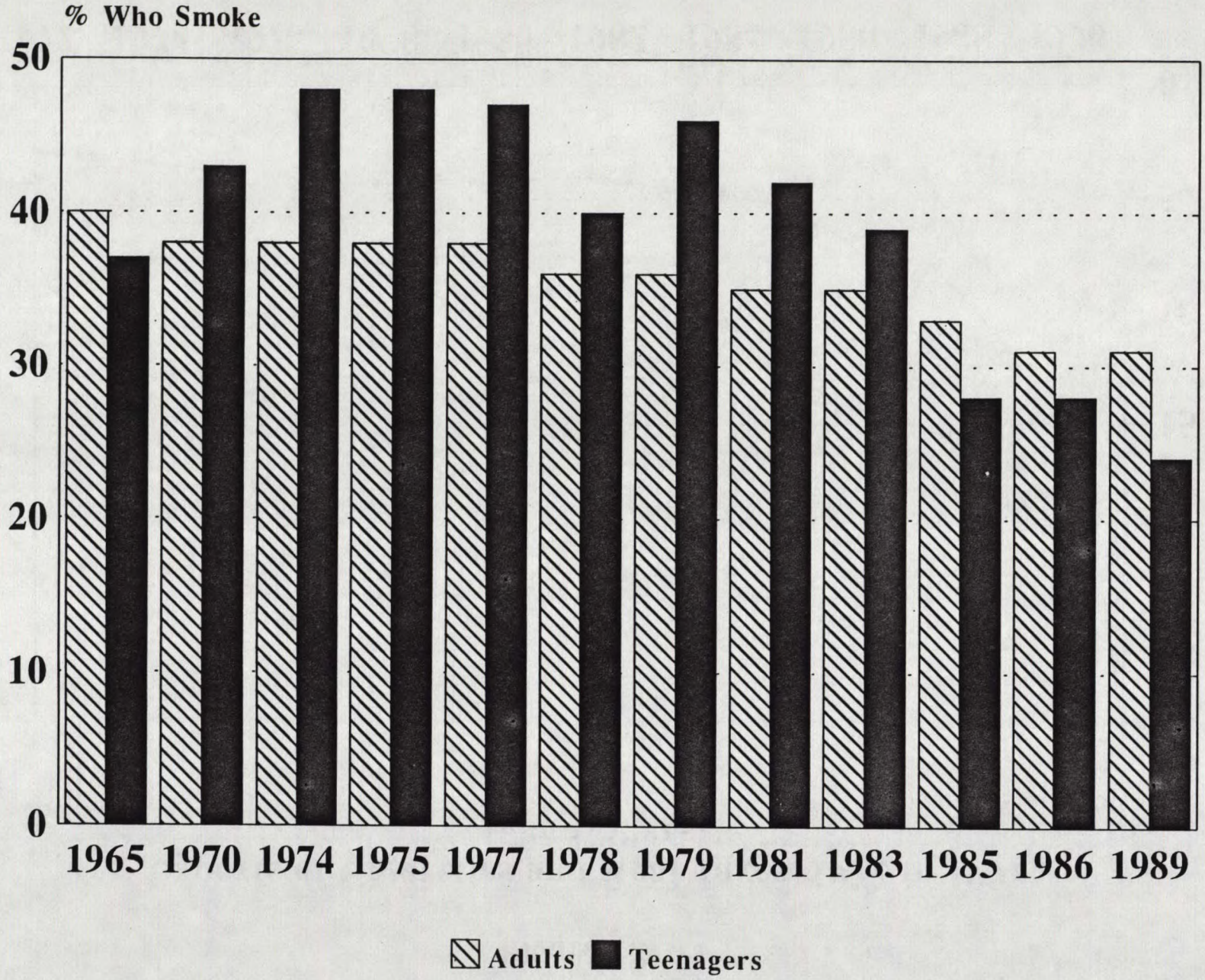


Figure 2.9

Exports of Cigarettes and Real Taxes, 1972 to 1991 (1986 Dollars)

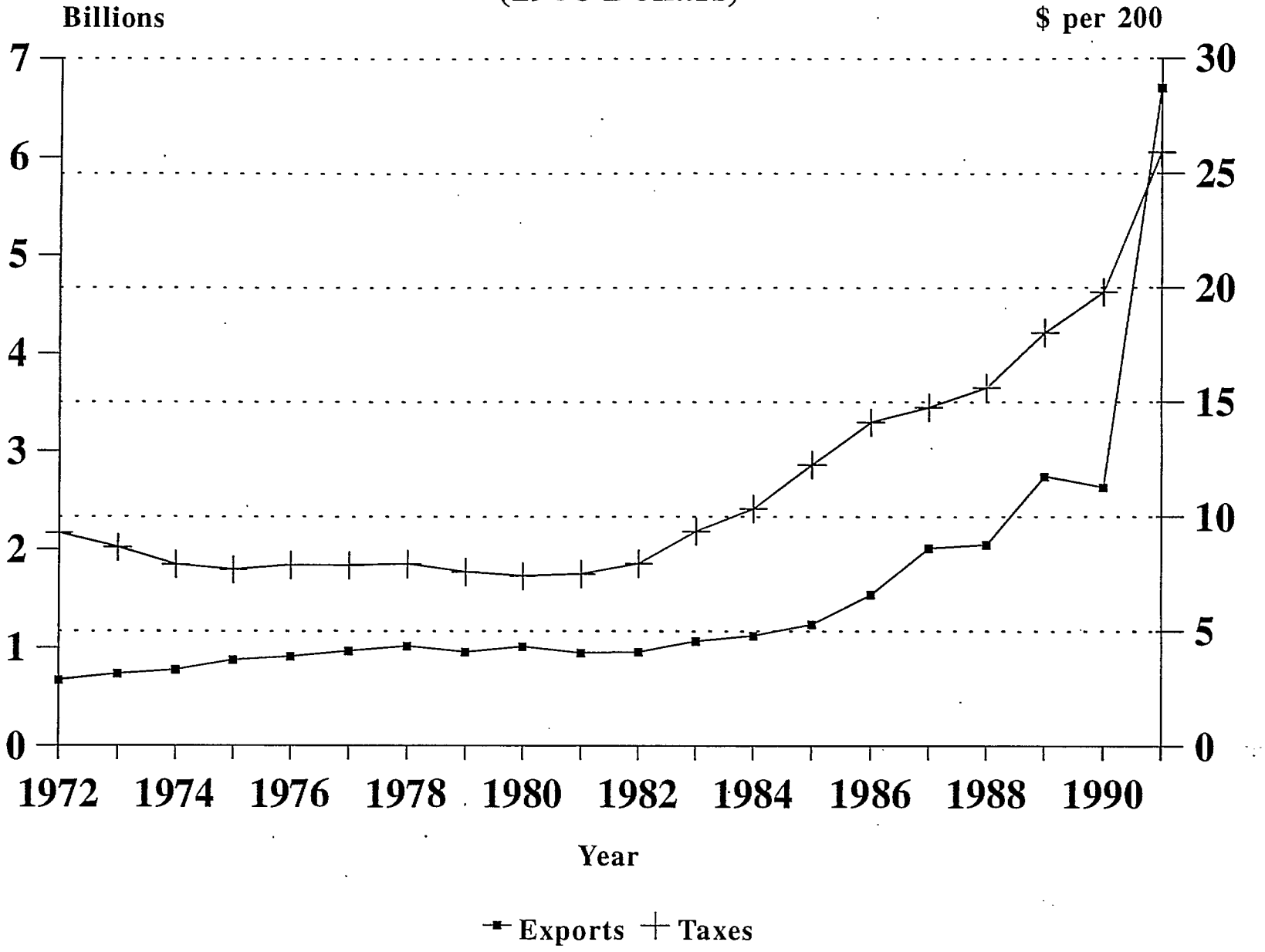


Figure 2.10

Exports of Fine-Cut Tobacco and Real Taxes, 1972 to 1991 (1986 Dollars)

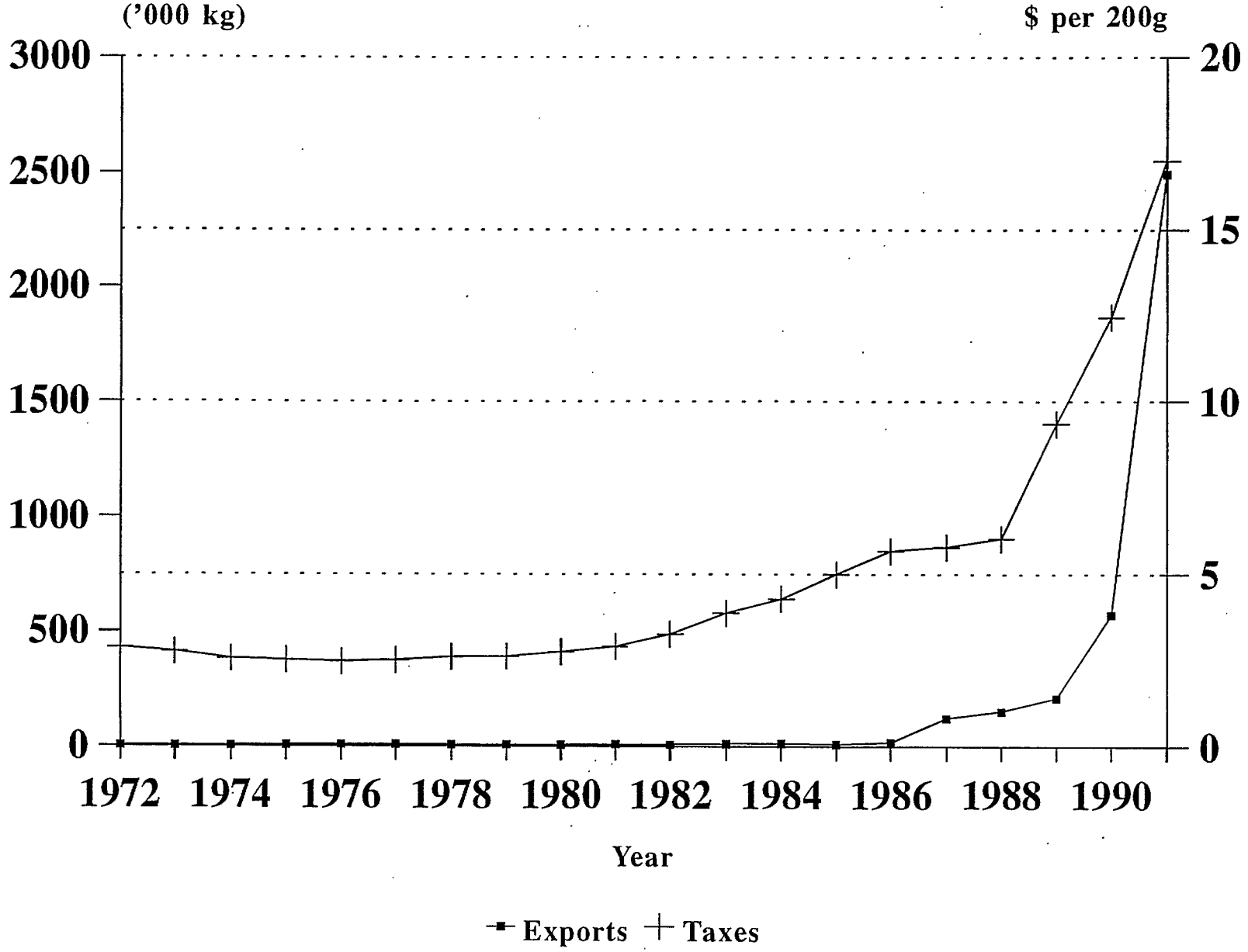
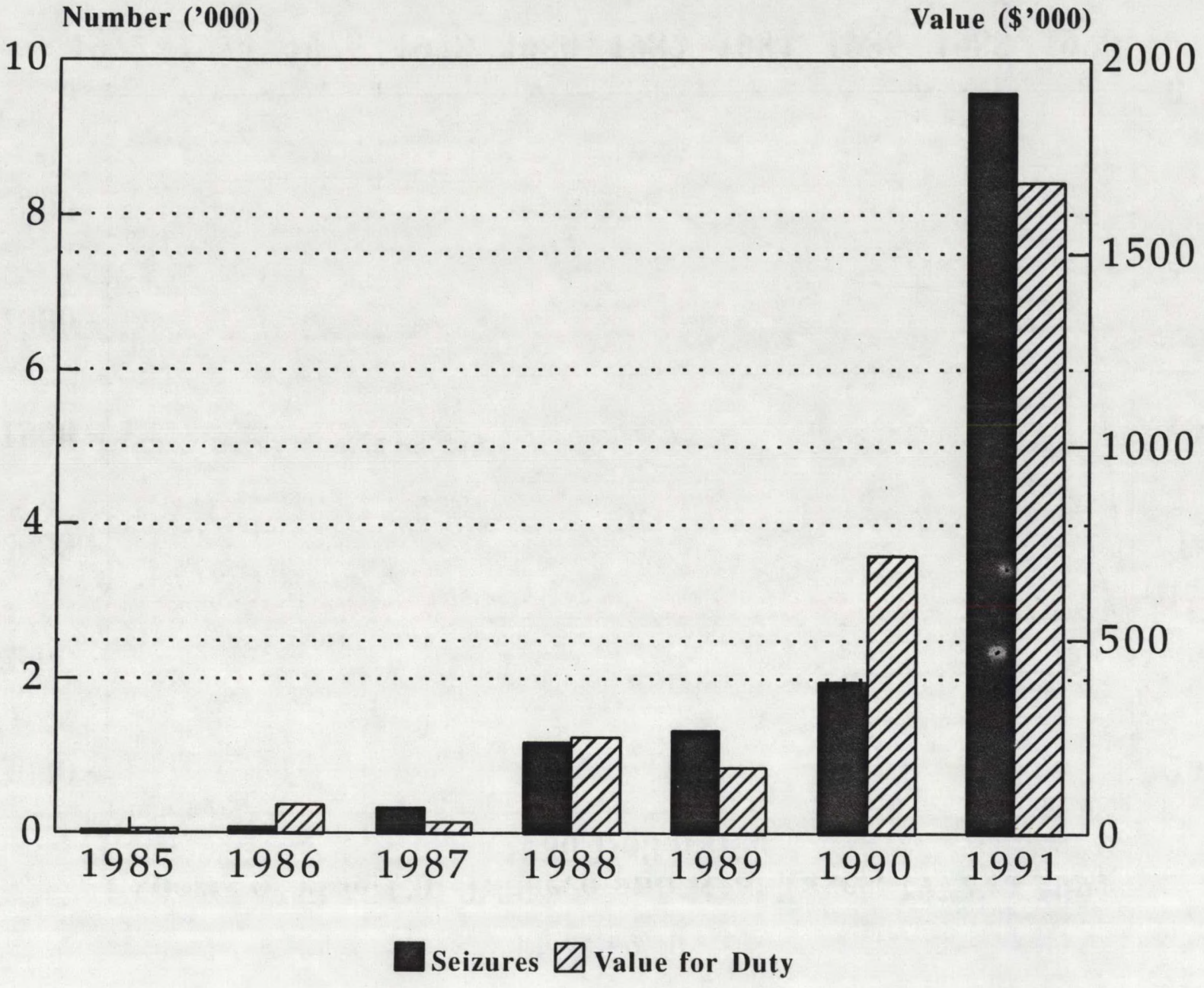


Figure 2.11

Tobacco Product Seizures Made By Canada Customs



III LITERATURE SURVEY

3.1 Introduction

The background data presented in Chapter II suggest that tax increases have played a major role in recent retail price changes and, thus, on changes in consumption. However, it is desirable to have a more precise estimate of the relationship between a change in price and a change in consumption -- that is, the price elasticity of demand. Specifically, the elasticity measures the percentage change in consumption given a one per cent change in price. For example, a price elasticity of demand for cigarettes of -0.4 would imply that a 10% increase in the real price[18] would lead to a 4% decline in consumption. Many studies have attempted to determine the price elasticity for tobacco and for cigarettes in particular. Such studies provide useful insights into the type of analysis and data necessary to estimate the current price elasticity of demand in Canada.

Previous studies have used several types of data to estimate the demand for tobacco. The most common is time-series where the demand for tobacco is estimated over a given time frame based on observed changes in aggregate quantity, price and income. Second, there is pooled time-series data where time-series data are obtained for different geographic areas, such as by province or state, in an effort to expand the number of observations. A third type is cross-sectional micro data where the demand is estimated based on individual expenditure data for a given year. That is, tobacco expenditures are compared across varying demographic characteristics and income levels with the location of the household determining the observed price[19].

There are several model types[20] used to estimate the demand for tobacco. The simplest form is a "static" model where quantity changes are explained by contemporaneous changes in price and income. However, this type of specification does not take into account the habit-forming nature of tobacco consumption. Therefore, several models of demand incorporating features which attempt to capture tobacco addiction have been applied to explain tobacco consumption. The two most common are the partial adjustment model and the Houthakker-Taylor model (state adjustment model). Both are dynamic in nature in that they include past consumption as a means of capturing the addictive nature of tobacco consumption. The only difference between the two is the

---

18. Price elasticities are generally defined with respect to real rather than nominal prices. That is, if the nominal price increased by 10% and the rate of inflation was 10%, then the real price of the product remains unchanged. It is generally assumed that this would not affect the demand for the product.

19. In other words, the price variation is derived from the fact that the price of tobacco products differs from province to province or state to state.

20. See chapter IV for a more rigorous presentation of these models.

approach taken to explaining how demand changes over time[21]. An alternative specification is the "rational addiction" model that allows future health consequences, as well as one's past consumption history, to influence current consumption.

The empirical results (in particular, price and income elasticities) vary markedly from one model type to another. The results differ further depending upon the estimation technique or data set used. In this chapter, the results of selected studies are reported to provide a foundation for the analysis to follow. Section 2 considers the empirical results associated with the static model. Section 3 reports findings based on the partial adjustment model. Section 4 deals with the state adjustment model while section 5 considers the rational addiction model. Attention is focused on studies carried out in Canada and the United States[22].

3.2 Static Models

In one of the earliest empirical analyses of cigarette demand using Canadian data, Thompson and McLeod (1976) regress per capita consumption[23] on the real retail price of cigarettes and real per capita disposable income. The demand equation, which is a linear-logarithmic specification, is estimated using ordinary least squares based on annual data from 1950 to 1973. As the initial results indicated a large degree of correlation in the errors, the equation was re-estimated, with a correction for first-order autocorrelation, and then for second-order autocorrelation. In each case, the fit of the demand equation was good, as measured by the R^2 statistic. The results indicate that the price elasticity ranges from -0.65 to -0.82 while the income elasticity lies between 0.15 and 0.43.

Quan (1984) carried out a preliminary assessment of the demand for cigarettes for the Department of Health and Welfare. He used pooled provincial data for the period 1971 to 1981. The model postulated that per-capita demand is explained by the real price of cigarettes, real disposable income and a time trend. The price elasticity was estimated at approximately -0.7 and so is consistent with that of Thompson and McLeod.

---

21. The partial adjustment model assumes that there is a "desired" level of consumption that is a weighted average of current and past consumption. In contrast, the state adjustment model posits that at any given time the habitual nature of smoking can be captured by a "stock" or quantity that needs to be consumed to maintain the habit. This "habit stock" changes through time based on current consumption and the depreciated value of the previous period's habit stock.

22. The vast majority of empirical studies have focused on cigarette demand since it accounts for well over 90 per cent of industry revenues and over 80% of "cigarette" equivalent sales (based on one gram of tobacco being equal to one cigarette).

23. The consumption series is derived from monthly manufacturers' shipments data. Monthly figures are aggregated to construct an annual series, taking into account the assumed one month lag between shipment dates and the dates when the goods appear on retail shelves.

In an interesting American study, Lewit, Coate and Grossman (1981) apply panel data[24] comprised of 6,738 teenagers aged 12 to 17 in the U.S. from 1966 to 1970. This study attempts to demonstrate that cigarette demand by youths is more sensitive than it is for the adult population, due to the habit-forming nature of smoking. The implication is that changes in teenage smoking induced by government policy can have a significant and lasting impact on aggregate consumption in the long run.

The authors measure smoking both in terms of participation (whether the youth is a current smoker[25]), and quantity consumed (number of packages of cigarettes smoked daily). Given the large sample size, these variables could be regressed on an extensive list of explanatory variables. The estimation technique was ordinary least squares. Those variables reported to affect demand significantly were the real cigarette price index and the number of anti-smoking messages aired[26]. The quantity-smoked regression and the smoking-participation regression both yielded an estimated price elasticity of just over -1.4 indicating that teenage demand is highly sensitive to price.

The empirical results of studies based on aggregate data generally find a much weaker sensitivity to price shocks since the total smoking population consists largely of adult smokers (18 and over). However, the finding by Lewit, Coate and Grossman should not be viewed as inconsistent with these other studies. Rather, it could be the case that price increases lead to a decline in youth participation and prompt some adult smokers to quit. The remaining smokers continue their habit largely unaffected by the change. As a result, the measured aggregate elasticity of demand is quite inelastic.

3.3 Partial Adjustment Models

The only Canadian studies which utilise the partial adjustment model are two recent Informetrica studies[27] of tobacco demand in Canada. In the first study, the partial adjustment approach is applied using a double logarithmic specification and two different

---

24. Panel data is similar to cross-sectional data except that there are observations for more than one year. Consequently, the empirical results would reflect price variation over time.

25. Smoking participation is captured by a dichotomous variable that assumes the value of one if the youth currently smokes, and zero otherwise.

26. Family and youth characteristics were included in the regressions, but the effects of these were not reported. Family characteristics captured were real family income, parents' schooling, absence of father from the household, whether the mother works. Youth characteristics included age, race, sex, student status, the number of hours worked per week during the school year, whether the youth works during school vacations, whether an allowance was earned, region of residence, and size of place of residence.

27. The 1990 Tobacco Demand Elasticity Study and the 1992 Some Implications of Tobacco Taxation were prepared by Informetrica for the Canadian Tobacco Manufacturers' Council.

data sources -- National Accounts tobacco consumption data[28] and shipments data provided by the Canadian Tobacco Manufacturers' Council. The estimated short and long-run price elasticities[29] derived from the National Accounts data are -0.39 and -0.57, respectively. When the shipments data are used as a consumption measure, the estimated short-run price elasticity was slightly lower at -0.37. Because the parameter on lagged consumption was significantly larger in this second run, the estimated long-run elasticity was larger, at - 0.71.

