A SIMULATION ANALYSIS OF ALTERNATIVE STABILIZATION
SCHEMES FOR BRITISH COLUMBIA BEEF PRODUCERS

by

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B. Sc., National Chung Hsing University, 1977

A THESIS SUBMITTED IN PARTIAL FUFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
in
THE FACULTY OF GRADUATE STUDIES
DEPARTMENT OF AGRICULTURAL ECONOMICS

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA
April 1981

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ABSTRACT

British Columbia Beef Producers' Income Assurance Program (FIAP) was implemented in 1974 to try to alleviate the income instability problem facing B.C. beef producers. The objective of this study was to estimate the costs and effects of FIAP and alternative stabilization schemes in meeting some likely provincial government goals for the B.C. beef industry.

Due to a lack of knowledge of policy makers' objectives, simulation was chosen because it is a relatively convenient research technique for studying a non-optimizing problem. Simulation can trace out the likely impacts of alternative schemes, without putting them into practise.

A mathematical model was built to incorporate the major features of the B.C. beef industry, in accord with relevant theory, experience and industry knowledge. A set of production assumptions and alternative schemes designed to stabilize beef producer income were also incorporated into the model. Later the mathematical model was translated for use on the computer. The model was validated with historical production data over the period 1959-1978, to ensure that it was a valid representation of the real world system.

The model was initially run without government intervention. Then it was run for each of the alternative income stabilization schemes to estimate the likely impacts of each scheme. The cost and effects for different schemes were
also compared to show the relative effectiveness of each scheme. The impacts of different schemes were shown by a set of summary measures that were thought to be of most interest to policy makers. Net welfare changes were also estimated and included in the summary measures.

The estimated results show that FIAP and the other stabilization schemes considered would be capable of achieving a goal of income instability, when compared to the "no scheme" situation. From the government point of view, the guaranteed price scheme was shown to be most effective in both raising beef producer gross revenue and reducing income variability. FIAP, as it existed in 1977, offered the greatest net producer receipts to B.C. beef producers.
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ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. George Kennedy for his encouragements and supports throughout my research work. I also want to thank Dr. Rick Barichello, Dr. John Graham, and Dr. Malcom Tait for being the members of my thesis committee and provided with precious suggestions. Last, but not the least, I would like to send my appreciation to Carol, Frances, and Cheng for their help on the typing.
CHAPTER I
INTRODUCTION

1.1 The Beef Industry in British Columbia

Beef production is one of the most important agricultural activities in B.C. In 1978, it represented 15 percent of the total farm cash receipts in B.C., and 25.4 percent of cash revenues derived from the sale of livestock and livestock products, being second only to that from dairy products (Statistics Canada, Farm Cash Receipts). Beef consumption in B.C. has increased from 75 pounds per capita in the early 1960's to just over 100 pounds in 1977 (B.C. Ministry of Agriculture, Beef Cattle Industry in British Columbia). However, out of the total consumption of 266.2 million pounds in 1978, only 88.3 million pounds were produced in B.C. The low supply rate (33.2%) suggests a potential to increase provincial production to more closely meet expanding demand.

1.2 Instability of Beef Producer Income

In addition to stochastic variation in supply, due to weather, disease, and tariff regulation, the income levels of beef producers are highly affected by the instability of both product prices and input prices. Product prices for B.C. beef producers have varied widely over the last decade. Feeder yearling prices (average feeder heifers of 700 lbs. and feeder steers of 700-800 lbs., Calgary) have fluctuated from $32.57 per cwt. in October 1971 to $50.66 in October 1973, down to $31.68
in October 1976, and up again to $70.56 in October 1978. Calf prices (average steer calves less than 400 lbs., steer calves of 400-500 lbs., heifer calves of 300-400 lbs., and heifer calves of 400-500 lbs., Calgary) have fluctuated from $33.09 per cwt. in October 1970, up to $56.46 in October 1973, down to $27.85 in October 1975, and up again to $83.54 in October 1978 (Agriculture Canada, Livestock And Meat Trade Report). Input prices have also varied in an upward trend. The fluctuations in product prices and input prices, together with the instability in production (mostly due to its biological characteristics), have brought fluctuations in the income levels of B.C. beef producers.

This income instability creates uncertainty for local beef producers, cautioning any plans to expand their production to meet the consumption demand of British Columbians. Costs of production may increase as resources are shifted in and out of production in response to fluctuating beef prices. "Farmers may forego some of the cost advantages of specialization as they diversify their operations in an attempt to achieve a more stable income level" ("Background to the proposed changes in the Federal Stabilization Program", Agriculture Canada, February 1979, pp.1). Because of the uncertainty of the beef market, the development of local beef industry may be hampered due to slowness in adoption of new technology. In addition, instability in beef production also adversely affects farm suppliers and beef consumers. In general, the beef industry in B.C. is intimately affected by the income instability of beef
producers. Both federal and provincial governments have
designed different income stabilization programs to alleviate
the instability.

1.3 Objectives of the Study

The British Columbia Beef Producers' Income Assurance
Program (FIAP) was implemented in 1974 as an income stabilizing
measures. It provided subsidies to beef producers whenever
their production costs exceeded the market return. Prior to
implementing such an income stabilization scheme, policy makers
need a better understanding of the costs and effects of these
schemes, in order to judge the effectiveness of alternative
schemes. This study attempts to provide estimates of these
costs and effects. In addition to the FIAP, alternative and
potential schemes will also be examined.

This study involves building a mathematical model for
the B.C. beef industry, including important supply-demand
relationships and the operating characteristics of alternative
stabilization schemes. In summary, the objective of this study
is to build and use a mathematical model to trace the impacts of
current and alternative government stabilization schemes for
B.C. beef producers in terms of:

(a) the level and variance of producer revenue;
(b) the level and variance of producer income;
(c) the quantity of beef supplied; and
(d) the costs to the provincial government and beef
producers.
Government involvement in agricultural development has frequently been the subject of discussion and criticism. Price support measures used by governments to maintain incomes of producers may reduce their incentives to adjust production to market requirements. This may lead to ineffectiveness by "holding" resources in uses where their productivity is less than their potential capacity. This problem of resource misallocation that can result from government interference has been discussed (Drummand, Anderson and Kerr). It is of interest to know the welfare changes to the society resulting from alternative government schemes. Estimates of net welfare change are included in this study.

1.4 Thesis Guide

This thesis is divided into six chapters. Chapter II describes the methodological approach and the reasons for choosing simulation. Chapter III describes current and alternative stabilization schemes for B.C. beef producers. Chapter IV presents the mathematical model that represents the B.C. beef industry, together with the procedures to validate the realism of the model. Chapter V reports the estimated results of different schemes and their relevance to income stabilization. Chapter VI presents the conclusions that drawn from the study.
CHAPTER II
METHODOLOGY

The objective of this study is to estimate the costs and effects of different income stabilization schemes. This chapter will discuss the reasons for choosing simulation as the most appropriate methodology. Following that, it will state the steps involved in using simulation.

2.1 Simulation

A simulation study entails investigating the properties of a real world system by constructing and analyzing an analogous but abstract system (Manderschied). The term "simulation" has a large scope, but the essence of simulation is the use of a model to analyze a number of alternatives. The model used for simulation could be based on a programming approach, or a systems approach (Sabourin).

2.1.1 Programming Approach

Linear programming and/or quadratic programming is widely accepted as an efficient way to solve an optimization problem. Without knowing the objective of policy makers, we cannot define the objective function of the model. The unique and optimal solution given by a programming approach is the main reason for its inappropriateness for this study, given our lack of knowledge of the objective function.


2.1.2 System Approach

A simulation model based on a system approach does not necessarily start off with any given structure, but rather it is based on what experts know about the system. This type of model is more flexible, allowing a variety of income stabilization schemes to be evaluated and a variety of relationships to be included.

2.2 Justification for Using Simulation

Simulation is chosen for use in this study for the following reasons:

(1) Our aim is not to determine an optimal stabilization scheme, but to estimate the costs and effects of different schemes. Simulation models can estimate what would happen if a certain scheme is implemented without first putting it into effect (which may be expensive or impossible).

(2) A simulation study determines the consequences of different assumptions, but does not try to explain the causes. It allows us to make conditional "if ... then" statements, i.e., if a given set of conditions holds, then these are the consequences.

(3) Simulation can show the path of getting to those consequences while a linear programming solution only gives an optimal solution without showing the path to achieve this optimum state. Simulation is usually dynamic, moving through time step by step, so that the decision maker knows how the final state is reached by simply printing the
values of intermediate variables.

(4) Simulation is flexible, requiring only small adjustments to obtain additional information without the reformulation of the whole model.

In summary, simulation is chosen because it is a relatively convenient technique for studying a non-optimizing problem.

2.3 Methodology of Simulation

Having chosen simulation as an appropriate technique for meeting the objectives of this study, we will briefly discuss the steps involved.

2.3.1 Formulation of the Problem

Simulation should begin with an explicit statement of the objectives of the simulation experiment. As mentioned above, our objective is to determine the costs and effects of alternative income stabilization schemes for B.C. beef producers.

2.3.2 Formulation of a Mathematical Model

A mathematical model should be an abstract (or simplified) version which relates to the components and the variables of the real world.

According to Naylor, a mathematical model of an economic system should consist of three well-defined elements: components, variables and functional relationships.
Components are the decision making units. In this study, they are beef producers and the provincial government.

Variables are used to relate between components. The variables can be conveniently classified as endogenous variables, exogenous variables, and policy variables. Endogenous variables are generated from the interaction of the system's exogenous and policy variables according to the system's behavioural equations and identities (Naylor); e.g. total beef production and total net government payment. Sometimes they are termed as "output variables". Exogenous variables and policy variables are both independent and act as input variables. Exogenous variables are predetermined outside the system, e.g. the supply elasticity of beef. Policy variables are those that can be manipulated by the policy makers of the system, e.g. the support price of beef.

Functional relationships act as linkages between components and variables. They include identities and operating characteristics, both describing the behaviour of the complete system.

The choice of variables to be included in the mathematical model is a critical consideration. Endogenous variables are usually determined as the result of experiments, therefore, not too many questions will arise. Exogenous variables and controllable variables should be carefully selected because they will affect the output variables. A model can usually be made more realistic by incorporating more
exogenous variables and more useful by incorporating more controllable variables. However, this will complicate the model and make it more expensive to compute and more difficult to manipulate. The tradeoff between simplicity and realism exists. A useful model should be realistic, yet simple.

2.3.3 Formulation of a Computer Program

Translating a mathematical model for use on the computer can eliminate the computational burden and reduce the likelihood of error. The computer program used in this study was written in FORTRAN IV, a general purpose language.

2.3.4 Model Validation

Validation refers to the process of showing that the model is a valid representation of the real world. Two crucial steps are involved:

(1) a rationalist step of ensuring the assumptions of the model are in accord with relevant theory, apriori knowledge and experience;

(2) comparing the model performance with the real system, with known historical data.

2.3.5 Model Experimentation

Experimentation with the model is employed to estimate the impacts of different sets of exogenous variables and policy variables on the output variables.
2.3.6 Interpretation of Results

Once the results are obtained, they will be analyzed and their usefulness interpreted. Finally, conclusions will be drawn and some suggestions will be made.
CHAPTER III
CURRENT AND ALTERNATIVE BEEF PRODUCER
INCOME STABILIZATION PROGRAMS

This chapter outlines the current programs used to stabilize the incomes of B.C. beef producers. It also describes some alternative schemes that could be used to achieve income stability. The latter part of the chapter describes the data used in this study and the procedure by which it was calculated.

Several mechanisms exist that can be used to stabilize producer income. Some of these measures fall under the jurisdiction of the government (e.g. price control, supply management, government purchase, deficiency payment, etc.), while others can be employed by the farmers themselves (e.g. forward contracting, co-operative marketing, etc.). In theory, the market price of a commodity can be stabilized by adjusting the quantity supplied. Quota systems are commonly practised by a variety of marketing boards in Canadian agricultural production. However, the B.C. beef market is small compared to the North American beef market implying B.C. producers are "price-takers". Currently, no trade restrictions on the flow of beef between the United States and Canada exist that would allow either price control or a quota system to work effectively in the B.C. beef market.

Deficiency payments have been adopted by the B.C. government to alleviate the problem of beef producer income instability. By using deficiency payments, it is possible to
maintain above-equilibrium prices for producers while permitting market prices to be determined by the market mechanism. The government makes up the difference between market clearing prices and the higher effective prices received by farmers. Although there are several input subsidy measures which B.C. beef producers can benefit from (e.g. land clearing subsidy, farm gasoline subsidy, etc.), these input subsidies are available to B.C. farmers in general, not just beef producers. This study will provide results for only those government schemes which involve product price deficiency payments.

Currently, two income stabilization programs are in operation for B.C. beef producers. One is the Federal Agricultural Stabilization Act, and the other is the B.C. Beef Producers' Income Assurance Program. Brief descriptions of both programs are given below, with some alternative schemes proposed. The alternative schemes represent some modifications of the current programs.

3.1 Agricultural Stabilization Act

The Agricultural Stabilization Act (A.S.A.) of 1958 established a list of "named commodities" for which support was mandatory at a minimum of 80% of the ten year moving average market price. In 1975, the Act was amended and the formula used to calculate the support price changed to a minimum of 90% of the national moving average market price over the previous five years, plus the difference between current national average costs of production and the national moving average costs in the
preceding five years. The supports price are calculated each year and subsidies are paid on an annual basis.

3.2 B.C. Beef Producers' Income Assurance Program, FIAP(1977)

The B.C. Beef Producers' Income Assurance Program began in January 1974 and ended in December 1978. The main features of this five year program can be summarized as follows:

A. **Eligibility** To be eligible the producer must be a member of the B.C. Cattlemen's Association and have a minimum of 20 beef breeding cows, or produce and market at least 8,075 pounds of calf and/or yearling annually. The maximum annual participation is limited to 121,125 pounds of calf and/or yearling. Sales of beef cows and bulls do not qualify as pounds for indemnities.

B. **Indemnities** The indemnity rate is equal to 75% of the return deficit (i.e. the difference between basic costs of production and the average market return less marketing costs). Indemnities are paid at three levels:

1. **Beef Calf Pounds** - for those beef animals born in B.C. and raised from birth to a live weight of 400 pounds. Dairy calves are not included because they are the products of dairy industry.

2. **Beef Yearling Pounds** - those pounds gained in excess of 400 pounds and up to 850 pounds for those animals raised from birth by B.C. beef producers. For those animals purchased outside the province, it includes those pounds gained between the greater of purchase weight or 400
pounds and 850 pounds (i.e. the yearling pounds gained in B.C.).

(3) Calf-Yearling Pounds - for those animals born in B.C. and raised to sell as yearlings in the following year. The first 400 pounds are classified as calf-yearling pounds. Their indemnities are equal to 75% of the difference between the basic costs of calf production and the average yearling market return less marketing cost.

The program regulations have set an upper limit on the indemnity rate, calculated as:

Maximum indemnity = \((0.75 \times \text{cost of production}) / 1.75\)

There is no indemnity paid for pounds gained exceeding 850 pounds; i.e. there is no indemnity paid for finishing animals.

C. Payments Market returns used to determine the indemnity of beef calf pounds are calculated by summing the weighted average prices received in Calgary market for steers under 400 lbs., steers of 400-500 lbs., heifers of 300-400 lbs., and heifers of 400-500 lbs. The weighted average prices obtained in October and November are summed and the total divided by two.

Market returns for beef yearling pounds are calculated by summing the weighted average prices received in Calgary market for steers of 700-800 lbs. and heifers over 700 lbs., for the months of September and October, then dividing the total by two.

Basic costs of production include cash costs, depreciation, interest on investment, operator and family labour, and
management fee. The costs are based on a hypothetical farm production model, negotiated by the B.C. Federation of Agriculture and the B.C. Ministry of Agriculture. Basic costs of production and market returns of beef are calculated annually and indemnities are paid on a yearly basis.

D. Program Fund If participating in the FIAP, beef producers pay an annual premium irrespective of whether a subsidy is received. The amount of producer premiums is determined annually with farmers paying 1/3 and the provincial government paying 2/3 to the B.C. Beef Producers' Income Program Fund.

3.3 Alternative Schemes

Some alternative schemes potentially useful in achieving producer income stability are described below.

3.3.1 New Farm Income Assurance Program, FIAP(1980)

A new Beef Producers' Income Assurance Program was announced and came into operation beginning January 1980. The new program also includes finished animals. The support level of return deficit has increased from 75% to 100%, and the producer premium which consists of two components, an advanced premium and an additional premium, is tied to the gross indemnity in the current year. The costs and effects of this new program will be examined.
3.3.2 Premium/Subsidy Scheme

An alternative scheme is proposed as being useful in stabilizing beef producer income. A premium/subsidy scheme involves an attempt to eliminate price "peaks" in addition to price "toughs" by paying subsidies to producers when market price of beef falls below a given floor, and collecting premiums when market price exceeds a given ceiling.

3.3.3 Heifer Retention Subsidy Scheme

The most common form of beef production in B.C. is the cow-calf operation. A beef producer's herd size is varied mainly through varying the number of heifers retained. When the cost of production exceeds the market return for calves, farmers may decrease herd size by decreasing the number of heifers. The total amount of beef produced in coming years will decline as a result of current liquidation of heifers. This will bring about fluctuations in beef supply and resulting fluctuations in beef producer incomes. Since heifer retentions play such an important part in the stability of beef production, it is reasonable to design programs to stabilize these retentions. A heifer retention subsidy scheme could work as follows. In periods of low calf prices, a subsidy would be paid to farmer for each heifer retained, providing an incentive not to engage in large scale liquidation of heifers. In periods of high calf prices, no subsidy would occur allowing farmers to adjust their herd sizes according to their own expectations.
3.3.4 Guaranteed Price Scheme

A scheme resembling the federal A.S.A. could be adopted by the provincial government in B.C. Similar schemes have been adopted in other provinces (e.g. Manitoba Beef Producers' Income Assurance Program) to subsidize beef outputs that are not covered under A.S.A., particularly calves and yearlings. Given the importance of cow-calf and backgrounding operations in the B.C. beef industry, this approach would seem applicable to B.C.

The formula used to calculate guaranteed price could be determined as a percentage of the average market price over the previous five years, plus the difference between current input cost and the average input cost in the preceding five years. The guaranteed price would become effective only if it were higher than the current market price. This way of calculating support level differs from that of FIAP, in that it would use the average prices and costs of the preceding five years instead of using current year figures only. One of the advantages of using the moving average as the base to determine support price is that the resulting support price will likely be more stable, whereas the return deficit of FIAP can fluctuate from year to year.
3.4 Data used

This section discusses the basic data used in this study and its derivation.

