THE B.C. MUSHROOM INDUSTRY:

AN ANALYSIS OF DEMAND AND SUPPLY

By

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ABSTRACT

The mushroom industry in British Columbia markets and distributes through a central selling agency under the trademark Money's Mushrooms. This member owned agency also exercises control, through production area quotas, on member production. This study analyses the market behavior of the B.C. mushroom industry[1], in order to ascertain whether producers collectively exercise monopoly control over the industry.

The main structural components of the industry are described in a mathematical model using a partial equilibrium analysis. The parameters which affect demand are estimated with econometric equations. Supply is formulated by minimizing a cost function subject to a Constant Elasticity of Substitution Production Fuction. A major feature in supply is the joint-product relationship between mushrooms which are sold fresh and mushrooms which are sold processed. Policy implications arising from the structure of the industry and its observed behavior in the market are then analysed.

The econometric analysis indicates that the demand for fresh mushrooms in B.C. over the period 1982 to 1986 was influenced by own price, advertising and the price of a complement, beef. The ability of the association to set prices in the fresh market is confirmed by the results. In the processed market, it was found

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[1]In this study, mushroom refers to the commercially marketed variety "Agaricus Bisporus".

that imported processed mushrooms are very close substitutes for domestic processed mushrooms. The factors which influence processed mushroom demand are consumer income, and price of imported processed mushrooms.

A mathematical model of the industry is formulated with two opposing models of market behavior -perfect competition, and monopoly power. The model generated results are then compared to actual market data. The results support a model of competitive market behavior in the B.C. mushroom industry. That is, producers do not collectively, through the marketing association, set prices above competitive levels. In addition, the analysis indicates that the production quota is not a binding input on production. Therefore, given the existing production technology, no societal welfare gains can be realized by increasing the total allocation of quota in the B.C. mushroom industry.

It is concluded that the centralized marketing of mushrooms in B.C. provides benefits to producers through scale economies in inputs and in marketing/distribution. However, the limited powers that the association has available to enforce cooperation amongst members has recently placed the association in financial difficulties. Specifically, the low prices (relative to cost of production) for processed mushrooms in 1986 has recently resulted in several growers opting out of the association in favour of forming their own marketing agency. There was also a significant increase in volume of illegal sales in 1986. The reduced volume of patronage, illegal sales, and competitive pressure from the

newly formed marketing agency has resulted in lower prices for members of the association.

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CHAPTER 1

INTRODUCTION

The mushroom industry in British Columbia is the only one in Canada that markets and distributes through a central selling agency. Most producers in B.C. belong to the Fraser Valley Mushroom Grower's Cooperative Association (F.V.M.G.C.A.). This member owned agency is responsible for distribution of all fresh and processed mushrooms cultivated in the agency area.[2] The association has an aggressive marketing campaign; the trademark "Money's Mushrooms" has become almost synonymous with fresh mushrooms in B.C. Mushrooms are also processed in the association's own cannery and marketed under the Money's label in every province of Canada. In addition, the association owns and operates a farm in southern Alberta which serves the local market.

In 1986, total mushroom production in B.C. was approximately 34.8 million pounds of which 49 percent was marketed as fresh and 51 percent as processed. Total crop value

[2]Non-member producers operate outside the Lower Mainland and are not subject to the rules and regulations of the British Columbia Mushroom Marketing Board. Non-member producers accounted for less than 5 % of total B.C. production in 1986.

at the wholesale level was 36.2 million dollars. This figure places mushrooms first in terms of vegetable crop value in B.C. For Canada, mushrooms are ranked second in vegetable crop value, behind potatoes (Statistics Canada 22-203, 22-008).

For 1986, a breakdown of the production and disappearance of mushrooms by end use is provided in Figure 1.1 below.

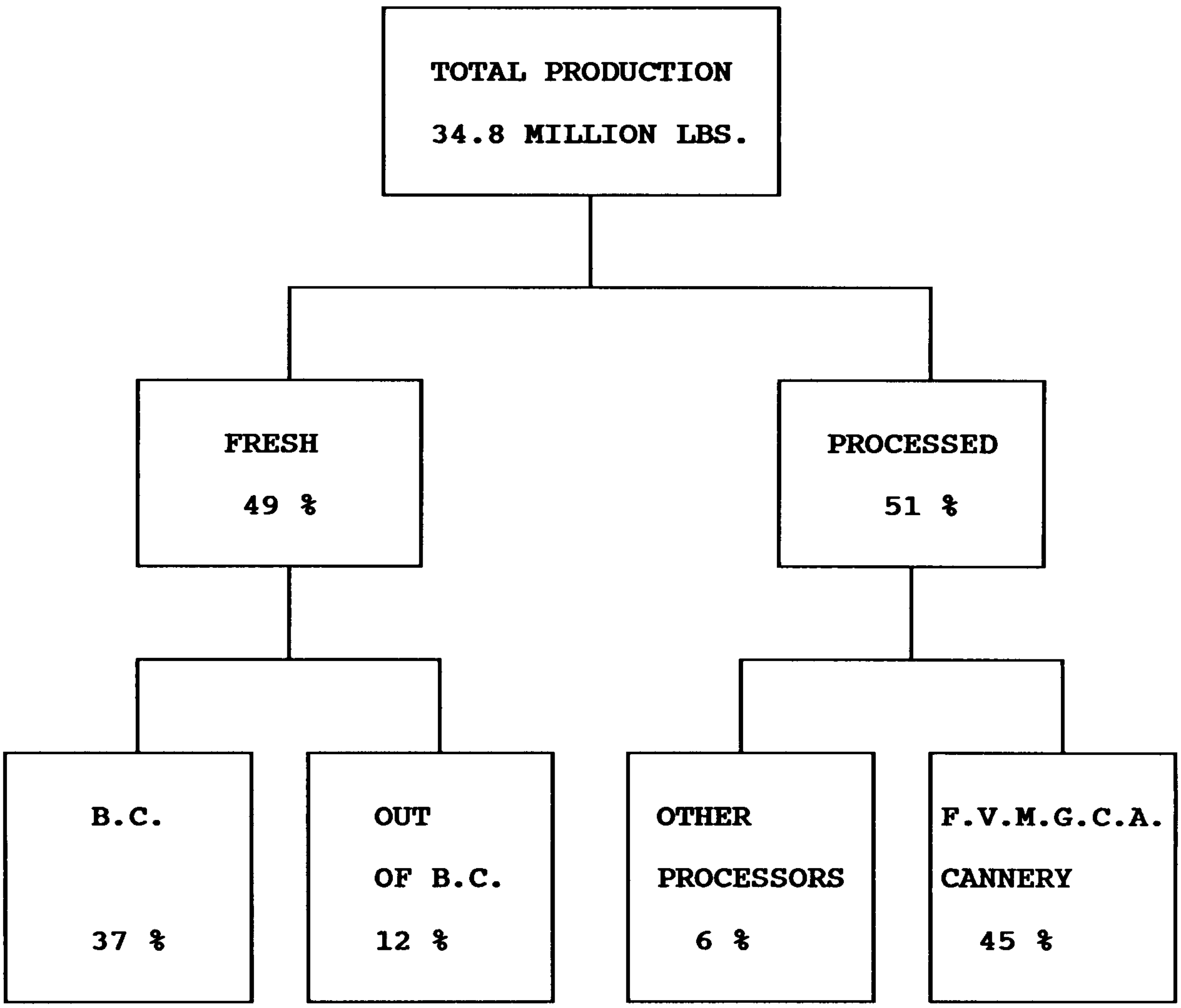

Figure 1.1 The B.C. Mushroom Industry 1986

1.1 Problem Statement

The B.C. mushroom industry has two features which makes it unique in Canada. The industry is regulated by quotas on the area of production. Also, producers collectively own and support a single marketing agent, the F.V.M.G.C.A. These features have important implications for producer returns. On the production side, restrictions on production area may distort the use of resources, and therefore affect the cost of production. On the marketing side, producer returns may be enhanced by controlling the price (or quantity) in the market.

The magnitude of the benefits to the producer from the quota depends on the structure of the market and the degree of control that producers collectively are able to exert, through the marketing agency, on the market for mushrooms.

To quantitatively assess the degree of producer control over the mushroom market in B.C., a model of the industry, describing the main structural relationships which affect supply and demand, can be formulated.

1.2 Objectives of the Study

The main objective of this study is to analyse the quota on production area in the B.C. mushroom industry, and determine whether producers use the quota to exercise monopoly pricing control over the industry.

Sub-objectives for this study are:

(1) To describe the B.C. mushroom industry

(2) To construct a cost of production model for the B.C. mushroom industry.

(3) To formulate and estimate an econometric model describing the market forces which affect the demand for mushrooms in produced in B.C. This will include demand functions for fresh and processed mushrooms. As well, estimates of various demand elasticities will be computed.

(4) To formulate a mathematical model of the B.C. mushroom industry, incorporating the results of the cost of production and demand models, with particular emphasis on the effects of the production quota.

(5) To use this model to analyse the welfare implications arising from the structure of the industry.

(6) To draw policy implications for the B.C. mushroom industry.

1.3 Research Procedure

To achieve the objectives outlined above, the mushroom industry in B.C. will be modelled using a partial equilibrium analysis. Using economic theory, the variables which affect demand and supply of mushrooms in B.C. will be specified. Two models of market behavior will be examined. Perfect competition will be modelled by equating price and marginal cost in the model. Monopoly behavior will be modelled by equating marginal revenue to marginal cost.

The parameters which affect demand will be estimated with econometric relationships. A numerical estimate of the effect that price has on the quantity of mushrooms demanded by consumers will then be calculated, holding all other variables constant.

The parameters which affect supply will be modelled using a linear cost function, minimized subject to a Constant Elasticity of Substitution (CES) production function. From the cost minimization problem, a supply function can be derived with output level, price of inputs, elasticity of substitution between inputs, and returns to scale as parameters. Some of the parameters which are neccessary to specify the supply function are then estimated. Specifically, a cost of production model will be estimated in order to obtain values for prices of inputs in the supply function. A range of plausible values for returns to scale and elasticity of substitution will be assumed, based on personal communication with producers in the industry.

Actual market data will then be used to calibrate the model, and market clearing prices and quantities are calculated for the two models of market behavior, perfect competition and monopoly.

1.4 Thesis Guide

The plan of this study is as follows:

Chapter 1 is a description of the B.C. mushroom industry, including some comparisons with the national industry. In Chapter 2, a mathematical model of the B.C. mushroom industry is formulated, with particular emphasis on the production quota. Specifically, the analysis will determine whether production quota has enabled the industry to behave in a monopolistic manner. A partial equilibrium analysis is employed for two models of market behavior -perfect competition and monopoly. The parameters which are needed in the mathematical model are estimated in Chapter 3. Section one is a brief discussion of consumer demand theory. In section two, market demand for mushrooms produced in B.C. is estimated using econometric equations. Demand functions for fresh and processed mushrooms are estimated. These provide the parameters for demand in the mathematical model. Section 4 presents a cost of production model for mushrooms in B.C. The cost of inputs are used as parameters for the production function in the mathematical model described in Chapter 2. The results of the mathematical model of the B.C. mushroom industry are presented in Chapter 4. Chapter 5 is a discussion of the conclusions and policy implications which arise from the results of this study.

1.5 History of the B.C. Mushroom Industry

Mushrooms were cultivated in B.C. long before the formation of the F.V.M.G.C.A. In 1928, William T. Money, one of the first growers, started a farm in Burnaby. Several other farms were also in operation throughout the Fraser Valley. In 1931 a collective agreement was made amongst the growers to allow W. Money to take over marketing of mushrooms. The agreement enabled producers to concentrate full-time on mushroom production, leaving the job of sales and promotion to W. Money.

By 1936, production had reached a point where fresh mushroom supply exceeded demand. As a result, the Money Canning Co. was formed to provide an alternative means of marketing the surplus that could not be sold in the fresh market.

When W. Money retired in 1956, the F.V.M.G.C.A. was formed to take over distribution of mushrooms. The trademark Money's Mushrooms was purchased at the same time for marketing of fresh mushrooms.

In 1963, several new growers formed their own company, Huntingdon Mushroom Company, which marketed in direct competition with the F.V.M.G.C.A. In 1964, yet another company was formed, called the United Mushroom Growers. A quote from Walter Loeffler, a producer who has been in the industry for many years, summarizes the situation, " Competition was fierce and mushroom prices dropped drastically. Many went out of business- others were barely hanging on".

In 1966, the B.C. Mushroom Marketing Board (B.C.M.M.B.) was formed to bring producers together under a collective marketing umbrella and put an end to the instability which was at that time characteristic of the industry. The F.V.M.G.C.A. was chosen to be the sole selling agency for producers in B.C. Packing and marketing costs were financed by a commission on sales of member production.

Restrictions on entry of new producers, in the form of quotas on area of production, were introduced in 1976. Producers were required to register existing production area with the B.C.M.M.B., and a licensing fee for quota was utilized as a means of raising capital to finance the purchase of the association's own packing facilities.

In 1979, the F.V.M.G.C.A. opened its own processing plant with the assistance of an ARDSA grant. The Money's Trademark for processed mushrooms, which was still under private ownership, was also purchased.

In 1982, production area quotas were increased to meet growing demand for fresh mushrooms. Of the total stock of new quota, 95 percent was to be allocated to existing producers who applied for expansion, and the remaining 5 percent for potential new producers. No new producers entered the industry.

1.6 Structure of the B.C. Mushroom Industry

The B.C. mushroom industry can be split up into three levels, the Marketing Board, the producer owned association, and the producers.

1.6.1 Marketing Board

The B.C. Mushroom Marketing Board is the governing body of the mushroom industry in B.C. The board acts as the liaison between the government and the mushroom industry. Some of the board's duties include licensing producers, and licensing square footage of growing area. To finance its activities, the B.C.M.M.B. has a levy per pound of production (in 1986, 1/3 cent per pound). Every year producers are required to sign a contract promising to deliver 100 percent of production to the board's designated selling agency, the F.V.M.G.C.A. Members of the board are elected from producers.

1.6.2 Fraser Valley Mushroom Growers Co-operative Association

The F.V.M.G.C.A. is a member owned cooperative association. It is controlled by a Board of Directors, whose members are elected from producers in the industry. The nature of the association as a grower's cooperative exempts it from income tax, because all income which is earned is distributed back to members. Allocation of growing area to members is determined by the association.

The association sells fresh mushrooms to wholesalers and retailers, and processors (e.g., Campbell's Soup). Processed products canned by the association are sold directly (Money's label) as well as through various sales agents as no name brands (e.g., Scotch Buy).

Each month receipts from sales are distributed to growers after deducting a commission to cover operating expenses for mushrooms delivered during that month. The commission is usually greater than the actual operating expenses, leaving the association with a profit. This profit is distributed to members at the end of the year. Each member's share of the distribution is based on the volume of patronage.

Members of the association are assessed a one time fee for each square foot of licensed growing area (\$1.00 per ft^2 in 1986) to finance acquisition of the member owned capital facilities of the F.V.M.G.C.A. In return, the association markets members' production and provides growing supplies at cost.

The association also operates a composting wharf which provides compost to growers at cost. This service is of special significance to smaller producers who would not find it economically feasible to produce their own compost without enlargening the scale of their operation. The capital investment required to produce this input is quite large. Also, the production of compost is a very specialized process which requires excellent management and technical skills. In addition, producers enjoy the advantages of not having to compete with each other for purchase of of a very important input used in the production of compost, namely horse manure. For these reasons, the majority of producers choose to purchase compost from the wharf. Any profits which are made by the composting wharf are also distributed back to users of the facility, pro rata, at the end of each year.

1.6.3 Production Technology at the Producer Level

Mushrooms are grown year round indoors under highly controlled conditions. An average crop cycle lasts two and a half to three months. The preparatory stage usually lasts six weeks, followed by six weeks of cropping. At the end of each growing cycle, all of the material substrate on which the mushrooms grow must be cleaned out of the buildings and new material loaded in for the next cycle.

Several growing rooms are employed on a rotation basis, usually weekly (eg. load a building every Saturday). In this way, mushrooms are cropped on a continual basis, the production from growing rooms which are cleaned out being replaced by rooms which are ready for harvesting. The variation in supply of mushrooms from week to week is small.

The lag between the time a production decision is made and its realization (six weeks) is quite short in comparison to vegetable crops which are grown on an annual basis. The implication of all this may be reduced variability in price due to factors which are exogenous to the producer (e.g., changing consumer tastes) because producers can quite quickly adjust production levels by stepping up/down the length of the growing cycle. However, in the short run, capital limitations place an upper bound (the maximum capacity of the farm) and a lower bound (fixed capital costs which are incurred regardless of the level of production) on the size of the adjustments. Producers are not likely to want to vary production dramatically, as continuity in employment of existing labourers is desirable from the viewpoint of stability.

Mushrooms which are sold on the fresh market are produced as a joint product with mushrooms which are sold on the processed market. That is, the two categories of mushrooms are not produced separately. The difference between fresh and processed mushrooms is based on a measure of quality as determined by size, shape, and colour criteria. Mushrooms which meet a minimum quality level are graded for sale into the fresh market. Mushrooms which are below this level of quality are processed. Production of mushrooms always involves a certain proportion of the total which does not meet the fresh quality criteria. As producer prices for fresh mushrooms is higher than for processed mushrooms, producers strive to obtain as high a proportion of fresh as possible.

