A SIMULATION ANALYSIS OF ALTERNATIVE STABILIZATION SCHEMES FOR THE BRITISH COLUMBIA HOG INDUSTRY

by

ALEJANDRO PALACIOS

A THESIS SUBMITTED IN PARTIAL FULFILLMENT 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

July, 1978

Department of AGRICULTURAL ECONOMICS

The University of British Columbia
2075 Wesbrook Place
Vancouver, Canada
V6T 1W5

Date AUGUST 24, 1978

ABSTRACT

Given the British Columbia Government goal of income stability for hog producers, the major objective of this study was to estimate the budgetary cost to the provincial government and effectiveness of the Farm Income Assurance Program (FIAP) and alternative schemes in achieving this goal.

To accomplish this objective, it was necessary to build a mathematical model incorporating the main features of the British Columbia hog industry and capable of simulating the operation and consequences of a variety of stabilization schemes.

Modelling of the British Columbia hog industry posed a number of difficulties. Overcoming these difficulties required a combination of economic theory and empirical knowledge. The basic assumption underlying the hog model was that British Columbia hog production represents a minor component of the Canadian and North American market. This assumption implies that British Columbia hog producers face a perfectly elastic demand function. Thus, hog prices could be treated as exogenous, implying that any increase in production, due to a shift in the supply function to the right, would be absorbed by the market with no effect on hog prices. Later a set of production assumptions and different alternative schemes designed to stabilize producer income were incorporated into the model.

Given that the objective of this study was not to determine an optimal stabilization program, because of the lack

of knowledge of the objective function of policy makers, but rather to evaluate costs and effects of alternative stabilization schemes, simulation was chosen as the research method.

When the mathematical model was completed it was translated into the computer model and the first step was to validate it. Historical validation was possible because the FIAP has been in operation since January 1974.

Although the model was built to be as flexible and general as possible, and was able to handle several different alternative stabilization schemes, this study reports results for only three of them: (1) Farm Income Assurance Program; (2) Modified Farm Income Assurance Program; and (3) Premium-Subsidy Scheme.

The analysis of the results began with a single run for each scheme, in order to determine its effects. Later, a detailed comparative analysis that involved changing one parameter value at a time was undertaken to assess the contribution of each parameter to the policy objective of income stability. Finally, a series of simulation runs was performed and performance functions were estimated to allow more general conclusions to be drawn.

To achieve income stability a premium/subsidy scheme was shown to be preferable to FIAP, because it collects farmer premiums in a stabilizing way. To the extent that reduced government cost is a goal, FIAP can be modified in a number of ways, including a sliding farmer premium.

TABLE OF CONTENTS

Page

Page

Page

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to thank my advisor, Professor George Kennedy and the members of my Thesis Committee, Professor Richard Barichello and Professor Richard M. Beames, for their numerous suggestions which led to substantial improvements in this thesis.

Chapter 1

INTRODUCTION

In this chapter the main characteristics of the British Columbia hog industry are presented to put in perspective the problem at hand. Later the problem statement and objectives of the study are discussed, and a thesis guide is provided.

1.1 The Hog Industry in British Columbia

British Columbia's hog production plays a relatively minor role as a component of total Canadian hog production. In 1975, swine production[1] accounted for only 68,692 head or 0.9 percent of the total number slaughtered in Canada (Agric. Canada, Meat Trade Report) and 1.3 percent ($11.6 million) of the total farm cash receipts from hog operations (Stat. Canada, Farm Cash Receipts).

Hog production also represents a small proportion of British Columbia's total agricultural production. In 1975, farm cash receipts from hog operations contributed only 2.9 percent of total farm cash receipts from farming operations and 4.3 percent of the total value of livestock and livestock products (Stat. Canada, Farm Cash Receipts).

1.1.1 Spatial Distribution of Production

British Columbia's hog production is highly concentrated

[1] "Production" as used here refers to total number of head slaughtered in federal or provincially inspected plants in British Columbia and Alberta; it does not include slaughter in non-inspected plants, farm kill or exports.

in the Fraser Valley and three other areas: the Okanagan, the Peace River and Vancouver Island. Out of 68,692 hogs marketed in 1975, the Fraser Valley produced 47,334 (70%), the Okanagan 6,157 (9%), the Peace River 5,919 (9%) and Vancouver Island 5,707 (8%). Throughout the last three years, the Fraser Valley and Vancouver Island have shown a steady climb in number of hogs marketed, the Okanagan a decreasing trend and the Peace River region small fluctuations (Agric. Canada, Annual Reports).