3.4.1 Cost Data

Costs of production for calves and yearlings for FIAP(1977) were determined through negotiations between the B.C. Ministry of Agriculture and the B.C. Federation of Agriculture. The cost figures reported below represent the costs of inputs needed to produce one cwt. of live animal\(^1\). They were estimated based on a hypothetical ranch production model assuming good management and good facilities. Since the costs were arrived at by agreement between government and the farmers association, we can offer no guarantee as to the realism of the cost data. However, their realism is not critical for the examination of the comparative results of alternative income stabilization schemes. The cost data used in this study for the period 1974-1978 were published by B.C.M.A. in "Beef Income Assurance Model: Basic Cost of Production", and they are used as the base to deflate the cost figures for the previous years (i.e. 1959-1973) by different index numbers.

The calculation procedures to determine the production costs for calves and yearlings are described below.

\(^1\)The same cost data are used to determine the basic costs of production for the alternative stabilization schemes examined in this study.
3.4.1.1 Cow-calf Cost

The hypothetical farm consists of 300 cows, 12 bulls, a calf weaning rate of 90%, a mortality rate of 2% among cows and bulls, and a weaning calf-weight of 425 lbs. Total calf production according to these assumptions would be 128,250 lbs. The cost items are listed as follow:

1. **Total Variable Cost** was divided into three items: feed costs, lador costs and other variable costs.

(a) **Feed Costs** included the costs of hay, grain, grazing, range and other minor items such as salts and minerals. **Hay cost** was estimated by assuming that 486.37 tons of hay were needed to produce 128,250 lbs. of calf. This figure was taken from FIAP model and can be broken down as follows:

- 450.00 tons for feeding cows (20 lbs./day*150 days*300)
- 27.75 tons for feeding bulls (25 lbs./day*185 days*12)
- 9.12 tons for feeding horses (25 lbs./day*365 days*2)

486.87 tons of hay in total.

The above hay consumption represented a rate of conversion of 0.38 tons of hay to produce one cwt. of calf (liveweight).

The base price of hay used was the average hay price reported by FIAP from October 1974 to October 1978. Later, by means of the hay price index taken from the *Annual Report* of B.C. Milk Board, the hay costs in the rest of the
twoenty year period being simulated were estimated\(^1\). The cost of hay for any month was computed, as in the model of FIAP, by using the hay price of the previous year.

**Grain cost** was estimated by assuming that 5.55 tons of grain were needed to produce 128,250 lbs. of calf. This consumption figure represented the amount of grain needed to feed the bulls was 0.004 tons of grain per cwt. of calf produced.

The base price of grain used was the average price of beef pellets (14% protein) reported by FIAP for the period October 1974 to October 1978. Later, by means of the dairy pellet prices (16%) taken from the *Annual Report* of B.C. Milk Board, the grain costs for the rest of the period were estimated. The costs of grain for any month was also calculated by using the grain price of previous year.

**Grazing cost** was estimated by assuming that 183.75 tons of grass were needed to produce 128,250 lbs. of calf. This figure was obtained as follows:

180.00 tons for cows grazing (20 lbs./day* 60 days*300)

3.75 tons for bulls grazing (25 lbs./day*25 days*12)

183.75 tons of grass in total.

The above grass consumption represented a rate of conversion of 0.143 tons of grass to produce one cwt. of

\(^1\)The appropriateness of the price index for hay from the B.C. Milk Board as a proxy for the price of hay used by beef producers will be greater for areas closer to the Fraser Valley where trade in hay occurs between beef and dairy producers.
calf (liveweight). The base price of grass was equal to half of the hay price.  

**Range cost** was estimated by assuming that 1,612 A.U.M. (animal unit months) were needed to produce 128,250 lbs. of calf. This figure was obtained as follows:

- 1,550 A.U.M. for cows (300 A.U. * 5.16 months)
- 62 A.U.M. for cows (12 A.U. * 5.16 months)

1,612 A.U.M. in total.

The above range cost represented a rate of conversion of 1.257 A.U.M. to produce one cwt. of calf (liveweight). The base price of range was provided by the B.C. Ministry of Forestry, Forest Service, Range Branch.

**Other feed costs** such as salts and minerals, were estimated based on the average FIAP figures for 1976, 1977 and 1978. The average figure indicated that they represented approximately 4.4% of all other feed components (i.e. hay, grain, grazing and range).

(b) **Labour Costs** were estimated by assuming 1.637 hours of labour were needed to produce one cwt. of calf (i.e. 2,100 hours to produce 128,250 lbs. of calf). The price of labour was estimated by using the 1978 FIAP rate of $7.05 per hour as a baseline. Later, by means of Index of Farm Labour for Western Canada (hourly rated) taken from Statistics Canada, Farm Input Price Index, the labour costs of the rest of the period were estimated.
(c) **Other Variable Costs** included the following cost items:

- **Veterinary cost** was estimated based on the average figures reported by FIAP for 1976, 1977 and 1978. The average figures indicated that veterinary cost represented approximately 5.04% of feed plus labour costs.

- **Interest on cows and bulls** was estimated as 7.5% of the investment value of the breeding stock.

- **Mortality of cows and bulls** was estimated as 2% of the investment value of the breeding stock.

- **Replacement of cows and bulls** was estimated by assuming an annual rate of 12% of replacement for cows and a 33% of replacement for bulls. The total replacement cost was computed as the difference between the acquisition value of the replaced cows and bulls and the selling value of culled cows and bulls.

- **Cash overhead** was estimated as 5% of all other variable costs (i.e. feed costs, labour costs, veterinary costs, interest on cows and bulls, mortality of cows and bulls, and replacement of cows and bulls).

- **Transportation cost** was estimated by assuming that an average cow-calf operator had to pay 7,500 miles of transportation costs for the production of 128,250 lbs. of calf (i.e. 5.8 miles per cwt. of calf produced). Transportation costs were estimated by using the 1978 FIAP rate of $0.23 per mile as a baseline. Later, by means of the Machinery and Motor Vehicle Operation Index
for Western Canada taken from Statistics Canada, Farm Input Price Index, the transportation costs of the rest of the period were estimated.

Tractor cost was estimated by assuming that an average cow-calf operator had to pay for 600 hours of tractor use for the production of 128,250 lbs. of calf (i.e. 0.47 hours per cwt. of calf produced). The cost for using tractor for an hour were estimated by using the 1978 FIAP rate of $9.50 per hour as a baseline. Later, by means of the same index used in the computation of transportation costs, the tractor costs for the rest of the period were estimated.

Interest on operating capital was computed as 8% of the quarterly expenditure of all the variable inputs except labour, transportation and tractor costs.

2. Fixed Costs were estimated by means of the average figure reported by FIAP for 1978, and the Mortgage Credit Index taken from Statistics Canada, Farm Input Price Index. The average fixed cost calculated by FIAP for 1978 was $13.23 per cwt. of calf produced. Fixed cost included interest on capital investment (land, buildings and equipment), depreciation, management fees and other minor items (e.g. bookkeeping, insurance, taxes, etc.).
3.4.1.2 Yearling Cost

The FIAP production model was based on a hypothetical ranch raising 300 calves from a liveweight of 420 lbs. to a selling weight of 781 lbs. (i.e. a net weight gain of 361 lbs. per animal over the period), with good management and good facilities. The model assumed a 2% mortality rate among calves. The total yearling production according to the above assumptions would be 106,134 lbs. A list of cost items are shown as follows:

1. **Total Variable Cost** was divided into three items: feed costs, labour costs and other variable costs.
   
   (a) **Feed Costs** included the costs of hay, grain, grazing, range and other minor items such as salts and minerals.

   Hay cost was estimated by assuming that 329.90 tons of hay were needed to produce 106,134 lbs. of yearling. This figure was taken from FIAP model and can be broken down as follows:
   
   - 360.76 tons for feeding cattle (12 lbs./day * 180 days * 297)
   - 9.13 tons for feeding horses (25 lbs./day * 365 days * 2)
   - 329.90 tons of hay in total.

   The above hay consumption represented a rate of conversion of 0.311 tons of hay to produce one cwt. of yearling (live-weight).

   The costs of hay used were computed in the same way as reported earlier for the cow-calf production.

   Grain cost was estimated by assuming that 106.92 tons of grain were needed to produce 106,134 lbs. of yearling. It was
obtained by assuming 297 calves would use 4 lbs. of grain per
day for 180 days. This consumption figure represented the
amount of grain needed to feed the calves was 0.10 tons per
cwt. of yearling produced.

The costs of grain were computed in the same way as
reported earlier for the cow-calf production.
Grazing cost was estimated by assuming that 160.38 tons of grass
were needed to produce 106,134 lbs. of yearling. This figure
was obtained by assuming 297 calves would use 18 lbs. of grass
per day for 60 days. This consumption figure represented the
amount of grass needed to feed the calves was 0.51 tons per
cwt. of yearling produced.

The costs of grass were computed in the same way as
reported earlier for the cow-calf production.
Range cost was estimated by assuming that 940 A.U.M. (animal
unit months) were needed to produce 106,134 lbs. of yearling.

The above range cost represented a rate of conversion of
0.886 A.U.M. to produce one cwt. of yearling (liveweight). The
base price of range was provided by the B.C. Ministry of
Forestry, Forest Service, Range Branch.
Other feed costs such as salts and minerals, were estimated
based on the average FIAP figures for 1976, 1977 and 1978. The
average figure indicated that they represented approximately
0.7% of all other feed components (i.e. hay, grain, grazing and
range).

(b) Labour Costs were estimated by assuming 1.10 hours of
labour were needed to produce one cwt. of yearling 
(i.e. 1,170 hours to produce 106,134 lbs. of yearling).
The costs of labour used were computed as reported earlier 
in the calculation for cow-calf production cost.

(c) Other Variable Costs included the following cost items:

Veterinary and fuel cost was estimated based on the 
The average figures indicated that veterinary cost and 
fuel cost represented approximately 3.84% of feed costs 
plus labour costs.

Interest on calves was estimated as 7.5% of the 
investment value of purchased calves.

Cash overhead was estimated as 5.0% of all other variable 
costs (i.e. feed costs, labour costs, veterinary and fuel 
costs, and interest on calves).

Transportation cost was estimated by assuming that an 
average cow-calf operator had to pay 5,000 miles of 
transportation costs for the production of 106,134 
lbs. of yearling (i.e. 4.7 miles per cwt. of yearling 
produced). The transportation costs were estimated as 
reported earlier in the calculation for cow-calf 
production cost.

Interest on operating capital was computed as 8% of the 
quarterly expenditure of all the variable inputs except 
labour and transportation costs.
2. **Fixed Costs** were estimated by means of the average figure reported by FIAP for 1978, and the Mortgage Credit Index taken from Statistics Canada, *Farm Input Price Index*. The average fixed cost calculated by FIAP for 1978 was $10.73 per cwt. of yearling produced. Fixed cost included interest on capital investment (land, buildings and equipment), depreciation, management fees and other minor items (e.g. bookkeeping, insurance, taxes, etc.)

3. **Marketing Cost** was added to total cost in the calculation of yearling cost. It was based on the 1978 figure reported by FIAP. According to the average figure, marketing cost represented approximately 0.29% of the total cost for yearling production.

3.4.2 *Beef Price Data*

The monthly prices were taken from Agriculture Canada, Food Production and Marketing Branch, *Livestock Market Review* and *Livestock and Meat Trade Report* and computed as follows:

1. **Calf Prices**
   (a) From January 1973 to December 1978, they were the arithmetic mean of the Calgary prices received by farmers for steers less than 400 lbs., steers of 400-500 lbs., heifers of 300-400 lbs., and heifers of 400-500 lbs. (less $3.00 per cwt. for marketing cost).
(b) From February 1963 to December 1972, they corresponded to the arithmetic mean of the Calgary prices received by farmers for steer calves and heifer calves. The average prices were computed from only these two figures instead of four, because prior to 1973 the calf prices reported weren't distinguishable among different weight categories.

(c) Prior to February 1963, there was only one calf price reported under the category of stocker calves (steers and heifers), without distinction of sex or weight.

2. Yearling Prices

From January 1954 to December 1978, they were the arithmetic means of the Calgary prices received by farmers for steers of 700-800 lbs., and heifers over 700 lbs.

3.4.3 Beef Production Data

The production data used to simulate the likely impacts of alternative income stabilization schemes for B.C. beef producers included beef calves, yearlings and calf-yearlings. The subsidies which these animals can receive under the alternative stabilization schemes considered were defined by the FIAP(1977) regulations as follows:

Calf Subsidy: those animals born and marketed within the same year of birth are eligible to receive the calf subsidies up to a maximum of 400 lbs.
Yearling Subsidy: those animals which were bought as calves and raised by B.C. beef producers to market as yearlings, are eligible to receive the yearling subsidies. The weight gained from 400 lbs. up to a maximum of 850 lbs. falls into the category of yearling pounds.

Calf-yearling Subsidy: those animals born in year \( t \) and marketed in year \( t+1 \) are classified as yearlings by FIAP regulations, despite their weight. These animals would receive the calf-yearling subsidies instead of the calf subsidies for their first 400 lbs., and the residual pounds (those pounds above 400 lbs.) are eligible for the yearling subsidies.

It was then necessary to identity the different categories of animals entitled to received these subsidies. They are beef calf pounds, beef yearling pounds and calf-yearling pounds.

1. Beef Calf Pounds

The animals eligible to receive the beef calf subsidies under FIAP include the following categories:

(a) beef calves born in B.C. and sold to backgrounding operations within B.C.

(b) beef calves born in B.C. and slaughtered in inspected plants (federal and provincial).

(c) beef calves born in B.C. and exported to the United States.

(d) beef calves born in B.C. and sent to other Canadian
provinces.

(e) beef calves born in B.C. and slaughtered in non-inspected plants.

(f) beef calves born in B.C. and slaughtered for animal food.

(f) beef calves born in B.C. and slaughtered on farms for commercial use.

2. Beef Yearling Pounds

The animals eligible to receive the beef yearling subsidies under FIAP include the following categories:

(a) beef and dairy steers and heifers born and raised in B.C. that were marketed within B.C.

(b) beef and dairy steers and heifers exported to the United States.

(c) beef and dairy steers and heifers sent to other Canadian provinces.

(d) beef steers and heifers brought from Alberta as calves in any one year and sold as yearlings within B.C. in the following year.

(e) beef and dairy steers and heifers slaughtered on farms for commercial use, provided the animals were raised in B.C. from their 400 lbs. to 850 lbs.

3. Calf-yearling Pounds

Within the groups of animals eligible for beef yearling subsidies indicated above, the possibility exists that some of them in categories 2-(a), 2-(b), 2-(c), and/or 2-(e) are also
entitled to receive subsidies for the first 400 lbs. of liveweight. These would include yearlings not being marketed as calves the year before. According to FIAP regulations, these animals are entitled to receive not only the beef yearling subsidies, but also what FIAP calls calf-yearling subsidies. This subsidy replace the calf subsidy in this specific situation. To compute the calf-yearling subsidy payments, it was assumed that all beef calves sold for backgrounding operations within B.C. in any year (i.e. year t-1) appeared the following year (i.e. year t) in categories 2-(a), 2-(b), 2-(c), and/or 2-(e). Thus, eligible calf-yearling pounds in year t were computed by subtracting the number of calves sold for backgrounding operations within B.C. in year t-1 from the sum of steers and heifers in 2-(a), 2-(b), 2-(c), and 2-(e).

The production data mentioned above are obtained from "Monthly Production Figures Relevant to the Beef Industry in B.C., 1959-1978" (Palacios and Kennedy), with some adjustments.
CHAPTER IV
THE MATHEMATICAL MODEL

The major characteristics of the beef industry in British Columbia, the assumptions made about beef production and the mathematical model of B.C. beef production are presented in this chapter. The resource allocation effects of the FIAP and alternative income stabilization schemes are also presented, with the computation of associated social costs/benefits. The validation procedure of the model is discussed in the last section.

4.1 Beef Production Assumptions for British Columbia

A list of production assumptions representative of beef production in British Columbia are presented below.

4.1.1 Decisions Not Influenced By Government Stabilization Programs

(1) Breeding of cows takes place three months after calving. Heifers are 15 months old at the time of breeding. The month of breeding does not vary with changes in beef prices.

(2) Cows not retained for breeding are sold eight months after calving ( i.e. when calf is weaned ).

These estimates were arrived at in consultation with Dr. R.J. Richmond, beef cattle specialist, B.C. Ministry of Agricultural, Kamloops District Office and Dr. John Hodges, Department of Animal Science, University of British Columbia.
(3) Number of calves per cow assumptions:
(a) 20 percent of heifers retained for breeding are culled prior to second breeding;
(b) after second calf, an additional 10 percent are culled;
(c) after third calf and thereafter, an additional 10 percent are culled; and
(d) cow remained are sold after having five calves.
These assumptions imply the following schedule if 100 heifers were retained for breeding:

<table>
<thead>
<tr>
<th>Number of calves</th>
<th>Percent of cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
</tbody>
</table>

(4) It is assumed that the number of calves per cow does not vary in response to changes in market prices. In other words, ranchers do not keep cows a year or two longer when beef prices are rising. Rather, it is assumed ranchers retain more heifers for breeding in times of high beef prices.

(5) Calves are weaned at age 8 months and 400 lbs. liveweight.

(6) Calves weaned at 400 lbs. reach average yearling weight of 600 lbs. four months later.

(7) There is a five month period from average yearling weight (i.e. 600 lbs.) until yearlings have reached what might be referred as "minimum slaughter weight" (i.e. 925
lbs.), a six month period to "average slaughter weight" (i.e. 1,000 lbs.), and a seven month period to "maximum slaughter weight" (i.e. 1,075 lbs.).

(8) Assumptions (6) and (7) imply the following schedule and rates of daily weight gain as shown in Figure 4.1.

Figure 4.1 Rate Of Daily Weight Gain In Beef Production

(9) In the absence of government programs, calves are sold at 400 lbs., yearlings at 600 lbs., and slaughter cattle are sold on reaching average slaughter weight (i.e. 1,000 lbs.).

The above production assumptions can be summarized in a beef production timetable and shown in Table 4.1.
Table 4.1 Beef Production Timetable

<table>
<thead>
<tr>
<th>Month</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>Heifers reach average yearling weight and the decision is made to retain them for breeding purposes.</td>
</tr>
<tr>
<td>t+3</td>
<td>Breed heifers.</td>
</tr>
<tr>
<td>t+12</td>
<td>Calves born.</td>
</tr>
<tr>
<td>t+15</td>
<td>Rebreed cows.</td>
</tr>
<tr>
<td>t+20</td>
<td>Calves weaned and cull cows sold (first breeding).</td>
</tr>
<tr>
<td>t+24</td>
<td>Calves reach average yearling weight.</td>
</tr>
<tr>
<td>t+30</td>
<td>Yearlings reach average slaughter weight.</td>
</tr>
</tbody>
</table>

For cows bred in t+15, then:

| t+24 | Calves born. |
| t+27 | Rebreed cows. |
| t+32 | Calves weaned and cull cows sold (second breeding). |
| t+36 | Calves reach average yearling weight. |
| t+42 | Yearlings reach average slaughter weight. |

For cows bred in t+27, then:

| t+36 | Calves born. |
| t+39 | Rebreed cows. |
| t+44 | Calves weaned and cull cows sold (third breeding). |
| t+48 | Calves reach average yearling weight. |
| t+54 | Yearlings reach average slaughter weight. |
4.1.2 Decisions Influenced By Government Stabilization Programs

It is assumed that farmer behavioral decisions occur at three levels: calf level (i.e. 400 lbs.), yearling level (i.e. 600 lbs.) and slaughter level (i.e. 1,000 lbs.).