1.7 Growth of the National Industry

Mushrooms are produced in almost every region of Canada, with major producing centres in southwestern B.C. and southern Ontario. In 1985, production in Ontario was estimated to be 55 percent of total Canadian production. B.C.'s share of domestic production was 30 percent.

Between 1975 and 1985, domestic production increased by approximately 160 percent, with an increase in growing area of only 42.9 percent (see Table 1.1). This production increase was a result of productivity increases in terms of lbs per square foot of cultivated area (2.57 to 3.93) and more intensified usage of existing growing area. The number of crops cultivated has increased from 3.45 to 4.93 crops per year.

Table 1.1 Total Growing Area, Production, and Yield of Mushrooms in Canada

year	total area	total lbs	crops per yr[a]	lbs per ft^2/crop[b]
1985	6574	99411	3.93	3.85
1984	6124	92325	3.84	3.92
1983	6017	82613	3.75	3.67
1982	6838	78512	3.59	3.20
1981	6710	72112	3.66	2.94
1980	N/A[c]	64517	N/A	N/A
1979	N/A	54584	N/A	N/A
1978	5573	51230	3.50	2.62
1977	5422	46150	3.54	2.40
1976	4913	43782	3.38	2.64
1975	4601	40798	3.45	2.57

Source: Statistics Canada (22-003)
Mushroom Growers Survey (annual)

[a]calculated, total area harvested/total area cultivated
[b]calculated, total lbs/total area harvested
[c]N/A, data not available

Increased production has been channeled to both processed and fresh markets, however closer inspection of the data reveal regional differences.

Fresh market disappearance of mushrooms in B.C. increased sharply between 1980-1981, but has since that time remained steady at 12.5 to 13 million pounds annually. The relatively stable fresh market demand may be due to the currently high levels of consumption being close the limits of consumer demand. In 1985, per capita consumption in B.C. was 4.3 lbs while the national average was 3.1 lbs. In fact, consumption in the greater Vancouver area is currently the highest in the world. Potential for fresh market expansion appear to be excellent in eastern Canada, as disappearance of fresh mushrooms have increased at an average annual rate of approximately 15 percent over the last decade.

Nationally, processed mushroom disappearance has exhibited a strong upward trend. However, much of the increased demand has been supplied by imports from Pacific Rim countries such as Korea, China and Taiwan. In eastern Canada, domestically processed quantities have virtually remained unchanged since 1975. In B.C., processed quantities have increased dramatically (Table 1.2), but the pressure of imports has caused prices to decline in recent years. Over 73 percent of domestic demand for processed mushrooms was supplied by imports in 1985.

Table 1.2 Total Production and Value of Mushrooms in B.C.

year	FRESH quantity '000 lb	value '000$	price per lb[a]	PROCESSED quantity '000 lb	value '000$	price per lb[a]
1985	15332	25871	1.69	17063	11085	0.65
1984	15492	24679	1.59	15734	9990	0.63
1983	14506	21026	1.45	16346	10071	0.62
1982	13092	18517	1.41	11999	7988	0.67
1981	12624	16648	1.32	6948	5299	0.76
1980	11372	12616	1.11	6487	4663	0.72
1979	9479	9615	1.01	4534	3245	0.72
1978	9576	8744	0.91	3545	2125	0.60
1977	7361	6610	0.90	3549	2131	0.60
1976	6319	5189	0.82	1797	896	0.50
1975	5321	3859	0.73	1926	949	0.49

Source: Statistics Canada (22-003)
Mushroom Growers Survey (annual)

[a]wholesale price, calculated as value/quantity

Table 1.3 Total Production and Value of Mushrooms in Canada (excluding B.C.)

year	FRESH quantity '000 lb	value '000$	price per lb[a]	PROCESSED quantity '000 lb	value '000$	price per lb[a]
1985	54520	77577	1.42	12496	9726	0.78
1984	49869	70504	1.41	11230	8900	0.79
1983	40884	56821	1.39	10877	8204	0.75
1982	39271	52819	1.34	14150	10975	0.78
1981	38640	49540	1.28	13900	11077	0.80
1980	35329	39780	1.13	10823	8624	0.79
1979	31522	33619	1.07	9049	6745	0.75
1978	28397	27191	0.96	9712	6362	0.66
1977	23723	21681	0.91	11517	6868	0.60
1976	21886	17788	0.81	13780	7232	0.52
1975	17348	13374	0.77	16202	8025	0.50

Source: Statistics Canada (22-003)
Mushroom Growers Survey (annual)

[a]wholesale price, calculated as value/quantity

1.8 Unique Features of the B.C. Industry

Centralized marketing/sales/promotion through the Fraser Valley Mushroom Grower's Cooperative Association has resulted in widespread acceptance of mushrooms by food retailers as an essential commodity in the vegetable section of stores. The ability of the industry to supply mushrooms on a year round basis with regularity is probably the single most important reason for the high levels of consumption in B.C. The closeness of the industry to a large urban centre (Vancouver and the lower mainland) facilitates efficient delivery of the product to retail outlets, a factor which is very important given the relatively short shelf life mushrooms have in comparison to other vegetable crops. In addition, the association has control over prices in the fresh market. This is made possible by diverting any product that is not sold fresh into the processing plant which is also owned by the association.

The mushroom industry in B.C. supplies more than 90 percent of fresh mushrooms consumed in B.C. It is one of the few vegetable commodity industries which is able to consistently do so on a year round basis. The small quantities (less than 10 percent) that arrive from the United States (Washington, Oregon) do not yet pose a serious threat to the fresh market in B.C., as American production capacity is currently not enough to supply larger shipments into B.C. In addition, the potential for fresh market expansion is much greater in the U.S. Pacific Northwest than in B.C., where per capita consumption is already the highest in North America. Imports from the U.S. are currently favored by a low tariff of only 5 percent ad valorem plus 5 cents per pound. In contrast, mushrooms going from B.C. into the U.S. face a tariff of 25 percent plus 5 cents per pound.

The existence of the association has made it possible for small, family operated farms to be economically viable. Without the facilities that the association provides, each farm would have to package, market and deliver its own production. Also, the association operated compost wharf eliminates the need for each producer to invest in the capital equipment required to prepare this major input. Undoubtedly, many B.C. producers would have to increase in size to take advantage of scale economies if the services provided by the association were not available.

Mushroom production in B.C. is controlled by allocating production quotas in terms of square footage of growing area to producers. Since productivity per unit of cultivated area is variable, the result is an industry which does not exhibit firm control over quantities which are placed on the market. Yields have increased as a result of ongoing technical innovations in capital and crop management. This trend of increasing productivity shows no sign of slowing down, particularly in light of continuing research on new hybrid strains of mushrooms, delayed release nutrient supplementation, shorter crop cycles, etc. In addition, each producer has some flexibility in deciding the intensiveness of usage for existing square footage.

1.9 Comparison of the B.C. Industry with Rest of Canada

Mushroom farms in the rest of Canada are predominantly large firm type operations. The farms are much larger than their B.C. counterparts, enabling division of a farm into individual units which specialize in production, packing and shipping, and marketing. This is particularly true in Ontario, the province with the largest volume of mushroom production in Canada. In 1986, the Canadian Mushroom Growers Association reported 24 producers in Ontario, compared to 73 in B.C.

Mushroom farms in the other provinces are more capital intensive than their B.C. counterparts, as each farm must have its own facilities for all phases of production, packaging and marketing. Table 1.4 compares capital investment per square foot of growing area. The B.C. industry consistently has a smaller capital investment per unit of cultivated area than the other provinces. The data for B.C. does not include capital value of the F.V.M.G.C.A., but adjusted figures have been calculated, and the results of a consistently lower capital investment than the rest of Canada still hold true.[3]

Mushroom production is a labour intensive process. Rising production costs, particularly labour, have motivated farmers to increase productivity. In B.C. yields per square foot increased from 6.53 in 1975 to 15.09 in 1985 (Table 1.4). Many capital

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[3]Adjusted figures are not reported, as capital value for the association facilities is confidential.

innovations have been adopted in the last decade which have allowed savings in labour and enhancements in yield. Capital intensification in the industry is apparent in the increases in capital investment per unit of cultivated area. In B.C., capital investment per square foot increased from $ 5.77 in 1975 to $ 13.85 in 1985 (Table 1.4).

However, these innovations have only been realized in the preparatory stages of mushroom production. Labour requirements for the cropping stage have remained unchanged. Harvesting is the single most labour intensive stage, with costs that can range from 15 to 20 percent of total production costs.

TABLE 1.4 Capital Investment and Yields, per square foot of Growing Area, for B.C. and the Rest of Canada

	BRITISH COLUMBIA		REST OF CANADA	
year	cap/ft^{2}[a]	lb/ft/year^{2}[b]	cap/ft^{2}[a]	b/ft/year^{2}[b]
1985	$ 13.85	15.09	$ 24.73	15.14
1984	12.24	14.50	23.51	15.39
1983	14.55	14.56	23.07	13.28
1982	14.33	11.83	19.78	11.33
1981	13.85	9.32	20.27	11.39
1980	N/A[c]	N/A	N/A	N/A
1979	N/A	N/A	N/A	N/A
1978	8.54	7.83	12.29	7.96
1977	7.72	6.63	9.72	6.92
1976	6.77	5.88	9.17	7.14
1975	5.77	6.53	8.22	6.32

Source: Statistics Canada (22-003)
Mushroom Growers Survey (annual)

[a]calculated, value capital/registered growing area data for B.C. does not include capital value of the F.V.M.G.C.A. for reasons of confidentiality
[b]calculated, total production/registered growing area
[c]N/A data not available

Mechanized harvesting, used in some countries which process the bulk of their production, is currently not feasible for Canadian producers because of their fresh market orientation. Product which is mechanically harvested is only suitable for processing. Processed mushrooms must compete with lower price imports, making that market much less attractive than the fresh market. Since only 29 percent of Canadian production in 1985 was processed, adoption of such technology is not economically feasible.

Even in B.C., where slightly more than 50 percent of production in 1986 was processed, adoption of mechanized harvesting would not be economically feasible for smaller producers. The additional capital investment required for this technology could only be financed by the larger producers, as scale economies are involved.

The processed mushroom market in Canada is essentially a residual market for product which cannot be sold fresh. Competing imports are currently priced at levels which are low relative to the domestic cost of production for fresh and processed mushrooms. For this reason, the continued viability of the mushroom industry is very much dependent on sales to the fresh market.

1.10 Pricing Conduct in the B.C. Mushroom Industry

The B.C. Mushroom Marketing Board has the power to set prices at the wholesale level, but its pricing behaviour is influenced by two factors: (a) the quantity that must be sold is not under the association's control and (b) processed mushroom prices are affected by prices of competing imports. The association operates in the following manner:

1. Mushrooms are graded for fresh and processed qualities at the farm level and shipped in bulk containers to the cooperative.
2. Upon receipt, the mushrooms are graded at the packaging plant to ensure uniformity in grading standards for all producers.
3. Fresh quality mushrooms are packaged and sold to retail chain outlets and wholesale distributors at a price fixed by the British Columbia Mushroom Marketing Board. This price applies to all customers and is revised once or twice a year, as market conditions change.
4. Fresh quality mushrooms which have not sold on the fresh market are pooled with processing grade product and transferred to the cannery facility or sold to other processors, such as Campbell's. Fresh mushrooms are not storable, as they have a shelf life of only a few days. It is the ability to process mushrooms which are in excess of fresh market requirements that enables the association to exercise price setting powers in the fresh market.
5. Pool prices are established for each grade, based on

actual quantities sold on the market. Producers receive payment based on the quantities of each grade they have shipped to the association. Thus the quantity that is produced and shipped of each grade differs from what is actually sold, but all producers receive the same price for the respective grades because of price pooling. This eliminates the need to keep track of individual producer's product as it is placed onto the market.

1.11 Recent Developments

In recent years, some changes have taken place in the mushroom industry with respect to the barriers to entry, production cutback, and problems with the unity of members in the association. Taken together, these events have had a destabilizing influence on the industry.

1.11.1 Barriers to Entry in the B.C. Mushroom Industry

The origin of a unified marketing umbrella for producers in B.C. began with the inception of the F.V.M.G.C.A. in 1956. However, the mushroom industry in B.C. was not under supply management control until 1972. Prior to that, producers were able to freely enter and exit the industry.

Recent developments pertaining to the extent of supply management in the mushroom industry have resulted in a new policy from the British Columbia Ministry of Agriculture. Effective January 1, 1986, any individual who applies to produce mushrooms can obtain a permit from the British Columbia Mushroom Marketing Board. No restrictions are placed on the square footage of production that may be applied for.

The change in policy was a result of complaints from individuals outside the F.V.M.G.C.A. Criticism of the existing system was focussed on the inaccessibility of the industry to individuals who did not belong to the F.V.M.G.C.A. The main thrust of the argument was centered around the individual's right to earn a living in the occupation of his/her choice.

The new policy has not yet affected the actual level of supply management for the British Columbia mushroom industry. While any individual has the right to produce mushrooms, no individual can gain membership into the F.V.M.G.C.A. without buying out an existing member's shares in the association. In addition, all mushrooms grown in the B.C. lower mainland area must still be marketed through the F.V.M.G.C.A. This has important implications, because while non-members have access to the F.V.M.G.C.A. facilities, they are under the following restrictions:

1. Compost, a major input in the production process is not supplied to non-members. The association feels that the compost wharf cannot handle any extra capacity without adversely affecting existing members.
2. Growing supplies (pesticides, spawn, etc.) are

available to non-members at a 35 percent surcharge.

3. A 10 percent surcharge on gross delivery credit for non-member product which is marketed through the association.
4. No quarterly or annual dividend payout to non-members

The restrictions, apart from being an effective economic deterrent to new entrants, are designed to give members preferential treatment because of their invested capital in the association. Additionally, there is a desire to promote stability of prices in the market, a goal which may be best achieved by maintaining a single selling agent for mushrooms.

1.11.2 Production Withdrawal

Consumption of fresh mushrooms in B.C. has been relatively stable for several years. Total production of mushrooms has also been stable, with only moderate increases of less than 5 percent for the years 1984 to 1986. As total production of fresh mushrooms exceeds market demand, the surplus has been channeled to the processed market. The processed market, up until 1985, provided a return sufficient to cover total costs of production, but in 1986, the situation changed dramatically. Prices of imported processed mushrooms declined considerably, mainly due to price reductions on shipments from mainland China. The price for domestic processed product eroded to levels below production costs. Some producers, after a year of strong market prices for both fresh and processed mushrooms and high levels of profit in 1985, were faced with losses in 1986.

In 1987, a decision was made by producers to set up a system of voluntary production withdrawal for a temporary period of six months, with an option to reapply for a further six months if market conditions were still unfavourable. Producers who volunteered for this program received payment from the F.V.M.G.C.A. of $ 0.25 per square foot of growing area set aside (adequate to cover fixed costs for most producers).

All producers were to finance this plan, by setting money aside from sales. The intent of the plan was to reduce the quantities of mushrooms going into processed grade, while still supplying as much fresh grade as the market would absorb. While feasible as a short run solution, this plan cannot be sustained in the long run without increasing the sales commission, as the association requires a minimum volume of member patronage to cover costs of operation.

Production withdrawal was initiated March 1, 1987. By May, 1987, total production decreased approximately 20 percent, similar to 1983 production levels.

1.11.3 The Marketing Contract and Problems of Enforcement

The continued problems of bootlegging in the B.C. mushroom industry well attest to the fact that poor enforcement of a marketing contract results in abuse of the system, particularly when producer prices are depressed relative to normal years.

Bootlegging, or the illegal sales of mushrooms from the farm, is a problem which has had a destabilizing influence on the industry in recent years. Growers sign a contract binding themselves to deliver 100 percent of their product to the association. However, no system of penalties was instituted to discourage abuse of the marketing contract. In 1985, several cases of bootlegging were brought to the attention of the Board of Directors of the F.V.M.G.C.A., and subsequently brought to court. In all cases, penalty was limited to damages which the association could prove were incurred as a result of illegal sales. This was far from being an effective deterrent, as monitoring producer bootlegging is extremely difficult.

In 1987, the combination of several factors led to a rift in the association, with several producers choosing not to renew their annual marketing contracts. Processed mushroom prices had been extremely low the previous year, resulting in a very low average price for producers in 1986. In addition, increase in bootlegging activity and the inability of the association to effectively control it was the source of much producer dissatisfaction.

1.11.4 Factors Affecting the Viability of the F.V.M.G.C.A.

The fixity of factor inputs in the facilities of the

F.V.M.G.C.A. makes it crucial that the volume of member patronage not be subject to large fluctuations. The F.V.M.G.C.A. obtains revenue, as do many other marketing agencies, through a percentage commission on sales. A minimum level of patronage is required in order to generate sufficient revenue to cover costs. Capital acquisitions are usually made on the basis of a planned level of activity. Labour requirements exhibit some downward inflexibility as union labour is employed.

The current structure of the F.V.M.G.C.A. makes it vulnerable to members leaving the association. The marketing contract that all members sign is renewed on an annual basis.
In addition, several producers have recently obtained a license to also act as a selling agent, effective October 15, 1988. This court decision makes it possible for other producers to follow suit. The decrease in volume of business as a result of bootlegging, members leaving the association, and the ongoing voluntary production withdrawal program, have put the association in financial difficulties.