The more recent study utilises both a linear and double logarithmic specification. The logarithmic specification yielded results similar to those in the original study. By contrast, the linear specification yields 1991 elasticity estimates[30] of -0.3 in the short-run and -1.6 in the long-run. However, it should be noted that the models used deviate from a pure partial adjustment model in two important ways -- consumption was regressed on a lagged price variable and the dependent variable was lagged four periods rather that just one period[31]. As such, the model makes the restrictive assumption that the current price has no influence on current consumption. Moreover, the lagged price variable implicitly captures part of the addictive nature of consumption as it takes approximately three months for a price change to affect demand.

One of the most notable applications of the partial adjustment model is that by Fujii (1980). Fujii estimates a linear demand equation and a double log specification using aggregate U.S. data from 1929 to 1973. The explanatory variables are a real cigarette wholesale price index[32], real per capita disposable personal income, a cigarette advertising expenditure index, and dummy variables to capture the effects of three events

---

28. The National Accounts contains data related to real personal expenditures on all forms of tobacco products and these expenditures can be used as a proxy for consumption. However, strictly speaking, the data do not represent the quantity consumed.

29. Any model which contains a lagged dependent variable has an infinite number of elasticities due to the dynamics. To simplify the interpretation, the model parameters are used to calculate a short-run elasticity, the contemporaneous impact of a change, and a long-run elasticity which is calculated assuming that the dependent variable is stationary ($Q_t=Q_{t-1}$).

30. A linear specification of a demand curve implies that the price elasticity depends upon the quantity consumed and the price paid and, hence, it changes through time. In contrast, a double logarithmic specification represents a constant elasticity demand curve.

31. That is, the lagged dependant variable was Q_{t-4} rather than Q_{t-1} required by the classical partial adjustment model (see equation 4.17 in Chapter IV).

32. The author appears to misspecify the demand equation by using a wholesale rather than a retail price index. Since the consumer faces retail prices, the latter index should be used.

related to the health effects of smoking[33]. The dependent variable, per capita consumption, is measured using cigarette production data.

Fujii uses the ridge regression estimating technique[34] because of multi-collinearity[35]. While ridge regression yields estimates that are biased, the average error of the estimates is smaller than the average error of the ordinary least squares estimator[36]. The price, income, advertising and lag coefficients all had the correct sign, were statistically significant, and were stable across the two specifications of demand[37] -- the linear and double log specifications. The advertising coefficient, while having a negative sign when estimated using ordinary least squares, had the correct sign when the ridge regression technique was used[38]. The parameters obtained from the estimation of the linear demand equation (evaluated at the sample means) suggest a short-run price elasticity of roughly -0.48, and a short-run income elasticity of 0.22. The corresponding implied long-run elasticities were -0.71 and 0.33. When using the double log specification, the price elasticity of demand was found to be -0.63 in the short run, and -0.92 in the long run. The short and long-run income elasticities were 0.33 and 0.50.

All of the studies considered to this point implicitly assume that demand is as sensitive to price increases as to price decreases. In contrast, Young (1983) assumes an asymmetric response and applies a "ratchet" model to test this. That is, the model contains two price variables -- price declines and price increases. Using the same explanatory variables and linear demand equation as Fujii, with modifications to allow for asymmetric

---

33. These events are: i) the first major health report of the U.S. Department of Health, Education and Welfare, in 1953; ii) the 1964 Surgeon General's report on smoking and health; and, iii) the introduction in 1968 of the Federal Communication Commission's Fairness Doctrine's requirement that anti-smoking messages be broadcast.

34. The classical regression model is depicted as $Y=X\beta+\varepsilon$ where β is estimated based on $\hat{\beta}=(X'X)^{-1}X'Y$. The essential idea behind ridge regression is that the problems resulting from an almost singular $(X'X)$ matrix can be circumvented by multiplying each diagonal element of the $(X'X)$ matrix by $(1+k)$, $0<k<1$. Starting with a low initial value, k is increased and the demand equation is estimated until the estimated parameters stabilize.

35. Multi-collinearity, which has been a problem in many of the American studies, arises when there is significant correlation between the explanatory variables in the estimating equation. If not addressed in the estimating technique, the parameter estimates will be highly sensitive to changes in specification or the sample data.

36. Hoerl and Kennard (1970) show that while ridge regression increases the bias of the parameter estimates, it reduces the variance of them so that an overall reduction in mean-squared-error (MSE) is possible.

37. Box-Cox tests indicated that the linear functional form was more appropriate than the double-log specification. See Zarembka (1974) and Chang (1977) for details on this test.

38. The ordinary least squares estimates were shown to be highly volatile, fluctuating substantially with the addition or deletion of three data points.

price and income responses as described above, and the same estimating technique (ridge regression), Young's results show that the short-run price elasticity of demand for cigarettes is approximately -0.34 for a price increase and -0.49 for a price decrease. Young's estimates indicate that the income elasticity is about 0.27 when income is rising, and 0.14 when it is falling. The reported elasticities are short-run and calculated at the sample mean. Using a modified F-test, Young rejects the restriction implied by Fujii's model[39] and claims support for his hypothesis. Young notes that his results would suggest that taxation policy would seem to be less powerful as a demand deterrent than is suggested by Fujii's elasticity figures.

In another U.S. study, Baltagi and Levin (1986) use pooled data for 46 states in the U.S. over the period 1963 to 1980 to estimate the demand for cigarettes. Their work is significant because of its attempt to incorporate smuggling effects into the demand equation. Due to the substantial variation in cigarette tax rates across states, cigarettes are smuggled from low- to high-tax states. This implies that cigarette consumption figures based on retail sales would tend to overestimate consumption in low-tax states and underestimate consumption in high-tax states. Therefore, price elasticity estimates based on such figures would be biased if the presence of smuggling were ignored. The approach taken is to incorporate a "substitute" price variable, measured as the minimum real price of cigarettes in the neighbouring states. The real price of cigarettes within-state, the real per capita disposable income and advertising expenditures are also included as explanatory variables. Their results indicate a short-run price elasticity of demand of about -0.22, and a long-run elasticity estimate of -3.14[40]. The "neighbouring" price elasticity estimate was 0.08, suggesting a small but statistically significant smuggling effect on demand. Income and advertising were found to be insignificant determinants of demand.

3.4 State Adjustment Model

Relative to the other models, there are few reported analyses of cigarette demand based on the Houthakker-Taylor (state adjustment) model. This is somewhat surprising given the attractive theory underlying it. Perhaps the lack of interest is due to estimation problems encountered in its application that, if not adequately addressed, can call the theory into question. This point can be illustrated by two Canadian studies which have used this approach.

---

39. The restriction on Young's regression equation implied by Fujii's model is that the parameter for a price increase is equal to the negative of the parameter for a price reduction.

40. The large difference between the short and long-run estimates is due to the fact that the estimated coefficient for lagged consumption was 0.93.

The estimated equation in the 1990 Informetrica[41] study regresses per capita cigarette consumption on lagged values of the dependent variable, the real price of cigarettes, and real per capita disposable income. Difference variables[42], measuring the change in value between the current and the previous period, for the real price and per capita disposable income variables enter as explanatory variables as well. Using Canadian domestic sales data to measure consumption in one regression, and National Accounts figures in another, estimation of the demand equation yields results that are not supportive of the underlying theory. In particular, the implied coefficient on the smoking habits stock is negative while theory would suggest a positive value[43].

A second Canadian study by Collishaw, Rogers and Myers (1984) used total per-capita tobacco consumption based on "cigarette" equivalent units[44]. The results indicate that the price elasticity of demand was -0.4 in the short-run and -0.8 in the long-run. The income elasticity of demand ranged from 0.4 in the short-run to -0.9 in the long-run. The major fault of this study was that the estimation did not adequately take into account the restriction in the state adjustment model which requires that there be only one rate of depreciation in the "habit" stock[45].

3.5 Rational Addiction Model

Proponents of rational addiction models of demand maintain that there are important intertemporal linkages in cigarette consumption that ought to be accounted for when estimating demand. Unlike partial adjustment models, where the dynamics are limited to the influence of past consumption on current consumption, models of rational

---

41. See footnote 27.

42. Difference variables refer to variables that are constructed based on changes in levels. For example, a first difference variable would be obtained by subtracting the value of a variable in the past period from the value in the current period (X_t-X_{t-1}).

43. The coefficient on the smoking habits stock measures the "strength" of the addiction. In this context, only a positive value would make any theoretical sense.

44. For example, it is assumed that one gram of fine-cut tobacco is equivalent to one manufactured cigarette.

45. See equations 4.4 and 4.9 in Chapter IV below.

addiction allow for the possibility that individuals consider the future when making their current consumption decisions[46].

The rational addiction model is derived in Becker and Murphy (1988) and is tested in Becker, Grossman and Murphy (1990). Using State cigarette sales data from 1955 to 1985, the results show that a fall in price in the current period increases consumption in that period which then increases consumption in the following period because of the addictive nature of smoking. Both future and past price changes are found to negatively affect current consumption. Their parameter estimates indicate that the elasticity of demand with respect to current price is roughly -0.35 in the short run if the price shock is anticipated and -0.30 if it is unanticipated. The long-run price elasticity is estimated to be about -0.75. Income elasticities are not reported.

Applying the same framework to national U.S. micro data for a sample of 28,000 people of all ages for years 1976 to 1980 and using the instrumental variables estimation method, Chaloupka (1990) obtains long-run price elasticity estimates that fall in the range of -0.27 to -0.48.

3.6 Summary

The studies discussed in this section provide a useful survey of the various types of data and models which can be used to estimate the demand for tobacco products and cigarettes in particular. Moreover, the studies provide an insight on how consumption is affected by price changes. The estimated initial effect of a change in price on consumption, or the short-run price elasticity of demand, ranges from -0.3 to -0.4 in Canadian studies and -0.22 to -0.49 in U.S. studies. The estimated final effect of a price change on consumption, or the long-run price elasticity of demand, falls between -0.57 and -1.5 in Canadian studies and -0.3 and -3.14 in U.S. studies.

---

46. This is theoretically possible if one allows current utility to depend on current consumption and past consumption. This effectively links decisions made in the past, present and future. With this formulation, the decision to consume Q_t in period t will depend upon the consumption in period t-1 (Q_{t-1}). Similarly, the consumption decision in the following period, Q_{t+1}, will depend on Q_t. Thus, there is an effective link between Q_{t-1}, Q_t and Q_{t+1}. One important implication is that, since future prices affect future consumption directly, they indirectly affect current consumption through the interaction of Q through time.

IV THE MODEL FOR DOMESTIC CONSUMPTION

4.1 Introduction

The review of the literature presented in the previous chapter identified several models which can be used to estimate the demand for tobacco products. Moreover, these models contain many different factors which are potential explanatory variables for tobacco consumption. The diverse approaches and results of these studies indicate that the choice of the most appropriate model to explain tobacco consumption in Canada requires careful consideration.

It is clear that one of the most fundamental issues in evaluating tobacco taxation is the price elasticity of demand. A reliable estimate of this variable is essential in estimating the effect of tax changes on the quantity of tobacco consumed and the potential revenue yield of these tax changes. The purpose of this chapter is to develop a model for the domestic consumption of tobacco products. Section 2 provides a description of the factors that affect the demand for tobacco. Section 3 proceeds to develop an empirical model which can be used to estimate that demand. The final section outlines the econometric considerations to be taken into account in undertaking the empirical estimation.

4.2 What Determines Demand

Tobacco is sold in a variety of forms and the total demand for tobacco is an aggregate of the demand for many individual products. These products include cigarettes, fine-cut tobacco, cigars, pipe tobacco, chewing tobacco, snuff and plug. Even a product like cigarettes can be broken down by size and brand name. For example, consumers of cigarettes can buy packages containing either 5, 15, 20 or 25 cigarettes. Furthermore, cigarettes can be bought by the pack or by the carton (containing 200 cigarettes). Moreover, cigarettes come in three common sizes -- regular, king or 100's.

It would be virtually impossible to try to estimate the demand for each brand and size of cigarette. Nevertheless, one should always keep in mind that price-induced demand changes begin at the product-type level. For example, cigarettes are cheaper when purchased by the carton than by the pack. Therefore, price increases might simply cause a smoker to switch to buying cigarettes by the carton without having any impact on overall consumption.

As with all other markets, the market for tobacco products consists of a supply and a demand. Tobacco manufacturers provide a supply of tobacco products based on the going market price. The higher the price, net of taxes, the higher the supply. Smokers demand tobacco products based on various economic factors including the market price. The higher the market price, including taxes, the lower the demand. Assuming that

markets *always clear* (the supply always equals the demand), then statistical data allow us to observe the points of equilibrium between the demand and supply of tobacco over time.

In theory, one should estimate both the supply and demand for tobacco products using simultaneous equations. However, simultaneously estimating supply and demand relationships is not common in empirical demand analysis. Instead, such analysis assumes that the supply curve is perfectly elastic -- that is, producers are willing to supply any level of demand at a given price. Thus, shifts in the supply curve, caused by changes in either taxes or costs, allow points along the demand curve to be identified.

In Canada, there are only three major cigarette manufacturers and, for the most part, the supply of raw leaf tobacco is governed by marketing boards. These supply characteristics might lead one to question whether it would be appropriate to assume a perfectly elastic supply curve in the Canadian context. One method to determine the validity of this assumption is to ascertain how prices respond to a tax change. If it can be shown that $\partial P/\partial T$ (the change in P given a change in T), where P stands for price and T for taxes, is close to but not greater than one, it is reasonable to assume that the supply of tobacco products is perfectly elastic[47]. Analysis of quarterly data from 1968 to 1991 supports this hypothesis as $\partial P/\partial T$ was found to be between 0.9 and 1.0. Therefore, this paper adopts the assumption that the supply of tobacco products is perfectly elastic.

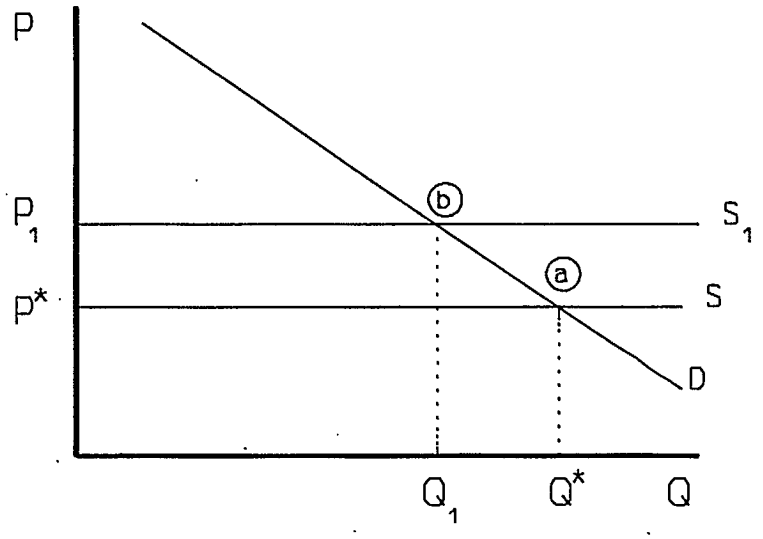
Figure 4.1 illustrates how a demand curve is identified through shifts in the supply curve. Changes in the cost of production and distribution as well as the associated taxes will "shift" the supply relationship S through time. These shifts will allow us to "perfectly" identify the demand for tobacco D as it relates to price changes. For example, an increase in the manufacturer's price would cause the supply curve to shift from S to S_1 increasing the price from P^* to P_1 and reducing the quantity demanded from Q^* to Q_1. The points of equilibrium a and b allow us to identify the demand relationship D.

---

47. In essence, $\partial P/\partial T$ represents the degree to which taxes are shifted forward to consumers. A value of zero would indicate backward shifting while a value of one would indicate full forward shifting which is implied by a perfectly elastic supply curve. A value for $\partial P/\partial T$ which exceeds one should be interpreted as evidence of an imperfectly competitive market since this condition can exist under perfect competition only if the long-run supply curve has a negative slope.

Figure 4.1

The Market For Tobacco Products



While the price of tobacco is an important influence on consumption, there are many other economic and social factors which also affect demand and so should be considered. These include the real price of substitutes (i.e. fine-cut versus cigarettes); population; education; social class; cigarette advertising; anti-smoking publicity; health consequences; smoking bans; degree of addiction; as well as other forms of taste changes. While changes in price cause movements along the demand curve, changes in these other factors lead to shifts in the demand curve. Unfortunately, it is not possible to include all of these factors since some cannot be observed while others cannot be quantified in any concrete way.

The previous chapter demonstrated that the majority of empirical studies have concentrated on the demand for cigarettes, although some studies, such as Collishaw, Rogers and Myers (1984), considered the aggregate demand for all tobacco products. However, none have attempted to address the issue of substitutability between different types of tobacco products. Since cigarettes and fine-cut tobacco together make up virtually all of the demand for tobacco products, the empirical analysis in this paper will focus on the demand for these two products and will try to determine the degree of substitution between them.

Data Periodicity

There are two potential sources of time-series data in Canada: pooled annual provincial data[48] and quarterly national data. Annual provincial data would provide ten separate observations for each year since there is a given level of consumption and price in each province. In contrast, quarterly national data provide only four separate observations. Each source has its advantages and disadvantages.

The advantage of using quarterly national data is that the quarterly periodicity allows for more immediate demand responses to price or income shocks. In contrast, annual data tends to "average" out these responses providing a more "long-run" type of elasticity. However, one potential disadvantage is that seasonal patterns can have a significant influence on the results. Quantity and prices can be influenced by stocking effects such as higher inventories in anticipation of a tax increase.

The advantage of using pooled provincial data is that provincial taxes have a major influence on the price of tobacco and provincially-specific data would allow the model to make better use of this information. However, there are two serious limitations -- there is only annual data and the estimation invariably assumes that each province and each provincial market is independent of the others. The latter poses the biggest concern since several American studies have concluded that the demand for tobacco in a given state is affected by the price in a neighbouring state[49]. There is no reason to believe that a similar situation would not exist in Canada. For example, prior to its 1992 budget, the province of New Brunswick levied the highest provincial tobacco tax in Canada. As a result, smokers in the province took advantage of lower prices in Québec or Nova Scotia leading to a noticeable reduction in reported consumption in New Brunswick[50].

The increase in information provided by provincial data can be assessed based on the correlation between provincial consumer price indices for cigarettes. The lower the correlation the greater the information content of the provincial data. Using annual data, it was determined that the lowest correlation value is 0.958 (Nova Scotia versus Newfoundland) and such a value suggests that it might be more beneficial to use quarterly national data than annual provincial data. Therefore, the empirical analysis conducted in this study uses quarterly national data to estimate the demand for cigarettes and fine-cut tobacco.

---

48. It is not possible to obtain quarterly data on a provincial basis.

49. For example, see Baltagi and Levin (1986).

50. A solution would be to explicitly allow for provincially-specific price and income elasticities in addition to incorporating the price of tobacco in neighbouring provinces. However, this would require the inclusion of a significant number of additional parameters and reduce the degrees of freedom.

The Dependent Variable

Ideally, the dependent variable in each case would be the actual amount of tobacco consumed. However, such data are available only through surveys and these results are not available on a consistent basis over a sufficiently long period of time. Furthermore, the health consequences and the negative stigma associated with smoking provide an incentive to under-report the true level of consumption.

An alternative variable would be the volume of retail sales of tobacco products. Unfortunately, Statistics Canada keeps track of only domestic shipments from Canadian Manufacturers and the quantity of tobacco imported into Canada. From a theoretical point of view, imports and domestic shipments could be added together to approximate total consumption. Excluding imports could lead to biased results. However, the same could be true if imports are included since neither domestic shipments nor imports provide a contemporaneously accurate proxy for consumption. Both take time to reach the final consumer and if the time lag associated with imports is different from that for domestic shipments then it would be statistically improper to add the two. Furthermore, imports represent less than 1.5% of the total Canadian market so that excluding them from the analysis should not pose a significant problem. Consequently, the dependent variable in the model will be the quantity of tobacco produced and shipped domestically by Canadian Manufacturers.

As noted above, the total quantity of tobacco sold in Canada is influenced by population. For example, an increase in tobacco consumption may be due to growth in the population of smoking age rather than individuals smoking more. Consequently, most studies estimate the demand for tobacco on a "per-capita" basis using the population age 15 and over. Unfortunately, the use of per-capita consumption may not be ideal since it fails to take into account changes in the demographic make-up of the total population. Specifically, at any point in time, the proportion of the population who smoke is different across age and sex cohorts. For example, Table 4.1 shows the proportion of people who smoked in 1989.

Table 4.1

Proportion of People Who Smoked in 1989
(Percentages)

Age Group	Male	Female
15-19	21	22
20-24	36	38
25-44	37	34
45-64	34	30
65 +	21	16

In light of these differing proportions, a change in the age distribution of the population could, by itself, influence the total amount of tobacco consumed. To account for this, an alternative approach is to divide the aggregate quantity consumed by a weighted population figure where the number of people in each cohort is "weighted" by a fixed proportion of people who smoke (usually the proportion at the beginning of the sample period)[51]. In the analysis to follow, the quantities of cigarettes and fine-cut tobacco are divided by a weighted population based on the proportion of people who smoked in 1965[52].

The Explanatory Variables

Any model which tries to assess the factors which affect demand through time must include a measure of price. In this analysis, the price of cigarettes is the CPI for cigarettes deflated by the total CPI. In the case of fine-cut tobacco, a retail price index is constructed using the methodology outlined in Appendix 2 and is also deflated by the total CPI.

Another important factor is income. One possible measure for income would be National Accounts data on personal disposable income. However, personal disposable income does not reflect the true discretionary income of an individual since it ignores such "mandatory" expenditures as rent and interest on personal loans. Furthermore, disposable income in the National Accounts includes monies earned by non-residents. Finally, interest and dividend payments contain elements that are related solely to inflation. Consequently, personal disposable income is adjusted to account for these factors[53] and then is deflated by the total CPI and transformed to a "per-capita" basis using the population 15 and over.

The demand for any product is affected by the price of substitutes. The most obvious form of substitution is between cigarettes and fine-cut tobacco. However, as was discussed in Chapter II, the market for illicit tobacco products has grown significantly over the last few years. These black market tobacco products are also substitutes for their legal counterparts. Unfortunately, one cannot observe the price for illicit tobacco products. Nevertheless, it is still possible to try and capture the influence of illicit tobacco products on domestic demand.

---

51. The proportion of people who smoke is affected through time by changing socio-economic factors. If the model allowed for this proportion to change, then the demand equation would be assessing the impact of price and income changes on the average consumption of a smoker. However, the model being developed is designed to address the influence of these socio-economic factors on total tobacco demand and, therefore, the propensity to smoke must be held constant through time.