4.1.2.1 The Calf Level

When calves have reached 400 lbs., cow-calf operators have two options:

(a) selling calves for slaughter or feeding outside B.C.; or
(b) backgrounding them over the winter.

The decision of backgrounding is assumed to be influenced by the amount of subsidies or premiums attached to the yearling prices.

4.1.2.2 The Yearling Level

At the yearling level, the model hypothesizes three kinds of responses:

(a) Heifer retention price response -- the decision regarding the number of heifers to retain for breeding is made when heifers are yearlings. This decision is assumed to be affected by the amount of subsidies or premiums established by a government program on calf and/or yearling production. In other words, the model allows beef producers to retain more heifers for breeding if the effective prices of calves and/or yearlings are
increased.

(b) Heifer retention non-price response -- this "non-price effect" is included because it is thought that any program that provides a more stable production environment may induce farmers to increase supplies over and above any increase caused directly by price changes.

(c) Yearling holdover price response -- assuming in the absence of government program, yearlings are sold at their 600 lbs. In response to yearling price increases caused by government intervention, yearling steers and heifers may be held over up to six months (i.e. to 850 lbs.) to take advantage of the increased effective yearling price. In other words, yearling steers and heifers may be retained an extra six months to be eligible for the subsidy on the extra 250 lbs. weight gain (600 lbs. to 850 lbs.).
4.2 The Model

The model used to simulate different income stabilization schemes for B.C. beef producers can be described as dynamic in the sense of tracing the behavior of the B.C. beef system from January 1959 to December 1978 with 240 observations of beef prices and quantities. Twenty years of data ensures that the model avoids the possibility of only describing a segment of the beef cycle, which is estimated to be 15 years (Meadows).

The model is non-optimizing, determining the costs and effects of alternative stabilization programs instead of choosing the best alternative. It is not intended to make decisions for planners or to provide an unique solution to the stated problem, but rather to provide a structured means to investigate the various plans (Sabourin).

Although stochastic models can often better represent agricultural production systems, the model is deterministic. The repeatability of elements (for each run of the model through time) not being manipulated makes comparisons appear more direct (Ladue). As this study compares the costs and effects of different income stabilization schemes, a deterministic model is appropriate.

The model represents the beef production system in B.C. through a set of equations which can be grouped into four modules:¹

¹The general form of the model in this study is similar to the B.C. hog industry model of Palacios.
(1) Equilibrium Module refers to the price and quantity prevailing in the market when no income stabilization program is in operation;

(2) Farmer Production Decision Module provides information as to how beef producers can be expected to respond to government income stabilization efforts;

(3) Government Program Module describes the alternative government income stabilization programs for B.C. beef producers, reflected in the value of policy parameters and formula for the calculation of the supporting level; and

(4) Summary Measure Module computes statistical parameters calculated to indicate the degree of stability and the level of variables that are regarded as important to policy makers.

These four modules will be described in detail below.

4.2.1 Equilibrium Module

In section 3.4, the data used in this study were described in detail. The production costs of beef are jointly determined by the B.C. Ministry of Agriculture and the B.C. Federation of Agriculture, and assumed to be a "fair" figure for local beef production. The market prices of beef are collected from Livestock Market Review, Agriculture Canada. The production quantity figures are reported by Palacios and Kennedy. All the data regarding the costs, prices and outputs
are the equilibrium figures determined by the market mechanism, without any government interference (except the production quantity in the period 1974-1978 when FIAP(1977) was in operation¹. If there is no government income stabilization program in operation, these equilibrium quantities of beef would be produced with these equilibrium production costs and would sell in the market at the equilibrium prices. The equilibrium beef prices, input costs and output quantities are reported in Appendix A, Tables A-1, A-2 and A-3, respectively.

4.2.2 Farmer Production Decision Module

Of the four modules, the farmer production decision module is the most critical. The equations of this model can be grouped into three main categories:

(1) Behavioral equations which represent farmer responses to changes in product prices and/or input costs that induced by income stabilization programs;

(2) Flow relationship and accounting identities which incorporate the beef production assumptions and the limitation of resources available; and

(3) Market identities which ensure all of the beef produced in B.C. finds its way to market.

The model has the ability to capture any output changes

¹The 1974-1978 production figures are deflated to their equilibrium quantity by using the procedure described later in the validation procedure in section 4.4.
which result from changes in either product prices or input costs.

The above three categories of the farmer production decision module are discussed in detail below.

4.2.2.1 Behavioral Equations

The behavioral equations allow two types of farmer responses to income stabilization schemes. They are:

(1) Heifer retention, allowing farmers to retain more heifers in response to changes in calf price and/or yearling price; both price effects and non-price effects may be included.

(2) Holdover response, allowing farmers to feed animals for a longer or shorter time in response to price changes.

It should be noted that the model does not provide a farmer response in terms of changes in culled cows. This is consistence with our earlier production assumption, i.e. the number of calves per cow does not vary in response to price changes.

Below is a detailed discussion on how the beef quantities are affected by the changes in product prices as captured by heifer retention response and/or holdover response.

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1Were data on cow numbers available, a culling response could be easily incorporated into the model.
4.2.2.1.1 Heifer Retention

The most important type of cattle production in B.C. is the cow-calf operation. The number of calves a farmer can produce each year is highly dependent on the size of his breeding herd. In general, a certain percent of calves are retained as heifers and are added to the breeding herd to replace the number of cows culled. Therefore, the number of heifers retained will determine the quantity of calves a farmer can supply in following year(s). A calf subsidy provided by any income stabilization measures may induce farmers to retain more beef heifers in order to increase the number of beef calves being produced and marketed a certain period of time later. Here we assume that the additional quantity of beef heifers retained (IQHRb) in a given time period is proportional to the equilibrium quantity of beef heifers retained for breeding purposes in the same period (QHRb), and is affected by the change in calf prices and input costs of the same period as shown in equation [1].

[1] \[ \frac{IQHRb}{QHRb} = B30 \left[ B3 (PCs - PCe) + B4 (ICe - ICs) + B5 \right] \]

where

- IQHRb the change of quantity of beef heifers retained due to a calf subsidy in a given time period.
- QHRb the equilibrium quantity of beef heifers retained for breeding purposes in a given time period.
PCs the simulated or effective price of calves in a given time period.

PCE the equilibrium B.C. market price of calves in a given time period.

ICs the simulated or effective cost of all inputs for calf production in a given time period.

ICE the equilibrium cost of all inputs for calf production in a given time period.

B3 effect of changes in the calf price on additional quantity of beef heifers retained for breeding.

B4 effect of changes in the calf cost on additional quantity of beef heifers retained for breeding.

B5 non-price effect on additional quantity of beef heifers retained due to government stabilization efforts.

B30 adjustment for death rate of keeping a calf to yearling.

A higher yearling price, due to the yearling subsidy, will induce farmers to keep more heifers for breeding and hence produce more calves a certain period of time later. Since the yearling subsidy applies to both beef and dairy animals, equation [2] captures the changes of total heifers retained (i.e. IQHRa, including both dairy and beef heifers) instead of only beef heifers (IQHRb) as in equation [1].

\[ 2 \]
\[
\frac{IQHRa}{QHRa} = B30 \left[ B1 (PYs - PYe) + B2 (IYe - IYs) + B5 \right]
\]
where

\[ \text{IQHR}_a \] the change of quantity of total heifers retained (both beef and dairy) due to a yearling subsidy in a given time period.

\[ \text{QHR}_a \] the equilibrium quantity of total heifers retained (both beef and dairy) for breeding purposes in a given time period.

\[ \text{PY}_s \] the simulated or effective price of yearlings in a given time period.

\[ \text{PY}_e \] the equilibrium B.C. market price of yearlings in a given time period.

\[ \text{IY}_s \] the simulated or effective cost of all inputs for yearling production in a given time period.

\[ \text{IY}_e \] the equilibrium cost of all inputs for yearling production in a given time period.

\[ \text{B}_1 \] effect of changes in the yearling price on additional quantity of all heifers retained for breeding.

\[ \text{B}_2 \] effect of changes in the yearling cost on additional quantity of all heifers retained for breeding.

Given that the monthly figures of the quantity of heifers retained in B.C. were not obtainable, \( \text{QHR}_b \) and \( \text{QHR}_a \) were replaced by the equilibrium quantity of beef calves (\( \text{QCWe}_b \ t+24 \)) and total calves (\( \text{QCWe}_a \ t+24 \)) sold in the market twenty four months later, both adjusted with the death rate of calves accordingly. The reason for choosing a twenty-four month lag is based on the time difference between when the heifer retention
decision is made and calves actually go to market, adjusted for seasonal factors. The non-price effect was included in the equations and was captured by the parameter $B5$.

Recognizing that the yearling subsidy applies to both dairy animals and beef animals while the calf subsidy applies only to beef animals, it is necessary to distinguish the change in beef heifers retained from the change in dairy heifers retained.

The changes in the quantity of beef heifers retained ($IQHR_{bb}$) include all the changes induced by the calf subsidy ($IQHR_b$) and part of the changes induced by the yearling subsidy ($IQHR_a$). The portion of additional beef heifers retained induced by yearling subsidy is equal to the change in total heifers retained ($IQHR_a$) multiplied by the proportion of quantity of beef heifers ($QHR_b$) divided by the total quantity of beef and dairy heifers ($QHR_a$), as in equation [3].

\[ [3] \quad IQHR_{bb} = IQHR_b + IQHR_a * \left( \frac{QHR_b}{QHR_a} \right) \]

where

$IQHR_{bb}$ the total change in beef heifers retained due to both calf subsidy and yearling subsidy.

The changes in dairy heifers retained ($IQHR_d$), on the other hand, include only part of the change induced by the yearling subsidy. They are the portion of the changes in total heifers retained ($IQHR_d$) multiplied by the proportion of
equilibrium quantity of dairy heifers (QHRa - QHRb) over total quantity of beef and dairy heifers (QHRa), as in equation [4].

\[ 4 \]

\[ IQHRd = IQHRa \times \left( \frac{QHRa - QHRb}{QHRa} \right) \]

where

IQHRd the change in dairy heifers retained due to yearling subsidy.

In the case of no stabilization program, that is when the equilibrium price is equal to or greater than the simulated price, there is no change in the quantity of heifers retained. (i.e. IQHRbb=0 and IQHRd=0)

4.2.2.1.2 Holdover Response

Holdover response allows farmers to feed animals for a longer or shorter time in response to price changes. A detailed description of the farmer holdover response is given below for calves, yearlings, and slaughter animals.

4.2.2.1.2.1 Calf Holdovers

In equilibrium, it is assumed farmers sell weaned calves at 400 lbs. (i.e. 8 months after birth). In response to a price change in yearlings, they may hold over market calves four additional months (positive holdover) to take advantage of the extra payment when the calves reach average yearling weight (i.e. 600 lbs.). More calves can be expected to be kept for backgrounding if there is a yearling subsidy. On the other
hand, no negative holdover will occur since it is assumed that when simulated yearling price is below the equilibrium price, farmers will not sell their calves earlier due to the characteristics of the beef market.

The quantity of calf holdovers (IQCWh) is assumed to be proportional to the quantity of calves available for holding over (QCWh); i.e. the equilibrium calves in month t (QCWe) plus additional offspring (IQAC) from additional heifers retained in the earlier periods; and is affected by the change in yearling price and change in yearling input cost. The quantity of beef calves available for holding over (QCWHb) and the quantity of beef calf holdovers (IQCWhb) are estimated by equations [5] and [6], while the quantity of dairy calves available for holding over (QCWHd) and the quantity of dairy calf holdovers (IQCWhb) are estimated by equations [7] and [8].

\[
[5] \quad QCWhb = QCWeb + IQACb
\]

\[
[6] \quad IQCWhb/QCWhb = B6 (PYs - PYe) + B7 (IYe - IYs)
\]

\[
[7] \quad QCWhd = (QCWea - QCWeb) + IQACd
\]

\[
[8] \quad IQCWhd/QCWhd = B6 (PYs - PYe) + B7 (IYe - IYs)
\]

if PYe ≥ PYs then B6 = 0.0

IYs ≥ IYe then B7 = 0.0
where

QCWhb quantity of weaned beef calves that are available for holding over in a given time period.

QCWhd quantity of weaned dairy calves that are available for holding over in a given time period.

IQCWhb quantity of weaned beef calf holdovers in a given time period.

IQCWhd quantity of weaned dairy calf holdovers in a given time period.

QCWeb quantity of weaned beef calves in equilibrium in a given time period.

QCWea quantity of total weaned calves in equilibrium in a given time period.

IQACb change of additional beef calves that come from extra heifers retained in the earlier periods.

IQACd change of additional dairy calves that come from extra heifers retained in the earlier periods.

B6 effect of yearling price changes on the quantity of calf holdovers.

B7 effect of yearling cost changes on the quantity of calf holdovers.

4.2.2.1.2.2 Yearling Holdovers

In equilibrium, it is assumed farmers sell yearlings when they reach the average market weight (i.e. 600 lbs.). In response to yearling and/or slaughter price increases, farmers may holdover yearlings six more months until they reach average
slaughter weight (i.e. 1,000 lbs.). In other words, they may retain yearlings for an extra six months to collect the subsidy on the extra 250 lbs. weight gain (600 lbs to 850 lbs) when the yearling subsidy applies, and on the extra 150 lbs. weight gain (850 lbs to 1,000 lbs) when the slaughter subsidy applies. The quantity of yearlings that can be heldover and sold six months later is related to the total yearlings available for holding over. Yearlings available for holding over (QYha) are equal to total yearlings at equilibrium (QYea) plus the additional calves retained for holdover four months earlier (IQCWhb t-4 and IQCWhd t-4) minus the number of heifers (both beef and dairy) being retained for breeding purposes (IQHRbb and IQHRd) due to higher calf and yearling prices. These heifers would have been marketed as yearlings if there were no subsidy provided. The estimation of the quantity of yearlings available for holding over (QYha) is shown in equation [ 9 ].

The quantity of yearling holdovers (IQYha) is assumed to be proportional to the quantity of yearlings available for holding over (QYea) and is affected by the change in slaughter animal prices and/or yearling prices, and the change in input costs of slaughter animals and/or yearling production, as in equation [ 10 ].

The quantity of calf-yearling holdovers (IQYhcy) is assumed to be proportional to the quantity of calf-yearlings available for holding over (QYhcy) and is affected by the change in slaughter animal prices and/or yearling prices, and the change in input costs of slaughter animals and/or calf
production, as shown in equation [11]. Quantity of calf-yearlings available for holding over (QYhcy) is assumed to be a proportion of QYha. The proportions are equal to the equilibrium quantity of calf-yearlings divided by the equilibrium quantity of yearlings in actual production data.

\[ QYha = QYea + B12 (IQCWhb_{t-4} + IQCWhd_{t-4}) - IQHRbb - IQHRd \]

\[ IQYha/QYha = B10 (PSs - PSe) + B11 (ISe - ISs) + B8 (PYs - PYe) + B9 (IYe - IYs) \]

\[ IQYhcy/QYhcy = B10 (PSs - PSe) + B11 (ISe - ISs) + B8 (PYs - PYe) + B21 (ICe - ICs) \]

If PSs ≤ PSe then B10 = 0.0

ISs ≥ ISe \quad B11 = 0.0

PYs ≤ PYe \quad B8 = 0.0

IYs ≥ IYe \quad B9 = 0.0

ICs ≥ ICe \quad B21 = 0.0

where

QYha quantity of yearlings available for holding over in a given time period.

QYea quantity of yearlings in equilibrium in a given time period.

QYhcy quantity of calf-yearlings available for holding over
in a given time period.

QYecy quantity of calf-yearlings in equilibrium in a given time period.

IQYha quantity of yearling holdovers in a given time period.

IQYcy quantity of calf-yearling holdovers in a given time period.

PSs simulated or effective price of slaughter animals in a given time period.

PSe equilibrium market price of slaughter animals in a given time period.

ISSs simulated cost of all inputs for slaughter animal production in a given time period.

ISEe equilibrium cost of all inputs for slaughter animal production in a given time period.

B8 effect of yearling price changes on the quantity of yearling holdovers and calf-yearling holdovers.

B9 effect of yearling cost changes on the quantity of yearling holdovers and calf-yearling holdovers.

B10 effect of slaughter animal price changes on the quantity of yearling holdovers and calf-yearling holdovers.

B11 effect of slaughter animal cost changes on the quantity of yearling holdovers and calf-yearling holdovers.

B21 effect of calf cost changes on the quantity of calf-yearling holdovers.

B12 adjustment for death loss from keeping a calf an extra four months.
4.2.2.1.2.3 Slaughter Animal Holdovers

In equilibrium, it is assumed farmers sell slaughter cattle when they reach 1,000 lbs. (18 months). In response to slaughter cattle price increases, they may hold the slaughter animals three extra months to take advantage of the 200 lbs. weight gain (1,000 lbs to 1,200 lbs), and receive the subsidy on the slaughter animals. The quantity of slaughter animals available for holding over ($Q_{Sh}$) is equal to the equilibrium quantity of slaughter animals ($Q_{Se}$) plus the change in yearling holdovers six months earlier ($IQ_{Yha \, t-6}$) adjusted with death rate ($B_{24}$), as in equation [12]. The quantity of slaughter animal holdovers ($IQ_{Sh}$) is assumed to be proportional to the quantity of slaughter animals available for holding over ($Q_{Sh}$) and is a function of the change in slaughter animal prices and their input costs, as shown in equation [13].

$$[12] \quad Q_{Sh} = Q_{Se} + \left( B_{24} \times IQ_{Yha \, t-6} \right)$$

$$[13] \quad IQ_{Sh} / Q_{Sh} = B_{13} (P_{Ss} - P_{Se}) \, + \, B_{14} (I_{Se} - I_{Ss})$$

If $P_{Se} \geq P_{Ss}$ then $B_{13} = 0.0$

If $I_{Ss} \geq I_{Se}$ then $B_{14} = 0.0$

where

$Q_{Sh}$ quantity of slaughter animals available for holding over in a given time period.

$IQ_{Sh}$ quantity of slaughter animal holdovers in a given time period.
period.

B13 effect of slaughter animal price change on the quantity of slaughter animal holdovers.