CHAPTER 2

A MATHEMATICAL MODEL OF THE B.C. MUSHROOM INDUSTRY

In this chapter, a mathematical model of demand and supply in the B.C. mushroom industry is presented. The model will be used to determine whether the market is competitive, or whether producers collectively exercise monopoly power. A partial equilibrium analysis will be employed. The variables which the model solves for are: market clearing price and quantity of mushrooms, and quantity of inputs used in the production process. All other variables, such as consumer income, prices of other goods, etc., are held constant.

Market demand for mushrooms is modelled by linear equations in price and quantity. Market supply of mushrooms is modelled by minimizing a producer cost function, subject to a Constant Elasticity of Substitution (CES) production technology.

The demand model is presented in section 1. This is followed by the supply model in section 2. Section 3 outlines the modelling of market equilibrium. In section 4, a discussion of welfare measurement using the concept of consumer and producer surplus is presented. Lastly, in section 5, an analysis of an agricultural quota is presented.

2.1 Demand Model

The demand for mushrooms produced in B.C. is divided into four sub-markets according to the different categories for consumption:

1. Retail demand for mushrooms consumed fresh in B.C.
2. Export demand for mushrooms consumed fresh outside of B.C.
3. Derived demand for mushrooms by other processors, such as Campbell's.
4. Derived demand for mushrooms processed by the F.V.M.G.C.A. and sold in Canada.

Fresh mushroom demand in B.C. at the retail level is modelled as a linear function in price and quantity:

(1) $X_f = c - bP_f$

where X_f = quantity of fresh mushrooms demanded

P_f = retail price of fresh mushrooms

Export demand for fresh mushrooms shipped out of B.C. is assumed to be perfectly elastic at 1986 prices. Similarly, mushrooms sold to other processors are also assumed to have perfectly elastic demand at 1986 prices.

(2) $P1 = \overline{P1}$

(3) $P2 = \overline{P2}$

where $\overline{P1}$ and $\overline{P2}$ are 1986 wholesale prices for fresh mushrooms sold outside B.C. and mushrooms sold to processors respectively

These assumptions are made in the interest of simplifying the model, as separate estimation of these two submarkets is not possible due to data limitations. These two markets act as residual markets for fresh mushrooms which cannot be sold in B.C. Also, these two markets make up less than 20 percent of total production in B.C., so any error introduced by these assumptions should not affect seriously the results of the model.

Derived demand for mushrooms processed by the association is assumed to be perfectly elastic at 1986 price levels:

(4) $P_p = \overline{P_p}$

where $\overline{P_p}$ = wholesale price of mushrooms processed by the F.V.M.G.C.A.

That is, the B.C. mushroom industry is a price taker in the processed mushroom market. The price for mushrooms processed in B.C. is assumed to be determined largely by prices of competing imported processed mushrooms. This assumption is justified for two reasons, based on the econometric results presented later in chapter 3:

1. Near one to one correspondence between domestic and import price.
2. Quantity variable not significantly different from zero in the price dependent regression equation. That is, the domestic level of processed mushroom production has no statistically measurable effect on the price level of processed mushrooms.

A diagramatic representation of the B.C. mushroom industry is presented in Figures 2.1 to 2.4 below:

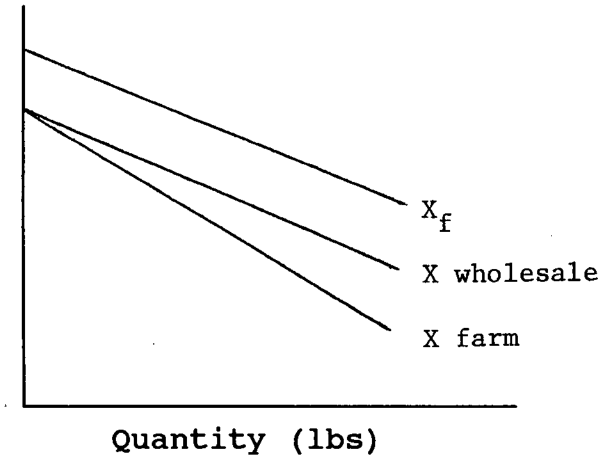

Figure 2.1 B.C. Fresh Market Demand

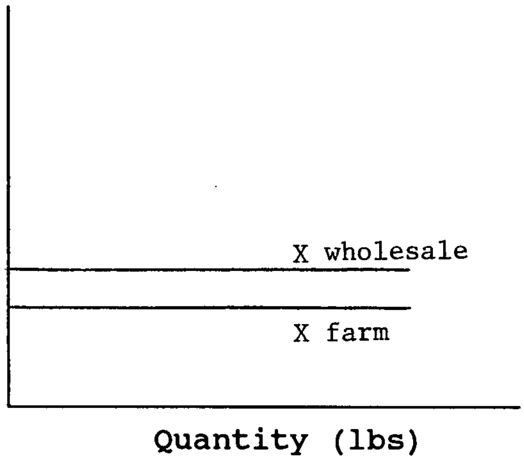

Figure 2.2 Fresh Market Demand (out of B.C.)

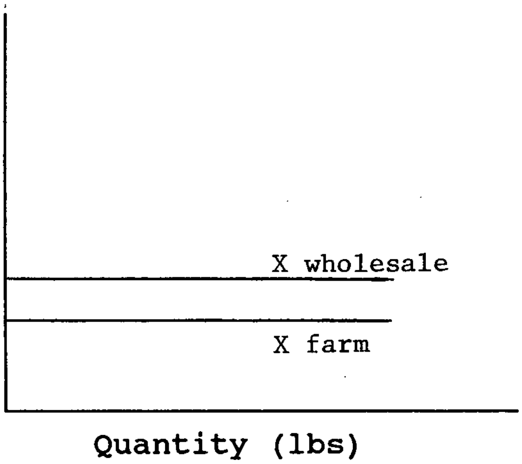

Figure 2.3 Derived Demand by Other Processors

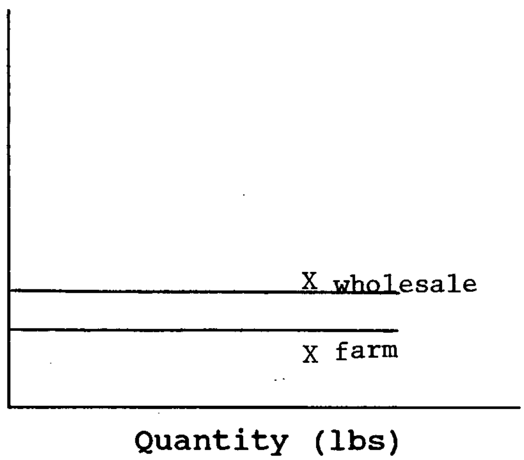

Figure 2.4 Derived Demand for B.C. Processed

Fresh and processed mushrooms are produced as a joint product. The fresh mushrooms are split into two components, sales within B.C. and sales outside of B.C.

(5) $X_f = aX$

(6) $Xf1 = k1X$

where: X = total production of mushrooms in B.C., fresh and processed

Xf = quantity of fresh mushrooms marketed as fresh in B.C.

a = proportion of X which is marketed as fresh within B.C.

$Xf1$ = quantity of fresh mushrooms marketed as fresh outside of B.C.

$k1$ = proportion of X which is marketed as fresh outside of B.C.

Processed mushrooms are also split into two components, mushrooms shipped to other processors and mushrooms processed at the F.V.M.G.C.A.

(7) $Xp2 = k2X$

(8) $Xp = (1-a-k1-k2)X$

where $Xp2$ = quantity of processed mushrooms shipped to other processors

$k2$ = proportion of X which is shipped to other processors

Xp = quantity of processed mushrooms canned by the F.V.M.G.C.A.

The industry average price received by producers is a weighted combination of the prices obtained in the four separate markets, adjusted for the wholesale-retail margin and marketing costs:

$$(9)\ P = a[(P_f-M)(1-CF)] + k1[P1(1-CF1)] + k2[P2(1-CP)] + (1-a-k1-k2)[P_p(1-CP)]$$

where M = Retail-Wholesale margin

CF = Commission (as a fraction of one) on fresh mushrooms sold in B.C.

CF1 = Commission on fresh mushrooms sold outside of B.C.

CP = Commission on mushrooms destined for processing

From (1), the price P_f can be expressed as follows

$$(10)\ P_f = (c-X_f)/b = (c-aX)/b$$

Substituting (10) into (9) and rearranging terms gives

$$(11)\ P = (ac/b-aM)(1-CF) + k1[P1(1-CF1)] + [k2P2 + (1-a-k1-k2-)P_p](1-CP) + a^2/b(1-CF)X$$

The total revenue function (TR) is obtained by multiplying the price function with total quantity sold X:

$$(12)\ TR = dX - fX^2$$

where $d = (ac/b-aM)(1-CF) + k1[P1(1-CF1)] + [k2P2+(1-a-k1-k2)P_p](1-CP)$

$f = a^2/b(1-CF)$

Finally, marginal revenue (MR) is obtained by differentiating total revenue with respect to quantity X:

(13) $MR = \delta TR/\delta X = d - 2fX$

2.2 Supply Model

On the supply side, production is assumed to be "reasonably" modelled using a CES technology (Arrow et al.). The production function is :

(14) $X = G(DK + (1-D)L)^{-v/p}$

where X = total production

K = level of fixed inputs

L = level of variable inputs

D = distribution parameter

G = scaling factor

v = returns to scale parameter

p = substitution parameter

Fixed inputs are mainly composed of buildings and equipment. Variable inputs include all inputs which are purchased for use in the production process and whose levels of utilization may be varied as economic conditions change.

The coefficient G is a scaling factor which varies according to the units in which output and inputs are measured.

Returns to scale is captured by the parameter v. An increase in both inputs by a factor θ would result in an increase in output of θ^v. Therefore, the production function exhibits increasing returns to scale technology when $v > 1$, decreasing returns to scale when $v < 1$, and constant returns to scale when $v = 1$.

The coefficient p is a substitution parameter. In fact, the CES production function encompasses a whole family of production functions, depending on the value of p. This is apparent from the derivation of the elasticity of substitution (Walters, p.286) between inputs K and L:

(15) b = elasticity of substitution = $1/(1+p)$

The higher the value of p, the lower the elasticity of substitution. The value of p cannot be less than -1. As p approaches -1, the elasticity of substitution tends to infinity. At the other extreme, as p approaches infinity, the elasticity of subsititution approaches zero, as in the case of fixed coefficients, or Leontief technology. When $p = 0$, the elasticity of substitution is 1 giving rise to a Cobb Douglas technology.

The distribution parameter D, together with the substitution parameter p determines the distribution of income between factors. To see this, the solution for a competitive equilibrium where the marginal rate of substitution is equal to the ratio of factor prices gives results in the following expression (Arrow *et al*, p.233),

(16) $WL/RK = D/(1-D)*(K/L)^p$

When the substitution parameter is equal to 0, (unit elasticity of substition between inputs), the distribution of income between K and L does not vary with the factor ratio K/L. The greater the deviation of p from zero, the greater the impact factor ratios have on the distribution of income.

The unit price of inputs is assumed to be constant with respect to quantity of inputs purchased. Total cost is:

(17) $C = RK + WL$

where R = unit cost of fixed input

W = unit cost of variable input

The cost function can be minimized subject to the production function (14). The details are presented in Appendix A. The result is a minimum cost function, with cost of inputs, G, D, and quantity of inputs as parameters. This is in fact a supply function.

(18) $\text{C-hat} = G^{-1/v} X^{1/v} e^{(p+1)/p}$

where $e = D^{(1/(p+1))} R^{(p/(p+1))} + (1-D)^{(1/(p+1))} W^{(p/(p+1))}$

Finally, marginal cost (MC) is obtained by differentiating the cost function with respect to output X.

(19) $MC = \delta \text{C-hat}/\delta X = G^{-1/v}/v e^{(p+1)/p} X^{(1-v)/v}$

2.3 Modelling Market Equilibrium

The welfare effects of two market situations can be examined. At one extreme, monopolistic market behavior is modelled by setting industry production at the level where marginal revenue (equation (13)) is equal to marginal cost of production (equation (19)). The other extreme, perfect competition, is modelled by setting market price (equation (11)) equal to marginal cost of production.

The competitive pricing decision works well when dealing with returns to scale less than or equal to unity. However, no competitive pricing decision exists for an increasing returns to scale industry if production occurs in the region where marginal cost is below average cost. In such a situation, there is incentive to produce the marginal unit when price is greater than marginal cost, even though such production is in the region where price is less than average cost. A competitive market would therefore result in exit of some firms from the industry as producers, trying to equate price with marginal cost, incur losses.

If increasing returns to scale characterized production for all relevant ranges of production, the eventual market outcome would be a single firm. Such a firm would then be able to exercise monopoly power in the market.

However, if increasing returns to scale exist only for a certain portion of the supply curve, then a competitive equilibrium may exist at some point near the region where returns to scale are neutral. This possibility is explored in the mathematical model by setting price equal to average cost when increasing returns to scale are involved.

Restrictions on the supply of mushrooms, through the use of production area quotas, are incorporated into the model by solving for a solution subject to a constant fixed level of fixed input, K (see Appendix A). The level of fixed input K is an appropriate measure of the quantity of resources whose level of usage is distorted due to the existence of the quotas on area of production.

2.4 The Concept of Consumer Surplus

Discussion of the welfare implications of supply management typically make use of the concept of economic surplus. In Figure 2.1, linear demand D and supply S functions are shown.

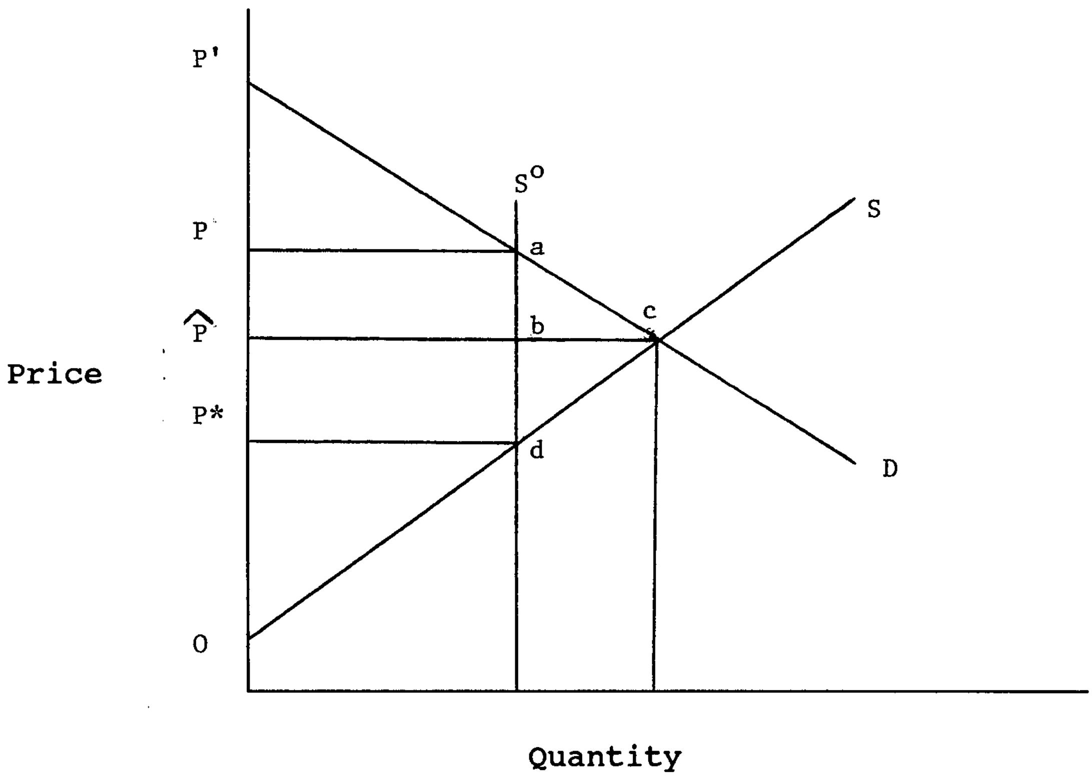

Figure 2.5 Welfare Effects of Supply Control

Source: Barichello (1985)

The consumer surplus is defined as the area $P'c\hat{P}$. This area is the extra revenue that a perfectly discriminating monopolist could extract by selling to individual consumers at sequentially lower prices. In a competitive market, consumers buy all units at one market clearing price. Therefore, the area under the demand curve and above the price line can be argued to be a consumer surplus. Similarly, area $\hat{P}cO$ is a producer surplus in the sense that the producers receive the same price P for every unit produced, but the costs of production lie below the supply curve S.

Restriction of production to the quantity Q gives rise to :

i) loss in consumer surplus $Pac\hat{P}$

ii) loss in producer surplus bcd

iii) gain in producer surplus $Pab\hat{P}$

The net effect is a welfare loss of area adc, which is the so called "deadweight triangle loss". Producers gain from imposition of the quota if the gain PabP more than offsets the loss bcd.

2.5 Financial Analysis of Production Quota

The ownership of quota will have a value attached to it as supply restriction results in greater than normal profits on all units of production. Producers who already have a quota allocation but wish to increase production would obtain benefits of magnitude 'ad' on <u>marginal</u> units of output. Assuming that the quota can be defined in terms of production, if a competitive market for quota which is sold on an incremental basis exists, producers would be willing to pay a price up to the expected net present value (NPV) of price "ad" for each additional unit of quota. The marginal benefits of quota ownership would be reflected in the market price for quota.