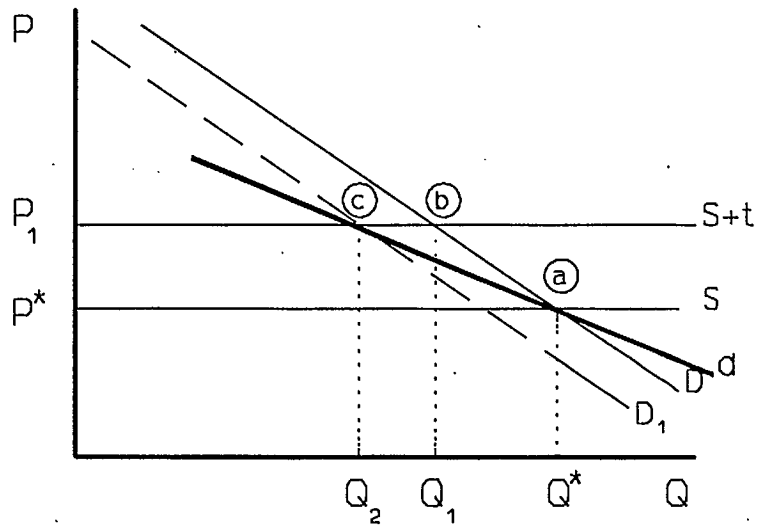
52. An alternative approach would be to explicitly capture demographic characteristics in the demand equation. However, this approach would entail additional parameters and reduce the degrees of freedom.

53. See R. Lamy (1993) for a more detailed description of the income adjustment.

An increase in the domestic tobacco tax affects both the demand for domestic tobacco products (i.e. legal products) and the demand for smuggled tobacco products. Figure 4.2 shows the impact of the tax increase on the domestic market. The supply curve shifts upward by the amount of the tax increase. As a result, the equilibrium point between supply and demand moves from **a** to **b** where the quantity demanded has fallen from $\mathbf{Q^*}$ to $\mathbf{Q_1}$ and the price has increased from $\mathbf{P^*}$ to $\mathbf{P_1}$. However, this is not the end of the story since smuggled tobacco has become relatively cheaper and some smokers substitute the illicit for the legal product. As a result, the demand curve for domestic tobacco products shifts downward (**D** to $\mathbf{D_1}$). Consequently, the new equilibrium point moves from **b** to **c** and the quantity demanded falls from $\mathbf{Q_1}$ to $\mathbf{Q_2}$ (providing an indication of the increase in the demand for smuggled tobacco products).

Figure 4.2

Impact Of An Increase In The Tobacco Tax On The Demand For Domestic Tobacco Products



The impact of changes in the demand for smuggled tobacco products on domestic demand has consequences for the empirical estimation of the latter. Specifically, if there were no market for smuggled tobacco products, then the observed change in the equilibrium point would be from **a** to **b**. However, the existence of a market for smuggled tobacco products leads to an even greater fall in the domestic demand which would lead to a **higher** elasticity of demand being estimated if the existence of the smuggled product were ignored. As Figure 4.2 shows, a given price increase ($\mathbf{P^*}$ to $\mathbf{P_1}$) results in a reduction in quantity demanded of $\mathbf{Q^*}$-$\mathbf{Q_2}$ when there is smuggling rather than only $\mathbf{Q^*}$-$\mathbf{Q_1}$. To account for the presence of the market for smuggled tobacco, the empirical estimation of the demand for cigarettes and fine-cut tobacco includes the associated level of tax (both

federal and provincial) as an independent variable. It acts as a proxy for the savings associated with switching from a legal to a smuggled product.

Quarterly data invariably have seasonal patterns associated with them. These patterns are captured in empirical studies by the use of quarterly dummy variables. However, it should be recognized that these dummy variables capture only systematic seasonal patterns and would not adequately reflect other supply shocks which might be associated with tobacco shipments. For example, pre-announced tax increases (such as during the time when the federal levies were indexed) provide an incentive for manufacturers to increase shipments to avoid the impending tax change. Moreover, there is always speculation prior to federal and provincial budgets about possible tobacco tax increases which might prompt agents to stock up inventories.

There are other factors which could influence the demand for cigarettes or fine-cut tobacco. These factors include advertising by the tobacco industry, anti-smoking publicity, as well as other social factors. However, all of these factors are virtually impossible to quantify with any precision making it difficult to include them in the empirical analysis[54]. These difficulties have also been encountered by other Canadian studies. For example, Collishaw, Roger and Myers (1984) attempted to incorporate advertising without much success.

4.3 Model Formulation

The literature review in Chapter III identified three common models which have been used in other empirical studies -- the static model, the partial adjustment model and the state adjustment model[55]. All of these models can be derived from an even more general model -- the error correction model. Following an econometric approach which has been associated with David Hendry[56], this analysis begins with a very general model which attempts to capture all of the factors associated with the demand for cigarettes or fine-cut tobacco. Using this general model, the restrictions which would be associated with the use of either the state adjustment, partial adjustment or static models are tested. Based on these tests, the appropriate model formulation will be derived. Of course, the choice among these formulations does not determine the functional form of the models as they can each be expressed linearly, logarithmically or in some other mathematical form.

---

54. Specifically, reliable time series data are not available which would capture the effects of such things as tobacco advertisements and anti-smoking publicity. However, time trends can be introduced in an attempt to capture a decline in smoking which might be attributable to anti-smoking publicity. In addition, one could try using dummy variables to test the importance of certain events such as smoking bans.

55. A fourth model, the rational addiction model, was also discussed. However, given the complexities and the novelty of this model, we are not taking it into consideration.

56. See Hendry, Pagan and Sargan (1984).

To simplify the discussion of the different models, it is assumed that the demand for tobacco (Q) depends only on its own price (P) and income (Y) and that the equations are linear. As such, the functional form of the first-order Error Correction Model can be written as follows:

$$(Q_t-Q_{t-1})=a_0+a_1(P_t-P_{t-1})+a_2(Y_t-Y_{t-1})+a_3P_{t-1}+a_4Y_{t-1}+a_5Q_{t-1}+\varepsilon_t \quad (4.1)$$

The basic premise of the error correction model is that it provides for both short-run and long-run responses to a given shock. Furthermore, it allows the data to determine the exact nature of the short-run and long-run responses. The first part of the model provides the short-run effect of changes in either price or income while the latter part of the model provides an "error correction" mechanism which recognises the long-term equilibrium relationship between each of the variables.

The state adjustment model, originally developed by Houthaker and Taylor[57], is a dynamic model which assumes that consumers of addictive products are influenced by an unobservable psychological requirement that a certain quantity (or stock) must be consumed. Let us assume that the psychological requirement at time t is represented by S_t then,

$$Q_t=\alpha+\beta P_t+\gamma Y_t+\theta S_t+\varepsilon_t \quad (4.2)$$

Re-arranging this formulation, one obtains,

$$S_t=[Q_t-\alpha-\beta P_t-\gamma Y_t-\varepsilon_t]/\theta \quad (4.3)$$

The model also formulates a method by which the psychological requirement changes through time. Specifically, the psychological requirement in any period is based on the actual quantity consumed in the previous period and the depreciated value of the previous stock. Specifically,

$$S_t=Q_{t-1}+(1-\delta)S_{t-1} \quad (4.4)$$

Equations 4.3 and 4.4 can be solved and the following obtained:

$$Q_t=\delta\alpha+\beta(P_t-P_{t-1})+\gamma(Y_t-Y_{t-1})+\delta\beta P_{t-1}+\delta\gamma Y_{t-1}+(\theta+1-\delta)Q_{t-1}+\varepsilon_t+(\delta-1)\varepsilon_{t-1} \quad (4.5)$$

Or,

$$Q_t=a_0+a_1(P_t-P_{t-1})+a_2(Y_t-Y_{t-1})+a_3P_{t-1}+a_4Y_{t-1}+(a_5+1)Q_{t-1}+v_t \quad (4.6)$$

---

57. See Houthaker and Taylor (1970).

Where,

$$\beta=a_1 \tag{4.7}$$

$$\gamma=a_2 \tag{4.8}$$

$$\delta=a_4/a_2=a_3/a_1 \tag{4.9}$$

$$\theta=a_5+(a_4/a_2) \tag{4.10}$$

$$\alpha=a_0a_2/a_4 \tag{4.11}$$

Equations 4.6 and 4.1 are identical except for the dependent variable. An OLS estimation of either equation will yield identical results except that the coefficient estimate for the lagged dependent variable in equation 4.6 will be exactly 1 greater than in equation 4.1. However, the premise of the state adjustment model gives rise to the parameter restriction shown by equation 4.9. This type of restriction can be tested using the error-correction model.

Given the habitual nature of tobacco consumption, a partial adjustment model would be an obvious choice to estimate the demand for tobacco. A partial adjustment model is a dynamic model where shocks to the factors which influence demand take time to be fully incorporated into the quantity consumed. Specifically, the long-run functional form can be expressed as:

$$Q^*_t=\alpha+\beta P_t+\gamma Y_t+\varepsilon_t \tag{4.12}$$

where Q^*_t is the "optimal" quantity desired. However, the quantity demanded in the short-run takes time to react to changes in income or prices. Specifically, one can postulate that the quantity demanded changes through time as follows:

$$Q_t-Q_{t-1}=\delta(Q^*_t-Q_{t-1}) \tag{4.13}$$

Therefore,

$$Q^*_t=\{Q_t-(1-\delta)Q_{t-1}\}/\delta \tag{4.14}$$

Substituting back into the original demand relationship,

$$\{Q_t-(1-\delta)Q_{t-1}\}/\delta = \alpha+\beta P_t+\gamma Y_t+\varepsilon_t \tag{4.15}$$

Solving for Q_t one obtains,

$$Q_t=\alpha\delta+\beta\delta P_t+\gamma\delta Y_t+[(1-\delta)/\delta]Q_{t-1}+\delta\varepsilon_t \tag{4.16}$$

$$=b_0+b_1P_t+b_2Y_t+b_3Q_{t-1}+\mu_t \tag{4.17}$$

The partial adjustment model is derived from the error correction model based on equation 4.1 with the following restrictions: $a_3=a_1$ and $a_4=a_2$.

The final model is the static model which can be described by the following equation:

$$Q_t=c_0+c_1P_t+c_2Y_t+\varepsilon_t \tag{4.18}$$

The static model can be obtained from the error correction model if the following restrictions are true: $a_3=a_1$, $a_4=a_2$ and $a_5=-1$.

4.4 Econometric Approach

It is clear that the error correction model described by equation 4.1 is the most general model considered in the analysis. That is, all of the other models can be derived from the error correction model with the implementation of the appropriate restrictions. There are two questions which have to be answered in the empirical analysis -- what is the most appropriate model and what is the functional form (linear, logarithmic or some other mathematical transformation)?

From the initial empirical work, it became clear that the final result depends upon the order in which these questions are answered. That is, the statistical tests for functional form could be affected by the choice of model. Therefore, the analysis begins by determining the appropriate functional form based on the error correction model and then the model selection tests are performed.

Choosing the Functional Form

There are several ways to test for the appropriate functional form. These include Box-Cox tests[58] and a test developed by Bera and McAleer[59] referred to as the BM test. An alternative test, which is employed in the analysis to follow, is the PE test developed by J.G. Mackinnon, H. White, and R. Davidson[60]. Suppose that one is interested in testing which of the following models is more appropriate.

$$Y_t = \alpha + \beta X_t + \varepsilon_t \tag{4.21}$$

$$y_t = \alpha + \beta x_t + \varepsilon_t \qquad (y_t=\log Y_t \text{ and } x_t=\log X_t) \tag{4.22}$$

The PE test is conducted by running the following two regressions:

---

58. See Godfrey and Wickens (1981).

59. See A.K. Bera and M. McAleer (1982).

60. See J.G. MacKinnon, H. White (1982).

$$Y_t = \alpha + \beta X_t + \gamma\,[\log\hat{Y}_t - \hat{y}_t] \tag{4.23}$$

$$y_t = \alpha + \beta x_t + \theta\,[\hat{Y}_t - e^{\log\hat{y}_t}] \tag{4.24}$$

where $\hat{Y}$ and $\hat{y}$ represent the predicted values obtained from estimating equation 4.21 and equation 4.22 respectively. If the null hypothesis that γ equals zero cannot be rejected, then one cannot reject the hypothesis that the relationship is linear. If the null hypothesis that θ equals 0 cannot be rejected, then one cannot reject the hypothesis that the relationship is logarithmic.

It is easily seen that the PE test could lead to an inconclusive result -- if one accepts that γ and θ are both equal to zero then the relationship can be either linear or logarithmic. In contrast, if one accepts that γ and θ are both significantly different from zero then the relationship is neither linear or logarithmic. In this case, one would have to explore some form of Box-Cox transformation.

The Box-Cox transformation allows the data to provide the appropriate functional form. In fact, linear and logarithmic formulations are special cases of the Box-Cox transformation. Any variable Z can be transformed in the following way:

$$z^{(\lambda)} = \begin{cases} \dfrac{z^{\lambda} - 1}{\lambda} & \lambda \neq 0 \\ \log z & \lambda = 0 \end{cases}$$

When $\lambda=1$, $z^{(\lambda)}=z-1$; when $\lambda= -1$, $z^{(\lambda)}=1-z^{-1}$; and when $\lambda=0$, $z^{(\lambda)}= \log z$ because $\lim_{\lambda\to 0}[(z^{\lambda}-1)/\lambda] = \log z$ from L'Hôpital's rule. Application of this transformation to the static model would yield the following model:

$$Q_t^{(\lambda)}=\alpha+\beta P_t^{(\lambda)}+\gamma Y_t^{(\lambda)}+\varepsilon_t \tag{4.20}$$

A more flexible form of this model would be to estimate a λ for each of the variables contained in the regression.

Choosing the Appropriate Model

Once the functional form has been established, the appropriate model can be determined using a simple F-test. Specifically, one imposes the required restrictions (let the number of restrictions equal q) on the error correction model to arrive at the model in question. The estimation of the error correction model provides the "unrestricted" sum of squared residuals (USSR) while the estimation of the alternative model provides the "restricted" sum of squared residuals (RSSR). Now, suppose there are n observations and k coefficients which are estimated in the error correction model. Then, the appropriate test statistic can be calculated as follows:

$$V = (RSSR-USSR)*(n-k)/(USSR*q) \quad (4.25)$$

and this statistic follows the F distribution with q and n-k degrees of freedom.

Using the equations described above, the state adjustment model (equation 4.6) imposes one restriction (as described by equation 4.9) on the error correction model (equation 4.1). In similar fashion, the partial adjustment model (equation 4.17) and the static model (equation 4.18) impose two and three restrictions, respectively, on the error correction model.

Threshold Variables

A threshold variable is one which is included in a model for only part of the sample period. For example, the real level of tobacco taxes is included in the model for domestic consumption to account for the influence of smuggled tobacco products. However, it is evident that smuggling has become a measurable problem only in recent years. Therefore, it would be inappropriate to include the level of taxes over the full sample period used in the analysis (1968 to 1991).

For illustrative purposes, a simple threshold model can be represented with the following equation:

$$S_t=a_0+a_1X_t+a_2d_tZ_t \quad (4.26)$$

Where, $d_t=0 \;\; t=1,...,T_1$
$d_t=1 \;\; t=T_1+1,...,T$

That is, the dependent variable S is a function of the explanatory variables X and Z. The variable Z is a threshold variable since it has no influence from the beginning of the sample period (t=1) to period T_1. The appropriate time to introduce the threshold variable can be determined statistically by estimating equation 4.26 using all possible values for T_1 and choosing the T_1 which maximizes the log of the likelihood function[61].

Other Considerations

There are other econometric problems which may affect any empirical analysis. The first, serial correlation, exists when the value of the random disturbance term depends upon past values. The most commonly discussed form is first-order serial

---

61. The classic linear model, expressed in matrix form, can be written as $Y=X\beta+\varepsilon$. The corresponding log of the likelihood function can be written as follows:

$$\ln\zeta(\beta,\sigma^2|Y,X)= - (T/2)\ln 2\pi - (t/2)\ln\sigma^2 - (Y-X\beta)'(Y-X\beta)/2\sigma^2$$

correlation where the random disturbance term can best be described by the following relationship:

$$\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t \qquad \text{where } \mu_t \sim N(0,\sigma^2) \tag{4.27}$$

In the context of the models being developed, there are two probable causes of serial correlation -- misspecification or the prolonged influence of a random shock. Two tests for the presence of serial correlation will be used -- a residual correlogram with the associated t-statistics as provided by SHAZAM V6.2[62] and a joint test for any order of serial correlation based on a regression of the estimated error term on past values.

A second problem, heteroskedasticity, occurs when the variance of the disturbance term is not constant over time. In such a case, ordinary least squares leads to inefficient estimates. One test for the presence of this problem, the Breusch-Pagan-Godfrey test, involves regressing the square of the error term on all of the explanatory variables[63].

A third consideration is the parameter constancy of the model. That is, the parameter estimates should not change through time. For example, if the sample period is divided into two sub-periods, the parameter estimates should be statistically equivalent between the two sub-periods. The parameter constancy of the models will be tested using either a simple Chow Test or an asymptotic F-Test which allows for the variance of the error term to be different in the two sub-samples[64].

4.6 Summary

The demand for tobacco is an aggregate of the demand for cigarettes, fine-cut tobacco, cigars, pipe tobacco, chewing tobacco, snuff and plug. Of these, cigarettes and fine-cut tobacco account for more than 95% of the total quantity of tobacco consumed in Canada. Thus, the demand for tobacco can be largely explained by estimating a demand function for cigarettes and fine-cut tobacco.

The demand for cigarettes and fine-cut tobacco can be influenced by many factors including own price; the price of substitutes; population; education; social class; cigarette advertising; anti-smoking publicity; health consequences; smoking bans; and the degree of addiction. Unfortunately, some of these factors cannot be observed while others cannot be reliably quantified. For these reasons, the cigarette and fine-cut models include variables reflecting own price, disposable income and the price of substitutes. With respect to the latter, the recent emergence of smuggled tobacco products is captured in the models

---

62. The t-statistics relate to the existence of a given order of serial correlation.

63. See equation 11.3.4 in Judge, Griffiths, Hill, Lütkepohl and Lee (1985).

64. See page 38 in Amemiya (1985) for a more detailed description.

by including the real level of tax as a proxy for the savings associated with switching from a legal to an illicit product.

The empirical estimation follows the Hendry Approach. That is, the error correction model is estimated first and, based on the results, the appropriate functional form is assessed. Then, the restrictions associated with the state adjustment model, the partial adjustment model and the static model are tested to determine which model should be used. Finally, careful attention is paid to the statistical properties to ensure that the final model is structurally sound and the estimated error terms are consistent with the properties of ordinary least squares.

V EMPIRICAL RESULTS FOR DOMESTIC CONSUMPTION

5.1 Introduction

The previous chapter outlined the components of the model for the domestic consumption of cigarettes and fine-cut tobacco. In this chapter, we present the empirical results from these models. Section 2 provides a description of the variables used in the estimation. Section 3 sets out the results for the demand for cigarettes while Section 4 presents the results for fine-cut tobacco. The final section utilizes the empirical results to consider the potential level of smuggled tobacco products consumed in Canada.

5.2 The Variables

The empirical analysis is carried out separately for cigarettes and fine-cut tobacco. As described in Chapter IV, the dependent variable is adjusted per-capita domestic shipments of either cigarettes or fine-cut tobacco. That is, changes in the dependent variable represent shifts in the quantity demanded by individual smokers and/or the individual's decision to smoke (or quit). The explanatory variables used in the analysis include the price of cigarettes, the price of fine-cut tobacco, the real per-unit level of taxes on the applicable product, real disposable income and the quarterly dummy variables.

For the most part, the variables included in the model have been defined in the previous chapter. Nevertheless, special attention should be paid to the level of taxes. The real per-unit level of taxes, including all of the federal and provincial levies described in Chapter II, was calculated based on monthly provincial data related to the price components of a carton of cigarettes or 200 grams of fine-cut tobacco. However, it has to be recognized that some of the taxes are ad valorem so their per-unit value can be affected by changes in private costs. Moreover, it might not be appropriate to have the tax variable reflect changing private costs[65]. Therefore, the value associated with the ad valorem portion of the tax level is allocated proportionately between specific taxes and private costs[66].

The inclusion of the level of taxes in the demand relationship is to account for the emergence of smuggling over the last several years. As there is no evidence to support the notion that smuggled tobacco products have had a significant influence on the domestic market over the full time period covered in our analysis (1968 to 1991), real

---

65. Changes in private costs, such as the manufacturer's price, could also affect the price of illicit tobacco products.

66. If TS is the per-unit dollar value of the applicable specific taxes, TV is the per-unit value of the applicable ad valorem taxes and PC are the private costs, then the adjusted tax value would be equivalent to the expression TS+TVxTS/(TS+PC).

taxes must be treated as a threshold variable. That is, up to a certain point in time it has no influence on demand and beyond that point its influence is measured by the coefficient. Furthermore, we assume that there is a critical value of tax which must be exceeded to engender any significant level of smuggling. According to the results presented in our analysis of the demand for exported tobacco products[67], it would appear that smuggling became a measurable problem only in 1983 for cigarettes and at the end of 1986 for fine-cut tobacco. Therefore, it is assumed that the critical value of tax which must be exceeded is the value of tax in the fourth quarter in 1982 for cigarettes and the third quarter of 1986 for fine-cut tobacco.

5.3 The Demand for Cigarettes

The starting point in the analysis was a first-order error correction model as described by equation 4.1. Using this model, it was determined that the demand for cigarettes is best represented by a "box-log" formulation. That is, the dependent variable is transformed using the Box-Cox transformation while the explanatory variables are in logarithmic form. The initial results revealed that the threshold variable in the model -- the real level of taxes -- becomes influential in the second quarter of 1987. Moreover, the analysis found that the real price of fine-cut tobacco is also a threshold variable since it had no influence on the demand for cigarettes prior to the second quarter of 1974. Finally, the simpler partial adjustment model was adopted since the null hypothesis that it was true could not be rejected using the error-correction model estimates.

Table 5.1 provides the results of the "box-log" partial adjustment model for the demand for cigarettes. The $\bar{R}^2$ value of .97 indicates that the model has a very good fit over the time period. The value for lambda, the Box-Cox adjustment factor, is 0.22 indicating that the dependent variable enters the model roughly as the square root of the square root of domestic cigarette consumption.