1.1.2 Hog Production and Enterprise Size

In 1971, according to the Agricultural Census (Stat. Canada, (1971)) there were 2,729 farmers in British Columbia (14.8 percent of the total) holding pig stocks (of all ages) ranging from 1 to over 500. Twenty-three farmers representing 0.8 percent of the total number of hog producers and 15.2 percent of all commercial hog producers (i.e., those who sell at least 50 hogs annually), produce 35.8 percent of the total number of hogs marketed or 50.5 percent of commercial hog production.

1.1.3 British Columbia's Hog Production and the Provincial Market

British Columbia's total pork consumption for 1974 was estimated to be 143.3 million pounds or approximately 890,000 head (B.C. Ministry of Agric., (Dec. 1976)) while the provincial production was only 13.09 million pounds or 82,000 head (Agric. Canada, Meat Trade Report). Therefore, a deficit of approximately 130 million pounds occurred. If the British

Columbia average per capita consumption of pork of 59.8 lbs. (1974) is used as a reference, then over the period 1971-76, British Columbia's hog production only contributed an average of 5.2 pounds per capita, or 8.7 percent of the British Columbia average level of pork consumption.

1.2 Instability in British Columbia's Hog Industry

Hog production in British Columbia, not unlike hog production elsewhere, has been unstable. Production and price cycles in both Canada and the United States are well recognized and have been analysed in a number of studies (West *et al* (1974); Petrie; Boswell and Kulshreshta). A review of the theories which have been advanced to explain the hog cycles is given in West *et al* (1974), Chapter II.

Throughout the last thirteen years (1964-1976), commercial hog slaughter in British Columbia has fluctuated widely; for example production went from 32,566 head in 1965 to 76,799 in 1971 and back down to 46,304 in 1973 (Agric. Canada, Meat Trade Report). Major variations in market price of hogs have also occurred. Slaughter hog prices (Calgary, index 100 hogs) rose from $39.18 per cwt in January 1973 to $82.35 per cwt in September 1975 and then fell to $44.89 per cwt in November 1976 (Agric. Canada, Meat Trade Report).

Instability in production is not only inherent in the hog industry but typical of agriculture. Because of the relatively inelastic supply and demand functions that characterize agricultural products, they generally show greater price fluctuations than do non-agricultural goods (Tweeten et al). On the supply side, biological factors including weather, domestic government policies, and changing farmers' expectations are likely to be important sources of instability. On the demand side, fluctuations in international demand can be an important source of instability.

Other factors that have contributed to instability in the hog industry include variations in input prices. Prices of inputs have shown a tendency to increase, and in some cases wide fluctuations (although mainly upwards) have also occurred. For example, the Wage Index for farm labor (hourly rated) for Western Canada increased from 177.0 in January 1973 to 334.3 in December 1976 (Stat. Canada, Farm Input Price Index); ground barley prices rose from $3.77 per cwt in November 1972 to $9.04 per cwt in November 1974, and then fell to $7.53 in November 1976 (Stat. Canada, Price and Price Indexes and Industry Price Indexes). Fluctuations in agricultural product and input prices and fluctuations in quantities produced have created a problem of income instability for British Columbian hog producers.

1.3 Problem Statement

The study is concerned with the problem of income instability which has traditionally faced British Columbia hog producers. Income instability can be expected to have detrimental effects on farm family welfare. In addition to welfare effects, fluctuations in gross income can lead to difficulties in production planning and inefficiencies due to over or under investment that generate instability in hog production. Instability in hog production at the farm level affects not only producer incomes but ultimately consumers, transmitted through the processing and food industries. In summary, stability in hog production at the farm level is a relevant matter not only for hog producers but also for the food and packing industries and consumers.

1.4 Provincial Government Goal for the Hog Industry

The instability that has characterized the British Columbia hog industry has given rise to a government goal of reducing it. Consequently, the provincial government introduced the British Columbia Swine Producers Income Assurance Program in an attempt to provide income stability to producers (Hudson, B.C. Ministry of Agriculture (1964)).

For the purpose of this study, the goal of income stability refers to avoiding excessive fluctuations in gross income, where gross income is calculated through multiplying gross margin[2] by total hog production.