If the market equilibrium is competitive, there is on average no excess profit to be obtained at the margin, as production continues up to the level where marginal cost is equal to price. Therefore, no value will be associated with marginal units of production quota, unless the prospective buyer has a lower marginal cost than the industry average. Such a situation would be remedied in a well functioning market for quota which allows the higher marginal cost producer to sell part of his quota to a lower marginal cost producer. The quota market would reduce marginal rents towards zero.

However, quota can still take on a value in a competitive market, as ownership of quota is essentially a license to produce. That is, there are inframarginal rents associated with quota ownership which can be approximated by the difference between total revenue and total cost of production (profit). Therefore, the market price for quota which is sold to a new entrant into the industry would be related to the benefits of entry into the industry.

The valuation of quota as the benefit from marginal units of production in a supply restricted market is separate and distinct from the valuation of quota as a production license in an otherwise competitive market. It is important to distinguish the marginal rents of the former from the inframarginal rents of the latter.

The market price for quota can be analysed in the same fashion as a financial asset which provides a flow of returns over time. The following discussion is a brief summary of the detailed analytical method that Barichello (1984) employs in his analysis of marketing quota in the British Columbia dairy industry.

The net present value of an asset is defined by the following formula,

(1) $P_q = \Sigma\, F_t/(1+r_t)_t$

where P_q = net present value of quota = quota price

F_t = benefit at time t from one unit of asset

r_t = discount rate at time t

N = expected life of the asset

As presented, the equation requires detailed information which is seldom available to the analyst/farmer contemplating a quota purchase decision. A useful simplification of the equation would be to assume a constant level over time of both the discount rate and the benefits of quota. The equation becomes

(2) $P_q = \Sigma\, F/(1+r)^t$

The quota investment can now be treated as an annuity, which can be solved for any one of P_q, F, r, or N when the other three are known. A producer would solve for P_q, given his knowledge of the other variables.

In a market where quota is rented, the magnitude of variable F is directly related to the rental rate of quota. Where there is no market for quota rental, the magnitude of the benefit can be approximated by the size of "ad" in Figure 1. However, there may be additional benefits to quota ownership which are not captured by the measures mentioned above. One source of benefit can be found in the tax system. Producers are permitted to deduct from income an allowance for depreciation of quota, even though quota does not depreciate and in fact usually appreciates in value. Although this tax advantage is partially recaptured upon resale of the quota through taxation of capital gains, the net result is the equivalent of an interest free loan which grows in size as depreciation is claimed until the quota is sold.

Another source of benefit is the possibility of future capital gains. This may arise from the institutional rules and regulations which exist in the industry. An example would be the situation in which the industry level of quota is increased in order to accomodate demand growth. The new quota may be shared among existing members. Since the increase in quota levels is a result of demand growth, there is no decrease in the value of existing quota, and therefore any additional quota can be treated as a capital gain resulting from ownership of the original quota. Quota prices may also appreciate as a result of technological advances which decrease the cost of production, thus increasing the value of benefits if producer prices are not adjusted downwards. The expectation of capital gains may be incorporated into the valuation of quota by subtracting from the discount rate a variable g, the expected rate of growth of in the price of the quota.

The discount rate r is the opportunity rate of interest that a producer can expect to earn on the next best alternative investment. This rate may be adjusted to reflect the perceived risk of owning quota. Returns to agricultural production can vary greatly from year to year as a result of biological factors beyond the producer's control, such as yields, disease, weather, etc. Input prices are variable, as are output prices. Also, the rules and regulations which govern the industry may be modified by new government regulations. Consumer groups may lobby for lower prices and partial or full dismantling of the quota system. These and other risks which would result in loss of benefits from ownership of quota can be implicitly included in the valuation of quota by adjusting upwards the discount rate r.

Alternatively, the time horizon N for expected life of the quota may be shortened. This corresponds to the notion of a "payback period", the number of time periods neccessary for the benefits of an asset to equal the market price of the asset. A riskier asset would command a shorter payback period than another asset with the same price but with a more certain rate of return.

To summarize the methodology, the final form of the expression for the net present value of quota is

(4) $P_q^* = \Sigma\, F/(1+r-g)^t$

where P_q^* = P_q adjusted for tax benefits

g = expected rate of appreciation of quota price

CHAPTER 3

CONSUMER DEMAND THEORY, ECONOMETRIC MODELLING AND ESTIMATION

This chapter focuses on the methodology for obtaining the parameters needed for the demand section of the mathematical model presented in Chapter 2. First, a brief overview of consumer demand theory is presented in section 1. Section 2 presents the formulation of econometric equations to estimate the demand for mushrooms produced in B.C. In section 3, the results of the econometric equations are presented. Lastly, in section 4, a cost of production model is specified.

3.1 Consumer Demand Theory

A history of the development of consumer demand theory can be found in Hassan and Johnson (Hassan and Johnson, pp. 2-4). Much of the organization and content for the discussion to follow is borrowed from Hassan and Johnson, and Deaton and Muellbauer. It is intended to be a brief discussion of some of the issues in demand theory as they pertain to this study.

3.1.1 Classical Consumer Demand Theory

The cornerstone of the classical theory of consumer demand is the utility function,

(1) $u = u(q)$

where u is the utility or satisfaction derived from consumption of goods $q = [q_i]$, an n-element column vector of quantities of various commodities. Restrictions on the curvature properties of the utility function, namely that it is strictly increasing, strictly quasi-concave, and twice continuously differentiable, result in a well indifference curve.

These restrictions are necessary in order to assure consistency of choice by the consumer. A set of six axioms of choice can be formulated (Deaton and Muelbauer 1980, pp. 26-30), the acceptance of which is equivalent to the existance of the utility function.

Figure 3.1 Indifference Curve for the Utility Function (1)

Consumer demand is subject to a linear budget constraint,

(2) $p'q = m$

where $p = [p_i]$ is an n-element column vector of prices, and $p'q$ is the vector product of p transpose and q. Using the method of Lagrange, the utility function (1) can be maximized subject to the budget constraint (2),

(3) $L(q,\mu) = u(q) - \mu(p'q - m)$

Where μ is the Lagrangian multiplier, which has an interpretation as the marginal utility of the constraint, income. The first order conditions for a maximum are:

(4a) $u_1 - \mu p = 0$

(4b) $p'q - m = 0$

Where u_1 is the partial derivative of utility u with respect to q.

The set of first order conditions provides n+1 equations in 2n+2 variables. From this, a unique set of equations can be solved in terms of prices and income. The solution comprises a set of "demand equations",

(5) $q_i = q_i(p_1,\ldots,p_n,m) \qquad i = 1,\ldots,n$

(6) $\mu = \mu(p_1,\ldots,p_n,m)$

Assumning the existance of a set of demand functions (5), the fact that they satisfy the budget constraint (2) places a restriction on the functions q_i,

(7) $\Sigma\, p_i q_i(p,m) = m$

This is commonly referred to as the "adding up restriction". Another implication of the budget constraint concerns the effect of overall price level on demand. For any positive number θ, and for all i from 1 to n,

(8) $q_i(\theta p, \theta m) = q_i(p,m)$

Homogeneity of degree zero implies an absence of "money illusion". If all prices and income are twice as high, overall demand remains unchanged, because only the absolute price level has changed, not the relative price level. This is of course a weak assumption, but it is not trivial, as examples may be found of goods which have an appeal because of their absolute price level. High profile luxury items, such as diamonds and other jewelry are an example.

Manipulation of the first order conditions (4) yield further restrictions on the set of demand equations. These are presented in Table 3.1 below.

Table 3.1 Restrictions on the System of Demand Equations

Restriction	Name
$\Sigma\, w_i \eta_i = 1$	Engel Aggregation
$\Sigma\, w_i e_{ij} = -\, w_j$	Cournot Aggregation
$e_{ij} = w_j/w_i * e_{ij} - w_j(\eta_i - \eta_j)$	Symmetry Relation
$\Sigma\, e_{ij} = -\eta_i$	Homogeneity Condition

Source: Hassan and Johnson (1976), p.11 Table 1

The Engel aggregation condition states that the weighted sum of income elasticities η_i with weights $w_i = p_i q_i/m$ (expenditure proportion of total) is unity. Cournot aggregation expresses the weighted sum of price elasticities e_{ij} in column j as the negative of expenditure proportion on commodity j. The symmetry relation implies that the matrix of cross-price elasticities is symmetrical. Lastly, the homogeneity condition is a re-statement of (8), in terms of elasticities.

In summary, the classical theory of consumer demand provides a complete set of demand equations which are obtained from maximization of a consumer utility function subject to a budget constraint. The demand functions relate quantities consumed to all commodity prices and income. Given n commodities, there are n direct price elasticities, n^2-n cross-price elasticities, and n income elasticities, for a total of n^2+n parameters that need to be estimated at the same time.

By imposing the restrictions which are outlined in Table 3.1 and the budget constraint, the number of parameters can be reduced. The symmetry relation allows a reduction of $\frac{1}{2}(n^2-n)$ parameters. Cournot and Engel aggregation further reduce this number by n-1, to $\frac{1}{2}(n^2+n)-1$ remaining independent parameters. This number of parameters is still too large to allow direct estimation of a complete demand equations.

3.1.2 Extension of the Classical Theory of Consumer Demand

In order to estimate the parameters of the set of demand equations, further restrictions are required. Many studies, including this, make <u>ad hoc</u> assumptions by omitting certain variables in the demand functions. The unfortunate drawback of this method is that the bias introduced by these restrictions needs to be evaluated in order to assess the validity of the results. As a solution to the unrestricted equations cannot be computed, there is, in general, no basis from which to assess the bias of additional restrictions. The results are therefore dependent on the restrictions which are applied.

The alternative to ad hoc estimation is a systematic re-working of the classical theory of consumer demand. What is needed are more restrictions on the basic theoretical groundwork; that is, more restrictive behavioral assumptions. Much of current research efforts in demand theory is centered about a more specialized utility function.

One widely used assumption is the notion of separability. Many published results (e.g., Hassan and Johnson) employ some form of separability assumption, and it is useful to compare their findings against the simpler, ad hoc specifications which will be employed in this study.

3.1.3 Single Equation Demand Estimation

Econometric estimation of single equation demand is widely used in the literature. From the discussion in the previous sections of this chapter, it is clear that single equation estimation implicitly contains some strong assumptions on the underlying theory of consumer behavior. As an example, the following demand equation is often used,

(9) $q_i = a + bm + \Sigma\, e_{ij}p_j + u_i \qquad i = 1,...,n$

where u_i is a disturbance term.

Some assumptions which are implied by (9) are:

1. The j summation index does not include all commodities, even within the same group (e.g., all vegetables). The limit k_i means that the rest of the $n-k_i$ parameters are forced to be zero. While the resulting bias may be zero for unrelated goods (e.g., vegetables and cars), the bias may not be trivial for goods which are close substitutes or complements.
2. Price is the dependent variable, and all the other right hand side variables are exogenous. In the market, equilibrium is generally determined simultaneously in price and quantity. Other behavioral equations may need to be estimated simultaneously, as not all the variables on the right hand side are completely exogenous to price. This is the problem of simultaneous equation bias.

Functional form also implies some form of restriction on consumer behaviour. For example, the double log form, popular in the literature, violates the Engel aggregation criterion. If Engel aggregation is applied to a system of equations employing the double log functional form, all income elasticities are forced to equal one (Yoshihara, p.261).

In general, single equation estimation imposes restrictions on the function estimated. In addition, not all the restrictions (Table 1) which are available from economic theory are employed. However, time and data limitations often dictate single equation methods. Single equation estimates are useful if the bias introduced is not too large.

3.2 The Demand for Mushrooms in B.C.

The demand for mushrooms produced in B.C. can be conveniently split into two components, fresh and processed. The bulk of fresh mushroom consumption in B.C. is centered in the heavily populated areas of Greater Vancouver and the Fraser Valley region (lower mainland). The relatively short shelf life of fresh mushrooms limits marketing of B.C. mushrooms in other regions of Canada. In contrast, B.C. processed mushrooms are marketed in every province of Canada.

3.2.1 Demand for Fresh Mushrooms

The F.V.M.G.C.A. is the sole selling agent for B.C. produced mushrooms. As the local fresh product accounts for more than 90 percent of B.C. consumption, the F.V.M.G.C.A. is a price setter. Therefore, price is an exogenous variable and the dependant variable for fresh mushroom demand is the quantity consumed.

From the discussion in the previous section on consumer demand theory, the other determinants of demand include prices of substitutes, complements, and income. The demand for fresh mushrooms in B.C. is formulated as follows:

(1) CONSUMP = f(PIFV, CPIB, RINCO, RAD, TREND, DUMMY)

where

CONSUMP = per capita consumption (lbs/capita/month) of fresh mushrooms in B.C.

PIFV = real price index of fresh mushrooms at the retail level minus real price index for vegetables

CPIB = real consumer price index of beef for Canada (1981=100)

RINCO = real labour income for B.C. ($/month)

RAD = real advertising expenditures, media and promotion ($/capita/month) for fresh mushrooms

TREND = time trend, Jan.1983=1...Sept. 1986=57

DUMMY = dummy variables denoting seasonality in each month of the year (except December)

Data on these variables were available on a monthly basis from January 1982 to September 1986. Values for CPIB, RINCO, and RAD have been adjusted by the consumer price index for all goods in Vancouver, 1981=100, to obtain real values. The variable PIFV was constructed as follows. The price for mushrooms was constructed into an index with base year 1981, and deflated by the consumer price index for all goods. A fresh vegetable price index for Vancouver, 1981=100 was also deflated by the consumer price index for all goods. The difference was then taken between the mushroom real price index and the vegetable real price index. Appendix B contains a listing of some of the variables used[4].

A priori, the standard assumptions based on economic theory state that the coefficient for:

1. Own Price is negative. Mushrooms are assumed to be normal good. In addition, fresh mushrooms are thought to be a substitute for fresh vegetables. As the price difference between mushrooms and other fresh vegetables increases, the quantity demanded decreases.
2. CPIB is negative. Mushrooms are believed to be complement to beef.
3. RINCO is positive. Mushrooms are a superior good. As income increases, more is available for expenditure on goods which the consumer desires more of.
4. RAD is positive. Advertising mushrooms is expected to increase consumption.

In a recent B.C. consumer survey commissioned by the F.V.M.G.C.A. (Marketrend), it was found that the two major uses for fresh mushrooms are as an accompaniment to meat dishes, particularly steak, and with salads. The variable CPIB is included in the demand equation as a proxy for steak prices. The usage of mushrooms in salads is captured in the variable PIFV, the difference between price indices for fresh mushrooms and all

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[4]The data on some of the variables is confidential, and therefore cannot be listed.

fresh vegetables.

Advertising is included in the model, as there is presently an extensive on-going promotion campaign. On average, for the years between 1982 and 1986, greater than $1,000,000 each year has been allocated for promotion of fresh mushrooms produced in B.C. The name brand "Money's Mushrooms" receives regular exposure in newspapers ads, magazines articles, radio spots, and t.v. comercials. The advertising variable is actual monthly expenditures on advertising for fresh mushrooms. This variable is not necessarily indicative of the actual amount of advertising that occured in any given month. For example, television commercial costs are often paid immediately, but the commercials may run for several months afterwards. Despite this major limitation, it is the best available measure of advertising expenditure.

An income variable is included, in order to test the hypothesis that increases in disposable income result in higher consumption of fresh mushrooms. No data were available for disposable income for B.C. on a monthly or quarterly basis. The variable RINCO, labour income, was chosen as a proxy for disposable income.

Monthly dummy variables are used to capture any seasonal component(s) which is not explained by the other variables in the model. In particular, inspection of monthly fresh mushroom sales data reveals a marked decline in quantities sold in the months of February, September and October of each year. No plausible explanation is available for decline in September and October, so a dummy variable is used for both months. The decline in quantity sold in the month of February can likely be attributed to fewer days in that month.

A trend variable is included to capture any pattern of change in consumption which is not explained by the other independent variables included in the model.

Time and data limitations necessitated exclusion restrictions with respect to complement and substitute relationships which are not explored in the demand model. The most obvious exclusion, processed mushroom prices, was made necessary by data limitations. Processed mushroom prices were only available at the wholesale level. Processed mushrooms are a storable commodity, therefore wholesale prices in any given month are not a reliable indication of retail prices in that month. Also, processed mushroom prices for imports into B.C. were not available on a monthly basis. Further, price of local processed mushrooms was only available for 44 observations, 13 fewer than were available for other variables in fresh demand. The decision was made to exclude processed prices in the fresh demand model.

3.2.2 Advertising and Demand

The role that advertising plays in the demand function is one that deserves special attention. Advertising effects are difficult to model for several reasons.

The appropriate unit with which to quantify advertising is not clear. The type of media employed, such as radio, t.v., or newspaper certainly has a bearing on the effectiveness of the advertising expenditure. However, the researcher rarely has access to sufficient information on these variables to attempt least squares regression. Usually, data limitations dictate using expenditure dollars as a measure, but this is, at best, only an approximation.

Another problem lies in the differences that exist in the response of individuals to advertising. Different people not only respond differently to advertising, but a particular person may also respond differently to repetition of the same stimulus depending on other factors which are too complex to model.

Lastly, even in the absence of the above problems, advertising effects are difficult to model because they are thought to persist longer than the current time period. Two important issues arise: (a) what is the magnitude of the effect, (b) how does this change over time. In the discussion that follows, all variables other than advertising are omitted for ease of exposition.