B14 effect of slaughter animal cost change on the quantity of slaughter animal holdovers.

B24 adjustment for death loss from keeping a yearling an extra six months.

This completes the discussion of behavioral equations of the model. Equations in the second category, flow relationship and accounting identities, are described as follows.

4.2.2.2 Flow Relationships and Accounting Identities

The equations representing flow relationships and accounting identities incorporate the beef production assumptions relevant to B.C. and account for changes in production resulting from earlier farmer responses. It seems reasonable to assume that changes in farmer production decisions induced by price changes would be bound with certain constraints (e.g. production facilities, supply of feed, etc.). It is assumed that upper limits exist to restrict the maximum changes in heifer retention and holdover response\(^1\).

\(^1\)These limits are particularly important in the model, given that cow culling decisions are assumed to be unaffected by the stabilization schemes.
4.2.2.2.1 Constraints on Heifer Retention

Due to resource constraints, it is reasonable to assume an upper limit to the quantity of additional heifers retained. Parameter B24 is used as the maximum proportion of additional heifers that can be added to the breeding herd (QUPHF) in a given time period. The change in additional heifers retained (IQHR) cannot exceed the upper limit (QUPHF) of the breeding herd, that is the equilibrium quantity of heifers retained (QHR) multiplied by B24. Equation [14] shows the upper limit on beef heifers (QUPHFb), and equation [15] shows the upper limit on all heifers (QUPHFa, both beef and dairy).

\[
[14] \quad QUPHFb = B24 \times QHRb \\
\text{If } IQHRb \geq QUPHFb \quad \text{then } IQHRb = QUPHFb
\]

\[
[15] \quad QUPHFa = B24 \times QHRa \\
\text{If } IQHRa \geq QUPHFa \quad \text{then } IQHRa = QUPHFa
\]

where

- \(QUPHFb\) maximum quantity of beef heifers that can be added to the breeding herd in a given time period.
- \(QUPHFa\) maximum quantity of total heifers that can be added to the breeding herd in a given time period.
- \(B24\) maximum proportion of heifers that can be added to the breeding herd in a given time period.
4.2.2.2.2 Constraints on Calf Holdovers

Similarly, given the resource constraints, there is likely some limit to the calves that can be heldover. The limit on beef calf holdovers (QUPCHb) is shown in equation [16], and the limit on dairy calf holdovers (QUPCHd) is shown in equation [17].

\[ QUPCHb = B25 \times QCWhb \]
\[ \text{if } IQCWhb \geq QUPCHb \quad \text{then } IQCWHb = QUPCHb \]

\[ QUPCHd = B25 \times QCWhd \]
\[ \text{if } IQCWhd \geq QUPCHd \quad \text{then } IQCWHd = QUPCHd \]

where

QUPCHb maximum quantity of beef calves that can be heldover in a given time period.

QUPCHd maximum quantity of dairy calves that can be heldover in a given time period.

B25 the maximum proportion of calves that can be withdrawn from market in a given time period.

4.2.2.2.3 Constraints on Yearling Holdovers

Similarly, it is reasonable to assume some limits to the yearlings and calf-yearlings that can be heldover in a given time period. Equation [18] shows the maximum quantity of yearlings that can be heldover (QUPYLH), and equation [19] shows the maximum quantity of calf-yearlings that can be
heldover \((\text{QUPCYH})\) in a given time period.

\[ 18 \]
\[ \text{QUPYLH} = \text{B26} \times \text{QYha} \]
\[ \text{If } \text{IQYha} \geq \text{QUPYLH}, \text{ then } \text{IQYha} = \text{QUPYLH} \]

\[ 19 \]
\[ \text{QUPCYH} = \text{B25} \times \text{QYhcy} \]
\[ \text{If } \text{IQYhcy} \geq \text{QUPCYLH}, \text{ then } \text{IQYhcy} = \text{QUPCYH} \]

where

\text{QUPYLH} \quad \text{maximum quantity of yearlings that can be heldover in a given time period.}

\text{QUPCYH} \quad \text{maximum quantity of calf-yearlings that can be heldover in a given time period.}

\text{B26} \quad \text{the maximum proportion of yearlings and calf-yearlings that can be withdrawn from market in a given time period and sold six months later.}

4.2.2.2.4 Constraint on Slaughter Animal Holdovers

Similarly, it is reasonable to assume a limit to the slaughter animals that can be heldover in a given time period, and is shown as \(\text{QUPSH}\) in equation \([ 20 ]\).

\[ 20 \]
\[ \text{QUPSH} = \text{B27} \times \text{QSh} \]
\[ \text{If } \text{IQSH} \geq \text{QUPSH}, \text{ then } \text{IQSH} = \text{QUPSH} \]
where

\( QUPSH \) maximum quantity of slaughter animals that can be heldover in a given time period and sold two months later.

\( B27 \) the maximum proportion of slaughter animals that can be withdrawn from market in a given time period.

4.2.2.2.5 Output Changes of Calves From Additional Heifers Retained

Where there is a change in the number of heifers retained, offspring from these extra heifers will come to market 24 months later as weaning calves. Additional heifers retained in month \( t \) will produce offspring of average market weight (i.e. 400 lbs.) in month \( t+24 \) and every 12 months thereafter for four years. Two equations are required here. Equation [ 21 ] captures the additional beef calves in a given time period (\( IQACb \)) that come from extra beef heifers retained in the earlier periods (\( IQHRbb \)), and equation [ 22 ] captures the additional dairy calves in a given time period (\( IQACd \)) for estimating the equilibrium quantity of dairy calves available for holding over in equation [ 7 ].

\[ [ 21 ] \quad IQACb = B22 \left[ IQHRbb \ t-24 + (1-B17) \ IQHRbb \ t-36 + (1-B17-B18) \ IQHRbb \ t-48 + (1-B17-B18-B19) \ IQHRbb \ t-60 + (1-B17-B18-B19-B20) \ IQHRbb \ t-72 \right] \]
\[ 22 \]
\[
IQACd = B22 \left[ IQHRd \ t-24 + (1-B17) \ IQHRd \ t-36 + (1-B17-B18) \ IQHRd \ t-48 + (1-B17-B18-B19) \ IQHRd \ t-60 \\
+ (1-B17-B18-B19-B20) \ IQHRd \ t-72 \right]
\]

where

\( IQACb \) change of additional beef calves in period \( t \) that come from extra beef heifers retained in the earlier periods.

\( IQACd \) change of additional dairy calves in period \( t \) that come from extra dairy heifers retained in the earlier periods.

\( B22 \) average number of calves weaned per cow bred annually.

\( B17 \) to \( B20 \) proportion of cow cullings per breeding (first, second, third and fourth respectively).

4.2.2.2.6 Market Supply of Beef Calves

The simulated quantity of beef calves in a given time period (\( QCsb \)) is equal to the equilibrium quantity of beef calves in the same period (\( QCWeb \)) plus the increased offspring from additional beef heifers retained earlier (\( IQACb \)) minus the beef calf holdovers (\( IQCWhb \)) which will enter the yearling sector four months later instead of being marketed as calves, as in equation [ 23 ].

\[ 23 \]
\[
QCsb = QCWeb + IQACb - IQCWhb
\]
4.2.2.2.7 Market Supply of Yearlings and Calf-Yearlings

The market supply of yearlings ($Q_{Ysa}$) in a given time period is equal to the quantity of yearlings available for holding over ($Q_{Yha}$) in the same period minus the quantity of yearling holdovers in that period ($I_{QYha}$). The quantity of eligible yearling pounds that could receive subsidies should also include the yearling pounds that come from those yearlings being held over six months earlier and now marketed as slaughter animals, as in equation [24]. Similarly, the market supply of calf-yearlings ($Q_{CYsa}$) in a given time period is equal to the quantity of calf-yearlings available for holding over ($Q_{YhcY}$) in the same period minus the quantity of calf-yearling holdovers in that period ($I_{QYhcY}$), plus the calf-yearling pounds that come from yearling holdovers six months earlier, as in equation [25].

\[
[24] \quad Q_{Ysa} = Q_{Yha} + (I_{QYha} t-6) - I_{QYha}
\]

\[
[25] \quad Q_{CYsa} = Q_{YhcY} + (I_{QYhcY} t-6) - I_{QYhcY}
\]

where

$Q_{Ysa}$ simulated quantity of yearlings in a given time period.

$Q_{CYsa}$ simulated quantity of calf-yearlings in a given time period.
4.2.2.2.8 Market Supply of Slaughter Animals

The market supply of slaughter animals in a given time period (QSs) is equal to the quantity of slaughter animals available for holding over in the same period (QSh) minus the quantity of slaughter animal holdovers in that period (IQSh), plus the additional heldover quantity two months earlier adjusted with death loss for keeping two extra months.

\[ QSs = QSh - IQSh + B15 \times (IQSh_{t-2}) \]

where

- **QSs** simulated quantity of slaughter animals in a given time period.
- **B15** adjustment for death loss from keeping a slaughter animal two extra months.

4.2.2.3 Market Identities

- Backgrounding, feedlot and packer demand functions are assumed to be perfectly elastic because the market price of beef in B.C. is determined largely outside the province. The assumption of perfectly elastic demand functions implies all animals supplied are purchased in the market.

\[ QCd = QCsb \]
[28] \[ QYd = QYsa \]

[29] \[ QSd = QSs \]

where

\( QCd \) quantity of beef calves demanded in a given time period.

\( QYd \) quantity of yearlings demanded in a given time period.

\( QSd \) quantity of slaughter animals demanded in a given time period.

All the equations with reference to farmer production decision module have been described above. Equations regarding government program module will be discussed as follows.

4.2.3 Government Program Module

The income stabilization schemes for B.C. beef producers that were discussed in Chapter III, are now presented in mathematical form, beginning with B.C. Beef Producers' Income Assurance Program.

4.2.3.1 British Columbia Beef Producers' Income Assurance Program

Under the B.C. Beef Producers' Income Assurance Program, farmers are eligible to receive an indemnity from the provincial government if the calculated total cost of production (\( IC \)) plus its marketing cost (\( MC \)) exceeds the market price (\( Pe \)) in that
period. It applies to both calf and yearling production. The amount of the indemnity paid (IND) is equal to 75% of the return deficit (RD), i.e. the difference between cost and price. The price received by the farmers under FIAP (Pf) is equal to the market price (Pe) plus the calculated indemnity. For participating producers, a producer premium (PP) is charged. Thus, the actual price they received (Pa) should deducted the producer premiums (PP) from Pf. Since not all B.C. beef producers have joined FIAP, the effective price received by the average farmer (Ps) is equalled to a weighted average of the effect price received by participating farmers (Pa) in each period and the equilibrium price (Pe) of the same period. Equation [30] to [34] are listed below to illustrate the procedure to determine the effective price received by the average farmer in each period if FIAP has been in operation.

\[
\begin{align*}
[30] & \quad RD = IC + MC - Pe \\
[31] & \quad IND = A18 \times RD \\
[32] & \quad Pf = Pe + IND \\
[33] & \quad Pa = Pf - PP \\
[34] & \quad Ps = \left[ (A89 \times Pa) + (1 - A89) \times Pe \right]
\end{align*}
\]

where

IND indemnity paid by the FIAP in a given time period.

RD return deficit in a given time period.

IC cost of production in a given time period.

MC marketing cost in a given time period.
Pe  marketing price at equilibrium in a given time period.
Pf  nominal price received by farmers that have joined FIAP in a given time period.
Pa  actual price received by farmers that have joined FIAP in a given time period.
Ps  weighted average price received by all farmers (the effective price) in a given time period.
PP  producer premium paid by participating farmers in a given time period.
A18  the proportion of return deficit guaranteed by FIAP (i.e. the support level)
A89  the proportion of participating beef output.

The above equations hold for both calves and yearlings. For calf-yearlings, the return deficit is equal to the production cost of calves minus the marketing price of yearlings.

4.2.3.1.1 Premium Calculation

The total premium in a given period t (TPt) is determined by dividing the total amount of indemnity in the previous five years with the total quantity of beef production in the previous five years as shown in equation [35].

Producer premium (PPt) in a given time period is an assigned proportion (A20) of the total premium of the same period (TPt), as shown in equation [36]. The way of premium calculation aims to make the scheme self-financing. A current year premium will be charged at a higher rate to the extent that the payments
in the previous five years have accumulated. Similarly, farmer premium will fall following periods of low indemnity payments, then the current premium will charge at a lower level.

\[ T_{Pt} = \frac{\sum_{t-6}^{t-1} \text{IND}_{t}}{\sum_{t-6}^{t-1} \text{SQ}_{St}} \]  

\[ P_{Pt} = A_{20} \times T_{Pt} \]

where

- \( Q_{St} \): beef output in a given time period \( t \).
- \( \text{IND}_{t} \): indemnity paid in a given time period.
- \( T_{Pt} \): total premium in a given time period \( t \).
- \( P_{Pt} \): producer premium in a given time period \( t \).
- \( A_{20} \): the proportion of producer premium as a percentage of the total premium in a given time period.

4.2.3.2 Premium/Subsidy Scheme

The basic idea of this scheme is to require beef producers to pay a premium when the market return exceeds a predetermined ceiling price, and have the government pay them a subsidy (or lower the premium rate) when the market return falls below their production costs. This scheme is designed to allow for the elimination of the "peaks" as well as "toughs" of the fluctuating level of product prices.

When the input cost exceeds the market price in a given time period, the indemnity can be determined in the same way as
in the FIAP. No producer premium should be collected in this case. The calculation of the effective price is shown as in equation [37].

When the marketing price exceeds the input costs in a given time period, the floor price \( (P_{ff}) \) can be determined by subtracting the indemnity calculated as mentioned earlier \( (\text{IND}) \) from the market price \( (P_e) \). Then the ceiling price \( (P_{ce}) \) can be set at a certain percentage above the floor price. If the market price exceeds the ceiling price, farmers will pay a premium (equal to the market price less the ceiling price) so that the effective price they receive is just equal to the ceiling price. The calculations of the effective price are shown as in equations [40] to [43].

For the case where input cost exceeds market price, equation [37] apply:

\[
[37] \quad P_s = P_e + \text{IND}
\]

For the case where market price exceeds input cost, equations [38] to [41] apply:

\[
[38] \quad P_{ff} = P_e - \text{IND} \\
[39] \quad P_{ce} = A^23 \times P_{ff} \\
[40] \quad PP = P_{ce} - P_e \\
[41] \quad P_s = P_e - PP
\]

where

\( P_{ff} \) floor price in a given time period.
Pce     ceiling price in a given time period.

A23    percentage of ceiling price set over the floor price.

4.2.3.3 Guaranteed Price Scheme

The model allows for a guaranteed price (GPt) to be determined by assigning a support level (B35) to the sum of the average market price of the previous five years (Pea) and the current cost of production (ICT) less the average cost in the preceding five years (ICA). If the market price (Pet) exceeds the guaranteed price (GPt) in any month t, then the guaranteed price just equals Pet. The calculation of the guaranteed price is shown in equation [42].

\[ GPt = B35 \times \left( Pea + (ICT - ICA) \right) \]

If GPt < Pet then GPt = Pet

where

GPt     guaranteed price in a given month t.

Pea    average market price of the previous five years (in the same month as t).

ICT    cost of production in a given month t.

ICA    average production cost of the previous five years (in the same month as t).

B35    percentage of support level.

The final module to be discussed is the summary measure module.
4.2.4 Summary Measure Module

The computer simulation experiments are designed to generate information that is valuable to government decision makers. The results are summarized as "summary measures". They are statistical parameters (e.g. mean, standard deviation, coefficient of variation, etc.) used to indicate the degree of stability and the level of variables regarded as important to policy makers. Other variables (e.g. producer income, quantity of beef produced, government expenses, etc.) are presented in this module, too. By comparing the values of summary measures obtained from different runs of the alternative schemes, it is possible to predict the likely impacts of these schemes. A list of the summary measures used in this study is given below in Table 4.2.
Table 4.2 Summary Measures Used In This Study

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<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MQc</td>
<td>mean of simulated annual calf production.</td>
</tr>
<tr>
<td>MQy</td>
<td>mean of simulated annual yearling production.</td>
</tr>
<tr>
<td>MQcy</td>
<td>mean of simulated annual calf-yearling production.</td>
</tr>
<tr>
<td>MQt</td>
<td>summation of means of annual calf, yearling, and calf-yearling production.</td>
</tr>
<tr>
<td>PSc</td>
<td>mean of effective calf price received by average farmer.</td>
</tr>
<tr>
<td>PSy</td>
<td>mean of effective yearling price received by average farmer.</td>
</tr>
<tr>
<td>PScy</td>
<td>mean of effective calf-yearling price received by average farmer.</td>
</tr>
<tr>
<td>PST</td>
<td>summation of means of calf, yearling, and calf-yearling effective prices.</td>
</tr>
<tr>
<td>MRc</td>
<td>mean of calf producers annual revenue.</td>
</tr>
<tr>
<td>MRY</td>
<td>mean of yearling producers annual revenue.</td>
</tr>
<tr>
<td>MRcy</td>
<td>mean of calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>MRt</td>
<td>summation of means of calf, yearling, and calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>SDRc</td>
<td>standard deviation of calf producers annual revenue.</td>
</tr>
<tr>
<td>SDRy</td>
<td>standard deviation of yearling producers annual revenue.</td>
</tr>
<tr>
<td>SDRcy</td>
<td>standard deviation of calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>SDRt</td>
<td>summation of standard deviations of calf, yearling, and calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>CV Rc</td>
<td>coefficient of variation of calf producers annual revenue.</td>
</tr>
<tr>
<td>CV Ry</td>
<td>coefficient of variation of yearling producers annual revenue.</td>
</tr>
<tr>
<td>CV Rcy</td>
<td>coefficient of variation of calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>CV Rt</td>
<td>summation of coefficient of variations of calf, yearling, and calf-yearling producers annual revenue.</td>
</tr>
<tr>
<td>Mlc</td>
<td>mean of calf producers annual gross income.</td>
</tr>
<tr>
<td>Mly</td>
<td>mean of yearling producers annual gross income.</td>
</tr>
<tr>
<td>Mlcy</td>
<td>mean of calf-yearling producers annual gross income.</td>
</tr>
<tr>
<td>Mlt</td>
<td>summation of means of calf, yearling, and calf-yearling producers annual gross income.</td>
</tr>
<tr>
<td>SD lc</td>
<td>standard deviation of calf producers annual gross income.</td>
</tr>
<tr>
<td>SDI y</td>
<td>standard deviation of yearling producers annual gross income.</td>
</tr>
<tr>
<td>SDI cy</td>
<td>standard deviation of calf-yearling producers annual gross income.</td>
</tr>
<tr>
<td>SDIt</td>
<td>summation of standard deviations of calf, yearling, and calf-yearling producers annual gross income.</td>
</tr>
</tbody>
</table>
TGPc  total provincial government contribution for calf production.
TGPy  total provincial government contribution for yearling production.
TGPy  total provincial government contribution for calf-yearling production.
TGPt  summation of total provincial government contributions for calf, yearling, and calf-yearling production.