---

67. The primary source of smuggled tobacco products appears to be Canadian exports. See chapter VII for a detailed description of the analysis of the supply of exported tobacco products.

Table 5.1

Final Model For The Demand For Cigarettes

$$(Q_t^{\lambda}-1)/\lambda = a_0+a_1\log P_t+a_2\log Y_t+a_3\log PF_t+a_4 QD2+a_5 QD3+a_6 QD4 +a_7\log CTAX_t+a_8(Q_{t-1}^{\lambda}-1)/\lambda$$

Variable	Estimated Coefficient	T-Statistic
Constant	24.907	13.49
P	-3.781	11.91
Y	0.385	1.60
PF	0.324	2.17
QD2	0.337	3.69
QD3	0.772	12.17
QD4	0.902	18.23
CTAX	-0.805	6.11
Q_{t-1}	-0.347	3.79
λ	.221	
$\bar{R}^2$	.970	

Q	Adjusted Per-Capita Quantity	P	Real price of cigarettes
Y	Real per-capita disposable income	PF	Real price of fine-cut tobacco beginning in 74Q2
QDi	Quarterly dummy for quarter i	CTAX	Real level of taxes beginning 87Q2
λ	Box-Cox Adjustment Factor		

The estimated coefficients for the explanatory variables are all consistent with economic theory. The coefficients associated with the price of cigarettes (P_t) and the real level of taxes ($CTAX_t$) are both negative and significant. The coefficient associated with income (Y_t) is positive but only significant at about the 90% level. Finally, the price of fine-cut tobacco (PF_t) is positively correlated with the demand for cigarettes.

One interesting observation is that the coefficient related to the lagged dependent variable is negative. By contrast, the usual postulation in a partial adjustment model when it is used to explain the consumption of an addictive product is that the coefficient on the lagged dependent variable is positive. The rationale is that the addictive nature of tobacco makes it difficult to respond to price and/or income changes in the short-run. That is, casual smokers can react quickly to a price increase by reducing their consumption while addicted smokers find it more difficult to quit immediately although they may succeed eventually. Consequently, a price increase leads to a reduction in

current consumption which, in turn, reduces future consumption and this relationship is captured by a positive coefficient for lagged consumption.

Although the rationale for a positive coefficient for lagged consumption seems appealing, the observed negative coefficient need not imply that the partial adjustment model is inappropriate. Rather, a logical explanation could be that, when faced with a price increase, many smokers try to cut back either by reducing their consumption or quitting altogether. However, over time the addictive nature of tobacco consumption catches up with many of them and they return to their past consumption levels. That is, the short-term response to a price increase will be greater than the long-term response and this is captured by a negative coefficient on lagged consumption.

Although the signs of the coefficients are consistent with economic theory, the "box-log" model does not allow for an immediate interpretation of the coefficient's implications. To gain a better understanding of the results, it is necessary to calculate the various elasticities. In the case of the elasticity of demand with respect to changes in price, the elasticity can be calculated as follows:

$$\eta^{P,q} = \frac{\partial Q}{\partial P}\frac{P}{Q} \qquad (5.1)$$

In the case of the model currently under consideration, it can be shown that the short-run price elasticity of demand[68] can be derived using the following formula:

$$\eta^{P,q}_t = a_1/Q_t^{\lambda} \qquad (5.2)$$

Since Q_t enters the formula, the price elasticity of demand changes through time. Similar elasticity formulas can be derived for income and the level of taxes. A sample of the calculated point elasticities is shown in Table 5.2.

68. The long-run price elasticity is calculated assuming that the quantity demanded is stationary so that $Q_t=Q_{t-1}$.

Table 5.2

Implied Point Elasticities of Demand For Cigarettes

Variable/Year	Short Run	Long Run
Own Price (Assuming no tax change)		
1980	-0.66	-0.53
1985	-0.71	-0.57
1991	-0.89	-0.71
Income		
1980	0.06	0.05
1985	0.06	0.05
1991	0.08	0.06
Tax (Assuming no price change)		
1980	-	-
1985	-	-
1991	-0.15	-0.12
Price of Fine-Cut		
1980	0.05	0.04
1985	0.05	0.04
1991	0.07	0.05

As with any econometric study, it is important to look at the statistical properties of the estimated model. The primary focus was to ensure that the error terms were statistically consistent with the principles of ordinary least squares, the model was structurally sound over time and that the assumptions related to the threshold variables were valid. With respect to the error term, the model exhibited no sign of heteroskedasticity or serial correlation[69].

The parameter constancy of the model over time is an important consideration in estimating the demand for tobacco. During the time period covered in this analysis, there was a significant increase in anti-smoking publicity, smoking bans were introduced and the social acceptability of smoking declined. As noted in Chapter IV, it is

69. The highest order of serial correlation tested was 12th order.

introduced and the social acceptability of smoking declined. As noted in Chapter IV, it is very difficult to include these variables in any model even though they could well lead to changes in the demand relationship. Several tests were performed to ensure there was no problem with respect to the parameter constancy of the model. The first assumed a constant value for lambda over time and employed the standard Chow Test to detect any structural changes. The second recognized that the Chow Test implicitly assumes that the variance of the error term remains constant over time and, instead, an asymptotic F-Test was carried out. The final test was a maximum likelihood test which allowed for lambda to change in the sub-samples. In each case, there was no significant evidence of structural change.

The lack of evidence of a structural break is not sufficient to dismiss the influence of anti-smoking publicity, smoking bans or changing social values on the demand for cigarettes. An alternative method for accounting for these variables is to include a time trend and/or dummy variables in the model. The time trend would allow for a constant reduction in smoking over time which might result from anti-smoking activities. The dummy variable approach would try to capture the influence of specific events such as the elimination of tobacco advertisements on television in 1972 or the ban on smoking in the federal workplace[70]. When such variables were added, the estimated coefficients were not statistically significant at the 5 per cent level. Nevertheless, it could be that the influence of the social factors described above are highly correlated with a variable already included in the model and its parameter estimate reflects both the influence of the variable and the associated social factor.

A further test dealt with the integrity of the threshold variables. In the case of the demand for cigarettes, there are two such variables -- the real level of taxes and the price of fine-cut tobacco. While the analysis conducted in Chapter VII indicates that smuggling started to become a measurable problem in 1983, the domestic model assumes no statistical influence until the second quarter of 1987. In addition, the price of fine-cut tobacco begins to have a statistical effect on consumption only in the second quarter of 1974. These threshold points can be tested by re-estimating the model and including two extra "full-sample" variables -- the real level of taxes since 1982 and the price of fine-cut tobacco beginning in 1968[71]. The tests revealed that the coefficients of these "full-sample" variables were not statistically significant at the 95 per cent level.

The inclusion of the real level of taxes in estimating the demand for any product is novel. Therefore, it would be useful to test the importance of its inclusion. To

---

70. The federal government implemented a two-stage ban. Effective October 1, 1987, smoking was permitted only in designated areas. This was followed by a prohibition of smoking in all federal offices starting January 1, 1989.

71. Of course, one could postulate that the real level of taxes also had an influence for the full sample. However, there is no evidence to suggest that smuggling had any significant affect on the market-place until the 1980's. That is, the real level of taxes prior to 1982 would have no real relationship to an economic phenomenon. Moreover, it could be highly correlated to price changes through time which would distort its true impact.

do so, the model is estimated to the end of 1984[72] (the 1984 model) and then re-estimated without the tax variable over the full sample period. A joint F-Test was used to determine whether the coefficients had changed statistically -- an indication of structural instability. The joint F-statistic between the 1984 model and the full sample model without the tax variable was 15.1 which shows very strong statistical proof of a structural break. In contrast, the joint F-statistic between the 1984 model and the model including tax was 0.86 showing very little evidence of structural change.

The final experiment dealing with the influence of the real level of taxes was carried out using the 1984 model (the tax variable is excluded as it begins only in 1987). Specifically, the model was used to forecast domestic consumption[73] over the period 1985 to 1991. The results of this forecast showed that the 1984 model consistently over-estimated the actual level of domestic consumption and that this discrepancy grew over time. Consequently, a model which excludes the influence of the tax variable in a world with smuggling would lead to a consistent over-estimation of domestic consumption.

5.4 The Demand for Fine-Cut Tobacco

As was the case with the demand for cigarettes, the starting point in the analysis of fine-cut tobacco was a first-order error correction model as described by equation 4.1. However, significant problems with second-order serial correlation were discovered in the resulting error terms. As the error-correction model is designed to capture the dynamic influences of an economic relationship, the presence of strong second-order serial correlation suggests that these dynamics had not been properly accounted for in the model formulation. Consequently, it was decided to begin with a second-order error correction model as described by equation 5.3.

In order to simplify the discussion for illustrative purposes, it is assumed that the demand for fine-cut tobacco (Q) depends only on its own price (P) and income (Y) and that the equation is linear[74]. As such, the functional form of the second order error correction model is as follows:

$$(Q_t-Q_{t-1})=a_0+a_1(P_t-P_{t-1})+a_2(P_{t-1}-P_{t-2})+a_3(Y_t-Y_{t-1})+a_4(Y_{t-1}-Y_{t-2}) +a_5P_{t-2}+a_6Y_{t-2}+a_7(Q_{t-1}-Q_{t-2})+a_8Q_{t-2}+\varepsilon_t \quad (5.3)$$

---

72. 1984 was chosen as the end of the sample period since it excludes the significant increase in tobacco taxes announced in the 1985 federal budget.

73. Recall, domestic shipments are used as a proxy for consumption. Therefore, the forecast level of consumption is actually the forecast level of domestic shipments.

74. These assumptions are consistent with those made to present the various models described in Chapter IV.

The restrictions required for equation 5.3 to be equivalent to the first-order error correction model are that $a_2=a_5$, $a_4=a_6$ and $a_7=a_8$.

The estimation phase started with the second-order error correction model. The empirical results confirmed that a first-order model was inappropriate since the restrictions required for the first-order error-correction model were rejected at the 95% level. The null hypothesis of a linear specification was not rejected and it was evident that the coefficient of the tax threshold variable became significant in the fourth quarter of 1989. Furthermore, it was discovered that the influence of the price of cigarettes on the demand for fine-cut tobacco seemed to change beginning in the first quarter of 1978[75]. Finally, the restrictions implied by a second-order partial adjustment model were accepted[76].

Table 5.3 provides the empirical results for the demand for fine-cut tobacco as represented by a second-order partial adjustment model. The $\bar{R}^2$ value of 0.906 indicates that the model provides a reasonable fit over the time period. The income coefficient is strongly significant and reveals that fine-cut tobacco is an inferior good -- increases in income lead to a reduction in consumption. The price of cigarettes, a substitute, is positively related to the consumption of fine-cut tobacco and is statistically significant. However, the influence of the price of fine-cut tobacco is statistically insignificant. Finally, consumption is negatively correlated with the real level of taxes.

In contrast to the results for cigarettes, the coefficients associated with lagged consumption are positive and so are consistent with the classical assumption of the partial adjustment model. One explanation for this contrast might be that fine-cut tobacco represents a smoker's last resort to maintain their habit. The high cost of cigarettes has forced many hard-core smokers to switch to the cheaper alternative since the nature of their addiction makes it difficult for them to quit. This same addiction makes it difficult for these smokers to adjust their consumption to subsequent increases in the price of fine-cut tobacco.

---

75. In the preliminary analysis, there was significant structural instability in the empirical results. One possible explanation is that the influence of the price of cigarettes on the demand for fine-cut tobacco changed through time (a change in the slope of the demand relationship). The existence and the potential timing of this change was determined by maximizing the log of the likelihood function by introducing a second variable for the price of cigarettes into the analysis at various points in time.

76. Using equation 5.3, the restrictions required for a partial adjustment model are that $a_1=a_2=a_5$ and $a_3=a_4=a_6$.

Table 5.3

Final Model For The Demand For Fine-Cut Tobacco

$$Q_t = a_0+a_1P_t+a_2Y_t+a_3PC78_t+a_4PC_t+a_5FTAX_t+a_6QD2+a_7QD3+a_8QD4+a_9Q_{t-1}+a_{10}Q_{t-2}$$

Variable	Estimated Coefficient	T-Statistic
Constant	0.117	5.00
P	0.024	0.77
Y	-2.569	4.37
PC78	-0.056	5.66
PC	0.136	3.11
FTAX	-1.070	5.84
QD2	0.005	1.40
QD3	0.010	2.34
QD4	0.012	3.40
Q_{t-1}	0.033	0.42
Q_{t-2}	0.252	3.29
$\bar{R}^2$	.906	

Q	Adjusted Per-Capita Quantity	P	Real price of fine-cut tobacco
Y	Real per-capita disposable income	PC78	Real price of cigarettes beginning in 1978
PC	Real price of cigarettes		
FTAX	Real level of taxes beginning 89Q4	QDi	Quarterly dummy for quarter i

The fine-cut model was subjected to statistical tests similar to the ones used in the demand for cigarettes. Unfortunately, two serious statistical problems were discovered. First, the associated error term showed strong signs of heteroskedasticity, Second, the model was not structurally sound. The latter problem is the more serious as structural breaks were discovered over a large portion of the sample period.

In recognition of the structural breaks, several attempts were made to determine the source of the instability. For example, the model was modified to allow the coefficients of the various parameters to change at given points in time using dummy variables. However, all of these attempts failed to alleviate the structural problems.

As noted in Chapter IV, a model which includes quarterly dummy variables assumes the same seasonal trends through time. However, these dummy variables could not account for exceptional changes in the level of manufacturers' shipments in a particular

period. Such exceptional changes could lead to structural instability and there is no reason to believe this is not the case with fine-cut tobacco. For example, pre-announced tax increases (such as during the time when the federal levies were indexed) provide an incentive for manufacturers to increase shipments to avoid the impending tax change. After the tax change, shipments fall below the seasonal average. In a crude attempt to account for such deviations in shipments, a variable (referred to as QSHOCK) is constructed to indicate those periods in which shipments are either significantly higher or lower than the seasonal norm[77].

The fine-cut model was re-estimated including the variable QSHOCK. As Table 5.4 shows, the inclusion of QSHOCK has a significant influence on the final results. The most obvious indicator is that the $\bar{R}^2$ increases from 0.906 to 0.930. Furthermore, there are relatively large changes in the coefficient estimates. The most important of these are the reductions in the influence of real income and the real level of taxes. Finally, the real price of fine-cut tobacco, although statistically insignificant, becomes negatively correlated with consumption.

77. The variable is calculated on a monthly basis using the monthly share of total annual shipments. The share in a given month in each year is compared. If the share in a given year is greater than (less than) the average share by at least 20%, then QSHOCK takes on a value of 1 (-1). The quarterly value of QSHOCK is simply the sum of the monthly values. The computed values are shown in Table A1.6 of Appendix 1.

Table 5.4

Final Model For The Demand For Fine-Cut Tobacco Including QSHOCK

$$Q_t = a_0+a_1P_t+a_2Y_t+a_3PC78_t+a_4PC_t+a_5FTAX_t+a_6QD2+a_7QD3+a_8QD4+a_9QSHOCK+a_{10}Q_{t-1}+a_{11}Q_{t-2}$$

Variable	Estimated Coefficient	T-Statistic
Constant	0.086	4.06
P	-0.020	0.71
Y	-1.860	3.53
PC78	-0.050	5.47
PC	0.170	4.36
FTAX	-0.800	4.79
QD2	0.007	2.29
QD3	0.007	1.89
QD4	0.014	4.44
QSHOCK	0.012	5.36
Q_{t-1}	0.105	1.51
Q_{t-2}	0.243	3.67
$\bar{R}^2$	.930	

Q	Adjusted Per-Capita Quantity	P	Real price of fine-cut tobacco
Y	Real per-capita disposable income	PC78	Real price of cigarettes beginning in 1978
PC	Real price of cigarettes		
FTAX	Real level of taxes beginning 89Q4	QDi	Quarterly dummy for quarter i

The inadequacies of the fine-cut model which excludes the variable QSHOCK might lead one to question the results of the model which includes it. While it is true that QSHOCK is arbitrary in nature, its purpose is to capture periods of exceptional shipments which could be the cause of the structural problems encountered in the model excluding QSHOCK[78]. Such structural problems were not evident in the model describing the demand for cigarettes. Thus, it might be useful to determine what the impact of QSHOCK would be on the parameter estimates in the domestic demand model for

78. In fact, the heteroskedasticity discovered in the model excluding QSHOCK could also be caused by the structural instability.

cigarettes. Accordingly, Table 5.5 compares the 1985 point elasticities[79] for cigarettes with and without QSHOCK and shows that the elasticities in both cases are basically the same. Since QSHOCK does not significantly change the results for cigarettes, the use of QSHOCK in the fine-cut model should not pose any serious problem.

Table 5.5

The Impact of QSHOCK on Cigarette Demand Elasticities
(1985)

Variable	Excluding QSHOCK	Including QSHOCK
Price:		
Short-run	-0.75	-0.71
Long-run	-0.56	-0.57
Income:		
Short-run	0.08	0.06
Long-run	0.06	0.05
Price of Fine-cut Tobacco		
Short-run	0.06	0.05
Long-run	0.05	0.04

The fine-cut model described in Table 5.4 can be used to determine the point elasticities of demand. Following equation 5.1, it can be shown that the own-price elasticity of demand, in the short-run, can be calculated using the following formula:

$$\eta^{P,q}_t = a_1 P_t/Q_t \qquad (5.4)$$

Similar formulas can be derived for the elasticity of demand with respect to changes in real incomes, the real level of taxes and the real price of cigarettes. The estimated point elasticities of demand for selected points in time are contained in Table 5.6.

79. It is not possible to compare coefficient estimates between the two models directly since the corresponding Box-Cox transformation parameters were different.

Table 5.6

Implied Point Elasticities of Demand For Fine-Cut Tobacco

Variable/Year	Short Run	Long Run
Own Price (Assuming no tax change)		
1980	-0.09	-0.14
1985	-0.10	-0.16
1991	-0.30	-0.47
Income		
1980	-0.50	-0.77
1985	-0.38	-0.59
1991	-0.44	-0.68
Tax (Assuming no price change)		
1980	n.a.	n.a.
1985	n.a.	n.a.
1991	-0.58	-0.89
Price of Cigarettes		
1980	0.58	0.89
1985	0.61	0.94
1991	1.31	2.01

5.5 Tobacco Smuggling

The term tobacco smuggling generally implies that a tobacco product has been illicitly imported into Canada[80]. These importations can be made by professional smugglers or by ordinary individuals. However, it should be recognized that there are legal ways to increase one's consumption of tax-free cigarettes by taking advantage of the rule regarding duty-free importations -- each individual is able to import a carton of cigarettes tax-free after being out of the country for more than forty-eight hours. That is,

80. Illicit tobacco products can also include tobacco which is supplied as ships' stores or for use by diplomats and subsequently resold.

smokers could spend more time out of the country or encourage friends to bring them cigarettes on their return from a foreign trip. **These types of importations are legal and should not be attributed to smuggling.** However, it is difficult to account for these legal imports as it is impractical for Customs to keep track of personal duty-free importations. Consequently, the influence of the tax variable in the domestic model might be capturing some of the increase in these legal importations.

The inclusion of the real value of taxes in the analysis attempts to capture the substitution between legal and illegal tobacco products. That is, as described in Chapter IV, the tax level is a proxy for the potential savings associated with consuming illicit rather than legal products. Of course, the substitution being measured reflects only the change in domestic consumption and not the change in smuggling. Moreover, there is no reason to believe that the change in domestic consumption would be equivalent to the change in illicit tobacco consumed since the prices of the two products are not the same. For example, an increase in real taxes would lead smokers to switch from legal to illegal sources. Since the price of illicit tobacco is lower, this could lead to an increase in consumption. However, there is no reason to believe that this change in consumption would be significant since the price elasticity of the individual (the source of the substitution) should be less than the aggregate price elasticity[81].

The estimated models for domestic cigarette and fine-cut consumption are used to simulate the potential increase in the quantity of smuggled tobacco products over the last few years. Specifically, the models are simulated using actual changes in the real tax variable to determine the potential impact of these changes on domestic consumption[82]. The results of these simulations can then be compared between years to determine the potential change in smuggled tobacco products.

Table 5.7 presents the final results of the simulations. Only the short-run results are presented as it takes several years for the long-run consequences of a given shock to be fully realized. As one would expect, the largest increase in tobacco smuggling coincided with the significant tax increases which occurred in 1989 and 1991. Specifically, the potential increase in the level of smuggled cigarettes in these two years was 21.2 million cartons. The total increase in cigarette smuggling since 1988, which should approximate the total annual magnitude, could be as high as 25 million cartons and this represents about 13% of the domestic shipments in 1991. A similar story emerges for fine-cut tobacco as the cumulative increase in smuggling since 1989[83] is approximately 18 million 200 gram tins equivalent to almost 57% of total domestic shipments in 1991.

---

81. See Lewis and Coate (1982).

82. To isolate the impact of the tax, it is assumed that none of the other variables change, especially price.

83. As with cigarettes, this should approximate the total annual magnitude.

Table 5.7

Potential Change In Smuggled Tobacco Products
(Millions)

Year	Cigarettes (Cartons)	Fine-cut Tobacco (200 Gram Tins)
1988	2.2	n.a.
1989	10.4	n.a.
1990	1.4	2.7
1991	10.8	15.4
Total	24.8	18.1

5.6 Summary

The results presented in this chapter support several conclusions. First, the price elasticity of demand for cigarettes is currently -0.9 in the short-run and this value changes through time based on changes in total domestic consumption. This result is higher than most other Canadian studies where estimates range from -0.3 to -0.4. Second, the demand for cigarettes tends to be more inelastic in the long-run (-0.7) than in the short-run. Third, there is a significant degree of substitutability between cigarettes and fine-cut tobacco. Finally, illicit tobacco products are becoming an important alternative to their domestic counterparts.

VI THE PRICE SENSITIVITY OF YOUNGER CANADIANS

Individuals usually begin to smoke early in life. For example, surveys conducted in the United States found that over 75% of adult smokers began to smoke before they turned 21[84]. Consequently, there is a good chance that if someone has not started smoking by the time they reach their mid-20's they never will. Furthermore, individuals who are already addicted to tobacco find it hard to quit. Consequently, preventing people from starting to smoke has a long-term effect on the total consumption of tobacco products.