The "direct lag" model is the simplest way of estimating advertising effectiveness over time. Lagged advertising values are included in the equation as independent variables:

(1) $y_t = a_o + \Sigma b_j x_{t-j} + \epsilon_t$

where: y_t = demand at time t

x_{t-j} = advertising expenditures at time t-j

ϵ_t = spherical disturbance term (identically distributed, with mean 0 and variance σ^2).

Specification of the lag length n requires a subjective decision by the researcher. If the lag length chosen is shorter than the true lag length, truncation bias would result. If n is longer than the true lag length, tests of the significance of additional lagged values may be used.

The above procedure results in efficient, unbiased estimates of the coefficients when the standard assumptions of ordinary least squares regression are valid (Johnson, pp.168-71). However, this is seldom the case and in practice, the assumption of independence among the exogenous variables is often violated. Specifically, lagged advertising variables are often found to be highly collinear (the problem of multicollinearity). The resulting estimates become inefficient (large standard errors), but are still unbiased asymptotically.

Another approach uses a weighted moving average representation for advertising. Past values are specified as a stock or "goodwill" variable. Studies that have used this method include Nerlove and Waugh, and Kinnucan. Again, a subjective decision must be made about the length of the lag, and as well, an appropriate weighting scheme must be chosen. The limitation of this approach is that the duration of advertising effectiveness cannot be reliably derived from the results. Significant estimates of the parameters may be obtained even if the actual duration is shorter than the moving average because of aggregation (Clarke, p.346).

The distributed lag family of models are used widely for estimating advertising effectiveness. In particular, the Koyck model (Koyck) is very useful. It circumvents the problem of multicollinearity by imposing a structure on the manner in which past values of advertising outlays affect demand. This results in a reduction in the number of parameters that need to be estimated. The model is derived from (1) and assumptions that:

1. n is infinite
2. the coefficient bt declines exponentially with parameter such that $0 < \theta < 1$ and $b_j = \theta b_{j-1}$

Equation (1) reduces to:

$$(2) \quad yt = a_o + \theta y_{t-1} + b_o x_t + v_t$$

$$v_t = \epsilon_t - \epsilon_{t-1}$$

The parameter θ represents the decaying effect of advertising over time. The reduced form (2) can also be derived from a hypothesis of adaptive expectations (Johnson, p.348).

A related model is the partial adjustment model. The reduced form is the same as (2), but with a much simpler structure for the error term. The partial adjustment model is derived from a different hypothesis of rational behaviour (Johnson, p.349). The carryover effect (represented by the lag dependent variable), is not all due to advertising as in the Koyck model. In this case, the inertia is attributed to demand in time t changing very little from demand in time t-1. The interpretation of θ would therefore include other variables such as price, product loyalty, etc.

The partial adjustment process may be specified as

(3) $y_t - y_{t-1} = \theta(y_t^* - y_{t-1}) + u_t$

That is, the difference between current period demand and the previous period is a fraction θ of the difference between optimal, desired current period demand y_t^* and previous period demand.

In contrast to the adaptive expectations and partial adjustment models, which are derived from models with an expectations mechanism, a third type of distributed lag model can be postulated which is driven solely by an autoregressive error. The cumulative effects model (Griliches) has assumptions:

i) $y_t = a_o + ax_t + u_t$

ii) $u_t = \theta u_{t-1} + \epsilon_t$

iii) $0 < \theta < 1$

Combining these assumptions results in:

(4) $y_t = a_o + ax_t + \theta ax_{t-1} + cy_{t-1} + e_t$

Noting that (4) is very similar to (2), Clarke (p.352) suggests a test equation:

(5) $y_t = A_o + Ax_t + Bx_{t-1} + Cy_{t-1} + v_t$

$v_t = \epsilon_t - D\epsilon_{t-1}$

The results can be categorized as follows:

Adaptive Expectations (Koyck)	B=0	C=D
Partial Adjustment	B=0	D=0
Cumulative Effects	B=-AC	D=0

A discussion of the results obtained from regression analysis of the three different models above is presented in section 3 of this chapter.

3.2.3 Demand for Processed Mushrooms

Processed mushrooms produced in B.C. are sold in every province in Canada. More than 50 percent of locally produced mushrooms are processed. Unlike the fresh market, the demand for processed mushrooms includes a significant quantity of imports from Pacific Rim countries. The market price is influenced by total quantities (import and domestic) available. The quality of local product is distinguishable from imports, allowing a small price premium for Money's name brand.

Processed market demand is not modelled in the same manner as the fresh market. The endogenous variable in the processed market is price, which is determined in the market. This is in contrast to price formation for fresh grade, where price is set by the seller. In addition, inventory management is possible in the processed market, an option which is not available in the fresh market.

The market for B.C. processed mushrooms in Canada is modelled as a price function, with variables as described above. An appropriate model using price as the dependent variable (Intriligator, p.224) is as follows:

(7) CPRICED = f(CCONSBC, CPRICEI, PINV, RPDI)

where

CPRICED = real price of B.C. canned product ($/lb) at the wholesale level

CCONSBC = Canadian consumption of B.C. product (lb/capita/month)

CPRICEI = real price of imported product ($/lb) at the wholesale level

PINV = processed inventories of B.C. product

RPDI = Canadian real per capita disposable income

The variables are available on a monthly basis from January 1983 to September 1986. Price for processed mushrooms was adjusted by the Consumer Price Index for Processed Foods in Canada (1981=100) to obtain real values. RPDI was adjusted by the Consumer Price Index for All Items in Canada (1981=100). A Canadian price function is estimated, instead of a B.C. price function, because data for B.C. consumption of processed mushrooms was not available. Appendix B contains a list of some of the variables used[5].

A priori, the expected sign of the coefficient for:

1. CCONSBC is negative. Processed mushrooms are a normal good.
2. CPRICEI is positive. A higher imported price permits a

[5] The data on some of the variables is confidential, and therefore cannot be listed.

higher B.C. price.

3. PINV is negative. Large inventories have a depressing effect on price. That is, in order to reduce inventories, price must also be lowered, all else being constant.
4. RPDI is positive. Processed mushrooms are a superior good.

As in the previous discussion of exclusion restrictions in the fresh mushroom demand model, an obvious substitute variable, fresh mushroom price, was excluded due to data limitations. Wholesale fresh mushroom prices were not available on a monthly basis. Also, prices of processed mushrooms for other regions of Canada were not available on a monthly basis.

An inventory variable is included as the local producers' association is actively engaged in inventory management. Inventory levels comprise a significant level of total processed quantities. In 1986, a year with very weak processed prices in the market, monthly inventory levels were on average as high as monthly sales of processed mushrooms.

Import processed prices are included as the import share of domestic sales is very high. In 1985, 73 percent of the Canadian processed market was offshore product. Imported mushrooms are believed to be a very close substitute for domestic processed mushrooms.

3.3 Econometric Estimation and Results of Demand for Mushrooms

In the following discussion of results, all of the regressions were obtained using the regression package SHAZAM (White). The equations were estimated using a linear functional form. A priori, economic theory does not indicate which functional form is the most appropriate.

3.3.1 Fresh Demand Equations

The various lag models discussed in the previous section on demand were estimated. In Table 3.2, the results for a simple model without lag variables, and the Partial Adjustment model are presented. The results for the test equation (5), the Cumulative Effects, and Koyck Model are presented in the Table 3.3.

In Table 3.2, the results for a simple model without any allowances for the dynamic, inter-period effects of advertising are presented. This estimate will be biased but it is provided as a base case from which to compare the results of the other models. The independent variables explain 73.7 percent of the variation in the dependent model. All the independent variables, except real income (RINCO), are statistically significant at a 90 percent level. The test of the null hypthesis:

H_o: RINCO is statistically different from zero

was rejected at the 5 percent critical level ($t_{calc} < t_{crit} = 2.02$).

The Stock (Partial) Adjustment model is also presented in Table 3.2 . The overall fit of this model is only marginaly better than the simple model. The usual test for serial correlation in the residuals, the Durbin-Watson statistic, cannot be used as it is biased in a lagged dependent model. An alternate test, the Durbin-h statistic, shows no serial correlation in the residuals. However, the crucial variable for this model, lagged consumption (LCONS) is not statistically significant at the 95 percent level. The Partial Adjustment model is therefore rejected.

The results for test equation (5) without any correction for serial correlation in the residuals are presented in the first column of Table 3.3 . As Durbin's h statistic cannot be calcultated for this particular regression, there is no test available for the presence of autocorrelation.

As both variables crucial to the Cumulative Effects model, lagged consumption (LCONS) and lagged advertising (LRAD) are not statistically significant, the equation is re-run with an assumption of first order serial correlation (column 2 in Table 3.3). The estimated autocorrelation parameter RHO is statistically significant (t-stat = -4.31), implying the original equation did indeed have first order serial correlation in the residuals. This result does not support the Current Effects model, which predicts the value of RHO to be zero (D=0 in equation (5)). Also, the lagged advertising variable LRAD is still statistically not significantly different from zero. The

Cumulative Effects model is therefore rejected.

Table 3.2 Econometric Estimates of Fresh Mushroom Demand Linear and Stock Adjustment Models

	LINEAR MODEL	STOCK ADJUSTMENT
LCONS		0.149
		(1.22)
RAD	4.32E-01	0.438
	(2.22)**	(2.25)**
RINCO	1.43E-06	1.50E-05
	(0.01)	(2.26)**
MVINDEX	-9.40E-04	-8.17E-04
	(-2.47)**	(-2.09)**
CPIB	-1.96E-03	-1.82E-03
	(-1.93)*	(-1.78)*
TREND1	1.59E-03	1.33E-03
	(7.28)**	(4.34)**
FE	-2.69E-02	-2.83E-02
	(-2.69)**	(-2.82)**
SE	-4.29E-02	-4.09E-02
	(-3.9)**	(-3.7)**
OC	-4.25E-02	-3.66E-02
	(-3.5)**	(-2.81)**
CONSTANT	0.445	0.382
	(3.4)**	(2.74)**
Durbin-Watson	1.73	2.01
Durbin-h	N/A	-0.19
R-Square Adj	0.737	0.740

NOTE: t-statistics in brackets
** significant at 95 %
* significant at 90 %

Table 3.3 Econometric Estimates of Fresh Mushroom Demand Cumulative Effects and Koyck Lag Models

	CUMULATIVE EFFECTS		KOYCK LAG	
	OLS	AUTO	OLS	AUTO
LCONS	0.117	0.457	0.127	0.455
	(0.87)	(4.08)**	(0.99)	(4.24)**
RAD	0.282	0.420	0.312	0.410
	(1.17)	(2.18)**	(1.46)	(2.72)**
LRAD	6.42E-05	-1.51E-05		
	(0.28)	(-0.08)		
RINCO	1.68E-04	1.35E-04	1.70E-04	1.34E-04
	(1.03)	(1.16)	(1.06)	(1.16)
LRINCO	-2.93E-04	-1.62E-04	-3.00E-04	-1.60E-04
	(-1.63)	(-1.15)	(-1.70)*	(-1.15)
MVINDEX	-1.21E-03	-1.59E-03	-1.18E-03	-1.60E-03
	(-2.26)**	(-3.52)**	(-2.27)**	(-3.77)**
LMVINDEX	5.03E-04	1.44E-03	5.11E-04	1.44E-03
	(0.98)	(3.59)**	(1.00)	(3.61)**
CPIB	-1.68E-03	-1.95E-03	-1.65E-03	-1.97E-03
	(-1.19)	(-1.62)	(-1.19)	(-1.68)*
LCPIB	3.33E-04	1.32E-03	3.00E-04	1.34E-03
	(0.24)	(1.09)	(0.22)	(1.14)
TREND1	1.29E-03	6.94E-04	1.27E-03	6.99E-04
	(3.96)**	(3.02)**	(4.03)**	(3.2)**
FE	-2.66E-02	-2.36E-02	-2.74E-02	-2.33E-02
	(-2.54)**	(-2.77)**	(-2.75)**	(-3.00)**
SE	-4.77E-02	-4.57E-02	-4.85E-02	-4.53E-02
	(-3.58)**	(-3.85)**	(-3.78)**	(-4.20)**
OC	-3.56E-02	-3.08E-02	-3.58E-01	-3.08E-02
	(-2.71)**	(-2.68)**	(-2.76)**	(-2.68)**
CONSTANT	0.449	0.225	0.450	0.224
	(2.66)**	(1.96)*	(2.70)**	(1.96)*
RHO		-0.551		-0.550
		(-4.31)		(-4.35)
Durbin-Watson	2.17	1.85	2.18	1.85
Durbin-h	N/A	0.94	-2.59	0.85
R-Square Adj	0.742	0.771	0.748	0.776

NOTE: t-statistics in brackets
** significant at 95 %
* significant at 90 %

The results for the Koyck model, with a correction for first order serial correlation of the residuals, indicate that it fits the data best, explaining 77.6 percent of the variation in the dependent variable. The Koyck model is not rejected, as the coefficient of the lag dependent variable, LCONS, is not significantly different from the serial correlation parameter RHO (D in test equation (4). The 95 percent confidence intervals for LCONS and RHO are calculated below:

	COEF.	STD. ERR.	CONFIDENCE INTERVAL
LCONS	0.455	0.107	+/- 0.216
RHO	0.550	0.127	+/- 0.256

Both variables are within each other's confidence interval. All other variables show the _a priori_ expected signs. As the Koyck model fits the data much better than the other models, the rest of the discussion will focus on the Koyck model.

All the variables, except labour income (RINCO) were statistically significant at at least the 90 percent level. Since labour income was included in the model as a proxy for disposable income (not available for B.C. on monthly or quarterly basis), its poor performance may be due to labour income being a poor approximation to disposable income. The regression was also run with Canadian disposable income, but the results were also not significant for the income variable. It is possible that in the short run, income has little effect on consumption of fresh mushrooms.

The exclusion of an important variable which is a substitute for fresh mushrooms, processed mushroom prices, was necessitated by data limitations as discussed earlier. However, the regressions were estimated with the inclusion of an additional variable; wholesale processed prices as a proxy for retail processed mushroom prices. The wholesale processed mushroom price may not be a good proxy for the retail processed price in any given month, since inventory management forms an integral part of that market. The econometric results confirmed this suspicion, as the results implied that processed mushrooms are a complement to fresh mushrooms. This is highly counter-intuitive, so these results were not used.

Clarke (Clarke, p.348) notes that the Koyck model has an implied duration interval which can be calculated using the formula:

$$l^* = \log(1-p) / \log(l)$$

where l^* = duration interval

p = cumulative proportion of total impact

l = coefficient of the lagged dependent variable

For the Koyck model estimated in Table 1, the implied duration interval for p = 0.9 is 2.92. That is, for advertising to exert 90 percent of its influence on demand requires on average 2.9 months.

3.3.2 Demand Elasticities for Fresh Mushrooms

Elasticities calculated from the Koyck model for the appropriate independent variables are presented in Table 3.4 below:

Table 3.4 Demand Elasticities for Fresh Mushrooms Calculated at the Means

VARIABLE	SHORT RUN ELASTICITY	LONG RUN ELASTICITY
RINCO	0.28	0.51
OWN PRICE	-0.56	-1.03
CPIB	-0.53	-0.97
RAD	0.036	0.066

Income elasticity of demand is substantially less than one, implying that mushrooms are a normal, but inferior good. This result is consistent with a priori expectations, as the demand for the majority of foods is income inelastic. By way of comparison, an Agriculture Canada study (Hassan and Johnson) employing a full system of demand equations for foods obtained an estimate for income elasticity for fresh vegetables of 0.09. The estimate for the income elasticity of demand should be treated with caution, as the income variable was not statistically significant in the demand equation.

In the short run, price elasticity of demand for fresh mushrooms is less than one in absolute value. Hassan and Johnson's estimate for direct price elasticity of fresh vegetables is -0.2420. Both estimates are price inelastic, although the own price elasticity obtained for fresh mushrooms in this study is higher (in absolute value) than the elasticity estimate for all fresh vegetables in the Hassan and Johnson study. Again, this is intuitively plausible, as one would expect that the aggregated category can to be less price responsive than any individual item within that category. This is due to the possibilities that exist for substitution between commodities within the same group. The long run estimate for own price elasticity is just slightly over one in absolute value.

The beef CPI elasticity was negative, as expected for a good which is postulated to be a complement for fresh mushrooms. The fact that beef CPI cross elasticity to fresh mushrooms is inelastic is also consistent with a priori expectations. However, Hassan and Johnson's estimate (Hassan and Johnson, table 15 p.42) for cross price elasticity of total fresh vegetable demand with respect to beef price was only 0.01689. The corresponding estimates for other meats were all less than 0.06. The value obtained in this study was -0.53, considerably larger (in absolute value) than the above mentioned estimate by Hassan and Johnson for beef cross price elasticity with respect to vegetable consumption. Fresh mushrooms are used in many other dishes, such as salads, pizza, soups, etc. Therefore, beef prices are expected to have a much smaller effect than estimated in this study. Beef prices must be behaving as a proxy for some other(s) variable which has not been included in the regression.

Advertising elasticiy is quite low. That is, advertising expenditures appear to have very little effect on the level of consumption of fresh mushrooms. The low demand responsiveness to advertising expenditures may be due to the variable not being a suitable measure of the actual levels of advertising activity. Alternatively, consumers may simply be unresponsive to advertising in the short run. The current high level of consumption of fresh mushrooms in B.C. may instead be attributed to widespread availability of product and stable prices.