TPPc  total producer premium for calf production.
TPPy  total producer premium for yearling production.
TPPcy  total producer premium for calf-yearling production.
TPPt  summation of total producer premiums for calf, yearling, and calf-yearling production.

NGPc  net government payment paid to calf producers.
NGPy  net government payment paid to yearling producers.
NGPcy  net government payment paid to calf-yearling producers.
NGPt  summation of net government payments paid to calf, yearling, and calf-yearling producers.

TWC  net welfare change due to government income stabilization efforts.
4.2.4.1 Summary Measures Computation

The annual mean, standard deviation and coefficient of variation of the producer revenue, producer income and beef production are computed using the standard statistical procedures.

4.2.4.2 Total Government Contribution

The amount paid to farmers by the government in any month (TGP<sub>t</sub>) is equal to the product of calculated indemnity payment (IND<sub>t</sub>) and the simulated quantity of participating beef (QHSt*A89) in the same month. The total amount of government contribution (TGP) over the simulation period is the sum of all the monthly contribution (TGP<sub>t</sub>), as shown in equation [ 43 ].

\[
[ 43 ] \quad TGP_t = IND_t \times (QHSt \times A89)
\]

\[
TGP = \sum_{t=1}^{T} TGP_t
\]

where

QHSt \quad simulated beef production in any given month.

TGP<sub>t</sub> \quad government contribution in a given month.

TGP \quad total government contribution over the simulation period.

T \quad total number of months in the simulation period.

4.2.4.3 Total Producer Premium

If any of the programs includes producer premium, the
monthly producer premium (TPPt) is equal to the premium paid per month (P Pt) times the quantity of simulated quantity of participating beef per month (QHSt*A89). The total amount of producer premium over the simulation period (TPP) is equal to the sum of all monthly producer premiums (TPPt) over the simulation period, shown as in equation [44].

\[ [44] \quad \text{TPPt} = \text{P Pt} \times (QHSt \times A89) \]

\[ \text{TPP} = \sum_{t=1}^{T} \text{TPPt} \]

where

TPPt monthly producer premium.

TPP total producer premium over the simulation period.

4.2.4.4 Net Government Payment

The net government payment (NPP) is equal to the total government contribution (TGP) minus total producer premium (TPP), that is the actual financial cost of the income stabilization programs shown in equation [45].

\[ [45] \quad \text{NGP} = \text{TGP} - \text{TPP} \]

where

NGP net government payment over the simulation period.

This completes the description of the mathematical model of the B.C. beef industry used in this study. In the next section, welfare change due to the implementation of alternative government programs will be discussed in detail.
4.3 Estimation Of Welfare Changes

Because the Farm Income Assurance program (FIAP) pays a subsidy for eligible beef pounds produced, B.C. beef producers would have received a higher return on beef production in recent years. Price support for income maintenance purposes may contribute to higher cost by holding resources in uses where their productivities are less than their potential capacities (Drummand, Anderson and Kerr). From the social point of view, government interference through any income stabilization programs may lead to problems of resource misallocation. It is interesting to estimate the resource allocation costs generated by the alternative income stabilization schemes. This involves estimation of social costs of resources used and the social value of beef produced.

As pointed out earlier, the amount of beef produced in B.C. is quite small compared to the North American beef market. This implies that B.C. beef producers are "price-takers". Thus, income stabilization programs cannot be expected to affect the demand side so no consumer surplus will be involved. The estimations below relate only to the supply side of the beef market.

By making use of the model, it is found that the simulated supply quantity of calves has increased whereas the simulated supply quantity of yearlings has decreased, assuming implementation of the alternative income stabilization schemes mentioned earlier. The reason for the decrease of yearlings is that more heifers were retained and some yearlings were heldover
to feed as slaughter animals. In the aggregate sense of beef production, those yearlings being held over to become slaughter animals are just a transfer from one type of production to another type and thus it is unlikely that they will exert any effect on the welfare changes. The increase in the quantity of calves will actually increase the aggregate beef production and the emphasis will be put on the welfare changes on calf production.

4.3.1 Direct Distortion

Without any government interference, the market clearing price of beef (Pe) is at the equilibrium point A (Fig. 4.2) where the marginal cost of productive resources is equal to the marginal benefit received by consumers. Since the demand for beef is assumed to be perfectly elastic, the demand curve can be represented by a horizontal line equal to the market price, as in Figure 4.2.

Figure 4.2 Welfare Change Due To Direct Distortion
At equilibrium (point A), beef producers produce $Q_e$ quantity of beef at a supply price equal to the market clearing price, $P_e$. If an income stabilization scheme pays a subsidy to the beef producers that increase the effective price they received to $P_s$. Induced by this higher price, farmers are likely to increase their production and will produce $Q_s$ quantity of beef at the price $P_s$. At point B, the marginal cost of resources is higher than the marginal benefit because the demand curve is still the same horizontal line (DD). This exerts a cost to society for the misallocation of resources which could otherwise be used more effectively in the production of other competitive activities. The social cost is represented by the shaded triangle ABC shown in Figure 4.2. The social cost can be calculated as in equation [46] below.

\[
TSC = \sum_{t=1}^{T} \frac{1}{2} (Q_{st} - Q_{et}) (P_{st} - P_{et})
\]

where

- $TSC$ total social cost over the simulation period.
- $P_{et}$ equilibrium market price in a given time period $t$.
- $P_{st}$ simulated price ($P_e$+subsidy) in a given time period $t$.
- $Q_{et}$ equilibrium quantity in a given time period $t$.
- $Q_{st}$ simulated quantity in a given time period $t$.
- $T$ total number of time period in the simulation period.

As mentioned earlier, it is reasonable to expect some "non-price" supply response to the advent of any income stabilization scheme. If farmers expect a more stable
production environment, they may be inclined to increase their supply. If they do, the beef supply curve will shift to the right, as in Figure 4.3. Beef will be produced with lower resource cost and actually benefit society. The benefits obtained are represented in Figure 4.3 by the area ABCD.

Figure 4.3 Welfare Change Due To Direct Distortion, with non-price response

As in the case above, when any income stabilization scheme comes into effect, beef will be produced at a higher than equilibrium price, thus implying a welfare loss. The welfare cost is represented by triangle EDF in Figure 4.3. The total welfare change induced by any income stabilization scheme assuming a "non-price effect" is equal to the difference between the social benefits generated by the more efficient production and the social cost of excess production; i.e. the difference between the areas ABCD and EDF in Figure 4.3.
4.3.2 Indirect Distortion

In Canada, beef is both imported and exported. Thus, an increase in beef production resulting from any income stabilization scheme suggests an increase in exports and/or a reduction in imports. Increases in B.C. beef production due to government intervention can be expected to improve Canadian foreign exchange earnings; hence, a social benefit. The benefit arises because the social opportunity cost of foreign exchange exceeds the market exchange rate used to translate foreign cash receipts and disbursements into Canadian dollars. The magnitude of this benefit depends on export subsidies, import tariffs and sales tax (Barichello).

Jenkins has estimated the social opportunity cost of foreign exchange in Canada to be 13% in excess of the market exchange rate (Jenkins), which means each dollar earned by increased production of beef induced by any income stabilization scheme is worth $1.13 to Canada. This rate of 13% is applied in this study for the evaluation of social benefits generated, as in equation [47].

\[ TSB = \sum_{t=1}^{T} 0.13 \times Pet \times (Qst - Qet) \]

where

TSB total social benefits over the simulation period.

There are other types of indirect distortions such as the increase in the amount of credit subsidies financed under Agricultural Credit Act and the land clearing subsidies financed
under ALDA. Increases in beef production can be expected to increase the expenditures of these programs indirectly. Due to the unavailability of data and/or their relatively small expected effects on net welfare change, they are neglected in this study's estimation of welfare change. However, it should be kept in mind that these social costs will offset part of the benefits gained from additional foreign exchange earnings.

4.3.3 Summary of Welfare Change

From the above analysis, the welfare change generated by any income stabilization scheme can be summarized as below:

1. Social Benefits-
   (a) If a "non-price effect" is included in the model, there are some resource savings gained by the added efficiency induced by a more stable production environment.
   (b) Because social opportunity cost of foreign exchange in Canada exceeds the market exchange rate, benefits to society will result from the expansion of beef outputs.

2. Social Costs-
   (a) Income subsidies which induce beef producers to increase their production lead to higher resource allocation costs.
   (b) The expenditures of ALDA and Agricultural Credit Act would have increased due to the expansion of beef production.
In summary, the total amount of welfare change presented in the summary measure module includes only the aggregate amount of the social costs induced by increased production (i.e. 2(a) above) and the social benefits gained from foreign exchange earnings (i.e. 1(b) above).
4.4 Model Validation

Validation is the stage of simulation procedure where a well accepted process is probably least developed (Johnson). This study's model is designed to trace the marginal changes in B.C. beef production due to the implementation of government income stabilization programs. The changes are reflected by quantity changes in heifer retention, the quantity changes in calf/yearling holdovers and the quantity changes due to a "non-price effect".

In the validation process, it should be possible to show that the model, under certain circumstances, is a valid representation of the real world. Two critical steps are involved in the validation procedure (Anderson):

1. to ensure that the assumptions of the model are in accord with relevant theory, experience and general knowledge;
2. to compare the model performance with the real system.

Regarding step (1), the production assumptions of the model were set with the guidance of B.C.M.A. cattle specialists. The values of the parameters used in this study were based on previous studies where available, with suitable adjustments.

Step (2) can be carried out using historical validation. This is possible because the B.C. Beef Producers' Income Assurance Program has been operating since 1974. The actual figures of production are used for comparison with the simulated quantity estimates generated by the model. Statistical tests are performed to show the "goodness of fit" between the observed
values and the simulated values.

Since the quantity of beef produced between January 1975 and December 1978 already includes the effects of the operation of FIAP, it is necessary to design a procedure to estimate the equilibrium quantity, i.e. when there was no government program in existence. Given the quantity of beef produced under FIAP is known from actual production data from 1974 to 1978, by assigning a supply elasticity based on previous studies, it is possible to estimate the equilibrium quantity in any given time period. The relevant equation is as follows:

\[
\frac{Q_o - Q_e}{Q_e} = \frac{E_{svr} \cdot (P_o - P_e)}{P_e}
\]

Then

\[
Q_e = \frac{Q_o}{1.0 + E_{svr} \cdot (P_o - P_e) / P_e}
\]

where

- \(Q_o\) observed quantity (with FIAP’s effect) in a given time period.
- \(Q_e\) equilibrium quantity in a given time period.
- \(P_o\) average price farmers received (with FIAP subsidy) in a given time period.
- \(P_e\) equilibrium market price in a given time period.
- \(E_{svr}\) short run supply elasticity.


4.4.1 Validation Procedure

As mentioned in the section above, two critical steps are involved in validation - selecting parameter values and showing that the model is a reasonable representation of reality.

4.4.1.1 Selecting Parameter Values

The parameters included in the model can be grouped into three categories: behavioral parameters, technical parameters and policy parameters. These parameters and the procedures used to select their values are discussed below.

4.4.1.1.1 Behavioral Parameters

Behavioral parameters show the farmer's response to changes brought about by government intervention. From previous studies on the Canadian beef industry, (Martin and Hacck, Tryfos, Kulshrestha, Kerr) the estimations made by Martin and Hacck seem to be most appropriate for use in this model, because the variables used in their study are quite closely related to the variables used in this study. In their study, inventory of beef cows for breeding purposes is a function of stocker calf price with a long run supply elasticity of 0.60 for Western Canada. Cattle quantity is a function of the steer price, which is assumed to be a proxy for yearling price, with a supply elasticity of 0.37. With these values as starting points, different behavioral parameters can be estimated by making use of the model with different runs. Since no study has been
conducted on the "non-price effect" of a more stable income environment, the non-price response parameter will be given a zero value in the experimental runs of the model.

The values of the behavioral parameters reflect farmer responses to income stabilization schemes in the following ways. If the price of calves increases, more heifers will be retained for breeding purposes, thus decreasing the number of yearling heifers being marketed. When more heifers are retained, more calves will go to market 24 months later and every 12 months thereafter. If there is an increase in yearling price, more calves will be heldover and marketed as yearlings four months later. If there is an increase in slaughter cattle price and/or yearling price, more yearlings will be heldover to collect subsidies when they are marketed as finished animals, (at a heavier weight) six months later thus decreasing the number of marketed yearlings in that period.

Several experimental runs were conducted with different parameter values, and the changes in each of the summary measures were in the expected direction. This suggests that the model is internally consistent.

4.4.1.1.2 Technical Parameters

Technical parameters show the biological characteristics of beef production in B.C. Their values have been verified by the B.C.M.A. cattle specialists.
4.4.1.1.3 Policy Parameters

Policy parameters show the degree of government interference. They are manipulated by the policy makers and can be set accordingly to examine their effects on the relevant summary measures.

The values of the behavioral and technical parameters used in this study are reported in Table 4.3.
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>VALUE</th>
<th>TYPE</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>0.0247</td>
<td>behavior</td>
<td>heifer retention response to a change in yearling price.</td>
</tr>
<tr>
<td>B3</td>
<td>0.0247</td>
<td>behavior</td>
<td>heifer retention response to a change in calf price.</td>
</tr>
<tr>
<td>B5</td>
<td>0.000</td>
<td>behavior</td>
<td>heifer retention response induced by a more stable production environment.</td>
</tr>
<tr>
<td>B6</td>
<td>0.019</td>
<td>behavior</td>
<td>calf holdover response to a change in yearling price.</td>
</tr>
<tr>
<td>B8</td>
<td>0.011</td>
<td>behavior</td>
<td>yearling holdover response to a change in yearling price.</td>
</tr>
<tr>
<td>B12</td>
<td>0.98</td>
<td>technical</td>
<td>death loss for keeping a calf an extra four months.</td>
</tr>
<tr>
<td>B17</td>
<td>0.20</td>
<td>technical</td>
<td>proportion of heifers slaughtered after first weaning.</td>
</tr>
<tr>
<td>B18</td>
<td>0.10</td>
<td>technical</td>
<td>proportion of heifers slaughtered after second weaning.</td>
</tr>
<tr>
<td>B19</td>
<td>0.10</td>
<td>technical</td>
<td>proportion of heifers slaughtered after third weaning.</td>
</tr>
<tr>
<td>B20</td>
<td>0.10</td>
<td>technical</td>
<td>proportion of heifers slaughtered after fourth weaning.</td>
</tr>
<tr>
<td>B22</td>
<td>0.804</td>
<td>technical</td>
<td>average number of calves weaned per cow annually.</td>
</tr>
<tr>
<td>B24</td>
<td>0.05</td>
<td>technical</td>
<td>heifer retention constraint.</td>
</tr>
<tr>
<td>B25</td>
<td>0.10</td>
<td>technical</td>
<td>calf holdover constraint.</td>
</tr>
<tr>
<td>B26</td>
<td>0.10</td>
<td>technical</td>
<td>yearling holdover constraint.</td>
</tr>
<tr>
<td>B30</td>
<td>1.243</td>
<td>technical</td>
<td>adjustment for death rate of keeping a calf until a yearling.</td>
</tr>
</tbody>
</table>
4.4.1.2 Validating The Model

Because the B.C. Beef Producers' Income Assurance Program has been in effect since 1974, historical validation can be used as a way to validate the model. By making use of the model, the simulated quantity of beef output in the period 1974-1978 is generated and compared with the actual production data of the same period. Additionally, in order to confirm that the values of the parameters chosen are appropriate for the B.C. beef industry, the model will be run for the past twenty years (1959-1978) to trace the year-to-year changes in beef production.

4.4.1.2.1 The 1974-1978 Period

The model is run with zero value policy parameters from January 1959 to December 1973, and with government stabilization parameters from January 1974 to December 1978. The Theil's U-coefficient is used to show the "goodness of fit" between the observed data and the simulated quantity estimated by the model (Theil). Theil's U-coefficient is calculated as in equation [49].

\[
U = \frac{\sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y_t - \hat{Y}_t)^2}}{\sqrt{\frac{1}{T} \sum_{t=1}^{T} Y_t^2} + \sqrt{\frac{1}{T} \sum_{t=1}^{T} \hat{Y}_t^2}}
\]

where

\(Y_t\) predicted values in a given time period.
Yt observed values in a given time period.
T number of total observations in the whole simulation period.
U Theil's U-coefficient.

The range of Theil U-coefficient is between 0 and 1, where U=0 indicates a perfect prediction and U=1 a very poor prediction. The Theil's U-coefficients obtained from the experimental run for the period 1974-1978 are 0.0605 for calves, 0.0559 for yearlings and 0.0639 for calf-yearlings, showing that the model has the ability to approximate reality.

4.4.1.2.2 The 1959-1978 Period

The same values of parameters listed in Table 4.3 are used for the past twenty years (1959-1978) to check their appropriateness. As the market prices of beef are determined by supply and demand in the market, the prices fluctuate from year to year. Farmers will respond to price changes by adjusting their output quantity. For purposes of validation, we can assume price changes over the twenty year period, 1959-1978 resulted from a government income stabilization program instead of the real cause - changing market conditions.

The current year's market price was compared with last year's price, assuming year to year differences in prices were induced by government income stabilization program, which would lead to changes in the quantity of beef outputs. The marginal change in current month t (IQt) is estimated by the model, and assuming it is proportional to last year's production quantity,
is a function of the change between current month's price (Pt) and price twelve months (Pt-12) earlier. It is illustrated as in equation [50]. The simulated quantity in a given month t (Qst) is equal to the sum of last year's simulated quantity (Qst-12) and any marginal change in quantity in that month (IQt) due to the price difference, as shown in equation [51]. This new simulated quantity would act as the base in simulating the following year's quantity, and the process similarly continues. The simulated quantity obtained by this procedure is compared with the actual production data to check the performance of the model over a longer period of time.

\[ 50 \] IQt / Qst-12 = B \times (Pt - Pt-12) \\
[51 ] Qst = Qst-12 + IQt

where

IQt marginal quantity change in month t due to the price difference between price at time t and price at time t-12.

Qst-12 simulated quantity in month t-12.

Qst simulated quantity in month t.

B effect of prices change on the change in quantity of beef production.

Pt market price of beef in month t.

Pt-12 market price of beef in month t-12.

The model is run with the listed parameter values for the twenty years (1959-1978) to generate the simulated
quantities. The year 1963 was chosen as the initial year and thus acted as the base to generate the subsequent years' beef output. The previous four years (1959-1962) were incorporated to allow the inclusion of some lagged changes in production, e.g. the change in offspring being produced due to a change in heifer retention caused by a previous price change.