In the 1991 Federal Budget, the Minister of Finance, the Honourable Michael Wilson, stated that "our national strategy to reduce tobacco use addresses all aspects of the problem of tobacco consumption. In particular, it is aimed at discouraging young people from beginning to smoke. ... Studies show that tobacco taxes are particularly important in discouraging younger Canadians from smoking". Given this goal, a review of tobacco taxation should address the question of whether younger Canadians are affected more than others by a tax increase. As tax increases affect individuals through the consequential change in the retail price, the issue is whether younger Canadians have a higher price elasticity of demand than adults.

The question of whether tobacco price increases affect younger people more than adults has not been addressed in many studies. In the United States, there have been four major studies which address this question. Three of these were co-authored by Lewit and Coate[85] and conclude that younger people are more price sensitive than adults -- especially in the context of the decision of whether or not to smoke. However, a more recent study by Wasserman el al (1991) concluded that there were no significant differences in the elasticity of demand between teenagers and adults. Rather, the differences were explained by smoking restrictions such as smoking bans in public places.

The only Canadian study on this issue assessed the effects of prices on cigarette consumption of teenagers and adults over the period 1980 to 1989 and was conducted by Ferrence, Garcia, Sykora, Collishaw and Farinon (1991). Their analysis attempted to calculate "arc elasticities" by comparing the change in consumption to changes in price. The consumption variable was estimated based on the proportion of people who smoke and the average daily consumption of cigarettes for each age cohort derived from various surveys. For those years in which there was no available survey, a "straight line" approach was used to determine the potential survey results for that year. Based on their analysis, the authors found that the elasticity of demand for teenagers was higher than that for adults.

---

84. See United States General Accounting Office (1989).

85. The three studies are: Lewit and Coate (1981); Lewit, Coate and Grossman (1981); and Lewit and Coate (1982).

The ideal approach to assessing the influence of price on the decisions to smoke and the quantity to be consumed by an individual smoker would be an econometric study based on panel data providing price and quantity observations for a sample of individuals over time. Unfortunately, such a data set does not currently exist in Canada. An alternative approach would be to use available cross-sectional micro data where price variation is derived from the fact that tobacco prices are different in each province. However, there is only a limited variation in prices across provinces and this makes it difficult to obtain a reliable estimate for the price elasticity of demand.

In an effort to confirm the results found by Ferrence et al, the following simple regressions were run:

$$\log(PR1519_{it})=a_0+a_1\log(PTOB_t) \qquad (6.1)$$

$$\log(PR2099_{it})=b_0+b_1\log(PTOB_t) \qquad (6.2)$$

where t represents time and i represents either males, females, or total. The mnemonic PR1519 represents the proportion of people between the ages of 15 and 19 who smoke as reported in the various national surveys from 1965 to 1989. Similarly, PR2099 represents the proportion of people aged 20 and over who smoke. Finally, PTOB represents the real price of tobacco products as measured by the consumer price index for tobacco products deflated by the total CPI.

As with the Ferrence et al study, data are available for only selected years. However, rather than deriving observations for these missing years as they did, this analysis simply ignores them. Furthermore, the survey results which are used in the regressions are adjusted to ensure comparability over time as suggested by Stephens (1988).

Equations 6.1 and 6.2 state that the proportion of people who smoke is influenced over time only by changes in the real price of tobacco products. If the influence of price is greater for younger Canadians, then the coefficient estimate for a_1 should be greater, in absolute terms, than the estimate for b_1. Moreover, statistically they should be significantly different from each other. That is, b_1-a_1[86], which is referred to as the price sensitivity differential, should be significantly greater than zero.

Table 6.1, which presents the results from the analysis, indicates that the price sensitivity differential between teenagers and adults is almost identical for males and females. Furthermore, in all cases, the estimates for teenagers and adults are statistically different at the 95% confidence level. These results would indicate that younger Canadians are, indeed, more sensitive to price changes than adults. However, one has to be careful about jumping to conclusions since other factors, such as the anti-smoking publicity that has been aimed at younger Canadians, might explain this differential. That is, the observed

86. The coefficient estimates should be negative and, for a_1 to be greater than b_1 in absolute terms, b_1-a_1 would be positive.

higher price sensitivity of teenagers might be capturing the influences of a well-targeted advertising campaign.

Table 6.1

Comparing the Price Sensitivity of Teenagers and Adults

Cohort	Price Sensitivity Differential	Significantly Different
Males	0.54	Yes
Females	0.56	Yes
Total	0.54	Yes

In an effort to account for the possible effects of anti-smoking campaigns as well as other possible changes over time, equations 6.1 and 6.2 are re-estimated with a time trend. The purpose of the time trend is to capture any decline in smoking which might be attributed to social factors and anti-smoking publicity. The revised results, which are presented in Table 6.2, confirm the previous findings.

Table 6.2

Comparing the Price Sensitivity of Teenagers and Adults Including a Time Trend

Cohort	Price Sensitivity Differential	Significantly Different
Males	0.55	Yes
Females	0.67	Yes
Total	0.60	Yes

While, it is reassuring that the introduction of the time trend does not change the overall results, the model is too simple to be sufficient to draw a definitive conclusion that younger Canadians are more price sensitive than adults. Furthermore, survey data on smoking have several potential problems. For example, the social stigma of smoking leads many people to underestimate their true tobacco consumption. Moreover, it is now illegal

in four provinces[87] for those under the age of 18 to purchase tobacco increasing the likelihood that these individuals might be dishonest about their smoking. Consequently, one can only say that the results in Tables 6.1 and 6.2 provide an indication that younger Canadians have a higher price elasticity of demand.

87. Federal legislation prohibits the sale of tobacco to people under the age of 16. However, Prince Edward Island, New Brunswick, Ontario and Manitoba have made it illegal to sell tobacco products to anyone under the age of 18.

VII THE SUPPLY OF EXPORTED TOBACCO PRODUCTS

7.1 Introduction

As indicated in Chapter II, the quantity of cigarettes and fine-cut tobacco exported from Canada increased very substantially between 1985 and 1991. For example, cigarette exports grew by over 440%. Over the same period of time, there have been significant tax increases. Moreover, there has been a large growth in the number of seizures of illicitly imported cigarettes and this indicates that smuggling has become a problem in Canada.

This is not the first time that tobacco smuggling has been a problem. In 1951, the federal excise levies were increased by over 21% and, when combined with an increase in the manufacturer's price, the retail price of cigarettes rose by more than 25%. As a result, the price of cigarettes sold in Canada was about twice that in the United States. By the fall of 1951, there were numerous reports of widespread cigarette smuggling. In Parliament, Opposition members made repeated calls for a reduction in cigarette taxes to offset the surge in smuggling. Newspapers reported a sharp increase in the volume of contraband American cigarettes seized by the R.C.M.P. Finally, in 1952 and again in 1953, the government lowered the tobacco tax to combat what was referred to as " the smuggling corporation of America". In time, the number of seizures made by the R.C.M.P. fell and the smuggling problem dissipated.

The important difference between today's experience and the smuggling problem of the early 1950's is the source of the product. In the 1950's, illicit tobacco products were American whereas today Canadian products are the primary source. However, the 1950's experience illustrates that Canadian smokers, given a sufficient price differential, will ignore differences in taste and switch to American cigarettes.

The existence of the market for smuggled tobacco products has consequences for government revenues. This chapter outlines an economic theory which explains the market for smuggled tobacco products. This model will then be used to provide an empirical assessment of the factors which might explain the recent increase in tobacco exports -- the primary source of illicit tobacco in Canada.

7.2 The Economics of Smuggling

The market for smuggled tobacco products is an example of a "black market". As with any market, there must be a supply and a demand for the product. The supply side consists of tobacco products illicitly imported from the United States and distributed in Canada. The demand side is made up of individuals who have left the legal market but continue to smoke. Based on the interaction between supply and demand, an equilibrium price is established for smuggled tobacco products.

If the price of smuggled tobacco products were the same as the legal price, there would be no demand for them. Therefore, for such a market to exist, consumers must be able to save money. On the other hand, if such a market exists with no barriers and perfect information, then consumers would purchase only smuggled cigarettes and the price of legally-sold tobacco products would fall until the prices became equal[88]. Although there are a few isolated cases where retailers are selling cigarettes as loss-leaders, there is no evidence to suggest an overall reduction in legal tobacco prices induced by the price of smuggled cigarettes. Consequently, there are either barriers between the two markets and/or there is less than perfect information.

Consider first the availability of information. Throughout the economy, there are significant variations in the prices of many goods and services. These price variations can be explained by a number of factors such as warranties, after-purchase service and quality of the sales staff. Perhaps the most important factor is the cost of information. It is costly to search actively among suppliers to find the lowest price for a given good. This cost involves search time (equivalent to one's foregone wage) and resources (e.g. gasoline for the car). Therefore, rational consumers will continue to search for lower prices only so long as the search costs are lower than the expected savings.

Search (or information) costs are especially important with smuggled tobacco products. As these products are illegal, the vendor cannot disseminate information in the same fashion as other vendors. For example, smugglers are unlikely to take out advertising in the local newspaper to promote their product. Moreover, most smuggled tobacco products are not available in the normal retail environment. Therefore, the potential consumer must determine who is selling the product and where it is available based primarily on word of mouth.

A further consideration in the demand for smuggled tobacco products is the fact that the consumer is participating in an illegal activity. Although it would be difficult to prosecute someone for smoking an illicit tobacco product, that smoker is certainly aware that the product has been obtained through illegal means. Since most individuals are law abiding, there is a perceived "cost" for smokers to purchase smuggled tobacco products and they are willing to purchase these products only if the savings more than cover these costs.

The costs of search and participating in an illegal activity ensure that the maximum price which consumers will pay for smuggled tobacco products is less than the retail price. If the costs of search and participating in an illegal activity are **i**, then the maximum price which consumers will pay is:

$$P^{max} = P^{retail} - i$$

88. Of course, if the legal price does not fall sufficiently to equal the illicit price, the legal market would cease to exist.

where $\mathbf{P}^{retail}$ is the legal retail price of tobacco products. If **i** increases, the demand for smuggled tobacco products goes down.

The supply of smuggled tobacco products is analogous to the supply of any other commodity. Economic agents will provide the product based on the principle of profit maximization. If the associated profits are less than zero, then the product will not be supplied. That is, if the price of the smuggled product does not cover the cost of supplying it, there will be no supply. Suppose the smuggled tobacco product originates in Canada and is purchased in the United States. The cost of supplying the smuggled tobacco product would include the manufacturer's export price, the transportation costs to the United States, the transportation cost back to Canada, the American distribution markups, and possibly the American tax.

Unlike most other products, the suppliers of smuggled tobacco products risk legal consequences if they are caught and so the price charged by suppliers must reflect this potential cost. The associated risk premium would be equivalent to the potential penalty associated with getting caught multiplied by the probability of that occurring. Thus, the minimum price at which smuggled tobacco products will be supplied can be described as:

$$\mathbf{P}^{min} = \mathbf{m} + \mathbf{s}$$

where **m** is the private costs associated with supplying smuggled tobacco products and **s** is the cost of getting caught. If there is an increase in the price of getting caught, then the minimum market price would also increase causing a reduction in the supply of smuggled tobacco products[89].

89. If the private costs **m** went up, the supply of smuggled tobacco products would be reduced only if the increase in private costs did not affect the price of legal tobacco products. An example could be higher tobacco taxes in the United States.

Figure 7.1
Market For Smuggled Tobacco Products

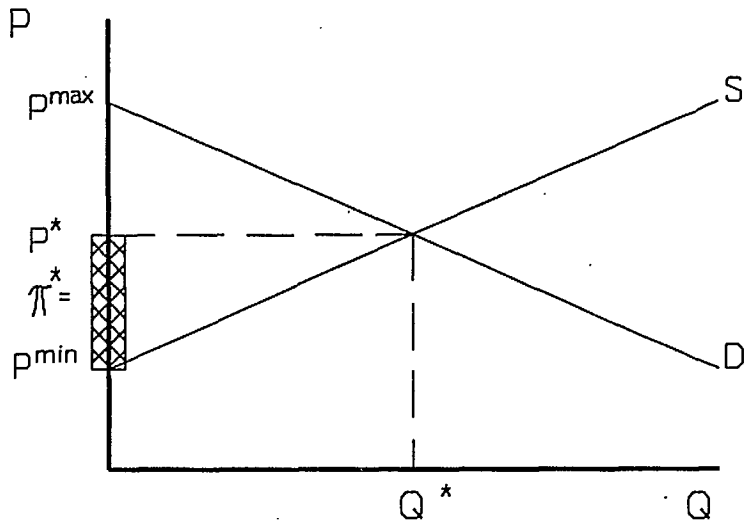
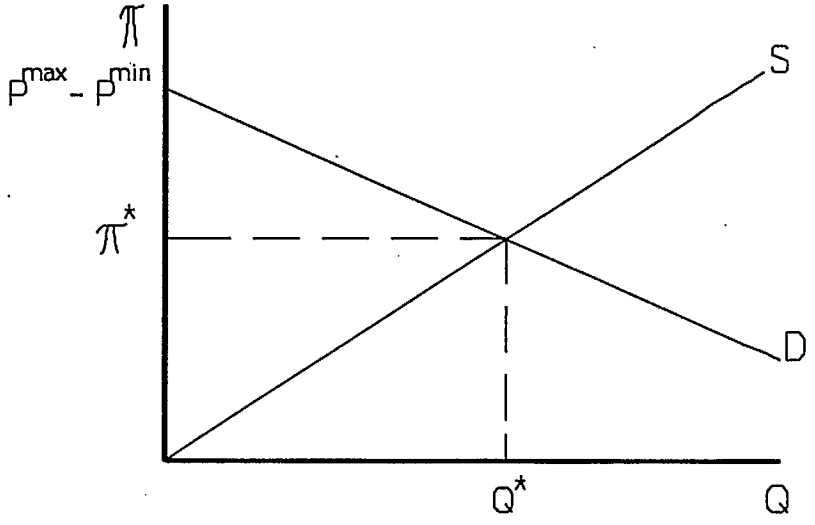


Figure 7.1 provides a geometric description of the market for smuggled tobacco products. The demand for smuggled tobacco products (**D**) approaches zero as the price of the product approaches $\mathbf{P}^{max}$. As with any other product, the demand increases as the price falls. The supply of smuggled tobacco products is positively correlated with the price and approaches zero as the price of the product approaches $\mathbf{P}^{min}$. The equilibrium price $\mathbf{P}^*$ and quantity $\mathbf{Q}^*$ are determined by the condition that supply equals demand.

An alternative way of describing Figure 7.1 is that the difference between the equilibrium price $\mathbf{P}^*$ and the minimum supply price ($\mathbf{P}^{min}$) can be viewed as a measure of the incentive to supply smuggled tobacco (π^*). When the incentive is zero, there will be no supply of smuggled cigarettes. As the incentive increases, so too will the supply of smuggled tobacco products. On the other hand, when the incentive is equal to $\mathbf{P}^{max}$ minus $\mathbf{P}^{min}$ there will be no demand since the savings which accrue to consumers are just equal to the search costs. As the incentive declines, the savings for consumers increase and this leads to increased demand. This interpretation of the market is shown in Figure 7.2.

Figure 7.2

Market For Smuggled Tobacco Products
(Quantity As It Relates To The Supply Incentive)

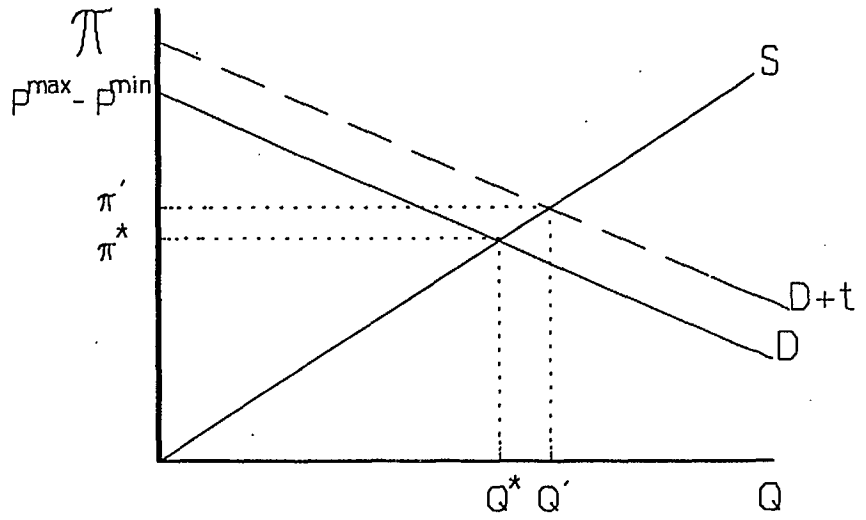


The model outlined above can now be used to predict what would happen to the supply and the demand given a shock. For example, let us assume that there is an increase in the domestic tobacco tax[90]. As Figure 7.3 shows, the demand for smuggled tobacco products will shift up by the amount of the tax. This shift arises from the fact that $\mathbf{P}^{max}$ has increased by the same amount as the tax (caused by the increase in $\mathbf{P}^{retail}$). Therefore, the tax change will lead to an increase in the supply of smuggled cigarettes (from $\mathbf{Q}^*$ to $\mathbf{Q}'$) and an increase in the associated supply incentive (from π^* to π').

90. This would be equivalent to increasing one of the federal excise levies or a provincial tobacco tax.

Figure 7.3

Impact Of An Increase In The Domestic Tobacco Tax On The Market For Smuggled Tobacco Products



7.3 Model Development

At first glance, the empirical estimation of the demand for smuggled tobacco products would appear to be impossible. As with any black market, one cannot observe the actual quantity traded or the associated price. Furthermore, it is very difficult to quantify information costs or the probability of being caught. Nevertheless, there are some methods which can be employed to test for at least the existence of the market for smuggled tobacco products and to obtain an approximation of the responsiveness of the demand for smuggled tobacco products to changes in the domestic tobacco tax.

To that end, two models are developed to explain the level of exported tobacco products over time. The first is a natural rate model which tries to explain changes in exports destined for legitimate markets. The second incorporates variables which attempt to capture the influence of smuggling explicitly. As with the analysis of earlier chapters, the models are developed and estimated for both cigarettes and fine-cut tobacco.

The Natural Rate of Exports

If there were no smuggling, Canadian tobacco exports would be destined for a legitimate economic market. The first question then is who is the ultimate consumer in this legitimate market. It is clear that Canadian and American tobacco products are significantly different in terms of both taste and smell. It might be the case that some Americans prefer Canadian cigarettes. However, in 1982 Canadian exports represented such a small share of the American market (0.15%) that this seems unlikely. The other group of consumers would be Canadians travelling to the United States and other countries who purchase Canadian cigarettes either while they are outside the country[91] or at duty-free stores on their way back.

In the absence of any smuggling, a properly specified natural rate model should be able to explain changes in the level of exports. However, once smuggling becomes significant, the variables in the natural rate model would not be sufficient to explain smuggling-related exports and the parameter constancy of the model would be compromised. Therefore, the natural rate model can be used to determine when smuggling became a problem by extending the sample period and assessing the parameter constancy of the model[92].

If one assumes that the legitimate market for Canadian cigarettes in the United States consists mostly of Canadian travellers, then it is relatively straightforward to identify what factors would influence the level of supply. The first factor would be the real price of tobacco products in the United States -- the higher the price, the higher the supply. The second factor would be the number of Canadians travelling outside the country for more than 2 days[93] -- the higher the number of travellers, the higher the demand. The final factor would be real disposable income in Canada which affects the consumption of each traveller.

---

91. A significant number of retailers in American resorts which are popular destinations for Canadians carry Canadian tobacco products.

92. This test is performed by breaking the sample in two and comparing the explanatory power of the regression in the sub-samples versus the overall sample.

93. Canada Customs require that individuals be away from Canada for more than 48 hours before tobacco products can be brought back duty free.

Therefore, the natural rate model for exports can be estimated based on the U.S. price of tobacco products, the number of Canadian travellers and disposable income using the following functional form[94]:

$$X_{c \text{ or } f}=a_0+a_1*PUS+a_2*TRAV+a_3*YD \qquad (7.1)$$

where X_c is the amount of exported cigarettes per smoker[95] in Canada; X_f is the amount of exported fine-cut tobacco per smoker in Canada; PUS is the real price of tobacco in the U.S. expressed in Canadian dollars; TRAV is the number of Canadians who travelled outside the country for two days or more as a ratio of the total population 15 years or older; and YD is real per capita disposable income.

Incorporating Smuggling Into The Demand For Exports

The theoretical presentation of the market for smuggled tobacco products yields an alternative method for assessing changes in the level of exports. As Figure 7.3 indicates, changes in the domestic tobacco tax cause shifts in the demand for smuggled tobacco products. If the quantity of smuggled tobacco products could be observed, the changes in the level of taxes would enable a researcher to observe the **supply** of smuggled tobacco products. That is, changes in tobacco taxes cause changes in the demand for smuggled tobacco products which leads to a new point of equilibrium **along the supply curve**. As long as only the level of taxes are changing then the relationship between supply and price would be identified[96].

Of course, the supply of smuggled tobacco products is also influenced by other factors such as the acquisition cost, distribution costs, and the expected cost of being caught (the actual penalty multiplied by the probability). Changes in any of these variables would lead to a shift in the supply curve and the impact of these shifts would have to be included in the empirical estimation. For example, the expected cost of being caught can be approximated[97] by the inverse of the total number of Canadians travelling outside the

---

94. The linear formulation is used for illustrative purposes only. One would have to test this functional form versus a logarithmic formulation or some type of Box-Cox transformation.

95. The number of smokers is estimated based on population data for Canada and the proportion of Canadians who smoke through time.

96. If the demand curve was shifting due to changes in information costs then it would be much more difficult to attribute changes in quantity to changes in price.

97. Ideally, one would like to construct the expected cost of being caught by multiplying the average fine with the probability of being caught. However, there are not sufficient data to allow this approach and a second-best alternative is followed.

country[98]. As the expected cost increases, then the supply curve in Figure 7.2 will shift up causing an increase in the price of smuggled tobacco products and a decline in quantity.

While it is useful to determine the factors that influence the level of smuggled tobacco products, it has to be remembered that there should still exist a level of exports to supply legitimate markets. Consequently, the smuggling components should be incorporated into the natural rate model described by equation 7.1. That is, the general smuggling model can be written as follows:

$$X_{c \text{ or } f}=a_0+a_1*PUS+a_2*TRAV+a_3*YD+a_4*TAX_{c \text{ or } f}+a_5*COST \qquad (7.2)$$

where TAX_c is the real level of taxes per 200 cigarettes; TAX_f is the real level of taxes per 200 grams of fine-cut tobacco[99]; and COST is an index of the expected cost of being caught which is computed by taking the inverse of the product of the total number of people crossing the border and the total CPI.