1.5 Objectives of the Study

Given the problem of income instability described above, the provincial government is interested in ways of alleviating it. However, since federal programs also exist

---

[2]Gross margin in this study refers to the difference between total receipts and total variable costs. A detailed description of the items included in the variable cost figures can be found in Appendix A.

to meet the same objective, the provincial programs can not be viewed in isolation and the study needs to account for them. The objectives of this study are to: (a) develop an internally consistent model of the British Columbia hog industry which can be used to determine the cost and effectiveness of alternative stabilization schemes; and (b) illustrate how this model can be used. The model should:

a) Incorporate the more important features of the British Columbian hog industry with sufficient flexibility to allow for
   (1) the implementation of different decision rules ("policy parameters") by the government, and
   (2) the inclusion of parameters to indicate the magnitude and direction of the responsiveness of farmers to government stabilization efforts.
b) Be able to determine the consequences of a variety of parameter combinations, and
c) Include measures to summarize the outcome of each set of parameter combinations.

In summary, the objective of this study is to build and use a mathematical model to answer questions related to the British Columbia Swine Producers Income Assurance Program and alternative schemes. Questions include:

1. What level and variance of producers' income can be

expected to result?

2. What is the budgetary cost to the government and to hog producers?

3. What are the effects on quantities of hogs produced?

1.6 Motivation for the Study

Although hog production is a relatively minor component of the British Columbia agricultural sector, given a large deficit of domestic production compared to provincial consumption, the British Columbia government views hog production as having much potential for growth (B.C. Ministry of Agric. (1977), (1976) and (Dec., 1976)).[3] Furthermore, the British Columbia government has spent approximately $800,000 in indemnities to hog producers on the first three years (1974-1976) of the British Columbia Swine Producers Income Assurance Program and is interested in evaluating its effectiveness.

Finally, given a government goal of income stability for British Columbia hog producers, the government requires information regarding the consequences of alternative methods of achieving it. Therefore, the prime motivation for this study is to provide this information so that more informed policy decisions can be made. Some possible alternative schemes which could be used in an attempt to achieve income

---

[3] From an economic point of view, this does not necessarily follow because the possibilities of expansion of the hog industry in B.C. will depend upon its economic comparative advantages within the B.C. agricultural sector.

stability are briefly described in Chapter 3.

1.7 Thesis Guide

This thesis has been divided into six chapters. Chapter II presents the methodological approach used in the study and discusses the reasons for choosing simulation. Chapter III describes both current and alternative schemes aimed at reducing income instability facing hog producers. Chapter IV outlines the mathematical model that represents the hog industry (at the farm level) in British Columbia. It also discusses the data used, makes explicit the production assumptions on which the analysis is based, and describes the model validation procedure. Chapter V presents the results of the different stabilization schemes and Chapter VI presents the conclusions which can be drawn from the study.

Chapter 2

METHODOLOGY

Given the objectives of this study stated above, the question arises as to what methodology should be used. To provide information to help answer this question, this chapter begins by giving a brief review of some previous studies which are relevant. Later it introduces the methodological approach used and presents the reasons for choosing the particular approach. Finally, it describes the necessary steps involved in its use.

2.1 Some Previous Studies

Zwart, *et al* (1974) proposed a methodology for evaluating the effects of changes in government or marketing agency policies based on a spatial and temporal model of the North American pork sector. Using quadratic programming, the model maximized a total indirect welfare function or "the sum of areas under the excess supply and demand schedules" ...which... "also includes the net summed area under the excess stocks supply and demand schedule" (Zwart *et al* (1974), page 20). This implies that the model assumes that the North American pork market behaves in a competitive manner between regions. The model was validated by running it recursively over a forty-one quarter period (1963-1973) and the results showed that it was able to simulate events in the pork sector very closely over this period.

The methodology employed in this model appears useful in evaluating the dynamic impacts of a change in government policies if the major concern is to incorporate intertemporal and interregional considerations, including the supply and demand for stocks. However, it must be clearly recognized that this approach relies on two basic assumptions: that the pork market behaves in a competitive manner between regions and that the goal of policy makers is to maximize the so-called "total indirect welfare function."

Hedley and Cushon proposed a different (and relatively simple) model for evaluating stabilization alternatives for the hog industry in Canada. Their model is a non-optimizing, dynamic, deterministic, econometric one. It includes two supply equations (one for Eastern Canada and one for Western Canada) that follows the Nerlove specification.[4] The model is completed by three other equations and one identity. The three equations include one demand equation for pork consumption in Canada and two stock demand functions (one for Eastern Canada and one for Western Canada). The identity specified that current period consumption demand in Canada equalled current period supplies plus opening stocks minus closing stocks minus exports plus imports. The specified model was used to simulate different stabilization plans to evaluate their results.