The test of Theil U-coefficients was again used here to check the "goodness of fit" between the simulated quantity and the actual production quantity. The test was first performed with the monthly data (with 180 monthly observations). The Theil U-coefficients were 0.2044 for calves, 0.2192 for yearlings and 0.222 for calf-yearlings.

When monthly quantities were summed to form annual data, the Theil U-coefficients obtained were 0.1353 for calves, 0.1749 for yearlings and 0.1825 for calf-yearlings.

When price increases, farmers may not necessarily increase their beef supply; instead they may hold supplies from market if they expect higher prices in the future. Limited by storage facilities and scale of economy, this behavior can occur only within certain limits. It seems reasonable to eliminate these kinds of "unusual" quantity changes by averaging the neighbouring years. Here every three years is chosen as an unit to calculate the "goodness of fit"; e.g. we use the production figures of January 1961, 1962 and 1963 to get the average monthly figure, giving a total of 72 monthly observations. The Theil U-coefficients of three years' average quantity were 0.0947 for calves, 0.1387 for yearlings and 0.1513 for calf-yearlings.
yearlings.

In summary, the values of Theil U-coefficients obtained from different sets of data are close to zero, indicating the predictive power of the model is quite good. The Theil U-coefficients obtained by Martin and Zwart in their model ranged between 0.024 to 0.146 (Martin and Zwart). The authors concluded that their model has the ability to predict the actual values of the variables. In light of this comparison, the coefficients obtained in the validation procedure of this study can also termed "satisfactory".

4.4.2 Limitations of the Validation Procedure

Given that the model only captures marginal quantity changes due to price changes, we cannot expect the simulated quantity to be exactly equal to observed production. There are several things which may cause the simulated values and the observed values to differ.

(1) We assume the technology of beef production remains the same throughout the twenty year period, which may not be too realistic. This may partially account for the better fit in the beginning years of the period.

(2) We haven't included any stochastic changes in the model, e.g. disease which may decrease beef production, or tariff regulation changes between the United States and Canada that may change the trade pattern of beef.

(3) We haven't included the input costs in the validation procedure, because the data indicated input prices have
only increased moderately throughout the whole period.

(4) Although the model incorporates a "non-price supply shifter", it hasn't been used in the experimental runs due to the difficulty of knowing what values it should assume.

(5) Only the beef price is considered in the model, the price of other supply substitutes are not included. Beef producers can, of course, shift their beef production to other livestock production if greater profit can be obtained.

Although it is possible to build a more sophisticated model to deal with some of these limitations, the tradeoff which exists between simplicity and realism must not be lost sight of. This model is designed to trace the marginal changes in B.C. beef production due to the implementation of government income stabilization programs, mainly through product price deficiency payments.

The statistical results reported above show that the model is capable of predicting output changes that are consistent with actual production data. This increases our confidence that the model is a reliable representation of the B.C. beef industry and thus can be used to draw conclusions to meet the objectives of this study.
CHAPTER V

THE RESULTS

This chapter presents the results obtained by running the model with different policy variables, and under alternative income stabilization schemes. The results are summarized via the summary measures (or output variables) that were thought to be of most interest to policy makers. When the results for each scheme are presented, a short analysis is made to interpret their relevance to income stabilization.

5.1 Comparing Effects of Alternative Stabilization Schemes

One of the advantages of using a computer simulation approach is that the costs and effects of different schemes can be estimated without putting them into practise. The model can be run under identical conditions except for a change in one of the policy variables; then any differences in the results can be attributed to the impact of that variable.

To trace the impacts of alternative income stabilization schemes on the output variables, the model was run on a monthly basis over a period of twenty years, from January 1959 to December 1978. As mentioned earlier, the reason for including twenty years of data is to ensure that the model can describe the behaviour of B.C. beef production over an extended period of time, avoiding the possibility of only describing a segment of the beef cycle.

The model was initially run without any government income stabilization measures, i.e. all the policy parameter
values were set equal to zero. Later each scheme was run once with the parameter values reported in Table 4.3 and with the relevant policy parameter values. The summary measures obtained from each scheme were then compared with the results of the initial run (i.e. without any income stabilization program). Any differences in the computed summary measures can be attributed to the particular scheme in operation. Runs were made for the four product price deficient payment schemes described in Chapter III and their results are presented below. The heifer retention subsidy scheme described in Chapter III involves an input subsidy and hence is not examined in this study. First model results assuming the absence of government intervention are given.

5.1.1 No Stabilization Scheme

The model was initially run assuming the absence of any government income stabilization program. All of the policy variables were set equal to zero for this run. This implies that the effective beef price the average farmer received (which is the simulated price if an income stabilization scheme exists) is equal to the equilibrium market price. The results for the period 1959-1978 are reported under "No Scheme" in Table 5.1. For example, without government intervention, the aggregate calf producer gross revenue would be 5,063 thousand dollars per year. The absolute variation of calf producer net income is indicated by a standard deviation of 2,758 thousand dollars per year. Since no government income stabilization scheme was in
operation, total government contribution, total producer premiums and government payment would all equal zero.

5.1.2 Effects of British Columbia Beef Producers' Income Assurance Program, FIAP(1977)

The British Columbia Beef Producers' Income Assurance Program was announced in 1975 and implemented retroactive to April, 1974. It was amended in 1977 (hereafter referred to as "FIAP(1977)") and included the following features:

(a) farmers receive an indemnity when the market price of beef falls below a computed support level. The support level is equal to the equilibrium market price plus 75% of the difference between input cost and market price.

(b) both farmers and the provincial government pay a premium on beef production on a 1/3 to 2/3 basis. The total premiums are determined by dividing the amount of average indemnity paid in the preceding five years by average beef output in the preceding five years.

The estimated results are presented in Table 5.1 assuming FIAP(1977) had operated over the period 1959-1978. Differences in the results between the "FIAP(1977) run" and the "No Scheme run" can be attributed to the effects of FIAP(1977). These differences are also reported in Table 5.1 to show the effects of FIAP(1977).

The estimated results include three levels of beef production: calves, yearlings, and calf-yearlings. Gross income
is defined as the product of beef output and gross margin, where gross margin is the difference between total receipts and total variable costs. Average gross incomes for calf producers and calf-yearling producers are found to be negative in the estimated results, indicating that average cost exceeds average market price resulting in a negative average income. As the government programs considered do not affect input costs, average producer revenue was reported instead of average income.

The results presented below are obtained assuming FIAP(1977) had operated over the period 1959-1978:

1. Level of Beef Production

Average calf production would have increased 2,629 thousand pounds per year, whereas the average yearling and calf-yearling production would have decreased 966 and 563 thousand pounds per year, respectively. (Table 5.1)

FIAP(1977) would have increased the average annual calf production by 17%, indicating the cow-calf segment of the B.C. beef industry would have expanded if FIAP(1977) had operated over the twenty year period. This is empirically affirmed by the actual increase in calf production in B.C. since FIAP was implemented in 1974. Actual production data shows that calf production in B.C. has increased from 57,236 head in 1974 to 93,655 head in 1978, a 63% increase (Palacios and Kennedy). The reason for a 3% and 4% decrease in yearling and calf-yearling production is twofold. First, the increase in effective calf price was assumed to induce an increase in heifer retention thus decreasing the quantity of yearlings heifers
being marketed. Second, the higher effective yearling price in a given month was assumed to induce more yearlings to be heldover in that month to collect subsidies from the extra weight gained (850 lbs. to 1,000 lbs.). The yearlings heldover would reach market as finished animals a few months later, thus further decreasing the quantity of yearlings being marketed in that month.

(2) Level of Effective Beef Price Received by Average Farmer

The monthly effective beef price would have increased $8.54 per cwt. for calves, $2.89 per cwt. for yearlings and $8.85 per cwt. for calf-yearlings.

Including the FIAP subsidy, both the effective calf price and calf-yearling price would have increased 29% above their equilibrium prices level, while there is only a 10% increase in the effective yearling price. This shows that beef producers would have received a larger per cwt. subsidy for calf production than for yearling production.

(3) Level of Beef Producer Revenue

For cow-calf producers, aggregate revenue would have increased 2,631 thousand dollars per year. For yearling producers, aggregate revenue would have increased 610 thousand dollars per year. For those beef producers1 involved in both cow-calf and backgrounding operation, their aggregate revenue would have increased 1,270 thousand dollars per year.

1Subsidies on calf-yearling pounds go to cow-calf producers, but of course not all cow-calf producers produce calf-yearlings.
The dramatic increase (51%) in the average annual gross revenue from calf production is attributable to two factors: an increase in calf output and an increase in effective calf price received by the average farmer (which includes FIAP subsidy). Increases in revenue levels of yearling and calf-yearling producers are relatively moderate, being 6% and 28% respectively. For these latter two groups, increases in revenue due to price increases are largely offset by decreases in output.

(4) Absolute Variation of Producer Gross Income

Per unit gross income is defined as the effective price farmers receive less variable input cost. As indicated earlier, the production cost is based on a hypothetical production model negotiated by the B.C. Federation of Agriculture and the B.C. Ministry of Agriculture. It is quite conceivable that this negotiation process leads to higher production costs than actually exist. The standard deviation of beef producer income indicates the income variability over the period. The absolute variability of beef producer annual income from one year to the next at all three levels of beef production would have been reduced if FIAP(1977) had operated over the twenty year period. This is indicated by a reduction in average standard deviation of 1,771 thousand dollars per year on calf production, 1,467 thousand dollars per year on yearling production and 1,835 thousand dollars per year on calf-yearling production.

(5) Relative Variation of Producer Gross Income

The relative variability of gross income is computed by
dividing average income level by the standard deviation of income level, and is shown as the coefficient of variation. FIAP(1977) would have reduced the relative variation of producer annual income if it had operated over the twenty year period, shown by a fall of 67 in coefficient of variation for calf producers, a fall of 35 for yearling producers, and a fall of 64 for calf-yearling producers.

In view of these results, FIAP(1977) seems capable of achieving a provincial government goal of reduced income variability for beef producers. The results suggest FIAP(1977) would be more effective in reducing income variability at the calf level than at the yearling level. Yearling producers benefitted less than cow-calf producers partly because the market returns of yearlings were quite close to production costs (as opposed to being well below as for the calf level). This means that the effective price received by yearling producers was roughly equal to market return.

(6) Net Government Payment

Total provincial government contribution under FIAP(1977) over the twenty year period would have amounted to 5,315 thousand dollars per year. The producer premiums collected under FIAP(1977) would have amounted to 1,396 thousand dollars per year. Thus, the total net government payment would have been 3,917 thousand dollars per year over the twenty year period. Although the premiums were calculated in the way proposed by the provincial government to achieve a self-financing program, the government would still require producers
to pay 3,917 thousand dollars per year for the operation of FIAP(1977) over the twenty year period. This suggests the procedure by which producer premiums are calculated needs some amendments if the program is really to be made self-financing.

Of the total net government payment, 1,656 thousand dollars per year went to calf producers (42% of total net government payment), 840 thousand dollars per year went to yearling producers (21%), and 1,419 thousand dollars per year went to calf-yearling producers (36%).

(7) Net Welfare Change

B.C. beef producers would receive higher effective prices through the income assurance subsidy of FIAP(1977). It was assumed higher effective prices would induce beef producers to expand their production. To the extent that they do, resource allocation costs will result. The resulting social loss is estimated to be 88 thousand dollars per year over the twenty year period. This loss is partially offset by social benefits generated by foreign exchange gains due to a decrease in imported beef and/or an increase in exported beef. These benefits are estimated to be 124 thousand dollars per year over the twenty year period. The net welfare change generated by FIAP(1977) over the twenty year period would be positive, 36 thousand dollars per year.
<table>
<thead>
<tr>
<th>TABLE 5.1</th>
<th>ESTIMATED EFFECTS OF FIAP(1977), 1959-1978</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEVEL OF BEEF PRODUCTION</strong> (AVERAGE PER YEAR IN THOUSAND POUNDS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>15,749</td>
</tr>
<tr>
<td>YEARLING</td>
<td>31,042</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>14,073</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>60,866</td>
</tr>
<tr>
<td><strong>LEVEL OF EFFECTIVE BEEF PRICE</strong> RECEIVED BY AVERAGE FARMER (AVERAGE PER MONTH IN DOLLARS PER HUNDRED WEIGHT)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>29.50</td>
</tr>
<tr>
<td>YEARLING</td>
<td>29.38</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>29.50</td>
</tr>
<tr>
<td><strong>LEVEL OF BEEF PRODUCER GROSS REVENUE(1)</strong> (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>5,101</td>
</tr>
<tr>
<td>YEARLING</td>
<td>9,674</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>4,508</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>19,284</td>
</tr>
<tr>
<td><strong>ABSOLUTE VARIATION OF PRODUCER GROSS INCOME(2)</strong> (AVERAGE STANDARD DEVIATION PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>2,760</td>
</tr>
<tr>
<td>YEARLING</td>
<td>3,206</td>
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<tr>
<td>CALF-YEARLING</td>
<td>2,305</td>
</tr>
<tr>
<td><strong>RELATIVE VARIATION OF PRODUCER GROSS INCOME</strong> (AVERAGE COEFFICIENT OF VARIATION PER YEAR)</td>
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<tr>
<td>CALF</td>
<td>89</td>
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<td>YEARLING</td>
<td>64</td>
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<td>CALF-YEARLING</td>
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<tr>
<td><strong>TOTAL GOVERNMENT CONTRIBUTION</strong> (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>0</td>
</tr>
<tr>
<td>YEARLING</td>
<td>0</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL PRODUCER PREMIUM</strong> (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>0</td>
</tr>
<tr>
<td>YEARLING</td>
<td>0</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
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</tr>
<tr>
<td>TOTAL:</td>
<td>0</td>
</tr>
<tr>
<td><strong>NET GOVERNMENT PAYMENT(3)</strong> (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>0</td>
</tr>
<tr>
<td>YEARLING</td>
<td>0</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
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<tr>
<td>TOTAL:</td>
<td>0</td>
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<tr>
<td><strong>WELFARE CHANGE</strong> (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
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<tr>
<td>COST</td>
<td>0</td>
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<tr>
<td>BENEFIT</td>
<td>0</td>
</tr>
<tr>
<td>NET CHANGE:</td>
<td>0</td>
</tr>
</tbody>
</table>

(1) PRODUCER REVENUE IS DEFINED AS THE PRODUCT OF BEEF OUTPUT AND BEEF PRICE
(2) GROSS INCOME IS DEFINED AS THE PRODUCT OF BEEF OUTPUT AND GROSS MARGIN
(GROSS MARGIN IS EQUAL TO TOTAL RECEIPT LESS TOTAL VARIABLE COST)
(3) NET GOVERNMENT PAYMENT EQUALS NET PRODUCER RECEIPT
5.1.3 Effects of FIAP(1980)

FIAP(1977) was a five year program, existing from 1974 to 1978. In response to demands from B.C. beef producers for continuation of the program, the provincial government proposed a new income stabilization scheme, which came into effect in 1980. Slaughter level was included in this new scheme, hereafter referred to as "FIAP(1980)". The new scheme, FIAP(1980) also differs from FIAP(1977) in the following respects:

(a) support level of the return deficit (i.e. total input cost less market return) on beef production was increased from 75% to 100%.

(b) unlike the way producer premium was determined under FIAP(1977), producer premium was consisted of two components:

1. An advanced premium was collected from producers at inventory time each year which would be matched by the provincial government. Its amount was determined in agreement between B.C. Ministry of Agriculture and B.C. Federation of Agriculture.

2. An additional premium was collected from the producers at the end of each year. Its amount was determined as follows:

(i) in years when the gross indemnity is no greater than 5% of the production cost, the additional producer premium per pound would equal the full gross indemnity that producers received.
(ii) in years when the gross indemnity is greater than 5% and no greater than 31% of the production cost, the additional producer premium per pound would equal to 50% of the gross indemnity that producers received.

(iii) in years when the gross indemnity is greater than 31% of the production cost, the additional producer premium per pound would equal to 50% of the gross indemnity that producers received less the initial advanced premium payment.

This section estimates the results of this new scheme (FIAP(1980)), had it operated over the same twenty year period, 1959-1978. The results are shown in Table 5.2. The results still pertain to calf, yearling and calf-yearling levels. The slaughter level has not been included due to a lack of cost data. Differences between the estimated results of FIAP(1980) and FIAP(1977), as well as differences between FIAP(1980) and "no scheme", are also given in Table 5.2.

The estimated effects of FIAP(1980) are presented below, assuming it had operated over the period 1959-1978.

(1) Level of Beef Production

Compared to the "no scheme" situation, average calf production would have increased 2,584 thousand pounds per year, whereas average yearling and calf-yearling production would have decreased 402 and 257 thousand pounds per year, respectively.

Note that the impacts on B.C. beef production by FIAP(1980) would be in the same direction as FIAP(1977), but to
a lesser degree.

(2) Level of Effective Beef Price Received by Average Farmer

The monthly effective beef price under FIAP(1980) would have increased $5.24 per cwt. for calves, $2.44 per cwt. for yearlings and $6.24 per cwt. for calf-yearlings, compared to "no scheme" situation.

Compared to FIAP(1977), the effective calf price under FIAP(1980) would have been $3.30 per cwt. lower, the yearling price $0.45 per cwt. lower, and the calf-yearling price $2.61 per cwt. lower.

(3) Level of Beef Producer Revenue

Compared to the "no scheme" situation, the revenue of calf producers would have increased 1,869 thousand dollars per year under FIAP(1980). For yearling producers, revenue would have increased 780 thousand dollars per year. For those beef producers involved in both cow-calf and backgrounding operation, their aggregate revenue would have increased 927 thousands dollars per year.

Compared with FIAP(1977), FIAP(1980) would have a lower effect on revenue by 762 thousand dollars per year for calf producers and 343 thousand dollars per year for calf-yearling producers. For yearling producers, revenue would have increased 170 thousand dollars per year more under FIAP(1980) than under FIAP(1977).

(4) Variation of Producer Gross Income

The results in Table 5.2 indicate that FIAP(1980) would have reduced income variability for all three categories of
animals, in both an absolute sense (shown by reduction in standard deviation) and a relative sense (shown by reduction in coefficient of variation).

Compared to FIAP(1977), FIAP(1980) showed less ability to stabilize producer incomes.

(5) Total Producer Premium

Total producer premium collected from beef producers under FIAP(1980) would have amounted to 3,807 thousand dollars per year at the three levels of beef production over the twenty year period. This represented 2,411 thousand dollars per year more than under FIAP(1977).

(6) Net Government Payment

The total net government payment under FIAP(1980) would be 3,224 thousand dollars per year over the twenty year period. This represents 1,144 thousand dollars per year for calf producers (35% of total net government payment), 965 thousand dollars per year for yearling producers (30%), and 1,114 thousand dollars per year for calf-yearling producers (35%).