As was pointed out above, the presence of smuggling should be reflected in the estimation of the natural rate model in the form of structural instability. Moreover, the point at which the structural problems are encountered should indicate when smuggling becomes measurable. The smuggling model can be used to confirm this hypothesis. That is, over the time period in which the natural rate model is structurally sound, the coefficients associated with the smuggling components in equation 7.2 (a_4 and a_5) should not be statistically different from zero. Furthermore, if the smuggling components adequately account for the full-sample structural instability of the natural rate model, then the coefficients associated with the natural rate model component of equation 7.2 (a_1, a_2 and a_3) should be equivalent to the values estimated for a structurally-sound natural rate model.

Therefore, the smuggling model described by equation 7.2 should be estimated for the full sample period (1972 to 1991[100]). The smuggling components become threshold variables where the associated coefficient is assumed to be zero during the period in which the natural rate model is structurally sound. As with the natural rate model, the smuggling model can be used to assess the potential change in the level of smuggled tobacco products over time.

---

98. Data from Canada Customs indicates that the number of searches at the border has remained relatively constant through the 1980's. However, the number of crossings has increased considerably over the same period of time. Therefore, the probability of being caught should be inversely proportional to the number of crossings. Since the associated penalties have remained relatively constant in nominal terms, the real costs of being caught should be proportional to the inverse of the total CPI.

99. Unlike the domestic models described in Chapters IV and V, there is no adjustment made in the level of the ad valorem levies.

100. Statistics Canada reports export data beginning only in 1972.

It is important to note that both of the methods described above can be used to measure only the potential illicit market for exported Canadian tobacco products. That is, the models fail to capture illicit tobacco products originating from other countries and, in particular, the United States. However, seizures of American cigarettes appear to represent only about 10% of total seizures and so this analysis should capture a large portion of the smuggling market. Moreover, the models cannot capture the effects of a change in the propensity of Canadians to import duty-free tobacco on their return to Canada.

7.4 Empirical Results

The approach used in the estimation process is similar to the one described in Chapter IV. That is, the Hendry Approach is followed beginning with a first-order error correction model. The appropriate functional form (linear, logarithmic or some form of Box-Cox transformation) is determined using a PE test. Then, the appropriate model is chosen by testing the restrictions implied by either a partial adjustment or static model. In all cases, the models are estimated using quarterly data from 1972 to 1991[101].

The Natural Rate of Exports Model

The error correction model results obtained for both cigarettes and fine-cut tobacco indicated that the equations should be estimated using a static model expressed logarithmically. Since the purpose of the natural rate model is to determine when smuggling becomes a measurable problem, the analysis begins by estimating a static logarithmic natural rate model for both product types over the period 1972 to 1991. Throughout this period, the models are tested for structural breaks using a Chow test and an Asymptotic F-test. That is, the sample is split in two at various points in time and the parameter constancy between the two sub-samples tested. The results revealed important structural breaks starting in the first quarter of 1983 in the case of cigarettes and the fourth quarter of 1986 in the case of fine-cut tobacco.

It is important to recognize that the existence of a structural break does not prove that smuggling is a problem. Other factors might explain the change. For example, there could have been an increase in the propensity of travellers to bring back tobacco[102]. In addition, Canadians could be spending more time away from Canada and this, in turn, would lead to an increase in the consumption of Canadian tobacco abroad. Finally, foreigners might have developed a preference for Canadian cigarettes. Therefore, the

---

101. As with the models for domestic consumption, quarterly data requires the inclusion of quarterly dummy variables -- QD2, QD3 and QD4.

102. In other words, more travellers take advantage of the duty-free limit including non-smokers buying tobacco for smokers.

presence of the structural break only suggests that smuggling started to become a problem in 1983 for cigarettes and 1987 for fine-cut tobacco.

The final natural rate model estimates should be based only on a time period in which the model is structurally sound. Therefore, the natural rate model for exported cigarettes is estimated from 1972 to the end of 1982 while the fine-cut model covers the period 1972 to the third quarter of 1986. The results are presented in Table 7.1.

Table 7.1

Empirical Results For The Natural Rate Model

i) Exported Cigarettes (1972 Q1 to 1982 Q4)

$$\log XC_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4$$

Variable	Estimated Coefficient	T-Statistic
Constant	-0.7832	
PUS	0.8471	1.71
TRAV	0.7032	4.51
YD	1.8574	4.85
QD2	-0.0531	1.10
QD3	-0.4656	4.78
QD4	-0.0318	0.51
$\bar{R}^2$	.776	

ii) Exported Fine-Cut Tobacco (1972 Q1 to 1986 Q3)

$$\log XF_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4$$

Variable	Estimated Coefficient	T-Statistic
Constant	-4.9412	
PUS	1.2264	2.91
TRAV	1.5048	3.09
YD	3.2185	3.77
QD2	-0.1454	1.10
QD3	-1.3212	5.29
QD4	0.2199	1.18
$\bar{R}^2$	.492	

XC Per-smoker cigarette exports
PUS Real price of tobacco in the U.S.
YD Real per capita disposable income
XF Per-smoker fine-cut exports
TRAV Number of travellers (2 or more days)
QDi Quarterly dummy for quarter i

One would expect that the coefficients associated with the price of tobacco in the United States would be positively correlated with the level of exports since the natural rate model measures a supply. In addition, the level of exports should be positively related to both the number of travellers and to disposable income. As Table 7.1 shows, the results from both the cigarette and fine-cut models support these expectations.

It is important to ensure that the estimated models conform to the statistical principles associated with ordinary least squares. Specifically, the residuals from both equations were submitted to various tests to identify the potential presence of autocorrelation or heteroskedasticity. None of the tests revealed any significant problems.

The Smuggling Model

In order to assess the impact of the factors that have contributed to smuggling, the natural rate models were re-estimated over the entire period incorporating the smuggling variables starting in the first quarter of 1983 in the case of cigarettes and the fourth quarter of 1986 in the case of fine-cut tobacco. Following the Hendry Approach, the results obtained from the error correction models indicated that a static model was appropriate in the case of cigarettes while a partial adjustment model would be more appropriate for fine-cut tobacco. Nevertheless, the results from the PE tests indicated that both equations should be estimated using a logarithmic functional form.

The models were estimated and tested for structural breaks. In both cases, the regression results indicated that the coefficient estimates were unstable. In particular, it was determined that there was a structural break in both equations in the second quarter of 1991. Furthermore, a comparison of the actual level of cigarette exports and the level implied by the cigarette regression revealed an important over-prediction in the second and third quarter of 1990[103].

The models had to be modified to account for these structural problems. To that end, an observation-specific dummy (D90) was introduced to account for this unexplained drop in the level of exported cigarettes in the second and third quarter of 1990[104]. In addition to the D90 variable, both equations were re-estimated twice: first, with

103. We have no explicit information relating to the cause of this temporary reduction.

104. D90 takes on a value of one only in the second and third quarters of 1990.

the sample ending in the first quarter of 1991 and, second, incorporating another observation-specific dummy (D912) to account for the structural break observed in the last three quarters of the estimation period[105].

The empirical results presented in Tables 7.2 and 7.3 indicate that a 10% increase in the level of real taxes on cigarettes would generate between a 10.2% and a 10.9% increase in the level of exported cigarettes. Similarly, a 10% change in the level of real taxes on fine-cut tobacco would generate roughly a 10.2% change in the level of exported fine-cut tobacco in the short-run and a 16.5% change over the long-run. That is, there is a significant correlation between taxes and the level of exports.

105. It should be noted that several different specifications were tested in order to account for this structural break. In particular, various specifications which included the interaction of observation-specific dummies and some combination of the other variables were tested. None of these specifications proved to be statistically appropriate. Clearly, there are not sufficient data after the break to allow us to identify the true nature of the problem.

Table 7.2

Empirical Results For The Smuggling Model Excluding D912

i) Cigarette Exports

$$\log XC_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4+a_7\log TAXC_t +a_8\log COST_t+a_9D90$$

Variable	Estimated Coefficient	T-Statistic
Constant	-1.9785	
PUS	0.0341	0.08
TRAV	0.5909	3.76
YD	1.3044	3.69
QD2	0.0623	1.46
QD3	-0.3263	3.92
QD4	0.0133	0.22
TAXC	1.0883	7.18
COST	-0.1316	6.64
D90	-0.2034	2.05
$\bar{R}^2$	.944	

ii) Fine-Cut Tobacco Exports

$$\log XF_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4+a_7\log TAXF_t +a_8\log COST_t+a_9XF_{t-1}$$

Variable	Estimated Coefficient	T-Statistic
Constant	-3.1990	
PUS	1.2296	2.28
TRAV	0.5401	0.88
YD	2.3626	2.15
QD2	0.7100	0.48
QD3	-0.5477	1.91
QD4	0.0223	0.10
TAXF	1.0298	2.54
COST	-0.3413	8.22
XF_{t-1}	0.3762	3.09
$\bar{R}^2$	.923	

XC Per-smoker cigarette exports
PUS Real price of tobacco in the U.S.
YD Real per capital disposable income
TAXC Real level of taxes - cigarettes
D90 Observational dummy for 90Q2 and 90Q3

XF Per-smoker fine-cut exports
TRAV Number of travellers
QDi Quarterly dummy for quarter i
COST Real cost of getting caught
TAXF Real level of taxes - fine-cut

Table 7.3

Empirical Results For The Smuggling Model With D912

i) Cigarette Exports

$$\log XC_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4+a_7\log TAXC_t +a_8\log COST_t+a_9D90+a_{10}D912$$

Variable	Estimated Coefficient	T-Statistic
Constant	-2.3727	
PUS	0.1768	0.38
TRAV	0.6717	4.00
YD	1.3160	3.47
QD2	0.0461	1.01
QD3	-0.3675	4.17
QD4	0.0484	0.75
TAXC	1.0246	6.33
COST	-0.1232	5.83
D90	-0.1925	1.89
D912	0.5847	5.13
$\bar{R}^2$	.959	

ii) Fine-Cut Tobacco Exports

$$\log XF_t = a_0+a_1\log PUS_t+a_2\log TRAV_t+a_3\log YD_t+a_4QD2+a_5QD3+a_6QD4+a_7\log TAXF_t +a_8\log COST_t+a_9XF_{t-1}+a_{10}D912$$

Variable	Estimated Coefficient	T-Statistic
Constant	-3.2780	
PUS	1.2332	2.33
TRAV	0.5473	0.91
YD	2.3503	2.18
QD2	0.0689	0.47
QD3	-0.5482	1.96
QD4	0.0260	0.12
TAXF	1.0190	2.60
COST	-0.3410	8.37
XF_{t-1}	0.3803	3.25
D912	0.7414	2.03
$\bar{R}^2$	.947	

XC Per-smoker cigarette exports
PUS Real price of tobacco in the U.S.
YD Real per capital disposable income
CTAX Real level of taxes - cigarettes
D90 Observational dummy for 90Q2 and 90Q3
TAXF Real level of taxes - fine-cut
XF Per-smoker fine-cut exports
TRAV Number of travellers
QDi Quarterly dummy for quarter i
COST Real cost of getting caught
D912 Observational dummy for 91 Q 2,3,4

It is also interesting to note that the COST variable, which is a proxy for the expected cost of being caught smuggling, is statistically significant in both equations. The results suggest that a 10 per cent increase in either enforcement at the border (number of searches) or the associated level of fines would result in a reduction of between 1.2 and 1.3 per cent in the level of exported cigarettes and a 3.4 per cent drop in fine-cut tobacco exports. That is, an increase in either enforcement at the border (number of searches) or the associated level of fines would result in a reduction in the level of smuggled tobacco.

It is also interesting to compare the coefficients of the natural rate components in the smuggling model to the estimates obtained from the natural rate model. This comparison is accomplished by testing whether the coefficients between the two models are statistically different from each other. In every case, the F-test accepted the hypothesis that the coefficients were the same.

The consistency of the smuggling and natural rate models provides even stronger evidence of the existence of a market for smuggled tobacco. Throughout the early years of the sample period, the natural rate models are structurally sound. Then, over the later years, the natural rate models fail to adequately explain changes in the level of tobacco exports. However, once the smuggling components are introduced, the revised models are basically structurally sound.

7.5 Potential Level of Tobacco Smuggling

The empirical results of the previous section can now be used to assess the potential level of tobacco smuggling in Canada. However, it is important to remember that none of the models can measure the potential flow of tobacco from foreign countries and that there are indications that American cigarettes comprise as much as 10% of total cigarette seizures[106]. Moreover, the models cannot account for a change in the propensity of Canadians to legally import duty-free tobacco products on their return from foreign trips. Finally, the models provide only a proxy for an activity that cannot be observed.

The natural rate model estimates changes in the level of tobacco exports which are destined for legitimate markets. The models are estimated only over the time period for which they are structurally sound and so smuggling is not a problem. These models can then be used to estimate the potential level of smuggling by projecting the level of exports consistent with the natural rate model and comparing it with the actual level of exports. The difference between this forecast and the actual levels can be attributed to smuggling. **In interpreting the results, it is important to realize that other factors might explain the presence of a structural break and that the existence of the structural break does not provide statistical proof of tobacco smuggling.**

---

106. If seizures represent an unbiased random sample of smuggling activity, then American cigarettes could represent about 10% of the total quantity of smuggled cigarettes in Canada.

The smuggling models explicitly incorporate variables to measure changes in the level of illicit tobacco products -- the real level of taxes and the real cost of being caught. The potential change in the level of smuggling can be derived based on changes in these variables. Careful attention has to be paid to the observation-specific dummy D912 used to capture the significant increase in the level of exports in the last three quarters of 1991 which could not be explained by the other variables in the model. It could be capturing the effects of a missing variable, a one-time event, a significant change in smuggling or many other things. Therefore, the potential change in the level of smuggled tobacco is measured based on a model which excludes D912 (Table 7.2) and one which includes the variable (Table 7.3). In the case of the latter, D912 is assumed to be related entirely to smuggled tobacco.

Table 7.4 provides the results based on the three different models. As one would expect, the largest increase in the potential level of smuggling occurred in 1991. The cumulative increase in smuggling over the last five years, which should approximate the total annual magnitude, ranges from 9.3 to 23.9 million cartons of cigarettes and from 3.1 to 12.0 million 200 gram tins of fine-cut tobacco. In other words, the cumulative increase in smuggling represents as much as 12% of the domestic shipments of cigarettes and 38% of the domestic shipments of fine-cut tobacco in 1991.

The most startling observation regarding Table 7.4 is the influence of the D912 variable. Including D912 in the smuggling model and attributing its influence to a structural change in smuggling results in an increase in the estimated change in cigarette smuggling in 1991 of over 100%. As was noted earlier, there are many possible explanations for D912 and the data do not allow for a proper statistical assessment. However, it should be noted that the level of exports implied by the model which excludes D912 is significantly less than the actual level over the first two quarters of 1992. That is, there are strong indications that the influence of D912 is persisting.

Table 7.4

Potential Changes in the Level of Tobacco Smuggling
(Millions of Cartons or 200 Gram Tins)

	Natural Rate Model		Smuggling Model			
			Without D912		With D912	
	Cigarettes	Fine Cut	Cigarettes	Fine Cut	Cigarettes	Fine Cut
1987	2.0	0.5	0.4	0.0	0.3	0.0
1988	-0.4	0.2	0.5	0.1	0.4	0.0
1989	2.7	0.3	2.0	0.2	1.9	0.2
1990	-0.9	1.8	1.6	0.7	1.5	0.7
1991	20.5	9.6	4.8	2.1	17.3	10.1
Total	23.9	12.4	9.3	3.1	21.4	12.0

The true nature of D912 could have serious implications for future tax revenues and, as such, an understanding of the variable would be very useful. To that end, the theory developed in section 7.2 to explain the market for smuggled tobacco products might provide some insight into D912. Specifically, D912 might be capturing shifts in the supply relationship shown in Figure 7.2. For example, the recent increase in the real level of taxes has led to a significant increase in the real profits for smugglers. Consequently, there has probably been a large increase in the number of suppliers and this would cause a downward shift in the supply curve.

D912 could also be capturing shifts in the demand curve. For example, a large increase in the number of suppliers could have led to a reduction in the information costs of consumers since it would be easier for a smoker to find the product. Moreover, a large increase in the number of people purchasing smuggled tobacco products could have led to a reduction in the perceived "cost" of participating in an illegal activity causing a "bandwagon" effect. Both of these effects would lead to an upward shift in the demand curve.

The consequences of a downward shift in supply and/or an upward shift in demand are the same. Both lead to an increase in the quantity of smuggled tobacco products. If these shifts are only a one-time event, then there will be no further long-term consequences. However, if they are dynamic in nature, then the number of suppliers would be continually increasing causing further reductions in information costs and an even larger volume of smuggled tobacco products. Alternatively, one cannot discount the possibility that D912 represents a structural change in one of the coefficients in the smuggling model. For example, it could be the case that the supply of smuggled tobacco products has become more sensitive to tax changes. As a result, future tax increases might lead to even larger increases in smuggling.

In order to gain further insight into the possible explanation for D912, the models which describe domestic cigarette consumption and cigarette exports (including D912) are used to forecast domestic cigarette consumption and cigarette exports in 1992. The forecast values are then compared with the actual values over the first two quarters. The domestic model accurately predicted consumption in the first quarter but over-predicted consumption by almost 6% in the second quarter. On the other hand, the export model over-predicted exports in the first quarter by almost 19% while under-predicting exports by roughly 12% in the second quarter.

The failure of the export model to predict the level of exports in the first quarter of 1992 can be attributed to the influence of the tobacco export tax. Likewise, the under-prediction in the second quarter might be attributed to a surge in exports as American distributors were restocked following the suspension of the export tax. However, it should be realized that the forecast level of exports is artificially high since it does not take into account the important increase in the level of enforcement in 1992. Furthermore, Canadian cigarette brands are now being manufactured in the United States. These considerations, when combined with the fact that the domestic model over-predicted

consumption by almost 6%, would suggest that smuggling is more of a problem than implied by the models described above.

7.6 Summary

This chapter has presented two models which try to explain changes in Canadian tobacco exports over time. The first, the natural rate model, sought to explain the supply of exported tobacco to legitimate markets meeting the demand created by Canadians travelling abroad. However, it could not explain the recent surge in the level of exports -- an amount which is attributed to smuggling. Therefore, a second model was presented which included not only the supply to legitimate markets but also incorporated variables which captured the influence of smuggling. The results of this smuggling model reveal that a 10% increase in the level of real tobacco taxes in Canada would lead to at least a 10% increase in the level of tobacco exports -- an amount which would appear to be destined for the smuggling market.

VIII SOME IMPLICATIONS OF THE RESULTS

8.1 Introduction

The estimates derived in previous chapters have direct consequences for the level of government revenues. The domestic consumption models estimated in Chapter V provide possible values for the price elasticity of demand. In addition, they show that, over the last few years, the change in the real level of tax has had an influence on the substitution between legal and illicit tobacco products. The models explaining the supply of Canadian tobacco exports attempt to shed more light on the market for smuggled tobacco products.

The purpose of this chapter is to take the empirical results developed in previous chapters and assess their consequences for federal revenues and overall consumption. Thus, section 2 looks at the events which took place in 1991 and their impact on federal revenues. In particular, attention will be paid to the 1991 federal budget, provincial tax increases and changes in private costs. Section 3 provides estimates for the potential loss in federal tax revenues as a result of the market for smuggled tobacco products. The final section provides an assessment of the potential change in overall tobacco consumption since 1985.

8.2 The Events of 1991 and Federal Revenues

i) The Impact of the 1991 Federal Budget

In the 1991 budget, the federal government announced the largest tobacco tax increase in history -- the excise tax was increased by three cents per cigarette along with commensurate increases in the federal rates on other tobacco products. Table 8.1 provides the impact of the excise tax increase on the price of a carton of 200 cigarettes. The pre-budget price represents the average price of a carton of cigarettes in Canada during January 1991. Furthermore, the analysis assumes that the tax change does not affect either provincial product taxes or private markups.

As Table 8.1 shows, the excise tax on a carton of cigarettes increased by $6 from $4.36 to $10.36 -- that is, a 137.6% change. Since both the GST and provincial sales taxes are levied on a price which includes the excise tax, their per-unit revenues increase automatically. The GST increased from $2.21 to $2.63 or by 19.0% while the average provincial sales tax increased from $1.94 to $2.32 for a change of 19.6%. As a result, the overall increase in the retail price of a carton of cigarettes was $6.80 or 19%.[107]

---

107. The analysis assumes that taxes are shifted forward to consumers dollar-for-dollar.

Table 8.1

Impact of the 1991 Federal Budget on the Price of Cigarettes
(A Carton of 200 Cigarettes)

Price Component	Pre-Budget	Post-Budget	% Change
Manufacturer's Price	$ 6.23	$ 6.23	0.0
Excise Duty	5.50	5.50	0.0
Excise Tax	4.36	10.36	137.6
Provincial Product Taxes	10.77	10.77	0.0
Private Markups	4.72	4.72	0.0
Goods and Services Tax	2.21	2.63	19.0
Provincial Sales Taxes	1.94	2.32	19.6
Retail Price	35.73	42.53	19.0

Table 8.2 provides the impact of the excise tax increase on the price of a 200 gram tin of fine-cut tobacco. The excise tax increased from $3.05 to $7.13 -- a jump of 133.8%. As a result, the GST increased by 29¢ or 19.2% and the average provincial sales tax increased by 30¢ or 21.4%. Therefore, the retail price of fine-cut tobacco went from $24.41 to $29.08 or an increase of 19.1%.

Table 8.2

Impact of the 1991 Federal Budget on the Price of Fine-Cut Tobacco
(200 Grams of Tobacco)

Price Component	Pre-Budget	Post-Budget	% Change
Manufacturer's Price	$ 4.59	$ 4.59	0.0
Excise Duty	3.67	3.67	0.0
Excise Tax	3.05	7.13	133.8
Provincial Product Taxes	6.90	6.90	0.0
Private Markups	3.30	3.30	0.0
Goods and Services Tax	1.51	1.80	19.2
Provincial Sales Taxes	1.40	1.70	21.4
Retail Price	24.41	29.08	19.1

One should bear in mind that there is no conclusive way to assess the true impact of the 1991 budget. First, the data never provide a point in time when domestic tobacco consumption is in a long-run equilibrium to which the tax shock can be applied. Second, it is difficult to identify the true level of domestic consumption immediately prior to the tax change. To approximate the potential impact of the budget, the domestic models are simulated assuming that the shock is applied to the observed data for the fourth quarter of 1990. Furthermore, the nature of the shock is derived from a pre-budget price -- the average price for January 1991.