---

[4]For a detailed description see Marc Nerlove, The Dynamics of Supply: Estimation of farmers' response to price. The John Hopkins Press, Baltimore, 1958.

Tyner and Tweeten postulated a similar model, although at an aggregate level, to evaluate the effect of government programs on agricultural efficiency and resource use in the United States. Their model can also be characterized as being deterministic, non-optimizing and dynamic.

A slightly different methodological approach has been used by Candler and Kennedy. They developed a model for the United States hog-pork system as a series of equations that can represent a long period of time and also incorporate carry-over effects and time lags. Their model is similar to the ones in Hedley and Cushon, and Tyner and Tweeten, except that the specified equations are assumed to be exact relationships and therefore are not estimated using econometric techniques. In summary, the model can be described by three basic properties: (1) deterministic, in the sense that the equations are assumed to be exact relationships; (2) dynamic, since it traces the behavior of the market over time; and (3) non-optimizing, because it does not attempt to maximize an objective function. The developed model, assumed to adequately represent the real system, was used to evaluate alternative methods of achieving a goal of price stability for hog-pork prices. Lacking knowledge of the objective function of policy makers, simulation was used because "it is a relatively convenient technique for studying non-optimizing problems" (Candler and

Kennedy, page 8). This type of approach was also used by Agarwala to evaluate different stabilization policies in the egg market in the United Kingdom during the period 1958-68.

An extensive literature review of the use of simulation in agricultural economics studies can be found in Anderson.

2.2 Research Technique Used in this Study

From the previous discussion it follows that the problem of evaluating different alternative stabilization schemes for the British Columbia hog industry can be analyzed by both mathematical programming and computer simulation. In general, use of mathematical optimization techniques implies a high degree of knowledge about policy makers' objective function and normally more sophisticated modelling (Candler and Kennedy; Orcutt; Tyner *et al*). Simulation, on the other hand, does not necessitate an "optimal solution"; also, it is better suited to handle time lags, nonlinearities and recursive effects (Candler and Kennedy; Tyner *et al*). This is not to say that mathematical programming cannot handle this kind of problem (Zwart *et al* (1974)), only that it would involve more cumbrous models. Therefore, given that the objective of this study is not to determine an optimal stabilization program (because of the lack of knowledge of the objective function of policy makers), but rather to evaluate costs and effects of alternative stabilization schemes implied by a certain set of assumptions, simulation seems appropriate. Simulation allows for conditional or "if...then" statements; <u>if</u> a set of conditions holds and <u>if</u> a certain stabilization program is in operation, <u>then</u> these are the results.

Simulation, according to Naylor ((1971), page 2), can be defined as: "A numerical technique for conducting experiments with certain types of mathematical models which describe the behavior of a complex system on a digital computer over extended periods of time."

In summary, simulation will be used mainly because it is a convenient technique for studying a non-optimizing problem.

The model that will be used to simulate different income stabilization schemes can be described as being of a symbolic, mathematical type. It has already been established that it will be non-optimizing. It will also be dynamic, in the sense of tracing the behavior of the system over-time. Within the group of non-optimizing, dynamic models, it is necessary to choose between a stochastic or deterministic one. Considering that agricultural production depends heavily on biological, meteorological and market forces, the models best suited to represent it are often of a stochastic nature. It has been suggested that "stochasticity in agricultural systems has too seldom been included by simulators" (Anderson, page 13). Despite this criticism, this study will take a deterministic approach, not because it simply ignores the "uncertainty principle of modelling" (Anderson), but because the emphasis is on assessing the consequences implied by alternative sets of values of decision variables, rather than explaining what has happened or forecasting what will happen (Agarwala). Given this objective, avoidance of the increased complexity which the inclusion of stochastic variables would necessitate is thought to outweigh the added realism which stochastic variables could provide (Naylor, 1971).

2.3 Methodology of Simulation

In this section a brief summary of the steps involved in the use of simulation as a tool of analysis are given. More detailed discussions can be found in Naylor (1971), Naylor *et al* (1968) and Anderson.