The total net government payment under FIAP(1980) would be 693 thousand dollars per year less than under FIAP(1977) for the period 1959-1978. Although the increased support level under FIAP(1980) raised total government contribution by 1,718 thousand dollars per year, this was more than offset by the increased producer premium (2,411 thousand dollars per year). Thus, total government net payment under FIAP(1980) has estimated to be lower than that of FIAP(1977) over the twenty year period, conceivably due to more premiums would have
collected from beef producers under the new scheme.

(7) Net Welfare Change

The net welfare change generated by FIAP(1980) over the twenty year period would be positive, 53 thousand dollars per year. The resource allocation cost generated by FIAP(1980) is estimated to be lower than that of FIAP(1977), although the social benefit generated is estimated to be lower as well. Net benefits under FIAP(1980) are estimated to be 17 thousand dollars per year more than under FIAP(1977).
### Table 5.2 Estimated Effects of FIAP(1980), 1959-1978

<table>
<thead>
<tr>
<th>Level</th>
<th>FIAP(1980)</th>
<th>Difference Compared to No Scheme</th>
<th>Difference Compared to FIAP(1977)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CALF</td>
<td>YEARLING</td>
<td>CALF-YEALRING</td>
</tr>
<tr>
<td>1. Level of Beef Production (Average per year in thousand pounds)</td>
<td>18,333</td>
<td>30,640</td>
<td>13,816</td>
</tr>
<tr>
<td>2. Level of Effective Beef Price Received by Average Farmer (Average per month in dollars per hundred weight)</td>
<td>34.74</td>
<td>31.82</td>
<td>35.74</td>
</tr>
<tr>
<td>3. Level of Beef Producer Gross Revenue(1) (Average per year in thousand dollars)</td>
<td>6,970</td>
<td>10,454</td>
<td>5,435</td>
</tr>
<tr>
<td>4. Absolute Variation of Producer Gross Income(2) (Average standard deviation per year in thousand dollars)</td>
<td>2,529</td>
<td>2,582</td>
<td>1,611</td>
</tr>
<tr>
<td>5. Relative Variation of Producer Gross Income (Average coefficient of variation per year)</td>
<td>66</td>
<td>44</td>
<td>39</td>
</tr>
<tr>
<td>6. Total Government Contribution (Average per year in thousand dollars)</td>
<td>2,875</td>
<td>1,646</td>
<td>2,509</td>
</tr>
<tr>
<td>7. Total Producer Premium (Average per year in thousand dollars)</td>
<td>1,731</td>
<td>681</td>
<td>1,394</td>
</tr>
<tr>
<td>8. Net Government Payment(3) (Average per year in thousand dollars)</td>
<td>1,144</td>
<td>965</td>
<td>1,114</td>
</tr>
<tr>
<td>9. Welfare Change (Average per year in thousand dollars)</td>
<td>65</td>
<td>65</td>
<td>119</td>
</tr>
</tbody>
</table>

(1) Producer revenue is defined as the product of beef output and beef price. 
(2) Gross income is defined as the product of beef output and gross margin (gross margin is equal to total receipt less total variable cost). 
(3) Net government payment equals net producer receipt.
5.1.4 Effects of Premium/Subsidy Scheme

Given a goal of beef producer income stability, it seems logical to charge producers a premium when beef prices are high relative to costs, and pay them a subsidy when the opposite holds. The current way of calculating producer premiums by FIAP (i.e. in every period despite the level of market prices), may not be contributing as much as it could be to income stabilization.

To compare the effects of FIAP(1980) with the premium/subsidy scheme, policy parameters were set in such a way to produce similar net government expenditure under both schemes. Further, in order to keep net government expenditures similar, producers were required to pay a premium every period\(^1\). The premium equalled a fixed percentage of the floor price (floor price for this scheme was set equal to market price plus 75% of return deficit). At the calf and calf-yearling levels, the premium equalled 14% of the floor price, and at the yearling level 1% of the floor price. Ceiling price was set 10% above the floor price. When the market price exceeded ceiling price, the excess was collected from producers as additional premium. Producers received an indemnity payment when costs of production exceeded market price. The indemnity equalled 75% of return deficit, where return deficit was equal to total input

\(^1\)We recognize this contradicts the logic mentioned above of only requiring producers to pay a premium when beef prices are high relative to costs.
cost less market price.

The estimated results of the premium/subsidy scheme are given in Table 5.3, if it had operated over the same twenty year period, 1959-1978. Differences of the premium/subsidy scheme compared to the "no scheme" situation, and compared to "FIAP(1980)", are also given in Table 5.3. The estimated results of the premium/subsidy scheme are summarized below:

(1) Level of Beef Production

Compared to "no scheme" situation, the calf production would have increased 2,475 thousand pounds per year under the premium/subsidy scheme; yearling production would have decreased 865 thousand pounds per year, and calf-yearling production would have decreased 524 thousand pounds per year.

Beef production under the premium/subsidy scheme would be quite close to that of FIAP(1980). The difference would be a decrease of 109 thousand pounds per year at the calf level, a decrease of 463 thousand pounds per year at the yearling level and a decrease of 267 thousand pounds per year at the calf-yearling level.

(2) Level of Effective Beef Price Received by Average Farmer

The premium/subsidy scheme would have raised the effective beef price received by an average farmer, with an increase of $6.40 per cwt. at the calf level, $3.33 per cwt. at the yearling level, and $6.73 per cwt. at the calf-yearling level.

The monthly effective beef price under the premium/subsidy scheme would be $1.16 per cwt. higher than
FIAP(1980) for calves, $0.89 per cwt. higher for yearlings, and $0.49 higher for calf-yearlings.

(3) Level of Beef Producer Revenue

The estimated producer revenue under the premium/subsidy scheme would be quite close to that of FIAP(1980), with 212 and 28 thousand dollars per year higher at the calf and calf-yearling levels, and 5 thousand dollars per year lower at the yearling level.

(4) Variation of Producer Gross Income

The annual income variability of calf and calf-yearling producers would have shown a remarkable reduction compared to under FIAP(1980), if premium/subsidy scheme had operated over the twenty year period. This is indicated by a dramatic difference in standard deviation of 1,509 thousand dollars per year lower for calf producers, 941 lower for yearling producers, and 980 lower for calf-yearling producers. The coefficient of variation of the three levels of beef producer income would be 41, 17 and 24 lower, respectively. The estimated results suggest that the premium/subsidy scheme would be more effective in reducing beef producer income fluctuations than would FIAP(1980).

(5) Total Producer Premium

Total producer premium collected from beef producers under the premium/subsidy scheme would be less than the amount collected under FIAP(1980) over the twenty year period. The difference would be 639 thousand dollars per year less at the calf level, 559 thousand dollars per year less at the yearling
level and 566 thousand dollars per year less at the calf-yearling level.

(6) Net Government Payment

As mentioned earlier, the premium/subsidy scheme examined involved setting the level of government net payment so that it was similar to that of FIAP(1980). The estimated total net government payments between the two schemes would differ by only 6 thousand dollars per year over the twenty year period. The total net government payment under the premium/subsidy scheme would be 3,230 thousand dollars per year over the twenty year period. This represents 1,170 thousand dollars per year for calf producers (36% of total net government payment), 966 thousand dollars per year for yearling producers (30%), and 1,093 thousand dollars per year for calf-yearling producers (34%).

(7) Net Welfare Change

The net welfare change resulting from the premium/subsidy scheme is estimated to be positive, 67 thousand dollars per year over the twenty year period. This represents 14 thousand dollars per year more in net benefits than that of FIAP(1980).
### TABLE 5.3 ESTIMATED EFFECTS OF PREMIUM/SUBSIDY SCHEME, 1959-1978

<table>
<thead>
<tr>
<th>Level</th>
<th>Premium/ Subsidy Scheme</th>
<th>Difference Compared to No Scheme</th>
<th>Difference Compared to FIAP(1980)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Calf</td>
<td>Yearling</td>
<td>Calf-Yearling</td>
</tr>
<tr>
<td>1. Level of Beef Production</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average per year in thousand pounds)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>18,224</td>
<td>2,475</td>
<td>- 109</td>
</tr>
<tr>
<td>Yearling</td>
<td>30,177</td>
<td>- 865</td>
<td>- 463</td>
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<tr>
<td>Calf-Yearling</td>
<td>13,549</td>
<td>- 524</td>
<td>- 267</td>
</tr>
<tr>
<td>Total:</td>
<td>61,951</td>
<td>1,085</td>
<td>- 840</td>
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<tr>
<td>2. Level of Effective Beef Price</td>
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<tr>
<td>Received by Average Farmer</td>
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</tr>
<tr>
<td>(Average per month in dollars per hundred weight)</td>
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<td></td>
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<tr>
<td>Calf</td>
<td>35.90</td>
<td>6.40</td>
<td>1.16</td>
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<tr>
<td>Yearling</td>
<td>32.71</td>
<td>3.33</td>
<td>0.89</td>
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<tr>
<td>Calf-Yearling</td>
<td>36.23</td>
<td>6.73</td>
<td>0.49</td>
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<tr>
<td>3. Level of Beef Producer Gross Revenue(1)</td>
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<tr>
<td>(Average per year in thousand dollars)</td>
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<tr>
<td>Calf</td>
<td>7,182</td>
<td>2,081</td>
<td>212</td>
</tr>
<tr>
<td>Yearling</td>
<td>10,449</td>
<td>775</td>
<td>5</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>5,463</td>
<td>955</td>
<td>28</td>
</tr>
<tr>
<td>Total:</td>
<td>23,096</td>
<td>3,812</td>
<td>237</td>
</tr>
<tr>
<td>4. Absolute Variation of Producer Gross Income(2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average standard deviation per year in thousand dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>1,020</td>
<td>- 1,740</td>
<td>- 1,509</td>
</tr>
<tr>
<td>Yearling</td>
<td>1,641</td>
<td>- 1,565</td>
<td>- 941</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>631</td>
<td>- 1,674</td>
<td>- 980</td>
</tr>
<tr>
<td>5. Relative Variation of Producer Gross Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average coefficient of variation per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>25</td>
<td>- 64</td>
<td>- 41</td>
</tr>
<tr>
<td>Yearling</td>
<td>27</td>
<td>- 37</td>
<td>- 17</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>15</td>
<td>- 59</td>
<td>- 24</td>
</tr>
<tr>
<td>6. Total Government Contribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average per year in thousand dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>2,262</td>
<td>2,262</td>
<td>- 613</td>
</tr>
<tr>
<td>Yearling</td>
<td>1,088</td>
<td>1,088</td>
<td>- 558</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>1,922</td>
<td>1,922</td>
<td>- 587</td>
</tr>
<tr>
<td>Total:</td>
<td>5,272</td>
<td>5,272</td>
<td>- 1,759</td>
</tr>
<tr>
<td>7. Total Producer Premium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average per year in thousand dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>1,092</td>
<td>1,092</td>
<td>- 639</td>
</tr>
<tr>
<td>Yearling</td>
<td>122</td>
<td>122</td>
<td>- 559</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>828</td>
<td>828</td>
<td>- 566</td>
</tr>
<tr>
<td>Total:</td>
<td>2,042</td>
<td>2,042</td>
<td>- 1,765</td>
</tr>
<tr>
<td>8. Net Government Payment(3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average per year in thousand dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calf</td>
<td>1,170</td>
<td>1,170</td>
<td>26</td>
</tr>
<tr>
<td>Yearling</td>
<td>966</td>
<td>966</td>
<td>1</td>
</tr>
<tr>
<td>Calf-Yearling</td>
<td>1,093</td>
<td>1,093</td>
<td>- 21</td>
</tr>
<tr>
<td>Total:</td>
<td>3,330</td>
<td>3,330</td>
<td>6</td>
</tr>
<tr>
<td>9. Welfare Change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Average per year in thousand dollars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>49</td>
<td>49</td>
<td>16</td>
</tr>
<tr>
<td>Benefit</td>
<td>116</td>
<td>116</td>
<td>- 3</td>
</tr>
<tr>
<td>Net Change:</td>
<td>67</td>
<td>67</td>
<td>14</td>
</tr>
</tbody>
</table>

(1) Producer Revenue is defined as the product of Beef Output and Beef Price
(2) Gross Income is defined as the product of Beef Output and Gross Margin
   (Gross Margin is equal to Total Receipt less Total Variable Cost)
(3) Net Government Payment equals Net Producer Receipt
5.1.5 Effects of Guaranteed Price Scheme

This scheme resembles the federal Agricultural Stabilization Act in calculating the effective beef price received by an average farmer in B.C. The effective price (i.e. guaranteed price) was determined to be the sum of 90% of average market return of the preceding five years and the current input cost less average input cost of the preceding five years. No producer premium would be collected from beef producers under this scheme. One of the advantages of this scheme is that the level of effective beef prices wouldn't fluctuate much from year to year, because its calculation is based on a five year moving average. The estimated results of the guaranteed price scheme are summarized below, assuming it had operated over the same twenty year period, 1959-1978.

(1) Level of Beef Production

Compared to "no scheme" situation, the guaranteed price would have increased the average calf production 642 thousand pounds per year, the average yearling and calf-yearling production would have decreased 232 thousand pounds and 272 thousand pounds per year, respectively. Beef production under the guaranteed price scheme over the twenty year period would be 1,942 thousand pounds per year less than FIAP(1980) at the calf level, 170 thousand pounds per year more at the yearling level and 15 thousand pounds per year less at the calf-yearling level.

(2) Level of Effective Beef Price Received by Average Farmer

The guaranteed price scheme would have increased the effective price received by an average farmer for all three
categories of animals. Compared to FIAP(1980), the guaranteed price scheme would have increase calf price $0.57 per cwt. less, yearling price $0.06 per cwt. more, and calf-yearling price $2.92 per cwt. less.

(3) Level of Beef Producer Revenue

The guaranteed price scheme would have increased the producer revenue for all the three levels of beef production. The increases in beef producer revenue under the guaranteed price scheme would be quite different from under FIAP(1980), there would be 644 thousand dollars per year lower at the calf level, 98 thousand dollars per year lower at the yearling level, and 378 thousand dollars per year lower at the calf-yearling level.

(4) Variation of Producer Gross Income

Compared to the "no scheme" situation, the guaranteed price scheme would have reduced the producer income variability for all three levels of production. However, the guaranteed price scheme appears more capable in reducing producer income variability than FIAP(1980) did. This is indicated by the standard deviations are 1333, 629 and 769 thousand dollars per year lower than under FIAP(1980) at the calf, yearling and calf-yearling levels, respectively. The coefficients of variation of beef producers income at the three different levels would respectively be 36, 11 and 17 lower than under FIAP(1980). The ability of the guaranteed price scheme to lower income variability suggests that calculating effective beef prices using a five year moving average can effectively dampen producer
income fluctuations from year to year.

(5) Net Government Payment

The total government net payment under guaranteed price scheme would be 2,251 thousand dollars per year over the twenty year period. This represents 898 thousand dollars per year for calf producers (40% of total government net payment), 723 thousand dollars per year for yearling producers (32%), and 629 thousand dollars per year for calf-yearling producers (28%).

Although no producer premium would be collected from beef producers under the guaranteed price scheme, the guaranteed price scheme would nevertheless cost the government 973 thousand dollars per year less than FIAP(1980) over the twenty year period.

(6) Net Welfare Change

The net welfare change is estimated to be positive, 40 thousand dollars per year over the twenty year period, this represents 13 thousand dollars per year less than the net change under FIAP(1980).
TABLE 5.4  ESTIMATED EFFECTS OF GUARANTEED PRICE SCHEME, 1959-1978.

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>GUARANTEED PRICE SCHEME</th>
<th>DIFFERENCE COMPARED TO NO SCHEME</th>
<th>DIFFERENCE COMPARED TO FIAP(1980)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. LEVEL OF BEEF PRODUCTION (AVERAGE PER YEAR IN THOUSAND POUNDS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>16,391</td>
<td>642</td>
<td>-1,942</td>
</tr>
<tr>
<td>YEARLING</td>
<td>30,810</td>
<td>-232</td>
<td>170</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>13,801</td>
<td>-272</td>
<td>-15</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>61,003</td>
<td>137</td>
<td>-1,788</td>
</tr>
<tr>
<td>2. LEVEL OF EFFECTIVE BEEF PRICE RECEIVED BY AVERAGE FARMER (AVERAGE PER MONTH IN DOLLARS PER HUNDRED WEIGHT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>34.17</td>
<td>4.67</td>
<td>-0.57</td>
</tr>
<tr>
<td>YEARLING</td>
<td>31.88</td>
<td>2.50</td>
<td>0.06</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>32.82</td>
<td>3.32</td>
<td>-2.92</td>
</tr>
<tr>
<td>3. LEVEL OF BEEF PRODUCER GROSS REVENUE(1) (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>6,326</td>
<td>1,225</td>
<td>-644</td>
</tr>
<tr>
<td>YEARLING</td>
<td>10,356</td>
<td>682</td>
<td>98</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>5,057</td>
<td>549</td>
<td>378</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>21,739</td>
<td>2,455</td>
<td>-1,120</td>
</tr>
<tr>
<td>4. ABSOLUTE VARIATION OF PRODUCER GROSS INCOME(2) (AVERAGE STANDARD DEVIATION PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>1,196</td>
<td>-1,564</td>
<td>-1,333</td>
</tr>
<tr>
<td>YEARLING</td>
<td>1,953</td>
<td>-1,253</td>
<td>-629</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>842</td>
<td>-1,463</td>
<td>-769</td>
</tr>
<tr>
<td>5. RELATIVE VARIATION OF PRODUCER GROSS INCOME (AVERAGE COEFFICIENT OF VARIATION PER YEAR)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>30</td>
<td>-59</td>
<td>-36</td>
</tr>
<tr>
<td>YEARLING</td>
<td>33</td>
<td>-31</td>
<td>-11</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>22</td>
<td>-52</td>
<td>-17</td>
</tr>
<tr>
<td>6. TOTAL GOVERNMENT CONTRIBUTION (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>898</td>
<td>898</td>
<td>-1,977</td>
</tr>
<tr>
<td>YEARLING</td>
<td>723</td>
<td>723</td>
<td>-923</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>629</td>
<td>629</td>
<td>-1,880</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>2,251</td>
<td>2,251</td>
<td>-4,780</td>
</tr>
<tr>
<td>7. TOTAL PRODUCER PREMIUM (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>0</td>
<td>0</td>
<td>-1,080</td>
</tr>
<tr>
<td>YEARLING</td>
<td>0</td>
<td>0</td>
<td>-435</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>0</td>
<td>0</td>
<td>-896</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>0</td>
<td>0</td>
<td>-2,411</td>
</tr>
<tr>
<td>8. NET GOVERNMENT PAYMENT(3) (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CALF</td>
<td>898</td>
<td>898</td>
<td>-246</td>
</tr>
<tr>
<td>YEARLING</td>
<td>723</td>
<td>723</td>
<td>-242</td>
</tr>
<tr>
<td>CALF-YEARLING</td>
<td>629</td>
<td>629</td>
<td>-485</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>2,251</td>
<td>2,251</td>
<td>-973</td>
</tr>
<tr>
<td>9. WELFARE CHANGE (AVERAGE PER YEAR IN THOUSAND DOLLARS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COST</td>
<td>4</td>
<td>4</td>
<td>61</td>
</tr>
<tr>
<td>BENEFIT</td>
<td>44</td>
<td>44</td>
<td>75</td>
</tr>
<tr>
<td>NET CHANGE:</td>
<td>40</td>
<td>40</td>
<td>13</td>
</tr>
</tbody>
</table>

(1) PRODUCER REVENUE IS DEFINED AS THE PRODUCT OF BEEF OUTPUT AND BEEF PRICE
(2) GROSS INCOME IS DEFINED AS THE PRODUCT OF BEEF OUTPUT AND GROSS MARGIN (GROSS MARGIN IS EQUAL TO TOTAL RECEIPT LESS TOTAL VARIABLE COST)
(3) NET GOVERNMENT PAYMENT EQUALS NET PRODUCER RECEIPT
5.2 Comparative Effectiveness of the Alternative Income Stabilization Schemes

The comparative effectiveness of alternative income stabilization schemes can be shown by comparing their impacts on producer revenue level and income variability. Relative effectiveness can be expected to vary depending on the points of view taken. A discussion on the effectiveness of alternative schemes is presented below, first from the point of view of the provincial government, and then from the point of view of B.C. beef producers.