Table 8.3 provides the estimated potential impact of the 1991 federal budget. The excise tax increase affected three variables in each model -- own price, the price of the substitute, and the real level of taxes. As Table 8.3 shows, the change in the price of cigarettes, all else being equal, led to a 13.2% reduction in domestic cigarette consumption. The increase in the real level of taxes led to a further reduction of 3.8%. Finally, the increase in the price of fine-cut tobacco resulted in a 1% increase in domestic cigarette consumption. The net result is that the budget led to a short-run reduction in domestic cigarette consumption of 16%. Over the long-run, the addictive nature of cigarettes catches up with some of those who tried to quit and this reduces the impact to a decline of 12%.

Table 8.3

Estimated Impact of the 1991 Federal Budget on Domestic Tobacco Consumption
(Percentage Changes)

Variable	Quantity Of Cigarettes		Quantity Of Fine-Cut Tobacco	
	Short Run	Long Run	Short Run	Long Run
Price of Cigarettes	-13.2	-9.9	20.0	30.7
Cigarette Taxes	-3.8	-2.9	n.a.	n.a.
Price of Fine-Cut	1.0	0.8	-4.6	-7.0
Fine-Cut Taxes	n.a.	n.a.	-18.4	-28.3
Total Impact	-16.0	-12.0	-3.0	-4.6

In the case of fine-cut tobacco, the increase in the price of the product led to a 4.6% reduction in domestic consumption in the short-run. The increase in the real level of taxes led to a further reduction of 18.4%. Finally, the increase in the price of cigarettes resulted in an increase of 20% in the demand for fine-cut tobacco. As a result, the net decline in domestic fine-cut consumption was 3%. Since domestic fine-cut consumption is positively correlated with past levels of consumption, the long-run impact of the budget is higher -- a reduction of 4.6%.

It should be noted that the estimated decline in domestic consumption represents only the change in the sale of legal tobacco products as measured by domestic shipments. It is not clear what happens to the true amount of total consumption as it includes the quantity consumed of illicit tobacco products. As discussed in chapter V, there is no reason to believe that the change in the demand for illicit tobacco would be equivalent to the change in legal consumption attributed to the tax changes shown in Table 8.3.

The model simulations can be used to ascertain the potential impact of the budget on domestic tobacco consumption prior to the switch to illicit tobacco products. Specifically, Table 8.3 shows that cigarette shipments decline by 12.2% in the short-run and 9.1% in the long-run (these values are obtained by subtracting the impact of taxes from the total impact shown in Table 8.3). This decline would be caused by a reduction

in the quantity consumed by each smoker, a reduction in the number of people who begin to smoke and an increase in the number of smokers who quit. In contrast, the quantity of fine-cut tobacco increases by 15.4% in the short-run and 23.7% in the long-run as the budget increased the real price differential between cigarettes and fine-cut tobacco.

These simulations can be used to determine how federal revenues would have been affected by the 1991 budget. Table 8.4 provides the estimated impact of the tax increase on domestic shipments of cigarettes and fine-cut tobacco. In fiscal year 1991/92, the level of domestic cigarette shipments were estimated to fall by about 28 million cartons while the domestic shipments of fine-cut tobacco was estimated to decline by 3.2 million 200 gram tins. However, the impact on domestic cigarette consumption in fiscal year 1992/93 would be slightly reduced as smokers who tried to quit return to their old habit[108]. That is, the long-run decline in domestic consumption is smaller than the short-run.

Table 8.4

Estimated Impact of Private Cost and Tax Changes Announced since 1991 on Domestic Shipments of Tobacco Products

Fiscal Year	February 1991 Tax Increase	Provincial Tax Increases	Private Cost Increases	Total Change
Cigarettes (Millions of Cartons of 200 cigarettes)				
1990-91	-0.7	0.0	0.0	-0.7
1991-92	-28.0	-11.3	-2.5	-41.8
1992-93	-27.8	-14.5	-3.0	-45.3
Fine-Cut Tobacco (Millions of 200 grams tins)				
1990-91	-0.1	0.0	0.0	-0.1
1991-92	-3.2	-1.6	0.9	-3.9
1992-93	-3.7	-2.4	1.5	-4.6

Table 8.5 presents the revenue implications of the 1991 budget. It shows that the tax increase generates $945 million in extra revenues from cigarettes and $105 million from fine-cut tobacco in fiscal year 1991/92. That is, the total revenue gain is $1,050 million -- $250 million less that the original budget forecast of $1,300 million[109]. In contrast, the total revenue gain in the following year, $1,075 million, is $30 million higher than that forecasted in the budget. It should be noted that the revenue reduction

108. Recall, the coefficient associated with lagged consumption in the domestic cigarette model is negative.

109. The budget actually forecasted a revenue gain of $1,400 million but this amount included $100 million in revenues from the application of the tax to inventories.

anticipated in the budget forecast assumed a constant decline in domestic tobacco consumption through time and this assumption is not supported by the empirical results described in Chapter V.

Table 8.5

Estimated Impact of Private Costs and Tax Changes Announced Since 1991 on Federal Revenues*
(Millions of Dollars)

Fiscal Year	February 1991 Tax Increase	Provincial Tax Increases	Private Cost Increases	Total Change
Cigarettes (Millions of Cartons of 200 cigarettes)				
1990-91	25	0	0	25
1991-92	945	(175)	(35)	735
1992-93	975	(225)	(45)	705
Fine-Cut Tobacco				
1990-91	5	0	0	5
1991-92	105	(20)	10	95
1992-93	100	(30)	15	85
Total				
1990-91	30	0	0	30
1991-92	1,050	(195)	(25)	830
1992-93	1,075	(255)	(30)	790

* Excise taxes and duties only, i.e., not accounting for sales taxes.

ii) Provincial Tax and Private Cost Increases

The increase in federal taxes was not the only factor that affected tobacco prices in 1991. The average provincial tax on cigarettes increased 23% and 28% for fine-cut during the year. Moreover, there was an increase of over 10% in the manufacturer's price. These changes led to an even higher real price for tobacco. As a result, there was a further reduction in domestic consumption causing an unanticipated loss in revenues to the federal government.

Table 8.4 shows that the increase in provincial taxes and private costs[110] led to a decline in domestic cigarette shipments of 13.8 million cartons in fiscal year 1991/92 and 17.5 million cartons in fiscal year 1992/93[111]. There was also a decline in the domestic shipments of fine-cut tobacco. These unanticipated reductions could not have been incorporated into the federal government's revenue forecast. As a result, the associated unanticipated loss in the federal revenues from tobacco excise levies will amount to $220 million in fiscal year 1991/92 and $285 million in the next year. That is, when all of the changes in 1991 are considered, total federal revenues in fiscal year 1991/92 are estimated to be $470 million lower than originally forecast in the 1991 budget -- $250 million because of a higher-than-expected quantity response and $220 million due to unanticipated changes in provincial taxes and private costs.

8.3 The Impact of Smuggling

Both Chapter V and VII presented estimates for the potential change in the annual level of smuggled tobacco products since 1986[112]. These results can be used to assess the implications of the market for smuggled tobacco on federal revenues. Table 8.6 provides the estimated potential revenue loss due to smuggling based on the per-unit revenues in December 1991[113]. That is, in 1991, the federal government lost anywhere from $555 million to $695 million in revenues[114].

---

110. The increase in private costs represents the change in the manufacturer's price and any changes in the distribution margins.

111. Unlike the results of the simulated impact of the 1991 federal budget, the quantity reduction grows in the following fiscal year. This increase arises from the fact that the price and tax changes occurred throughout 1991 and 1992. As a result, the full impact of these changes are not reflected in fiscal year 1991/92.

112. See Table 5.7 and Table 7.4.

113. The per-unit revenues would include the excise tax, the excise duty and the GST collected from each carton of cigarettes or 200 gram tin of fine-cut tobacco.

114. The analysis in Chapter VII clearly shows the importance of D912 in the smuggling model and it appears that the effects of this variable are persisting through time. Therefore, Table 8.6 does not consider the smuggling model which excludes D912.

Table 8.6

Potential Revenue Loss From Smuggling In 1991
Based on Per-Unit Revenues in December 1991
(Millions of Dollars)

Type of Model	Change	Total
Domestic Consumption Models	400	695
Natural Rate Models	510	605
Smuggling Models Including D912	455	555

It is interesting to note that the natural rate model and the smuggling model with D912 yield estimates which exceed those of the domestic consumption models in 1991. Of course, there is no reason to believe that the domestic models would yield the same results as the export supply models. The level of tax in both domestic consumption models attempts to measure the change in domestic demand as a result of a substitution between legal and illicit products. In contrast, the export supply models try to quantify changes in the supply of illicit tobacco products based on the quantity of Canadian tobacco exports.

In interpreting the results, it is important to realize that the implied revenue loss could only be recovered by the total elimination of smuggling at prevailing tax rates, which would likely be impractical given the long border between Canada and the United States. In addition, increases in enforcement entail additional costs which would reduce the potential increase in revenues. Moreover, the models provide estimates which are only indications for a market that cannot be observed. Therefore, the revenue losses presented in Table 8.6 should not be viewed as revenues which could actually be realized.

8.4 Change In Overall Tobacco Consumption Since 1985

To this point, the study has provided insights into the relationship between taxes and domestic consumption as well as the market for smuggled tobacco. However, very little attention has been paid to the overall level of tobacco consumption in Canada which would include both legal and illicit tobacco purchases. The purpose of this section is to assess the potential change in the overall level of tobacco consumption in Canada since 1985.

Table 8.7 provides the potential change in the overall consumption of cigarettes. The domestic shipments column depicts the quantity of legal tobacco purchases in Canada. The estimated quantity of smuggled cigarettes is based on the results obtained from the natural rate model as described in Table 7.1. That is, the level of smuggling is determined by netting the quantity of cigarette exports suggested by the natural rate model from total cigarette exports. However, to take account of the cigarettes smuggled into Canada but manufactured outside of the country, the natural rate estimates are inflated by 10%[115]. The overall consumption of cigarettes is obtained by summing domestic shipments and the estimated level of smuggling. As can be seen from Table 8.7, the estimated level of overall cigarette consumption has declined every year since 1985.

Table 8.8 provides a similar assessment for fine-cut tobacco consumption. In contrast to cigarettes, the overall consumption of fine-cut tobacco has generally increased since 1985. These increases can be attributed to the fact that fine-cut tobacco has become relatively cheaper than cigarettes. Consequently, smokers are switching to the less-expensive alternative.

115. Recall, American cigarettes could represent about 10% of the total market for smuggled cigarettes in Canada. However, it should be noted that the market for smuggled fine-cut tobacco appears to be primarily supplied from Canadian sources.

Table 8.7

The Overall Consumption of Cigarettes Since 1985

(Millions of Cartons)

Year	Domestic Shipments (1)	% Change	Estimated Smuggling (2)	% Change	Estimated Consumption (1)+(2)	% Change
1985	294.8		0.5		295.3	
1986	277.2	-6.0	2.3	360.0	279.5	-5.4
1987	263.1	-5.1	4.6	100.0	267.7	-4.2
1988	255.3	-3.0	4.1	-10.9	259.4	-3.1
1989	238.0	-6.8	7.1	73.2	245.1	-5.5
1990	229.6	-3.5	6.1	-14.1	235.7	-3.8
1991	194.7	-15.2	28.7	370.5	223.4	-5.2

Table 8.8

The Overall Consumption of Fine-Cut Tobacco Since 1985

(Millions of 200 Gram Tins)

Year	Domestic Shipments (1)	% Change	Estimated Smuggling (2)	% Change	Estimated Consumption (1)+(2)	% Change
1985	34.3		0.0		34.3	
1986	37.1	8.2	0.1	-	37.1	8.2
1987	39.3	5.9	0.6	500.0	39.8	7.3
1988	40.1	2.0	0.8	33.3	40.8	2.5
1989	38.7	-3.5	1.0	25.0	39.7	-2.7
1990	33.3	-14.0	2.9	190.0	36.1	-9.1
1991	32.0	-3.9	12.5	331.0	44.4	23.0

IX CONCLUSION

The purpose of this report was to address several important questions: how do tax increases affect the demand for tobacco products; to what degree are cigarettes and fine-cut tobacco substitutes; are younger Canadians more price sensitive than older Canadians; and, to what extent have recent tax increases affected the market for smuggled tobacco products. To that end, several models were developed to assess the demand for domestic tobacco products, the price sensitivity of younger Canadians and the supply of exported tobacco products.

It is clear that the tobacco taxes levied by both the federal and provincial governments comprise a large share of the ultimate retail price. As such, the retail price is very sensitive to changes in the level of tax. Therefore, this report has sought to quantify the price elasticity of demand for tobacco since it will be useful in providing more reliable revenue forecasts. Two models were developed to explain changes in the demand for cigarettes and fine-cut tobacco. The empirical results indicate that the short-run price elasticity of demand is currently -0.9 for cigarettes and -0.3 for fine-cut tobacco.

The analysis provides several other conclusions. First, fine-cut tobacco is an inferior good in that increases in income reduce consumption. Second, the demand for cigarettes is more inelastic in the long-run (-0.7) than in the short-run. Third, the cross-elasticity of demand for fine-cut tobacco with respect to an increase in the price of cigarettes is about 1.3. This indicates that fine-cut tobacco is a strong substitute for cigarettes. Finally, the inclusion of the real level of taxes in the empirical analysis provides strong evidence that illicit tobacco products have become an alternative to legal products.

The government has placed an emphasis on reducing tobacco consumption, especially among younger Canadians. In 1991, the Minister of Finance stated that "taxes are particularly important in discouraging younger Canadians from smoking". A simple model was created to test the price sensitivity of teenagers versus adults. The empirical results provide an indication that teenagers have a higher price elasticity of demand than adults.

The level of Canadian tobacco exports has increased significantly over the last few years. At the same time, there has been a large increase in the number of seizures of Canadian tobacco products imported illegally into Canada. These trends provide a strong indication that tobacco smuggling has become a problem in Canada. In an effort to explain the changes in tobacco exports, two models were developed -- the natural rate model and the smuggling model. The former attempts to explain changes in the level of exports destined for legitimate markets while the latter incorporates variables which might capture changes in the level of smuggling. These models were then used to estimate the potential change in smuggling activity over the last five years.

The empirical analysis of Canadian exports based on the smuggling model could not fully explain the extent of the increase in the level of exports over the last three

quarters of 1991 without an observation-specific dummy variable. Although the data do not allow for a proper evaluation of the unexplained increase in exports, evidence would suggest that there has been a structural change in the smuggling market. For this reason, it would be useful to monitor the level of smuggled tobacco into Canada because of the implications for government revenues.

Recent increases in federal tobacco taxes complement the government's comprehensive strategy of reducing tobacco smoking in Canada. The empirical results clearly show that federal tax increases have led to a reduction in the level of tax-paid consumption in Canada. However, it also results in an increase in the market for illicit tobacco. Moreover, the trade in illicit tobacco products creates a financial burden for society -- higher law enforcement costs; higher insurance costs to protect against tobacco thieves; and the economic costs of increased criminal activity. On balance, federal tax increases since 1985 have resulted in a net decline in overall tobacco consumption in Canada.

X BIBLIOGRAPHY

Amemiya, T. (1985), Advanced Econometrics. Cambridge, Massachusetts: Harvard University Press.

Andrews, R.L. and G.R. Franke (1991), "The Determinants of Cigarette Consumption: A Meta-Analysis", Journal of Public Policy & Marketing, 10, pp. 81-100.

Atkinson, A.B., J. Gomulka and N.M. Stern (1984), "Household Expenditure on Tobacco 1970-1980: Evidence from the Family Expenditure Surveys", ESRC Programme on Taxation, Incentives and the Distribution of Income. Working Paper No. 57.

Baltagi, B.H. and R.K. Goel (1987), "Quasi-Experimental Price Elasticities of Cigarette Demand and the Bootlegging Effect", American Journal of Agricultural Economics, 69, pp 750-754.

Baltagi, B. and D. Levin (1986), "Estimating Dynamic Demand for Cigarettes Using Panel Data: The Effects of Bootlegging, Taxation, and Advertising Reconsidered", Review of Economics and Statistics, 68, pp. 148-155.

Becker, G.S. (1971), Economic Theory. New York: Alfred A. Knopf.

Becker, G., M. Grossman and K. Murphy (1990), "An Empirical Analysis of Cigarette Addiction", Working Paper No. 3322, National Bureau of Economic Research, Cambridge, MA.

Becker, G., and K. Murphy (1988), "A Theory of Rational Addiction", Journal of Political Economy, 96, pp. 675-700.

Bishop, J.A. and J.H. Yoo (1985), "*Health Scare*, Exicse Taxes and Advertising Ban in the Cigarette Demand and Supply", Southern Economic Journal, 52, pp. 402-411.

Canadian Tax Foundation, Tax Memo (Various Issues).

Chaloupka, F. (1992), "Clean Indoor Air Laws, Addiction and Cigarette Smoking", Applied Economics, 24, pp. 193-205.

Chaloupka, F. (1991), "Rational Addictive Behaviour and Cigarette Smoking", Journal of Political Economy, 99, pp 722-742.

Chaloupka, F. (1990), "Rational Addictive Behaviour and Cigarette Smoking", Working Paper No. 3268, National Bureau of Economic Research, Cambridge, MA.

Chang, H. (1977), "Functional Forms and the Demand for Meat in the United States", Review of Economics and Statistics, 59, pp. 355-359.

Darnell, A.C. and J.L. Evans (1990), The Limits of Econometrics, Aldershot, U.K., Edward Elgar.

Davidson, R. and J. G. MacKinnon (1985), "Testing Linear and Log-linear Regressions Against Box-Cox Alternatives", Canadian Journal of Economics, 88, pp. 499-517.

Deaton, A. and J. Muellbauer (1980), Economics and Consumer Behavior. Cambridge: Cambridge University Press.

Department of Finance, The Budget, (May 1985).

Department of Finance, The Budget, (April 27, 1989).

Department of Finance, The Budget, (February 26, 1991).

Ferrence, R.G., J.M. Garcia, K. Sykora, N.E. Collishaw and L. Farinon (1991), "Effects of Pricing on Cigarette Use Among Teenagers and Adults in Canada 1980-1989", Health and Welfare Canada Mimeo.

Fujii, E. (1980), "The Demand for Cigarettes: Further Empirical Evidence and Its Implications for Public Policy", Applied Economics, 12, pp. 479-489.

Godfrey, C. (1986), Factors Influencing The Consumption of Alcohol and Tobacco - A Review of Demand Models, Centre for Health Economics, University of York, York, U.K.

Godfrey, L.G. and M.R. Wickens (1981), "Testing Linear and Log-Linear Regressions for Functional Form", Review of Economic Studies, 48, pp. 487-496.

Gritzke, M.C. (1979), "The Revenue Loss of Alcohol and Tobacco Smuggling" in C.M. Gray (ed), The Costs of Crime. Beverley Hills: Sage Publications.

Hamilton, J. (1972), "The Demand for Cigarettes: Advertising, the Health Scare, and the Cigarette Advertising Ban", Review of Economics and Statistics, 53, pp. 401-411.

Harris, J.E. (1980), "Taxing Tar and Nicotine", American Economic Review, 70, pp. 300-311.

Harris, J. E. (1987), "The 1983 Increase in the Federal Cigarette Excise Tax," in Lawrence H. Summers (ed), Tax Policy and the Economy, vol. 1. Cambridge, Massachusetts: National Bureau of Economic Research.

Hausman, J. and W. Taylor (1981), "Panel Data and Unobservable Individual Effects", Econometrica, 49, pp. 1377-1398.

Hendry, D.F., A.R. Pagan and J.D. Sargan (1984), "Dynamic Specification" in Z. Griliches and M.D. Intriligator (eds), Handbook of Economics Vol II, Amsterdam: North Holand, Chapter 18.

Hoerl, A. and R. Kennard (1970), "Ridge Regression: Biased Estimation for Nonorthogonal Problems", Technometrics, 12, pp. 55-67.

Houthakker, H.S. and L.D. Taylor (1970), Consumer Demand in the United States: Analysis and Projections. Cambridge, Massachusetts: Harvard University Press.

Jacobsen, P.M. and G. Bromfield (1992), "Some Implications of Tobacco Taxation", a paper prepared by Informetrica for the Canadian Tobacco Manufacturers' Council.

Jacobson, P.M. and P. Rodway (1990), "Tobacco Demand Elasticity Study", a paper prepared by Informetrica for the Canadian Tobacco Manufacturers' Council.

Johnson, J.A., E.H. Oksanen, M.R. Veall and D.A. Fretz (1990), "Short-Run and Long-Run Elasticities For Canadian Consumption of Alcoholic Beverages: An Error-Correction Mechanism/Cointegration Approach", mimeo.

Judge, G.G., W.E. Griffiths R.C. Hill, H. Lütkepohl and T. Lee (1985), The Theory and Practice of Econometrics, New York, John Wiley & Sons.

Judge, G.G., R.C. Hill, W.E. Griffiths, H. Lütkepohl and T. Lee (1988), Introduction to the Theory and Practice of Econometrics (Second Edition). New York: John Wiley & Sons.

Kennedy, P. (1992), A Guide to Econometrics. Cambridge, Massachusetts: MIT Press.

Kuh, E. and J. Meyer (1957), "How Extraneous are Extraneous Estimates?", Review of Economics and Statistics, 38, pp. 380-393.

Lamy, R. (1993), "Cointégration, Modèle de Correction des Erreurs et la Consommation au Canada", Department of Finance, Forthcoming Working Paper.

Leu, R.E. (1984), "Anti-Smoking Publicity, Taxation, and the Demand for Cigarettes", Journal of Health Economics, 3, pp. 101-116.

Lewit, E.M. (1989), "U.S. Tobacco Taxes: Behavioural Effects and Policy Implications", British Journal of Addiction, 84, pp. 1217-1234.

Lewit, E.M. and D. Coate (1981), "The Potential For Using Excise Taxes to Reduce Smoking", Working Paper No. 764, National Bureau of Economic Research.

Lewit, E.M., D. Coate and M. Grossman (1981), "The Effects of Government Regulation on Teenage Smoking", The Journal of Law and Economics, 24, pp. 545-569.

Lyon, H.L. and J.L. Simon (1968), "Price Elasticity of the Demand for Cigarettes in the United States", American Journal of Agricultural Economics, 50, pp. 888-895.

Mackinnon, J.G. (1983), "Model Specification Tests Against Non-Nested Alternatives", Econometric Reviews, 2, pp. 85-110.