2.3.1 Formulation of the Problem

As in any scienfitic study, this step involves a clear formulation of the problem and the objectives pursued by the simulation technique. In the present case, simulation will be used to assess the effects on relevant policy variables of alternative stabilization schemes for British Columbia hog producers.

2.3.2 Formulation of the Mathematical Model

Once the objectives of simulation are stated, the system of interest is studied to detect its more important features and components. Next is the formulation of a mathematical model, which is an abstracted or simplified version of the real system incorporating those features considered to be significant for the questions at hand. A model has the advantage of allowing the researcher manipulations which would be impossible or too expensive to perform on the real system. In other words, it allows the researcher to infer the effects of different policies without the necessity of putting them into effect (Shubik; Candler and Kennedy; Naylor (1971)).

An important consideration in the formulation of the mathematical model is the choice of variables to be included in it. In general, the endogenous variables, once selected, are not crucial since they are determined as a final result of the experiment. Exogenous variables and "policy parameters" (Naylor, (1971)) must be more carefully selected because there exists a trade-off between realism and computation procedures. A model can usually be made more realistic by incorporating more exogenous variables and more useful by incorporating more policy parameters. In both cases, however, the inclusion of additional variables will likely make the model more difficult to compute and manipulate. In general, when formulating a mathematical model the interest is to construct one that produces reasonable descriptions or predictions about the behavior of the real system while minimizing computational and programming time (Naylor, (1971)).

According to Naylor ((1971), page 41), a mathematical model of an economic system should include: components, variables, and functional relationships.

1) Components: are the decision making units, able to influence the system. In this study, the components are hog producers and governments.

2) Variables: as the name itself indicates, are elements in the model that can assume different values at different points of observation. They may be classified as endogenous, exogenous, status variables, and policy (or decision) variables.

   Exogenous variables or independent variables are those whose values are determined outside the system being modelled, and are entered in the model as parameters. Their values are held constant in each simulation run, but may be changed between runs to assess their effects on the system. The price elasticity of demand, for example, is assumed to have a value predetermined by the environment in which the modelled system exists. Policy variables, such as a floor price for hogs, are those that can be manipulated.

   Endogenous variables or input variables are those whose values are determined within the model as a result of the interaction of exogenous (including policy) variables (Naylor, (1971)). An example of an endogenous variable in this study's model is total hog production.

Status variables are a subset of the output variables and describe the properties of some component of the model at some specific point of time.

3) Functional relationships: include identities and behavioral equations that relate the components and variables of the system. In other words, functional relationships describe the behavior of the complete system.

2.3.3 Formulation of the Computer Program

After completing the mathematical model, the next step is to translate it into computer language. Although there exists special purpose simulation languages, this study will use FORTRAN IV, a general purpose one. FORTRAN IV, being a general purpose language, can be easily adapted to the type of mathematical model developed for this study.[5]

2.3.4 Checking the Model

This stage involves two different activities: verification and validation (Anderson).

2.3.4.1 Verification: refers to checking the correctness of the model, to determine if it is internally consistent. For example, are all hogs produced eventually sold?; does producer gross income equal gross revenue less total variable costs?; etc. At this stage, nothing has been

[5] Special-purpose languages are, in general, more inflexible and specifically oriented to work with some type of models (e.g. DYNAMO and FORDYN are suited to work with models characterized by numerous first-order difference equations and complex feedbacks and SINSCRIPT for queuing and inventory systems (Anderson)).

said about the realism of the assumptions built in to the model or its ability to reproduce reality. This is a matter of validation.

2.3.4.2 Validation: is the stage of the simulation process destined to find out how closely the model represents reality (Anderson). Elsewhere (Anderson; Naylor (1971)) it has been pointed out that the validation process is a rather difficult one because it involves several theoretical, practical, statistical and even philosophical problems (Naylor, (1971)).

In general, however, two types of approaches can be described as being useful for validation of a simulation model: first, to compare the results of the model with historical data (i.e. historical validation) and/or second, to compare the predictions of the model with future events (i.e. events that have evolved since the study was initiated).

2.3.4 Model Experimentation

Once the model has been validated, experimentation with the model is needed to explore the effects of different sets of values of the exogenous or policy variables on the endogenous or output variables. Where simulation experiments involve a large number of variables, to avoid unnecessary calculations and to economize in computer time, experimental designs are advantageous (Anderson). Experimental design implies the selection of a particular combination of parameters and the range (or levels) over which they will be allowed to fluctuate, thus helping the researcher to conduct model experimentation in a systematic way.