3.3.3 Processed Demand Equations

The market for processed mushrooms produced in B.C. was modelled as a price dependant equation. The results are presented below:

<u>Table 3.5</u> Price Dependent Demand Model

VARIABLE	COEFFICIENT
CCONSBC	-1.01
	(-1.56)
CPRICEI	1.14
	(6.22)**
PINV	-1.88 E-05
	(-1.12)
RPDI	1.01 E-04
	(2.40)**
CONSTANT	-0.863
	(-1.82)*
D-W	1.55
R^2 ADJ.	0.496

** significant at 95%
* significant at 90%

The overall fit of this regression was not high, with only 49.6 percent of the variation in processed price explained by the independent variables. All coefficients have the a priori expected signs. However, import price (CPRICEI) and income (RPDI) were the only variables which were statistically significant at the 95 percent confidence level (see t-statistics, Table 3.5). The inventory variable, PINV, was not significantly different from zero at the 90 percent level. The quantity variable, CCONSBC, was also not significantly different from zero at the 90 percent level.

The main conclusion that can be drawn from the results is the strong relationship between import price and domestic price. The coefficient for CPRICEI is 1.14; very close to one. That is, the wholesale price of local processed mushrooms moves with the import wholesale price on an almost one for one basis. This implies that changes in the import processed price determine to a large extent the corresponding change in the price level for local, B.C. product.

3.3.4 Elasticity of Price Flexibility for Processed Mushrooms

The interpretation of elasticities for processed mushrooms needs to be discussed. In a price dependent equation, the calculated elasticities are in fact elasticities of price flexibility. That is, the dependent variable being price, not quantitity, means that calculated elasticities measure the percentage change in price that is caused by a one percent change in dependent variable, for example quantitity.

This is the inverse of the usual definition of price elasticity if certain restrictions are satisfied (Houck p. 792), namely that the matrix of cross elasticities for substitutes is zero. When this condition is not satisfied, the absolute value of the inverse of the price flexibility of demand is a lower limit on the absolute value of the actual, unobserved price elasticity of demand.

All of this is not to imply that the elasticity of price flexibility is not a useful statistic, only that it is a non-standard measure and therefore requires care to ensure that the correct interpretation is used.

The coefficients of price flexibilities for the processed mushroom price dependent demand function are presented in Table 3.6.

Table 3.6 Coefficients of Price Flexibilities for Processed Demand Function, Calculated at the Means

Variable	Coefficient of Price Flexibility
CCONSBC	-0.06742
CPRICEI	0.8898
PINV	-0.02545
RPDI	1.376

The coefficient of price flexibility for CCONSBC, the quantitity of local product demanded, is quite low (-0.06742). This supports the initial assumption of an exogenously determined price. The quantitity of local supply has very little effect on its own price, as a close substitute, import processed mushroom is available.

The coefficient of price flexibility for import processed mushroom price is close to unity (0.89). A one percent change in import price results in a 0.89 percent change in domestic price. This also confirms the dominant effect that import price has on domestic price.

3.4 Cost of Production Model

In this section, a cost of production model for a mushroom farm in B.C. is presented. The results will be used as parameters for the Constant Elasticity of Substitution Production Function in the mathematical model of the B.C. mushroom industry (Chapter 2). Total costs are grouped into two broad categories- fixed costs (R) and variable costs (W). The model is based on data for the years 1983 to 1986. A Balance Sheet and Capital Cost Schedule is included for 1986.

Mushroom farms in B.C. vary in size, from small operations which rely entirely on family labour, to larger farms which employ several labourers. To simplify the analysis, the notion of a "representative farm" is used as the basis for a cost of production model.

3.4.1 Assumptions

The cost of production for B.C. mushroom farms was examined in detail by building a cost model on the spreadsheet package, Lotus 1-2-3. For the year 1986, the following assumptions are employed in the model[6]:

1) The size of operation, in terms of square footage of production area, is 30,000 square feet, which is divided into 12 growing rooms of 2,500 square feet each. This is approximately the average size of a production unit in B.C.[7]

2) 4.75 cycles (crops) are employed per year per growing room. This figure is obtained from a biological growing cycle of 77 days which is currently employed by the majority of producers.

3) Yield per growing cycle is calculated from the average yield for all producers in B.C. In 1986, the average yield was 3.53 pounds of mushrooms per square foot per crop.

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[6]Some of the data is obtained from the financial records of indiviudal producers. For reasons of confidentiality, no data sources are quoted.

[7]Average area per producer calculated as total B.C. square footage divided by number of producers.

4) Labour requirements are broken down into operator and hired labour. The operator is assumed to work 10 hours a day, 5 days a week, for an annual total of 2,600 hours. Operator wage is $12 an hour, plus a WCB rate (Workers' Compensation Board) of 3 per cent. Hired labour requirements are 592 hours per cycle, for an annual total of 2808 hours based on complete turnover of one growing room per week. The cost of hired labour is $8 an hour, plus 4 percent for benefits and 3 per cent for WCB. The rates used for benefits and WCB are those required by the B.C. labour code.

5) Energy requirements are broken down into four categories:

   i. Natural gas and electricity for heating and air conditioning costs $0.22 per square foot per cycle.

   ii. Truck and panel van require 7800 litres of fuel per year.

   iii. Tractor and bobcat require 8350 litres of fuel per year.

   iv. Oil and lubrication for all farm vehicles is 15 percent of fuel cost.

6) Harvesting cost is $0.18 per pound of mushroom, plus 4 per cent benefits and 3 per cent WCB.

7) Quantities and cost of materials used are as outlined in the Cost of Production Model. It should be noted that the

quantities used are based on what is believed to be the average for the industry as whole. An individual operation may be using more or less.

8) Interest on operating capital is calculated using the Chartered Bank Rate for prime business loans. The time period used is half of a growing cycle, to reflect the fact that not all costs are incurred at the beginning of the cycle, but are in fact distributed throughout the cycle.

9) Property taxes are $3,000 a year.

10) Insurance costs $3,300 a year.

11) Accounting, legal, and office expenses are $4,100 a year.

12) The real rate of interest is applied to capital costs to obtain the opportunity cost of capital. The rate used is 5 percent.

13) Depreciation can be calculated using two alternative methods: straight line and declining balance. For tax purposes, the declining balance method is required, but this method places the most weight on the first few years, and is therefore not very suitable for looking at costs using a single year time frame. The declining balance method gives

equal weight to all years and is therefore a more appropriate measure of depreciation in this case.

14) The rental rate of land is used as the cost of land. For a 5 acre farm in the Fraser Valley, the rental rate is $140 per acre per year.

15) The market return for growers is $0.838 a pound, as calculated from monthly statements from the Fraser Valley Mushroom Grower's Cooperative Association for the year 1986.

16) The capital cost schedule in the model is obtained by estimating the capital equipment needs of a representative farm. Repair and maintenance is calculated as 5 percent of capital cost for truck, tractor and van and other equipment. For buildings it is 2 percent of capital cost.

3.4.2 The Cost of Production Model

Analysis of Mushroom Production Costs in B.C. (1983-1986):
A Representative Operation in the Fraser Valley

	1983	1984	1985	1986	
Farm Characteristics					
Number of Buildings	12	12	12	12	rooms
Square Footage	2500	2500	2500	2500	ft/room
Cycles per Year	4.32	4.32	4.40	4.75	cycles/year
Average Yield	3.48	3.52	3.57	3.53	lbs/ft2
Labour Requirements					
Operator Hours	2600	2600	2600	2600	hours/year
Hourly Rate	9.50	10.00	12.00	12.00	$/hour
WCB Rate	3	3	3	3	%
Hired Labour Hours	2554	2554	2601	2808	hours/year
Hourly Rate	6.50	7.00	7.50	8.00	$/hour
WCB Rate	3	3	3	3	%
Benefits	4	4	4	4	%
Total Labour Costs					
Operator (+WCB)	0.196	0.207	0.243	0.226	$/ft2/cycle
Hired	0.128	0.138	0.148	0.158	$/ft2/cycle
WCB & Benefits	0.01	0.01	0.01	0.01	%
Energy Requirements					
Gas and Electricity	27216	27648	28600	31350	$/year
Truck and Panel Van	7094	7094	7225	7800	litres/year
Tractor	7593	7593	7734	8349	litres/year
Oil and Lube Rate	15	15	15	15	%
Fuel Cost	0.35	0.36	0.37	0.38	$/litre
Harvesting Cost					
Harvest Rate	0.16	0.17	0.18	0.18	$/lb
WCB Rate	3.00	3.00	3.00	3.00	%
Benefits	4.00	4.00	4.00	4.00	%
Total Harvested	451008	456192	471240	503025	lbs/year
Total Harvest Cost	0.5958	0.6403	0.6876	0.6799	$/ft2/cycle
Materials					
Spawn Cost	29.00	30.00	31.00	32.75	$/case
Cases Used	12	12	12	12	cases/cycle

Supplement Cost	32.00	33.00	34.00	34.50	$/bag
Bags Used	4	4	4	4	cases/cycle
Chemical Cost	4000.00	5000.00	6000.00	6000.00	$/year
Compost Cost	27.21	29.79	29.97	30.00	$/yard
Yards Used	55	55	55	55	yards/cycle
Casing Soil Cost	20.50	21.00	21.50	22.00	$/yard
Yards Used	12	12	12	12	yards/cycle
Bed Plastic Cost	48.00	49.00	49.50	50.00	$/roll
Rolls Used	0.33	0.33	0.33	0.33	rolls/cycle
Bed Netting Cost	1732.00	1732.00	1732.00	1732.00	$/roll
Rolls Used	8.25	8.25	8.25	8.25	rolls
Replacement Freq.	10	10	10	10	years
Interest on Operating Capital					
Chartered Bank	11.17	12.06	10.58	10.50	%
Divided by	4.32	4.32	4.40	4.75	cycles/year
	2	2	2	2	for average
Property Taxes	2850.00	2900.00	3000.00	3000.00	$/year
Insurance	2800.00	2800.00	2800.00	3300.00	$/year
Repair & Maintenance					
Building Rate	5	5	5	5	%
Truck, Tractor, etc.	2	2	2	2	%
Legal & Accounting	1800.00	1900.00	2000.00	2100.00	$/year
Office	2000.00	2000.00	2000.00	2000.00	$/year
Interest on Investment					
Real Interest Rate	5	5	5	5	%
Land Cost					
Cost per acre	145.00	150.00	140.00	140.00	$/acre
Number Acres	5	5	5	5	acres
Market Return					
Average Farm Price	0.8105	0.8689	0.9142	0.8378	$/lb

Cost of Production Summary Dollar Basis	1983	1984	1985	1986	
Cultural Costs	0.553	0.584	0.599	0.610	$/lb
Nonvariable Cash Costs	0.059	0.059	0.057	0.055	$/lb
Total Cash Costs	0.611	0.644	0.656	0.665	$/lb
Non-cash Costs operator labour	0.056	0.059	0.068	0.064	$/lb
Subtotal	0.668	0.703	0.724	0.729	$/lb
Return to Investment	0.035	0.035	0.033	0.031	$/lb
Depreciation	0.053	0.053	0.048	0.045	$/lb
Total Non-cash Costs	0.145	0.146	0.150	0.140	$/lb
Cost of Production	0.756	0.790	0.806	0.805	$/lb
Grower Return	0.811	0.869	0.914	0.838	$/lb
Net Returns to Risk and	0.054	0.079	0.108	0.033	$/lb
Management	24477	36034	51115	16451	$/year

Cost of Production Summary Percentage Basis	1983	1984	1985	1986
Cultural Costs	73.11	73.99	74.37	75.82
Nonvariable Cash Costs	7.75	7.52	7.08	6.78
Total Cash Costs	80.86	81.51	81.44	82.60
Non-cash Costs operator labour	7.46	7.43	8.46	7.94
Subtotal	88.32	88.94	89.91	90.54
Return to Investment	4.62	4.37	4.15	3.89
Depreciation	7.06	6.69	5.94	5.57
Total Non-cash Costs	19.14	18.49	18.56	17.40
	100.00	100.00	100.00	100.00

Cost of Production 1986

Cultural Costs	$/sq.ft./year	$/pound
Hired Labour	0.158	0.045
WCB Premium & Benefits	0.011	0.003
Heating and Air Conditioning	0.220	0.062
Vehicle Fuel & Lubrication	0.050	0.014
Materials	1.037	0.294
Harvesting	0.680	0.193
Total Cultural Costs	2.155	0.610
Nonvariable Cash Costs		
Interest on Operating Capital	0.024	0.007
Taxes	0.021	0.006
Insurance	0.023	0.007
Legal & Accounting	0.015	0.004
Office Expenses	0.014	0.004
Repair & Maintenance	0.086	0.024
Land Rental	0.010	0.003
Total Nonvariable Cash Costs	0.193	0.055
Total Cash Costs	2.348	0.665
Non-Cash Costs		
Operator Labour	0.226	0.064
Return to Investment	0.111	0.031
Depreciation	0.158	0.045
Total Noncash Costs	0.494	0.140
	2.842	0.805

Cost of Production	2.842	per square foot
	0.805	$ per pound
Grower Return	0.838	$ per pound
Net Returns to Risk and Management	0.033	$ per pound
	16451	$ per year

Capital Cost Schedule, 1986

Buildings	Cost	Class	Deprec.	Interest	Life
Mushroom Houses	200000	6	13333	10000	15
Cooler	5000	8	333	250	15
Electrical Hookup	8000	8	533	400	15
Equipment					
Air Handling Equip.	40000	8	4000	2000	10
Bed Filling Machine	10000	8	1000	500	10
CO 2 Meter	1500	8	150	75	10
Front End Loader	10000	10	667	500	15
Fuel Tanks	400	8	20	20	20
Manure Conveyor	3000	8	300	150	10
Pallet Jack	300	8	0	15	5
Pesticide Spray Equip.	300	8	0	15	5
Ph Meter	100	8	10	5	10
Picking Equipment	600	12	0	30	5
Pick-Up Truck	5000	10	333	250	15
Portable Air Cond.	4000	8	400	200	10
Portable Lighting	100	8	0	5	5
Power Tools	1500	8	150	75	10
Small Tools	1500	12	150	75	10
Spawn Machine	2000	8	0	100	5
Steam Boiler	10000	8	667	500	15
Table Scales	400	8	0	20	5
Tamping Machine	2000	8	0	100	5
Thermometers	432	8	0	22	5
Truck	7000	10	467	350	15
Watering Equipment	900	12	0	45	5
Welding Equipment	500	8	50	25	10
Wheelbarrows	600	8	0	30	5
Total Equipment					
Total Build., Equip.	315132		22563	15757	
Coop Shares	30000	-	-	1500	-
Total	345132				

3.4.3 Results of the Cost of Production Model

The cost of producing a pound of mushrooms in 1986 was $0.808, while the grower return was $0.838. The profit for producing 503,025 lbs was $16,451.

Total cost of production was distributed with 16 percent fixed cost, and 84 percent variable cost.

Fixed cost (R) was $1.69 per square foot of growing area. Variable cost (W) was $8.70 per square foot of growing area. These values for R and W will be used as parameters for the cost function derived in Chapter 2. The minimization of this cost function, subject to a CES production function, results in an expression which relates cost of production to output level, and prices of inputs. This is the supply function.

CHAPTER 4

RESULTS OF THE MATHEMATICAL MODEL OF THE BRITISH COLUMBIA MUSHROOM INDUSTRY

In this chapter, the mathematical model for the B.C. mushroom industry, described in chapter 2, is used to determine whether the market behaves in a competitive or monopolistic manner. The parameters required for the demand section of the model are obtained from econometric estimation of the demand functions presented in chapter 3. Results of the cost of production function in chapter 3 are used in the supply section of the mathematical model.

In section 1, actual industry data from the year 1986 is entered into the mathematical model, using the alternative assumptions of monopoly and perfect competition in the market. In section 2, the analysis is extended to include the years 1983 to 1985. Based on the results obtained for market behavior in sections 1 and 2, an analysis of quota values is then presented in section 3.

4.1 Monopoly versus Competitive Pricing, 1986

The results for market equilibrium predicted by the mathematical model of the B.C. mushroom industry are presented in Tables 4.1 to 4.4 . Actual data from the calendar year 1986 are used to calibrate the model. All prices are expressed in constant 1981 dollars. The assumptions used to generate the results are:

1. a range of 0.8 to 1.05 for the returns to scale technology in the production function and
2. a low elasticity of substitution between the two factors of production, namely b=0.5, implying p=1.
3. all other variables which affect demand, such as income, price of complements, etc., are fixed at their mean values for the year of interest, 1986. In terms of the econometric equations, the effects of all the independant variables except price were combined into a constant intercept term.

In Table 4.1, some data for 1986 is presented. The data for average price and quantity produced are actual values for 1986. The quantity of L, variable input, is an estimate of the average for the industry in 1986, as calculated in the cost of production model in Chapter 2.

In Table 4.2, the results for the monopoly pricing model with a quota restriction is presented. The square footage of production area is restricted to equal the actual quota level in the industry. Positive profits are earned, as the monopoly pricing model equates marginal revenue with marginal cost.