Mackinnon, J.G., H. White, and R. Davidson (1983), "Tests for Model Specification in the Presence of Alternative Hypotheses, Some Further Results", Journal of Econometrics, 21, pp. 53-70.

Mackinnon, J.G., H. White, and R. Davidson (1982), "Some Further Results on Tests For Model Specification in the Presence of Alternative Hypotheses", Discussion Paper 491, Queen's Institute for Economic Research, Queen's University.

Madalla, G.S. (1988), Introduction to Econometrics. New York: MacMillan Publishing.

Maddala, G.S. (1977), Econometrics. New York: McGraw-Hill.

Manchester, P.B. (1976), "Interstate Cigarette Smuggling", Public Finance Quarterly, 4, pp. 225-238.

McGuinness, T. and Cowling, K. (1975), "Advertising and the Aggregate Demand for Cigarettes", European Economic Review, 6, pp. 311-328.

Nickell, S. (1975), "Biases in Dynamic Models with Fixed Effects", Econometrica, 49, pp. 1417-26.

Quan, D.C. (1984), "An Estimate of the Demand For Cigarettes in Canada 1971 to 1981", Agriculture Canada Mimeo, unpublished.

Receiver General of Canada, Public Accounts of Canada, Volume 2, Part I (Various Issues). Ottawa: Supply and Services Canada.

Schneider, L., B. Klein, and K.M. Murphy (1981), "Government Regulation of Cigarette Health Information", Journal of Law and Economics, 24, pp. 575-613.

Schweitzer, T. (1970), "Personal Consumer Expenditures in Canada, 1926-75, Parts 1,2,3", Economic Council of Canada Staff Study No. 26, Ottawa.

Seldon, B.J. and R. Boyd (1991), "The Stability of Cigarette Demand", Applied Economics, 23, pp. 319-326.

Stamler, R.T. (1992), "Contraband Tobacco Estimate", a report prepared by Lindquist, Avey, Macdonald, Baskerville Inc. for the Canadian Tobacco Manufacturers' Council.

Statistics Canada, The Consumer Price Index (Various Issues), Catalogue 62-001.

Statistics Canada (1989), The Consumer Price Index Reference Paper: Updating Based on 1986 Expenditures, Catalogue 62-553.

Statistics Canada, National Income and Expenditure Accounts (Various Issues), Catalogue 13-001.

Statistics Canada, Production and Disposition of Tobacco Products (Various Issues), Catalogue 32-022.

Statistics Canada, Touriscope - International Trade (Various Issues), Catalogue 66-001.

Stephens, T. (1988), "A Critical Review of Canadian Survey Data on Tobacco Use, Attitudes and Knowledge", Tobacco Programs Unit, Health and Welfare Canada.

Stock, J. H. and M.H. Watson (1988), "Variable Trends in Economic Time Series", Journal of Economic Perspectives, 2, pp. 147-74.

Sumner, M.T. and R. Ward (1981), "Tax Changes and Cigarette Prices", Journal of Political Economy, 89, pp. 1261-1265.

Surgeon General of the United States (1989), Reducing the Health Consequences of Smoking, 25 Years of Progress. Rockville, Maryland: U.S. Department of Health and Human Resources.

Task Force on Alcohol and Tobacco Tax Indexation (April 1984), Report to the Honourable Marc Lalonde, Minister of Finance, Department of Finance Mimeo.

Theil, H. (1971), Principles of Econometrics. New York: John Wiley & Sons.

Thompson, M. and I. McLeod (1976), "The Effects of Economic Variables on the Demand for Cigarettes in Canada", Mathematical Scientist, 1, pp. 121-132.

Thursby, M., R. Jensen and J. Thursby (1991), "Smuggling, Camouflaging, and Market Structure", The Quarterly Journal of Economics, 106, pp. 789-814.

The Tobacco Institute (1991), The Tax Burden on Tobacco, Historical Compilation, Volume 25, 1990, Washington: The Tobacco Institute.

Townsend, J. (1983), "Cigarette Tax and Social Class Patterns of Smoking", Paper presented to the Fifth World Conference on Smoking and Health.

United States Department of Labour, "Monthly Labour Review" (Various Issues), Table 31.

United States General Accounting Office (1989), Teenage Smoking. Higher Excise Tax Should Significantly Reduce the Number of Smokers, A Report to the Honourable Michael A. Andrews, House of Representatives.

Warner, K. (1977), "The Effects of the Anti-Smoking Campaign on Cigarette Consumption", American Journal of Public Health, 67, pp. 645-650.

Warner, K. (1978), "Possible Increases in the Underreporting of Cigarette Consumption", Journal of the American Statistical Association, 73, pp. 314-318.

Warner, K. (1982), "Cigarette Excise Taxation and Interstate Smuggling: An Assessment of Recent Activity", National Tax Journal, 35, pp. 483-490.

Wasserman, J., W.G. Manning, J.P. Newhouse, and J.D. Winkler (1991), "The Effects of Excise Taxes and Regulations on Cigarette Smoking", Journal of Health Economics, 10, pp. 43-64.

White, K.J., S.D. Wong, D. Whistler and S.A. Haun (1990), Shazam Users Reference Manual Version 6.2. Toronto: McGraw-Hill.

Willis, K. (1967), "Lagged Dependent Variables and Serially Correlated Errors: A Reappraisal of Three-Pass Least Squares", Review of Economics and Statistics, 49, pp. 555-567.

Young, T. (1983), "The Demand for Cigarettes: Alternative Specifications of Fujii's Model", Applied Economics, 15, pp. 203-211.

Zarembka, P. (1974), "Transformation of Variables in Econometrics", in P. Zarembka (ed), Frontiers in Econometrics. New York: Academic Press.

Zellner, A. and M. Geisel (1970), "Analysis of Distributed Lag Models with Applications to Consumption Function Estimation", Econometrica, 38, pp. 865-888.

APPENDIX 1

BACKGROUND STATISTICAL TABLES

Table A1.1

Price Structure of a Carton of 200 Cigarettes

(Average Canadian Price in December)

Year	Federal Taxes ($)	Provincial Taxes ($)	Private Costs ($)	Retail Price ($)	Share of Retail Price: Federal Taxes (%)	Share of Retail Price: Provincial Taxes (%)	Share of Retail Price: Private Costs (%)
1968	2.26	0.56	1.69	4.51	50.1	12.4	37.5
1969	2.27	0.71	1.78	4.76	47.7	14.9	37.4
1970	2.27	0.71	1.78	4.76	47.7	14.9	37.4
1971	2.27	0.83	1.85	4.95	45.9	16.8	37.4
1972	2.28	0.83	1.99	5.10	44.7	16.3	39.0
1973	2.28	0.83	2.03	5.14	44.4	16.1	39.5
1974	2.54	0.83	2.32	5.69	44.6	14.6	40.8
1975	2.56	0.84	2.69	6.09	42.0	13.8	44.2
1976	2.57	1.32	2.84	6.73	38.2	19.6	42.2
1977	2.59	1.52	3.21	7.32	35.4	20.8	43.9
1978	2.60	1.92	3.29	7.81	33.3	24.6	42.1
1979	2.61	2.05	3.50	8.16	32.0	25.1	42.9
1980	2.92	2.18	4.25	9.35	31.2	23.3	45.5
1981	3.26	2.82	4.92	11.00	29.6	25.6	44.7
1982	3.73	3.58	5.23	12.54	29.7	28.5	41.7
1983	4.28	4.92	5.63	14.83	28.9	33.2	38.0
1984	4.56	5.38	5.97	15.91	28.7	33.8	37.5
1985	6.61	6.32	6.57	19.50	33.9	32.4	33.7
1986	7.14	7.27	7.38	21.79	32.8	33.4	33.9
1987	7.42	8.31	7.77	23.50	31.6	35.4	33.1
1988	7.70	9.55	8.47	25.72	29.9	37.1	32.9
1989	11.86	10.51	9.51	31.88	37.2	33.0	29.8
1990	11.99	12.39	10.75	35.13	34.1	35.3	30.6
1991	18.76	16.25	12.05	47.06	39.9	34.5	25.6

Table A1.2

Price Structure of 200 Grams of Fine-Cut Tobacco

(Average Canadian Price in December)

Year	Federal Taxes ($)	Provincial Taxes ($)	Private Costs ($)	Retail Price ($)	Share of Retail Price: Federal Taxes (%)	Share of Retail Price: Provincial Taxes (%)	Share of Retail Price: Private Costs (%)
1968	0.65	0.23	0.94	1.82	35.7	12.6	51.6
1969	0.66	0.26	0.98	1.90	34.7	13.7	51.6
1970	0.66	0.26	0.98	1.90	34.7	13.7	51.6
1971	0.67	0.28	1.08	2.03	33.0	13.8	53.2
1972	0.67	0.35	1.14	2.16	31.0	16.2	52.8
1973	0.68	0.36	1.21	2.25	30.2	16.0	53.8
1974	0.76	0.37	1.30	2.43	31.3	15.2	53.5
1975	0.78	0.39	1.54	2.71	28.8	14.4	56.8
1976	0.79	0.47	1.68	2.94	26.9	16.0	57.1
1977	0.79	0.60	1.88	3.27	24.2	18.3	57.5
1978	0.79	0.74	1.91	3.44	23.0	21.5	55.5
1979	0.82	0.86	2.14	3.82	21.5	22.5	56.0
1980	0.92	1.09	2.60	4.61	20.0	23.6	56.4
1981	1.01	1.42	2.96	5.39	18.7	26.3	54.9
1982	1.17	1.89	3.31	6.37	18.4	29.7	52.0
1983	1.34	2.41	3.59	7.34	18.3	32.8	48.9
1984	1.44	2.77	3.88	8.09	17.8	34.2	48.0
1985	2.04	3.32	4.31	9.67	21.1	34.3	44.6
1986	2.26	3.66	4.94	10.86	20.8	33.7	45.5
1987	2.34	3.86	5.23	11.43	20.5	33.8	45.8
1988	2.52	4.35	5.79	12.66	19.9	34.4	45.7
1989	7.93	5.80	6.56	20.29	39.1	28.6	32.3
1990	8.08	8.03	7.71	23.82	33.9	33.7	32.4
1991	12.80	11.12	8.58	32.50	39.4	34.2	26.4

Table A1.3

Tobacco Products -- Prices and Taxes in 1986 Dollars

	Cigarettes			Fine-Cut Tobacco			
	(1)	(2)	(3)	(4)	(5)	(6)	(1)-(4)
Year	Price	Taxes	Tax Ratio	Price	Taxes	Tax Ratio	Real Savings
	($)	($)	(%)	($)	($)	(%)	($)
1968	15.52	9.65	62.2	6.18	2.88	46.5	9.34
1969	15.60	9.76	62.6	6.14	2.88	47.0	9.46
1970	15.36	9.62	62.6	6.03	2.84	47.1	9.33
1971	15.44	9.65	62.5	6.25	2.85	45.5	9.19
1972	14.85	9.28	62.5	6.18	2.87	46.5	8.67
1973	14.29	8.65	60.5	6.08	2.75	45.2	8.21
1974	13.40	7.91	59.1	5.81	2.55	43.8	7.59
1975	13.49	7.68	56.9	5.84	2.51	43.0	7.65
1976	13.65	7.88	57.8	5.79	2.46	42.6	7.86
1977	13.61	7.87	57.8	5.89	2.50	42.4	7.72
1978	13.76	7.92	57.6	6.01	2.60	43.2	7.75
1979	13.26	7.58	57.2	6.02	2.61	43.3	7.24
1980	13.20	7.40	56.0	6.24	2.74	43.9	6.96
1981	13.35	7.50	56.2	6.43	2.90	45.2	6.92
1982	13.92	7.94	57.0	6.89	3.26	47.2	7.03
1983	15.52	9.36	60.3	7.73	3.87	50.0	7.79
1984	16.55	10.34	62.5	8.22	4.28	52.0	8.33
1985	18.71	12.26	65.5	9.09	4.99	54.9	9.72
1986	21.14	14.11	66.7	10.26	5.67	55.3	10.88
1987	22.07	14.76	66.9	10.60	5.78	54.5	11.47
1988	22.94	15.65	68.2	10.89	6.03	55.4	12.05
1989	25.81	18.05	69.9	14.54	9.35	64.3	11.27
1990	28.17	19.82	70.4	18.30	12.45	68.0	9.87
1991	35.05	25.91	73.9	23.44	17.01	72.5	11.61

Source: Statistics Canada - Consumer prices and price indexes Cat. 62-010 and internal estimates.

Table A1.4

Production of Tobacco Products -- Domestic Shipments and Exports

YEAR	CIGARETTE SHIPMENTS (million #)	FINE-CUT SHIPMENTS ('000 kg)	EXPORTED CIGARETTES (million #)	EXPORTED FINE-CUT ('000 kg)
1968	46,270	7,022	n.a.	n.a.
1969	46,582	6,818	n.a.	n.a.
1970	49,823	6,922	n.a.	n.a.
1971	50,864	7,190	n.a.	n.a.
1972	53,290	6,979	668	4
1973	54,864	7,363	733	4
1974	57,123	6,706	771	5
1975	57,756	6,759	872	7
1976	60,743	6,577	908	9
1977	61,786	6,313	964	10
1978	61,608	5,660	1,013	7
1979	63,860	5,227	951	8
1980	64,492	4,785	1,008	7
1981	66,560	4,765	941	10
1982	66,339	5,552	955	9
1983	63,115	6,025	1,063	11
1984	61,734	6,164	1,121	13
1985	58,954	6,866	1,234	9
1986	55,437	7,414	1,538	18
1987	52,612	7,863	2,012	123
1988	51,054	8,028	2,046	153
1989	47,603	7,749	2,742	211
1990	45,917	6,656	2,630	573
1991	38,946	6,363	6,696	2,493

n.a. stands for not available.

Source: Statistics Canada - Production & Disposition of Tob. Products Cat. 32-022.

Table A1.5

Canada Customs Tobacco Products Seizures, 1985 to 1991

Year	# of Seizures	Value for Duty
1985	45	$12,579
1986	83	$75,706
1987	335	$30,706
1988	1,180	$249,868
1989	1,334	$171,712
1990	1,969	$718,634
1991	9,567	$1,681,733

Source: Revenue Canada - Customs and Excise
Enforcement Directorate
Intelligence Services Division

Table A1.6

QSHOCK Values For Fine-Cut Tobacco

Period		Value	Period		Value	Period		Value	Period		Value
1968	Q1	0	1974	Q1	1	1980	Q1	0	1986	Q1	0
	Q2	0		Q2	0		Q2	0		Q2-	1
	Q3	0		Q3	0		Q3	0		Q3	1
	Q4	0		Q4	0		Q4	0		Q4	0
1969	Q1	0	1975	Q1	0	1981	Q1	0	1987	Q1	-1
	Q2	0		Q2	0		Q2	0		Q2	-1
	Q3	0		Q3	0		Q3	0		Q3	0
	Q4	0		Q4	0		Q4	0		Q4	0
1970	Q1	0	1976	Q1	0	1982	Q1	0	1988	Q1	0
	Q2	0		Q2	0		Q2	0		Q2	0
	Q3	0		Q3	0		Q3	0		Q3	0
	Q4	0		Q4	0		Q4	0		Q4	0
1971	Q1	0	1977	Q1	0	1983	Q1	0	1989	Q1	0
	Q2	0		Q2	0		Q2	1		Q2	0
	Q3	0		Q3	0		Q3	0		Q3	2
	Q4	0		Q4	0		Q4	0		Q4	-2
1972	Q1	0	1978	Q1	0	1984	Q1	1	1990	Q1	0
	Q2	0		Q2	0		Q2	-1		Q2	0
	Q3	0		Q3	0		Q3	0		Q3	0
	Q4	0		Q4	0		Q4	0		Q4	0
1973	Q1	0	1979	Q1	0	1985	Q1	-1	1991	Q1	2
	Q2	0		Q2	0		Q2	-1		Q2	1
	Q3	0		Q3	0		Q3	0		Q3	0
	Q4	0		Q4	0		Q4	0		Q4	0

APPENDIX 2

CALCULATING AN INDEX FOR THE RETAIL PRICE OF FINE-CUT TOBACCO

Statistics Canada does not calculate a consumer price index for fine-cut tobacco, although it does for cigarettes. This index is essential in any attempt to calculate the elasticity of substitution between cigarettes and fine-cut tobacco. Therefore, it is necessary to use information related to the price of fine-cut tobacco and calculate a retail price index.

The retail price of fine-cut tobacco (RP) can be decomposed into the following components: the manufacturer's price (MP); the federal excise duty (FED); the federal sales tax[1] (FST); the federal excise tax (FET); provincial tobacco taxes (PTT); private markups[2] (PMU); the goods and services tax (GST); and, where applicable, the provincial sales tax (PST). In other words,

$$RP=MP+FED+FST+FET+PPT+PMU+GST+PST \qquad (A.1)$$

If each of these elements is directly observable, then it would be quite simple to calculate an appropriate price index. Unfortunately, it is impossible to observe all of these variables over time. As a result, it is necessary to estimate the various components in order to calculate a price index.

The tax variables in equation A.1 are either specific or ad valorem levies. In either case, the value of tax or the tax rate is observable. Let us first look at the federal taxes. The federal excise duty and excise tax are per-unit specific levies which can be converted into the amount applicable on 200 grams of tobacco. The ad valorem federal sales tax can be calculated in the following way:

$$FST = rate\times(MP+FED) \qquad (A.2)$$

Similarly, the goods and services tax can be calculated using equation A.3.

$$GST = rate\times(MP+FED+FET+PMU+PPT) \qquad (A.3)$$

Turning to provincial taxes, there are three different types of provincial tobacco taxes: specific taxes, specific taxes which are indexed to changes in the retail price, and ad valorem taxes. If the provincial product tax is ad valorem in nature, it is assumed that it can be calculated in the following way:

$$PPT = rate\times(MP+FED+FST+FET+PMU) \qquad (A.4)$$

The provincial sales tax, which is ad valorem, can be calculated in a similar fashion to the GST using the following equation:

$$PST = rate\times(MP+FED+FST+FET+PMU+PPT+GST\times TI) \qquad (A.5)$$

---

1. The federal sales tax was levied on fine-cut tobacco prior to January 1, 1991. On January 1, 1991, the goods and services tax replaced the federal sales tax.

2. Private markups consist of retail, wholesale and transportation margins.

where, TI is a dummy variable representing whether the province in question includes the GST in their provincial sales tax base[3].

Unlike the tax variables, the wholesale and retail markups associated with fine-cut tobacco are not directly identified. However, if one could observe the final retail selling price, then the private markups could be calculated as follows:

$$PMU = RP-PST-GST-PPT-FET-FST-FED-MP \qquad (A.6)$$

A similar type of calculation can be done for the price structure of a carton of cigarettes. What follows is a description of how each of the elements is identified through time.

Choosing the Base Month

Statistics Canada calculates an Industrial Product Price Index (IPPI) for fine-cut tobacco[4]. If one could identify the manufacturer's price of fine-cut tobacco at a given point of time, then this price could be used to calculate a manufacturer's price through time based on movements in the IPPI. Information on the federal and provincial taxes collected from fine-cut tobacco provided to us by the Non-Smokers' Rights Association gives us some insight on the price structure for several points in time. Specifically, data related to the various taxes collected from fine-cut tobacco on June 9, 1989 and January 1, 1990 allow us to identify the manufacturer's price in each province as there is an estimated value for the FST[5]. The retail price in Newfoundland, Nova Scotia, New Brunswick, Ontario and Manitoba can be identified using the estimated provincial sales tax[6]. The private markups can then be calculated as a residual for these provinces.

The pre-1991 data do not allow us to calculate a complete price structure for fine-cut tobacco since we cannot identify the retail price in Prince Edward Island, Quebec, Saskatchewan, Alberta or British Columbia. The data related to the various taxes collected from fine-cut tobacco on January 23, 1991 and June 9, 1991 allow us to identify the retail

---

3. These provinces are Québec, New Brunswick, Nova Scotia and Newfoundland.

4. The relevant Cansim D number is 691236.

5. The FST was levied on the manufacturer's price inclusive of the excise duty. Therefore, to obtain the value of the manufacturer's price, one only has to divide the FST value by the statutory rate and subtract the relevant excise duty amount.

6. The retail price is equal to the PST value divided by the PST rate and then adding the value of PST.

price in each province based on the amount of GST collected[7]. Unfortunately, we have no information on the relevant manufacturer's price since there is no longer a FST. Nevertheless, this information can be estimated using either the June 9, 1989 or January 1, 1990 estimates calculated above based on changes in the IPPI. Once estimates have been calculated for the manufacturer's and retail price, the relevant private markups can be calculated as a residual based on equation A.6.

All of the data are then compared to test their consistency through time. Based on these comparisons, it was decided to use the estimated provincial price structure for June 1991 as the base for the price index calculation.

Calculating the Retail Price Through Time

The retail price for fine-cut tobacco is calculated for each province by month based on the formulas described above. The manufacturer's price is determined in the following fashion:

$$MP_t = MP_{JUNE91} \times IPPI_t / IPPI_{JUNE91} \qquad (A.7)$$

The appropriate taxes can be assessed directly based on the appropriate tax rate. There is no obvious way to calculate the applicable private markups since there are no "published" or "statutory" rates. Therefore, it is necessary to make an assumption on how the private markups change through time. We have assumed that the private markups change in proportion to the private markups on cigarettes[8]. That is

$$PMU_t = PMU_{JUNE91} \times CIGPMU_t / CIGPMU_{JUNE91} \qquad (A.8)$$

Calculating the Price Index

The Consumer Price Index is a fixed-basket price index. That is, the index is calculated using weights established for a particular point in time. The weights are changed through time to reflect updated family expenditure surveys. In order to ensure that a change in weights does not influence the percentage change in the index from one month to the next, the indices are "linked". That is, both the old and new weights will generate the same average price for Canada for that month.

---

7. The retail price would be calculated by dividing the amount of GST revenues by 7% and then adding the amount of PST and GST.

8. The private markups associated with the price of cigarettes (CIGPMU) is calculated as a residual. That is, the manufacturer's price and the associated taxes are netted from the retail price.

We have attempted, where possible, to follow this type of methodology in creating the price index for fine-cut tobacco. The retail prices established above are used to calculate a weighted average for all of Canada based on the domestic sale of fine-cut tobacco by province. Following Statistics Canada, we have used the following weights:

January 1968 to March 1982	*1978 Weights*
April 1982 to December 1988	*1982 Weights*
January 1989 to Present	*1986 Weights*