2.3.6 Interpretation of the Simulation Output

The results of the simulation experiment can be analyzed by one of the two following methods: analysis of variance or regression analysis. In general, analysis of variance is used when qualitative factors are present, while regression analysis is directed towards quantitative evaluation (Naylor, (1968)). Given the objective of this study, i.e. to quantitatively evaluate the outcome of different hog producer income stabilization policies, regression analysis will be used. Performance functions will be estimated as a way of obtaining more general functional relationships between the variables incorporated in the study and the resulting output.[6]

---

[6] Performance functions have been described by Candler and Cartwright. Additional examples of their application can be found in Chudleigh and in Kennedy (1973).

Chapter 3

APPROACHES TO HOG PRODUCER INCOME STABILIZATION

This section outlines some alternative schemes for stabilizing the incomes of British Columbia hog producers. It includes a description of current programs - the British Columbia Swine Producers Income Assurance Program and the Agricultural Stabilization Act.

Several mechanisms exist through which income stabilization can be achieved (e.g. price controls, deficiency payments, quotas, etc.). Some of these instruments fall under the jurisdiction of the government (e.g. price controls, financial contributions to a specific program, price supports and product purchase programs, etc.), while others can be administered by the government and/or by private institutions (e.g. production quotas or storage policies managed by farmers through a marketing board). There are also measures that farmers can use to cope with income stabilization without relying on the government (e.g. forward contracting and futures trading). Although many different policy instruments exist, this study will consider only government schemes involving producer subsidies.

3.1 Government subsidies related to product price or gross margin

This section introduces current and alternative approaches for hog producer income stabilization, involving government subsidies related to product price or gross margin.

3.1.1 Deficiency Payment Schemes

Within this group of stabilization schemes the most common approach has been what is usually referred to as a "price deficiency payment" program. This implies subsidies to farmers in times of low product prices. The Federal Agricultural Stabilization Act, the British Columbia Farm Income Assurance Program and the Manitoba Beef Producers Income Stabilization Plan are examples of this kind of program (Eyvindson).

A brief description[7] of the main operational characteristics of the Agricultural Stabilization Act (hereafter referred to as ASA) and of the British Columbia Swine Producers Income Assurance Program (hereafter referred to as FIAP) are given below to provide a basis for comparing them with various alternative schemes.

3.1.1.1 Agricultural Stabilization Act

The 1958 Agricultural Stabilization Act of the federal government guaranteed hog producers a floor price which was 80% of the national moving average hog market price over the previous ten years. Under the amended Act (1975), the floor price was raised to 90% of the national moving average hog market price over the previous 5 years, plus the difference

---

[7]The description refers only to those aspects relevant to the hog industry.

between current national average cash costs of production and the national moving average cash costs in the preceding five years.

The floor price is calculated each year and published in April at the end of the hog production year. This means that hog producers do not know whether an indemnity will be paid until after the production process is completed (Martin).

3.1.1.2 British Columbia Swine Producers Income Assurance Program (FIAP)

The British Columbia Swine Producers Income Assurance Program began in January 1974 for a period of five years, ending December 31, 1978. The program was set up to be "actuarially sound", with farmers and the Provincial government paying premiums into the British Columbia Swine Producers Assurance Fund. When the accumulated money in the Fund is not enough to cover subsidy payments the Provincial government makes an "advance" into the Fund which is expected to be recouped in periods of small (or no) subsidy payments. Involvement is on a voluntary basis. The main characteristics of FIAP can be summarized as follows (B.C. Ministry of Agriculture, (1974)):

- Eligibility. To be eligible the producer must be a member of the British Columbia Swine Producers Association and market a minimum of 50 eligible hogs annually. The maximum number of eligible hogs on which a producer can collect an indemnity must not exceed 1,800, with some special rules for partnerships, corporations and cooperatives.

Eligible market hogs are those graded 88 to 112 which have been born, raised and marketed in British Columbia. For the year 1977, previously existing expansion constraints on eligible market hogs were removed and the minimum size eligibility requirement was raised to 300 market hogs per year for new producers.

- Indemnities. In 1975, the Central Bargaining Committee of the British Columbia Ministry of Agriculture and the British Columbia Federation of Agriculture agreed to adopt a standard indemnity formula for all Farm Income Assurance Programs. The gross indemnity is equal to 75% of the basic cost of production plus a marketing charge minus the market return. The "basic cost of production" includes cash costs, depreciation, interest on investment, operator and family labor, and a management fee. The cost is jointly determined by the British Columbia Department of Agriculture and the British Columbia Federation of Agriculture, based on an assumed model of a hog enterprise marketing 1,800 hogs per year.