The results are not consistent with the data. Production levels are only about 55 percent of actual production in 1986. For example, in the case of constant returns to scale (v=1), predicted output was approximately 19 million pounds, as compared to actual output of 34.8 million pounds in 1986. The predicted demand for variable input was also only about 52 percent of actual. Given a very low elasticity of substitution between fixed and variable input, the implication is for substantial idle capacity.

The results for a competitive market equilibrium with a quota restraint are presented in Table 4.3. The predicted production levels are consistent with the actual market data. The variation between predicted and actual is only about five percent. Where returns to scale are less than and equal to one, positive profits are earned. The competitive pricing model equates price with marginal cost, and given an upward sloping marginal cost curve, profits will be positive provided the equilibrium price lies above the total cost curve at the equilibrium quantity. Where returns to scale are greater than one, price is equated to average cost, and therefore profits are zero.

Table 4.1 Market Quantity, Price, Input Levels, 1986

TOTAL PRODUCED (lbs)	34800000
AVERAGE PRICE ($/lb)	0.64
K (square feet/farm)	30000
L ($/farm)	261103

Table 4.2 Monopoly Pricing Model, with Quota Constraint, 1986

	v=.8	v=.9	v=1	v=1.05
TOTAL PRODUCED (lbs)	18800637	18947331	19152192	19269768
AVERAGE PRICE ($/lb)	1.16	1.16	1.15	1.14
COST ($/lb)	0.59	0.63	0.66	0.67
REVENUE-COST ($/farm)	156057	145458	136235	132076
K (square feet/farm)	30000	30000	30000	30000
L ($/farm)	111762	123531	134354	139414

Table 4.3 Competitive Pricing Model, with Quota Constraint, 1986

	v=.8	v=.9	v=1	v=1.05
TOTAL PRODUCED (lbs)	31822179	33513921	35192553	35417631
AVERAGE PRICE ($/lb)	0.73	0.68	0.63	0.62
COST ($/lb)	0.61	0.62	0.62	0.62
REVENUE-COST ($/farm)	58588	30490	3268	0
K (square feet/farm)	30000	30000	30000	30000
L ($/farm)	233835	253358	269396	270962

Table 4.4 Competitive Pricing Model, no Quota Constraint, 1986

	v=.8	v=.9	v=1	v=1.05
TOTAL PRODUCED (lbs)	31153431	33322653	35391480	35421288
AVERAGE PRICE ($/lb)	0.76	0.69	0.62	0.62
COST ($/lb)	0.61	0.62	0.62	0.62
REVENUE-COST ($/farm)	69143	33573	0	0
K (square feet/farm)	26615	29065	30968	30946
L ($/farm)	231639	252971	269528	269336

Note: All values are in 1981 real dollars

Table 4.5 Industry Welfare Effects of Moving from Competitive to Monopoly Pricing, with Current Quota, 1986

	v=.8	v=.9	v=1
Loss in Consumer Surplus	10760816	12472866	14225680
Loss in Producer Surplus	1263231	1073386	849884
Gain in Producer Surplus	7994307	9010870	10027740
Net Gain Producer Surplus	6731075	7937483	9177856
Deadweight Loss	4029740	4535382	5047823

Note: all values are in real 1981 dollars

An interesting result is the predicted magnitude of profits which the industry would enjoy if a monopoly pricing market could be sustained. The relevant measures of consumer and producer surplus are presented in table 4.5. The derived demand for mushrooms at the farm-gate level is used. This is obtained by deducting from retail demand the retail-wholesale margin, and the percentage commission that the association charges for marketing member production, in order to arrive at the price schedule that producers face.

For a value of v=1, annual producer surplus would increase by approximately 9 million dollars (1981 dollars). Consumers would be adversely affected with higher prices. The loss in consumer surplus of approximately 14 million dollars a year would be quite substantial. The net result would be a social net loss of 5 million dollars annually. The resultant prices are predicted to be about 100 percent higher than current levels. In order to sustain these prices, higher tariffs would be required for fresh mushroom imports from the U.S. Movement of fresh mushrooms from other provinces, such as Alberta, would also have to be restricted, as the higher prices would make it profitable to ship into the B.C. market.

This result, that the fresh mushroom industry in B.C. is not regulated in such a way as to extract more than competitive prices from consumers, is not surprising given the nature of the supply restricting mechanism employed. The restriction is on the square footage of production area, and not on output. Moreover, the restriction is not binding on output, as producers are still able to supply sufficient quantities of mushrooms into the market to arrive at a competive market clearing equilibrium.

The quota does, however, shift the relative ratio of fixed to variable input. Given a low elasticity of substitution between fixed and variable inputs, the shift in the ratio of fixed to variable inputs has an upper bound. This change in ratio can result in a higher cost of production, depending on the degree of substitutability between the inputs. Even with an assumption of constant returns to scale in the production function, when the quota restriction on fixed input is binding, the average cost of production is not completely independent of production level.

In Table 4.4, for v=1, the cost of producing mushrooms is \$ 0.62 per pound without the quota restriction. The cost of production with quota restriction, in Table 4.3, is also \$ 0.62 per pound. The ratio of fixed and variable inputs are close to the ratio that would be obtained in a competitive market for both inputs. This implies that the restriction on quota is not binding on production, given the assumptions in the model.

The above conclusions are robust to changes in the basic assumptions employed in the production function technology. The parameters of interest are the substitution parameter p, and the returns to scale parameter v.

The substitution parameter, initially set at one, was varied from a range of one half to two. Factor demands in the models without the quota restriction are not affected at all. In the models with a quota restriction, the effect on factor demands is very small, as the quota restriction is not binding. The results of the model are not very sensitive to changes in the value of the substitution paramameter, indicating that the factor ratios are not very far from where they would be in a competitive equilibrium.

The returns to scale parameter v was varied from a range of 0.8 to 1.05. The value of v has a potentially large impact on the results of the mathematical model, as it directly affects the marginal cost of production, and therefore the intersection of supply and demand. However, the main conclusion, that the market is in a competitive equilibrium, is stable for the plausible range of v from 0.8 to 1.05 . Personal discussion with knowledgeable sources in the industry leads the author to place the most likely value of v at about one, for constant returns to scale.

4.2 Monopoly versus Competitive Pricing, 1983 to 1986

The results in section 1 support a model of competitive pricing behavior in the B.C. mushroom industry for the year 1986. In this section, data for the years 1983 to 1985 are also applied to the model in order to assess industry market behavior in previous years. For the reasons outlined before in section 1 of this chapter, the assumptions used in the model are:

1. constant returns to scale (v=1), and
2. a low elasticity of substitution (p=1).

The model is used to generate average producer prices and total industry supply. In Figure 4.1, monopoly and competitive prices for the years 1983 to 1986 are expressed as a percentage of the actual prices. For all years, the pricing model that fits the data best is the model of perfect competition. In Figure 4.2 the corresponding industry supplies for the two pricing models are presented as a percentage of actual industry supply. The competitive model provides the best fit for market behavior in the B.C. mushroom industry.

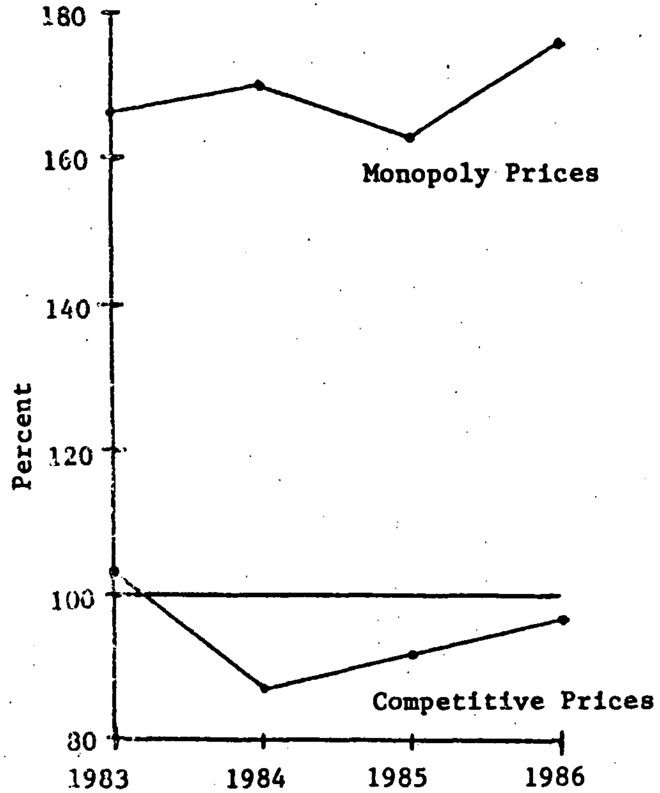

Figure 4.1 "Optimal" Prices as a Percentage of Actual Prices

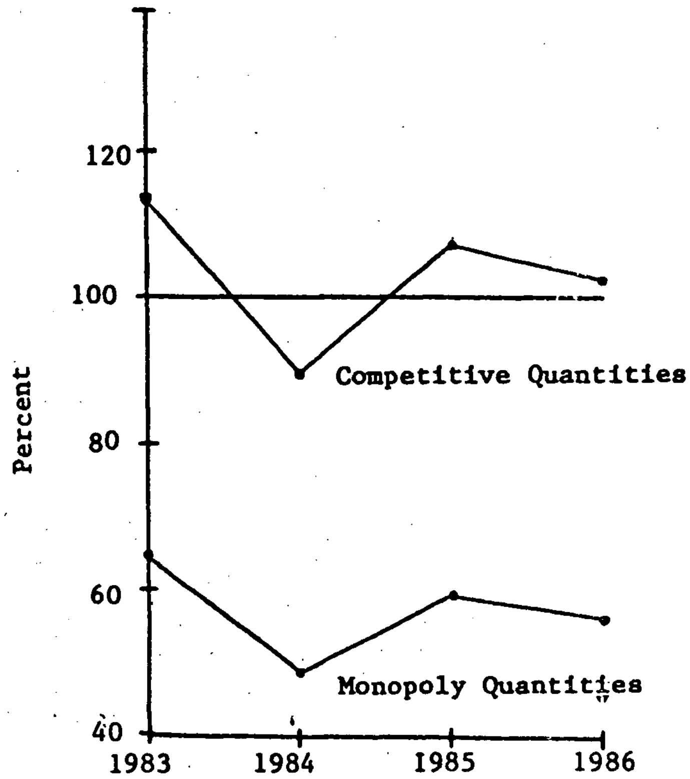

Figure 4.2 "Optimal Quantities as a Percentage of Actual Quantities

4.3 The Payback Period for Quota

Given the results of the mathematical model, analysis of the value of quota in the B.C. mushroom industry must be based on the inframarginal rents of quota ownership. The market situation for quotas in the B.C. mushroom industry supports this conclusion. The majority of quota sales involve transfers of the entire farm. The market is very thin for incremental units quota to add to an existing operation.

All the elements needed to analyse the price of quota are now available. Assuming quota is purchased at the 1986 average price of four dollars per square foot, the number of years required for quota benefits to sum to the purchase price can be calculated. This is known as the payback period.

A direct estimate of the annual benefits of quota ownership is not available, as no market for the rental of quota in the B.C. mushroom industry exists. As a proxy, from the cost of production model (chapter 3), the average net returns to risk and management (total revenue minus total cost) for the years 1983 to 1986 is $ 1.07 per square foot of quota. This value will be used as the annual benefits arising from the purchase of quota.

A choice for the opportunity interest rate is available from Jenkins' estimate of the private real cost of capital facing farmers in Canada for the decade from the mid-1960's to mid-1970's, five percent. In addition, because of the potential risks of partial or complete loss of quota rents discussed earlier, a three percent risk premium is added to the interest rate, for a total of eight percent.

The expected rate of quota appreciation is difficult to determine, as no quota price series of a reasonable sample size are available. However, an estimate can be obtained from prices prevalent in the period from 1983 to 1986. Using four annual observations (3, 3.5, 4, 4 for the years 1983 to 1986 respectively), the calculated average annual rate of quota appreciation was 7.7 percent. Very little quota appreciation occured in 1985-1986. Problems with the unity of members in the industry very likely had an impact on the trading value of quota in these two years. Assuming recent quota price performance has greater weight than past performance, a compromise rate of five percent will be assumed.

Quota purchase merits a special tax advantage. An Eligible Capital Account is created, made up of one half the cost of quota purchase. An annual deduction from taxable income of up to 10 percent of the balance in this account may be made for as long as there is a positive balance. Upon eventual resale of the quota, if half the proceeds of the sale exceeds the remaining balance in the Eligible Capital Account, the difference (half the capital gains), is added to taxable income. The marginal tax rate will be assumed to be 50 percent.

Using equation (4) in chapter 2, the calculated payback period is four years. The result is reasonably robust to changes in the values of the parameters used in the calculations.

For example, using an opportunity interest rate of 10 percent and an expected rate of capital appreciation of zero percent (cf 8 and 5 respectively) gives a payback period of five years. This relatively short payback period can be interpreted in one of two ways. It may be a signal that investment in quota is very profitable. Alternatively, quota purchase may be perceived by producers as a high risk investment which requires a very short payback period. Given the recent instability in the B.C. mushroom industry, it seems likely that quota purchase is associated with a high level of risk.

CHAPTER 5

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

In this chapter, the study is summarized, and conclusions are drawn with specific emphasis on the policy implications of this study. The first section is a summary of the major findings in this study. This is followed by a brief discussion of some issues which have a large bearing on the future prospects of the B.C. mushroom industry. Policy implications as they relate to the results of this study are examined.

5.1 Summary and Conclusions

The mushroom industry in B.C. is the only mushroom producing region in Canada which markets and distributes through a central selling agency. In addition, industry output is regulated through the use of production area quotas.

The major objective of this study is to determine whether the mushroom market in B.C. behaves in a competitive manner, or if producers collectively exercise monopoly power. In order to do achieve this objective, a mathematical model of the B.C. mushroom industry is constructed, using a partial equilibrium analysis.

The major structural relationships are defined in terms of demand and supply parameters. The parameters which affect demand are estimated with econometric equations. Supply response is modelled by minimizing a linear cost function, subject to a Constant Elasticity of Substitution production function. Quota on production area is modelled by solving the cost minimization problem subject to a constant level of fixed input. The level of fixed input is assumed to be an appropriate measure of the quantity of resources whose level of usage is distorted due to the existance of quotas on the area of production.

The results of this study show unambiguously that the mushroom industry in British Columbia operates in a competitive manner. That is, producers do not collectively exert market power in order to extract higher than competitive prices for output. In addition, analysis of the quota restriction on production area indicates that the quota is not binding on production. Therefore, given the production technology, no societal welfare gains can be realized by increasing the total allocation of quota in the B.C. mushroom industry.

A key feature of the industry is the joint product relationship between fresh and processed mushrooms. Mushrooms which are of sufficiently fine quality for the fresh market are produced as a joint product with mushrooms whose lower quality necessitate sales into the processed market. There is a minimum proportion of total production that producers must sell to the processed market. Producers collectively have some degree of control over the market for fresh mushrooms. They determine the fresh market price, which in turn determines the quantity which is sold fresh.

The ratio of fresh to processed is under the control of producers, subject to a minimum proportion of total production which must be sold as processed. Producers are able to do this since mushrooms which are not sold fresh are sold as processed into a market which can absorb all production at the price of imported processed mushrooms. The processed market is dominated by imports from Pacific Rim countries such as Taiwan, Korea, and China.

The returns which producers obtain from the fresh market are higher than from the processed market. From the cost of production model in Chapter 4, in 1986 the total costs of production were higher than the prices that producers received for mushrooms in the processed market. Therefore, the lower prices, relative to total cost of production, that producers received in the processed market were offset by higher prices in the fresh market.

5.2 Policy Implications

The results obtained in this study have several implications for future policy in the B.C. mushroom industry. At present, it would appear that the current structure of the industry is in the process of some dramatic changes. One catalyst of change, the problem of lower priced import processed mushrooms, is longstanding, and not under the direct control of the B.C. industry. This is discussed in the first part of this section. A much more serious issue concerns the breakdown of the cooperative spirit which fostered the beginnings of the industry as it exists today. This is discussed in the second part of this section.

5.2.1 The Problem of Processed Mushroom Imports

Processed mushroom imports have been perceived as a problem by the Canadian mushroom industry since the late 1960s. The matter was brought to the attention of the Canadian Government in 1969 (Skrow). In 1973, the matter was referred to the Anti-Dumping Tribunal. The findings of a subsequent study by the Anti-Dumping Tribunal, summarized in the final paragraph of the report, were that

> "preserved mushrooms, as defined for the purposes of this inquiry, are likely to be imported into Canada at such prices, in such quantities, and under such conditions as to threaten serious injury to Canadian producers of like or directly competitive goods."

In October 1979, the tariff on imports of processed mushrooms into Canada was increased from 12.5 percent to 20 percent. However, this measure was not sufficient to curb the growth of imports. In 1973, the import share of the Canadian processed market was 46 percent. In 1979, the import share reached a high point of 84 percent, declining to 73 percent by 1985.

Import processed mushrooms have penetrated the Canadian market through low prices. As a result of high import share in the processed market, the processed mushroom market is not profitable for domestic producers. The price domestic producers receive for processed grade mushrooms is often below the total cost of production. In B.C., the transfer price to producers for processed mushrooms was on average approximately 20 percent below the total cost of production for the years 1982-1986.