A. From the government point of view:

In achieving the goal of income stability, different amounts of expenditure would be required for the alternative income stabilization schemes. The costs of implementing these schemes were summarized by the summary measures, such as total government contribution, total producer premium, and net government payment.

For purposes of comparing the effectiveness of alternative stabilization schemes from the provincial government's point of view, we assume that the government would evaluate the effectiveness of alternative schemes by considering total expenditure, including both net government payment and producer premium, to be the relevant cost figure. This assumption was based on the belief that the provincial government is concerned with expenditures by beef producers as well as its own direct costs.
The effectiveness of each scheme can be shown by the increase of producer gross revenue and the reduction in the standard deviation of producer income per thousand dollars of total expenditure, if these schemes had operated over the period 1959-1978. The comparative effectiveness of alternative schemes are presented in Table 5.5 and discussed below, first on their effectiveness in increasing beef producer gross revenue, then in reducing producer income variability, followed by the estimation of social benefit that would generated by each scheme.

(1) Effectiveness of Alternative Schemes in Increasing Beef Producer Annual Gross Revenue

For every thousand dollars per year of government and/or producer expenditure on calf production during the twenty year period, aggregate calf producer revenue would have increased by 1,140 dollars per year under FIAP(1977), 650 dollars per year under FIAP(1980), 920 dollars per year under the premium/subsidy scheme, and 1,364 dollars per year under the guaranteed price scheme. (see Table 5.5)

For every thousand dollars per year of government and/or producer expenditure on yearling production during the twenty year period, aggregate yearling producer revenue would have increased by 561 dollars per year under FIAP(1977), 474 dollars

---

1These figures were calculated by dividing the annual increase in producer gross revenue (compared to "no scheme" situation) by the total expenditure per year over the 1959-1978 period (from Table 5.1-5.4), and then multiplying by 1,000 dollars.
per year under FIAP(1980), 712 dollars per year under the premium/subsidy scheme, and 943 dollars per year under the guaranteed price scheme.

For every thousand dollars per year of government and/or producer expenditure on calf-yearling production during the twenty year period, aggregate calf-yearling producer revenue would have increased by 662 dollars per year under FIAP(1977), 369 dollars per year under FIAP(1980), 497 dollars per year under the premium/subsidy scheme, and 873 dollars per year under the guaranteed price scheme.

From the overall view (i.e. summation of all three levels of beef production), for every thousand dollars per year of government and/or producer expenditure on same aspect of beef production during the twenty year period, B.C. beef producer revenue would have increased by 849 dollars per year under FIAP(1977), 508 dollars per year under FIAP(1980), 723 dollars per year under the premium/subsidy scheme, and 1,091 dollars per year under the guaranteed price scheme.

These figures provide a general insight to the effectiveness of each of the alternative schemes at different levels of beef production. The guaranteed price scheme is shown to be the most effective in raising revenues for all three levels of beef production, whereas FIAP(1980) is shown to be the least effective.
(2) Effectiveness of Alternative Schemes in Reducing Beef Producer Income Variability

For every thousand dollars per year of government and/or producer expenditure on calf production during the twenty year period, calf producer income variability would have decreased, as shown by a reduction of standard deviation 768 dollars per year under FIAP(1977), 80 dollars per year under FIAP(1980), 769 dollars per year under the premium/subsidy scheme, and 1,741 dollars per year under the guaranteed price scheme'. (see Table 5.5)

For every thousand dollars per year of government and/or producer expenditure on yearling production during the twenty year period, yearling producer income variability would have decreased, as shown by a reduction of standard deviation of 1,350 dollars per year under FIAP(1977), 380 dollars per year under FIAP(1980), 1,438 dollars per year under the premium/subsidy scheme, and 1,733 dollars per year under the guaranteed price scheme.

For every thousand dollars per year of government and/or producer expenditure on calf-yearling production during the twenty year period, calf-yearling producer income variability would have decreased, as shown by a reduction of standard

---

'These figures were calculated by dividing the annual reduction in standard deviation of producer net income (compared to "no scheme" situation) by the total expenditure per year over the 1959-1978 period (from Table 5.1-5.4), and then multiplying by 1,000 dollars.
deviation of 957 dollars per year under FIAP(1977), 277 dollars per year under FIAP(1980), 871 dollars per year under the premium/subsidy scheme, and 2,326 dollars per year under the guaranteed price scheme.

The figures in Table 5.5 indicate that the guaranteed price scheme is the most effective alternative in reducing producer income variability. The second most effective scheme is the premium/subsidy scheme, followed by the FIAP(1977) and the FIAP(1980).

(3) Net Social Benefits Generated by Alternative Schemes

The net welfare change per year for each of the schemes was shown to be positive, indicating social benefits would have been generated had these schemes operated over the period 1959-1978. Net social benefits generated per thousand dollars total expenditure per year would be 7 dollars per year under FIAP(1977), 8 dollars per year under FIAP(1980), 13 dollars per year under the premium/subsidy scheme, and 18 dollars per year under the guaranteed price scheme¹. (see Table 5.5)

Thus, regarding social benefit generation, the guaranteed price scheme would have the largest effect of the alternative schemes.

¹These figures were calculated by dividing the net welfare change by the total expenditure per year over the 1959-1978 period (from Table 5.1-5.4), and then multiplying by 1,000 dollars.
Table 5.5 Effectiveness Of Alternative Schemes Per $1,000
Government And Producer Expenditure Per Year, 1959-1978.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in level of beef producer gross revenue per $1,000 expenditure per year (average per year in dollars)</td>
<td>Calf</td>
<td>1,140</td>
<td>650</td>
<td>920</td>
</tr>
<tr>
<td></td>
<td>Yearling</td>
<td>561</td>
<td>474</td>
<td>712</td>
</tr>
<tr>
<td></td>
<td>Calf-yearling</td>
<td>662</td>
<td>369</td>
<td>497</td>
</tr>
<tr>
<td></td>
<td>Overall¹</td>
<td>849</td>
<td>508</td>
<td>723</td>
</tr>
<tr>
<td>Reduction in absolute variation of producer net income per $1,000 expenditure per year (average standard deviation per year in dollars)</td>
<td>Calf</td>
<td>768</td>
<td>80</td>
<td>769</td>
</tr>
<tr>
<td></td>
<td>Yearling</td>
<td>1,350</td>
<td>380</td>
<td>1,438</td>
</tr>
<tr>
<td></td>
<td>Calf-yearling</td>
<td>957</td>
<td>277</td>
<td>871</td>
</tr>
<tr>
<td>Net welfare change per $1,000 expenditure per year (dollars per year)</td>
<td>7</td>
<td>8</td>
<td>13</td>
<td>18</td>
</tr>
</tbody>
</table>

¹Overall represents all three levels of beef production (i.e. calf, yearling, and calf-yearling)
B. From the producer point of view:

Prior to participating in any of the stabilization schemes, producers may be interested to know how these schemes would increase their revenue and decrease their income variability. The comparative effectiveness of alternative schemes are discussed below, first on the net receipts producers would receive, then on the decrease on producer income variability.

(1) Net producer receipts under alternative stabilization schemes

For purposes of comparing effectiveness of the alternative schemes from the producer point of view, we assume that producers are not concerned with the amount of total government contribution. In other words, we assume producers are only concerned about the receipts they receive under each of the alternative schemes; i.e. after total producer premiums are deducted from the subsidies the alternative schemes provide. Net producer receipts under alternative schemes are equal to total government contribution less total producer premium (i.e. the same amount as net government payment in Table 5.1-5.4). Net producer receipts under alternative schemes are reported in Table 5.6 and described below, if they had operated over the period 1959-1978.

The average net producer receipts for calf production would be highest under FIAP(1977) with 1,656 thousand dollars per year, 1,170 thousand dollars per year under the premium/subsidy scheme, 1,144 thousand dollars per year under FIAP(1980), and lowest under the guaranteed price scheme with
The average net producer receipts for yearling production would be highest under the premium/subsidy scheme with 966 thousand dollars per year, 965 thousand dollars per year under FIAP(1980), 840 thousand dollars per year under FIAP(1977), and lowest under the guaranteed price scheme with 723 thousand dollars per year.

The average net producer receipts for calf-yearling production would be highest under FIAP(1977) with 1,419 thousand dollars per year, 1,114 thousand dollars per year under FIAP(1980), 1,093 thousand dollars per year under the premium/subsidy scheme, and lowest under the guaranteed price scheme with 629 thousand dollars per year.

Summing the three levels of beef production, average net producer receipts would be highest under FIAP(1977) with 3,917 thousand dollars per year, and lowest under the guaranteed price scheme with 2,251 thousand dollars per year only.

(2) Effectiveness of Alternative Schemes in Reducing Beef Producer Income Variability

Each of the four stabilization schemes would have successfully decreased the producer income variability, however, with different producer contributions through the producer premium. The premium/subsidy scheme was shown to be most effective in reducing the standard deviation of producer net income (from Table 5.1-5.4), this was done with producer premium amounted to 1,765 thousand dollars per year over the twenty year...
period. Although the decrease in standard deviation of producer income variability under the guaranteed price scheme was not as low as the premium/subsidy scheme, that was done without any producer expenditure (since no producer premium would be collected under this scheme). With the same producer expenditure on beef production during the twenty-year period, the premium/subsidy scheme would be shown as the most effective of all stabilization schemes in reducing producer income variability¹, followed by FIAP(1977), whereas FIAP(1980) would be shown as the least effective.

¹These estimations were calculated by dividing the annual reduction in standard deviation of producer net income (compared to "no scheme" situation) by the producer premium per year over the 1959-1978 period (from Table 5.1-5.4), and then multiplying by 1,000 dollars.
### Table 5.6 Average Net Producer Receipts Under Alternative Stabilization Schemes, 1959-1978.

<table>
<thead>
<tr>
<th></th>
<th>FIAP 1977</th>
<th>FIAP 1980</th>
<th>Premium/ Subsidy scheme</th>
<th>Guaranteed Price scheme</th>
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<td><strong>Yearling</strong></td>
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¹Overall represents all three levels of beef production (i.e. calf, yearling, and calf-yearling).
CHAPTER VI
CONCLUSIONS

This chapter summarizes the most important conclusions that can be drawn from this study. It includes discussions on both methodological aspects and model results. A discussion on further research is presented at the end of the chapter.

6.1 Methodological Aspects

A number of points can be concluded with respect to the methodology employed in this study.

(1) Simulating a mathematical model has enabled prediction of the likely impacts of different income stabilization schemes on the B.C. beef industry, without the necessity of putting the schemes into practice.

(2) The model was built in a general and flexible way allowing it to incorporate recent changes in government efforts to stabilize the B.C. beef industry.

(3) The validation results given in Chapter IV support the view that the model is a valid representation of the real world system. The results that test the model's performance were reported as "good" over the twenty year period. The validation results also suggest that the basic production assumptions made for the B.C. beef industry and the parameter values assigned to the model are valid.

(4) The model used in this study disaggregated B.C. beef production into three distinct levels (i.e. calf, yearling and calf-yearling) in order to trace the impacts of
alternative schemes on the different levels of beef production. Results with relevance to different levels of beef production were considered preferable to the results of aggregate beef outputs, as they provide policy makers with more information in making decisions.

6.2 Model Results

The model provided useful information of two main types: (1) the likely impacts of several income stabilization schemes for B.C. beef producers, and (2) the comparative effects of these schemes. The main conclusions for each of these two types of information are given in turn below.

6.2.1 Likely Impacts of Alternative Stabilization Schemes

The model was run under alternative income stabilization schemes, and the estimated results were compared to the "no scheme" situation. Estimated differences showed the impacts of alternative income stabilization schemes. As the validation results were reported as "good and acceptable", the conclusions drawn from model results can be considered helpful to policy makers in making real world decisions. However, caution must be exercised in using these results, because they are dependent on the model assumptions and parameter values assigned. For example, the results rely on assumptions made regarding farmer production decision responses.

The impacts of four different income stabilization schemes were estimated and examined in this study - the
FIAP(1977), the FIAP(1980), the premium/subsidy scheme, and the guaranteed price scheme. Several points can be concluded from the estimated results of these schemes, if they had operated over the period 1959-1978.

(1) Compared to the "no scheme' situation, each of the stabilization schemes considered would have increased the market quantity of calf production and decreased the market quantity of yearling and calf-yearling production in B.C. The percentage increases in calf production in all cases were greater than percentage decreases in yearling and calf-yearling production. If policy makers wish to expand B.C. beef production, then the stabilization schemes considered could be used to expand calf production, but not yearling or calf-yearling production.

(2) Each of these schemes would have successfully increased beef producer revenues, having more of an effect at the calf level than the yearling and calf-yearling levels. At the yearling and calf-yearling levels, increases in effective price were partly offset by decreases in output.

(3) The income variability of beef producers would have decreased (both in the absolute sense and the relative sense) if any one of the four stabilization schemes were employed over the period 1959-1978.

(4) Under each of the alternative stabilization schemes, excess beef production would result, generating a resource allocation cost; benefits would also be generated from foreign exchange gains. Net welfare changes for each of
the schemes were positive, assuming they had operated over the period 1959-1978. This suggests that expanding the beef industry in B.C. via one of the four stabilization schemes examined in this study would have increased social welfare in B.C. if they had operated in the period 1959-1978. This may suggest that expanding the beef industry in B.C. would increase the welfare of the British Columbian.

6.2.2 Comparative Effects of Alternative Stabilization Schemes

The model has the ability to contribute some useful information on the comparative effects of the different stabilization schemes. This information can be used by policy makers in amending current stabilization schemes and designing new ones. In interpreting comparative effects, the particular model assumptions and assigned values of the technical and behavioral parameters are less critical than in the case of determining the impacts of a single scheme (as above). This is because the assumptions and parameter values are held constant for each of the schemes compared. For example, the same assumptions regarding farmer production decision responses are assumed to hold for each scheme.

Some conclusions which can be drawn from the comparative effects of alternative stabilization schemes are mentioned below.

(1) From the provincial government point of view, for a given expenditure, the guaranteed price scheme would be most effective in both raising beef producer revenue and
reducing their income variability. The relative success of this scheme is due to the way its support prices are calculated. The effective price beef producers would receive under the guaranteed price scheme is based on a five year moving average of market return. This enables it to effectively dampen producer income fluctuations from year to year. This is in contrast to the FIAP calculations of return deficit based on current product prices and current input costs, which tend to fluctuate widely between years.

(2) From the producer point of view, the guaranteed price scheme would yield the fewest net producer receipts of any of the stabilization schemes examined. FIAP(1977) would yield the highest net producer receipts, i.e. the highest transfer payment from the provincial government.

(3) Under the recently implemented FIAP(1980), the effect of raising support level of return deficit from 75% to 100% was offset by the 50% increase in the producer share of total premium and the collection of advanced premium. FIAP(1980) was shown to be the least effective of all the schemes, in terms of increasing beef producer revenue and reducing income variability.

(4) The tying of producer premium to gross indemnity under FIAP(1980) was shown to be less effective than the five year moving average ratio of indemnities and beef output used under FIAP(1977), in terms of reducing producer income variability.
(5) The total net government payments on both FIAP (1980) and the premium/subsidy scheme were arranged to be similar. If the government wished to achieve greater reductions in producer income variability, then the premium/subsidy scheme would be preferred to FIAP (1980) for it would provide a lower income variability with same amount of government and/or producer expenditure.

6.3 Further Research

(1) The cost data used in this study implies that beef producers in B.C. would have suffered deficit incomes over the twenty year period, 1959-1978. The type of cost data on which support levels of stabilization schemes should be based continues to be questioned. Alternatives include cash expenses, cash costs less capital costs, or cash costs less management input costs. As mentioned earlier, the cost data used in this study are determined by a hypothetical model negotiated by the B.C. Ministry of Agriculture and B.C. Federation of Agriculture. More precise and reliable calculations may improve the effectiveness of government income stabilization schemes. A study on the justification of various cost items in calculating return deficit would likely be helpful in improving the effectiveness of income stabilization schemes.

(2) It is quite likely that a more stable production environment would increase the amount of beef produced in
B.C., in addition to that induced by beef price changes. Although a "non-price effect" is built into the model, it hasn't come into effect because of lack of knowledge about its value. Empirical estimates of such a "non-price effect" would be useful in improving the usability of the model.

(3) Farmer production responses on slaughter animals have been included in the model. But results at the slaughter level have not been included in this study due to the lack of availability of cost data relevant to the slaughter level. As soon as slaughter level cost data can be obtained, the model can be easily extended to incorporate the slaughter level.
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### Table A-1.1

**Market Prices of Calves Without Government Intervention**

**Dollars per Hundred Weight**

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**Source:** Agriculture Canada, Livestock and Meat Trade Report.
**MARKET PRICES OF YEARLINGS WITHOUT GOVERNMENT INTERVENTION**

**DOLLARS PER HUNDRED WEIGHT**

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**SOURCE:** AGRICULTURE CANADA, LIVESTOCK AND MEAT TRADE REPORT.
### Table A-2.1

**Total Input Costs on Calf Production in British Columbia**

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**Source:** "Beef Income Assurance Model: Basic Cost of Production, 1974-1978", B.C.M.A.
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**Dollars per Hundred Weight**

**Total Input Costs on Yearling Production in British Columbia**

***Table A-2.2***
**TABLE A-3.1**

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### **TABLE A-3.2**

Quantities of Yearlings Produced Without Government Intervention

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