- Payments. Market returns used to calculate if indemnities are applicable are equal to the Calgary price for hogs index 100 plus $3.00 per cwt dressed carcass. Starting April 1st, 1977, market returns are calculated based on the Calgary price of hogs index 103 instead of 100.

Basic costs of production and market returns are calculated monthly and indemnities paid on a quarterly basis (weighted average of the three months).

- Program Fund. Under the FIAP farmers pay a fixed monthly premium, irrespective of whether or not a subsidy is received. The amount of the total premium (i.e., farmers plus government payments) was set at \$3.00 per cwt in 1974, with farmers paying one third (\$1.00/cwt) and the provincial government two thirds (\$2.00/cwt) into the British Columbia Swine Producers Assurance Fund. In 1975 the total premium was raised to \$4.50 per cwt and has remained stable thereafter. Total premiums are received annually but at no time can a producer's share exceed \$3.00 per cwt, dressed carcass.

3.1.2 Premium-Subsidy Scheme

This type of scheme is a different approach to producer income stability, in the sense that both price "peaks" and "troughs" are eliminated. In other words, the program includes a floor and a ceiling price, paying subsidies when the equilibrium price[8] falls below the floor, and collecting premiums when price exceeds the ceiling. The Maritime Hog Stabilization Program operates along these lines; producers contribute to a stabilization fund whenever the market price of hogs exceeds the support price by \$5.00 (Eyvindson). Hudson has suggested a similar type of scheme in his proposal of an "Agricultural Stabilization Fund".

[8] "Equilibrium" refers to the price and quantity prevailing in the market when no stabilization scheme is in operation.

Given a goal of producer income stability, it seems logical to require farmers to pay a premium in times of high hog prices (or wide margin) but not to require them to pay a premium when prices are low. The scheme could be made self-financing by allowing floor and ceiling prices to slide in response to changes in the stabilization fund. As the government advance became large, the floor and ceiling could be lowered to reduce subsidies paid to farmers and increase premiums paid by farmers. Similarly, if successive farmer premiums built up the fund, the floor and ceiling could be raised. Figure 3.1 presents a schematic version of the operation of the premium-subsidy scheme.

3.2 Subsidy on Inputs

Under this type of approach, subsidies are tied to input prices and are intended to affect producers' investment decisions.

3.2.1 Subsidies Tied to Feed Prices

Studies on hog supply functions in Canada (West et al, (1974) and (1973)) and in the United States (Meilke) show that farmers react differently to a rise in hog prices than to a decrease in feed prices. Therefore, it seems reasonable to consider a scheme that includes a subsidy to feed costs.

3.2.2 Gilt Retention Subsidy Scheme

This scheme is similar to Alberta Agriculture's Sheep Retention Program where producers received a subsidy for each ewe lamb retained for breeding purposes. Given that short