Domestic producers need to process a certain proportion of their output because of the joint product relationship that exists between fresh and processed grade mushrooms. Therefore, in the long run, domestic producers must subsidize lower returns in the processed market with higher returns from the fresh market. For all producers acting collectively, there exists a ratio for sales of fresh to processed mushrooms which results in zero profits.

In a competitive market, where each producer perceives his/her own action to have a very small effect, short run competition amongst producers in the fresh market has the potential to be sufficiently disrupting to force exit of some producers. The competitive solution of marginal cost equals price would not be stable. Individually, producers would have an incentive to sell a ratio of fresh to processed which is higher than the zero profit ratio for all producers collectively. This would occur because each producer believes that his/her own behavior has no effect on fresh market prices.

From the results of this study, it appears that B.C. producers have some control over pricing in the fresh market, but little control over pricing in the processed market, which is dominated by the price of competing imports. Further, the price of processed mushrooms is low relative to total costs of production. A case can therefore be made for the formation of a central marketing agency for mushroom producers in B.C. solely on the basis of increased industry stability.

The B.C. mushroom industry is an example of the benefits that producers can enjoy by marketing through a central selling agency. Members benefit from scale economies for purchase of input, and processing/marketing of output. More importantly, they can collectively set price in the fresh mushroom market such that the average price received for output (processed and fresh) is equated to marginal cost.

The results of the mathematical model of the B.C. mushroom industry support this hypothesis. The industry, through the central selling agency, exercises its price setting power in the fresh mushroom market in order to obtain for members an average price that at least covers the cost of production. Were this not the case, the association would be in serious jeopardy of dissolving its membership. The mathematical model with competitive assumptions of marginal cost equated to average price generates results which are consistent with the actual industry data.

5.2.2 Producer Unity

It is concluded that the B.C. mushroom industry operates within a competitive market. Producers collectively market through a central selling agency, the Fraser Valley Mushroom Growers' Co-operative Association, and achieve economies of scale in input purchase, marketing and distribution. However, the results discussed above are dependent upon the assumption that members of the producer association are able to act collectively. Recent instability within the industry point to some areas where changes in the rules and regulations of the association would inject more stability into the industry.

The marketing contract needs to be enforced rigidly, with penalties that effectively discourage producers from breaching the contract. Specifically, producers must be effectively discouraged from illegal off-farm sales, as this reduces the average pool price that producers receive through the marketing association.

The large capital investment in the processing facilities of the F.V.M.G.C.A. necessitates a long term financial commitment from member producers, as a minimum volume of activity is required to cover costs of operation. The annualy renewable marketing contract that the association currently uses needs to be lengthened in order to provide the association with more financial stability.

Finally, given the fixed financial obligations of the association, its future viability is threatened by the recent change in marketing policy which allows the formation of other marketing agencies.

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APPENDIX A. Mathematical Proofs

Production Function, two Inputs

$$X = G[DK^{-p} + (1-D)L^{-p}]^{-v/p}$$

Cost Function

$$\min \quad C = RK + WL \quad \text{s.t.} \quad X^{-p/v} = G^{-p/v}[DK^{-p} + (1-D)L^{-p}]$$

$$C = RK + WL + \mu[X^{-p/v} - G^{-p/v}(DK^{-p} + (1-D)L^{-p})]$$

First Order Conditions

(1) $\delta C/\delta K = R + \mu p D K^{-p-1} G^{-p/v}$

(2) $\delta C/\delta L = W + \mu p (1-D) L^{-p-1} G^{-p/v}$

set (1) and (2) equal to zero for stationary point
divide (1) by (2) and rearrange

$$\frac{R}{W} = \frac{D}{1-D} \left(\frac{K}{L}\right)^{-p-1}$$

multiply both sides by K/L

$$\frac{RK}{WL} = \frac{D}{1-D} \left(\frac{K}{L}\right)^{-p-1}$$

add one to both sides

$$\frac{RK + WL}{WL} = \frac{D}{1-D} \left(\frac{K}{L}\right)^{-p} + \frac{(1-D)L^{-p}}{(1-D)L^{-p}}$$

substitute for: $C = RK + WL$

$$X^{-p/v}G^{-p/v} = DK^{-p} + (1-D)L^{-p}$$

$$\frac{C}{WL} = \frac{X^{-p/v}G^{p/v}}{(1-D)L^{-p/v}}$$

solve for L

$$\frac{(1-D)L^{-p}}{L} = \frac{X^{-p/v}G^{p/v}}{C}$$

$$L = (1-D)^{1/(p+1)} W^{-1/(p+1)} X^{p/(v(p+1))} C^{1/(p+1)} G^{-p/(v(p+1))}$$

therefore

$$WL = (1-D)^{1/(p+1)} W^{p/(p+1)} X^{p/(v(p+1))} C^{1/(p+1)} G^{-p/(v(p+1))}$$

by symmetry

$$RK = D^{1/(p+1)} R^{p/(p+1)} X^{p/(v(p+1))} C^{1/(p+1)} G^{-p/(v(p+1))}$$

since C = WL + RK

$$C = G^{-p/(v(p+1))} X^{p/(v(p+1))} C^{1/(p+1)} e$$

where $e = [D^{1/(p+1)} R^{p/(p+1)} + (1-D)^{1/(p+1)} W^{p/(p+1)}]$

<u>Marginal Cost</u>

$$MC = \frac{\delta C}{\delta X} = \frac{G^{-1/v} e^{(p+1)/p} X^{(1-v)/v}}{v}$$

<u>Factor Demands</u>

Using Duality: $\delta C/\delta R = K$ and $\delta C/\delta W = L$

where K and L are factor demands

$$\frac{\delta C}{\delta R} = \frac{(p+1)}{p} X^{1/v} e^{(p+1)/p-1} \frac{p}{p+1} D^{1/(p+1)} R^{p/(p+1)-1} G^{-1/v}$$

therefore

$$K = D^{1/(p+1)} X^{1/v} e^{1/p} R^{-1/(p+1)} G^{-1/v}$$

similarly

$$L = (1-D)^{1/(p+1)} X^{1/v} e^{1/p} W^{-1/(p+1)} G^{-1/v}$$

<u>Production Function with Fixed Input K</u>

$$X = G[D\bar{K}^{-p} + (1-D)L^{-p}]^{-v/p}$$

<u>Cost Function</u>

$$C = R\bar{K} + WL$$

from production function

$$L = \left[\frac{X^{-p/v} - G^{-p/v} D\bar{K}^{-p}}{G^{-p/v}(1-D)}\right]^{-1/p}$$

therefore

$$C = R\bar{K} + W \left[\frac{X^{-p/v} - G^{-p/v} D \bar{K}^{-p}}{G^{-p/v}(1-D)} \right]^{-1/p}$$

<u>Marginal Cost</u>

$$MC = W\left(\frac{-1}{p}\right) \left[\frac{X^{-p/v} - G^{-p/v} D \bar{K}^{-p}}{G^{-p/v}(1-D)} \right]^{-1/p-1} \left(\frac{-p}{v}\right) \frac{X^{-p/v-1}}{G^{-p/v}(1-D)}$$

$$MC = \frac{W G^{p/v} X^{-((p+v)/v)}}{v(1-D)} \left[\frac{X^{-p/v} - G^{-p/v} D \bar{K}^{-p}}{G^{-p/v}(1-D)} \right]^{-((p+1)/p)}$$

APPENDIX B. Data Tables

Table B1 Fresh Mushroom Price, Sales, Imports

	Retail Price Vancouver	Sales in B.C.	Quantity of Imports into Canada	Value of Imports into Canada
	$ per lb	lbs in '000s	lbs	$ in '000s
1982 1	1.69	749214	5499036	3417
2	1.69	724956	4043778	2741
3	1.69	749426	7431864	4793
4	1.70	774432	4597504	3018
5	1.75	790052	7197937	4646
6	1.69	775354	4884894	3131
7	1.69	781142	5391459	3677
8	1.69	732595	3607714	2304
9	1.75	689296	4427916	2868
10	1.67	711640	3378613	2286
11	1.70	834771	3925093	2406
12	1.80	863033	3953569	2326
1983 1	1.77	920091	6000778	3836
2	1.76	805992	4574604	2929
3	1.78	962000	3623327	2243
4	1.80	844000	4759995	2861
5	1.82	886000	4720051	2884
6	1.81	900000	4418376	2847
7	1.88	827000	3786658	2352
8	1.93	833000	2922026	1889
9	1.91	803000	5263896	3185
10	1.99	802000	2967187	1889
11	1.97	977894	4020227	2485
12	1.93	971288	2337496	1453
1984 1	1.97	977000	3277549	2058
2	1.90	926000	2966127	2057
3	1.90	1016000	4003528	2602
4	2.02	1027000	3729220	2472
5	2.20	953000	4936078	3456
6	2.18	897000	5574986	3771
7	2.18	859000	4385135	2977
8	2.13	899000	6860586	4694
9	2.13	745000	4097563	3055
10	2.13	744000	1911504	1385
11	2.13	861000	2912666	2078
12	2.13	939000	2523062	1741

Table B1 Fresh Mushroom Price, Sales, Imports -Continued

	Retail Price Vancouver	Sales in B.C.	Quantity of Imports into Canada	Value of Imports into Canada
	$ per lb	'000 lbs	lbs	'000 $
1985 1	2.13	922000	3832703	2395
2	2.15	894000	4577244	3205
3	2.13	1042000	5034151	3284
4	2.16	988000	5110207	3363
5	2.20	1129000	5360360	3388
6	2.20	1005000	4791109	2992
7	2.20	1010000	8060318	4902
8	2.18	972000	5431033	3313
9	2.16	851000	7018034	4126
10	2.10	965000	4809269	2837
11	2.10	955000	3447621	2114
12	2.10	1087000	5074305	2966
1986 1	2.10	1158000	4720254	2733
2	2.08	971000	3237844	1822
3	2.06	1102000	3361232	1927
4	2.05	1123000	5004586	2756
5	2.05	1095000	5493098	3233
6	2.04	1054000	4789698	2748
7	2.10	1144000	4540471	2554
8	2.05	927000	4525188	2417
9	2.06	980000	3808195	1927

Source: Fruit and Vegetable and Honey Crop and Market Report
Agriculture Canada, various issues

Manager's Report
F.V.M.G.C.A., various issues

Statistics Canada
Catalogue 65-007

Table B2 Consumer Price Indices

	All Items Vancouver 1981=100	Fresh Veg. Vancouver 1981=100	Process Veg. Canada 1981=100	All Items Canada 1981=100	Beef Canada 1981=100
1982 1	106.40	104.80	109.00	105.40	92.70
2	107.10	113.80	109.60	106.70	91.60
3	107.80	104.10	113.20	108.00	95.40
4	108.50	111.80	115.40	108.60	96.50
5	110.00	111.10	117.70	110.10	104.50
6	110.70	117.00	118.80	111.20	109.00
7	111.20	106.10	120.10	111.80	106.90
8	112.10	94.40	122.70	112.30	103.10
9	112.50	83.20	123.00	112.90	100.20
10	113.00	84.90	122.60	113.60	96.60
11	113.50	91.50	124.10	114.40	97.70
12	113.20	96.50	124.80	114.40	98.20
1983 1	113.60	95.50	126.10	114.10	95.30
2	114.20	95.50	127.40	114.60	97.20
3	115.00	101.60	125.70	115.80	95.20
4	115.60	100.90	125.70	115.80	100.00
5	115.60	107.20	125.10	116.10	104.90
6	116.30	111.00	125.50	117.40	104.80
7	117.60	106.70	126.70	117.90	101.20
8	117.90	95.90	126.40	118.50	100.30
9	118.10	93.90	127.70	118.50	99.60
10	118.30	99.60	127.50	119.20	101.90
11	118.40	102.50	128.00	119.20	100.00
12	118.50	104.90	128.90	119.60	101.30
1984 1	119.00	118.60	128.50	120.20	102.50
2	119.70	128.00	131.10	120.90	105.90
3	120.10	128.50	131.60	121.20	107.30
4	120.50	127.30	130.40	121.50	108.40
5	120.90	121.00	131.00	121.70	106.50
6	120.80	117.20	131.90	122.20	107.40
7	122.00	114.10	132.20	122.90	106.30
8	122.30	119.40	131.50	122.90	106.80
9	122.50	103.60	131.20	123.00	106.00
10	122.50	103.30	128.60	123.20	107.10
11	122.90	109.10	129.20	124.00	105.10
12	122.80	104.20	129.80	124.10	111.20

Table B2 Consumer Price Indices -Continued

	All Items Vancouver	Fresh Veg. Vancouver	Process Veg. Canada	All Items Canada	Beef Canada
	1981=100	1981=100	1981=100	1981=100	1981=100
1985 1	123.20	111.70	131.50	124.60	108.20
2	123.50	115.80	131.80	125.40	111.40
3	123.30	111.50	133.30	125.70	110.30
4	124.40	118.50	131.70	126.20	113.60
5	124.90	110.70	133.40	126.50	109.80
6	125.10	113.90	134.40	127.20	110.50
7	125.60	113.90	133.40	127.60	110.80
8	125.80	103.80	133.60	127.80	108.50
9	126.20	96.10	132.80	128.00	106.10
10	126.50	96.10	131.70	128.40	105.60
11	126.60	103.70	132.00	128.90	108.20
12	126.70	117.60	131.60	129.50	110.00
1986 1	127.30	123.80	133.30	130.10	112.40
2	127.40	112.70	134.60	130.60	108.60
3	128.00	106.70	133.30	130.90	110.00
4	128.10	117.30	133.60	131.10	106.50
5	129.00	124.30	134.20	131.70	108.90
6	129.30	126.90	136.70	131.90	108.90
7	130.00	119.50	135.60	132.90	109.20
8	130.30	111.30	137.40	133.30	109.90
9	130.30	106.60	137.10	133.30	113.40

Sources: Statistics Canada
Catalogue 62-010

Table B3 Income and Population

	Labour Income B.C.	Disposable Income Canada	Population B.C.	Population Canada
	'000,000 $	'000,000 $	'000	'000
1982 1	2134.2	260616.0	2778.8	24534.3
2	2141.7	261752.0	2781.6	24556.8
3	2186.0	263060.0	2784.3	24579.3
4	2190.6	264368.0	2787.2	24605.6
5	2206.6	265676.0	2790.1	24631.8
6	2240.7	265573.3	2794.6	24656.3
7	2093.2	265470.7	2797.3	24678.6
8	1951.1	265368.0	2800.0	24700.9
9	2168.1	265070.7	2802.7	24723.2
10	2181.9	264773.3	2804.5	24743.0
11	2154.0	264476.0	2806.3	24762.8
12	2079.6	265853.3	2808.1	24782.6
1983 1	2180.0	267230.7	2810.4	24801.5
2	2102.9	268608.0	2812.6	24820.5
3	2165.0	274286.7	2814.9	24839.4
4	2170.0	279965.3	2820.5	24862.0
5	2250.6	285644.0	2826.0	24884.5
6	2299.5	285261.3	2824.4	24904.6
7	2171.4	284878.7	2827.9	24924.5
8	2161.7	284496.0	2831.4	24944.4
9	2297.9	284978.7	2834.9	24964.3
10	2238.5	285461.3	2837.5	24983.3
11	2147.9	285944.0	2840.1	25002.4
12	2142.9	290394.7	2842.7	25021.4
1984 1	2133.9	294845.3	2845.3	25040.1
2	2094.3	299296.0	2848.0	25058.9
3	2097.5	300352.0	2850.6	25077.6
4	2193.7	301408.0	2854.3	25100.9
5	2293.2	302464.0	2857.9	25124.1
6	2343.5	305612.0	2860.4	25145.2
7	2227.2	308760.0	2863.4	25166.6
8	2231.2	311908.0	2866.4	25188.0
9	2334.1	313726.7	2869.4	25209.4
10	2343.7	315545.3	2871.4	25227.5
11	2323.9	317364.0	2873.3	25245.7
12	2290.3	319542.7	2875.3	25263.8

Table B3 Income and Population -Continued

	Labour Income B.C.	Disposable Income Canada[a]	Population B.C.	Population Canada
$ in	'000,00	'000,000	'000	'000
1985 1	2284.1	321721.3	2877.2	25282.3
2	2257.0	323900.0	2879.1	25300.8
3	2304.6	323750.7	2881.0	25319.3
4	2316.4	323601.3	2882.9	25339.6
5	2401.6	323452.0	2884.7	25359.8
6	2465.9	325264.0	2886.5	25380.0
7	2368.7	327076.0	2888.4	25402.1
8	2408.6	328888.0	2890.4	25424.1
9	2499.9	331516.0	2892.3	25446.2
10	2472.1	334144.0	2894.2	25464.5
11	2427.0	336772.0	2896.0	25482.9
12	2393.6	337921.3	2897.9	25501.2
1986 1	2371.9	339070.7	2898.9	25517.9
2	2346.7	340220.0	2900.0	25534.5
3	2386.4	340274.7	2901.0	25551.2
4	2429.1	340329.3	2903.5	25571.2
5	2494.2	340384.0	2905.9	25591.1
6	2540.1	342369.3	2908.8	25611.9
7	2439.8	344354.7	2911.8	25633.0
8	2390.7	346340.0	2914.9	25654.1
9	2495.4	348325.3	2917.9	25675.2

Source: Statistics Canada
Catalogue 72-005

Statistics Canada
Catalogue 13-001

Canadian Statistical Review
Catalogue 91-001

[a]Generated from quarterly data by linear interpolation