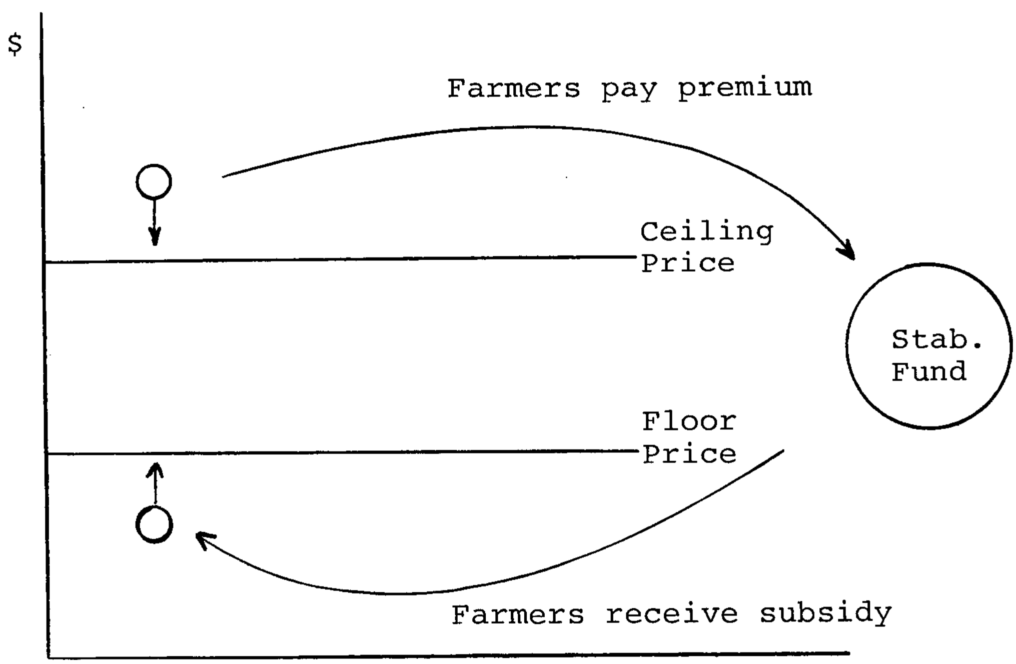

Figure 3.1 Schematic of Premium/Subsidy Scheme

term production responses are very limited for hogs, the purpose of this scheme is to affect breeding decisions through a subsidy for each extra gilt retained. In periods of low product prices or high input prices, the gilt retention subsidy might be effective in preventing large scale breeding stock liquidation. This scheme may be used in lieu of or in addition to some of the above schemes.

Chapter 4

THE MATHEMATICAL MODEL

This chapter presents the mathematical model intended to represent the main characteristics of the British Columbia hog industry. It discusses the basic data used and makes explicit production assumptions on which the analysis is based. Later it describes the characteristics of the model and the explicit form of the functions employed. The last section discusses the model validation procedure.

4.1 Data Used

The basic data used in this study is a monthly series of British Columbia hog production for the period January 1964 to December 1976, reported by Canada Livestock and Meat Trade Report (Agric. Canada). From this series and through multiplying by the yearly average carcass weight, the equilibrium quantity of hog production (dressed carcasses), at the farm level, is obtained. The hog price series (average price of slaughter hogs Index 100 received by farmers, Calgary), is also taken from the publication mentioned above. Input price series is taken from Statistics Canada Publications, Price and Price Indexes, Farm Input Price Index and Industry Price Indexes.

4.2 Hog Production Assumptions for British Columbia

Below is a list of production assumptions considered to be representative of hog production in British Columbia.[9]

(1) Number of sow cullings per farrowing:

first farrowing	10% of sows
second farrowing	20% of sows
third farrowing	25% of sows
fourth farrowing	20% of sows
fifth farrowing	15% of sows
sixth farrowing	5% of sows
seventh farrowing	5% of sows

(2) The farrowing intensity decision is price inelastic; i.e., it is unaffected by changes in product or input prices. This implies the proportions of producers on different farrowing systems are not affected by government policy and farmer response to input or product price changes with respect to the breeding herd is only in terms of gilts retained.

(3) A sow which is to be retained is rebred two months after farrowing.[10]

(4) A sow which is to be sold, is sold two months after farrowing.

(5) There is a four month period from the time of conception until farrowing.

(6) There is a five month period from farrowing

[9] These estimates were arrived at in consultation with British Columbia Ministry of Agriculture hog specialists, Abbotsford, British Columbia.

[10] More precisely, 6 to 7 weeks after farrowing. However, since the model is monthly, the period was rounded to two months.

until offspring have reached minimum slaughter weight and a six month period from farrowing to average slaughter weight.[11]

(7) In the absence of any scheme, market hogs are sold on reaching average slaughter weight.

(8) The decision to retain gilts for breeding is made at the time gilts reach average slaughter weight.

(9) Gilts which are retained for breeding are bred two months after reaching average slaughter weight.

(10) Market hogs can be kept a maximum of two months after reaching minimum slaughter weight (or one month after reaching average slaughter weight).

The above assumptions imply the following schedule for a gilt which is retained for breeding purposes.

Month	
t-1	gilt reaches minimum slaughter weight.
t	gilt reaches average slaughter weight and the decision is made to retain it for breeding purposes.
t+2	breed gilt.
t+6	first farrowing.
t+8	breed sow or sell sow.

---

[11] For the purpose of this study, it is assumed that average slaughter weight is the weight at which hogs are normally marketed for slaughter. It is further assumed that a hog needs 6 months to reach that weight (200 lbs live or 160 lb dressed carcass). Minimum slaughter weight is the minimum weight at which a hog can be sold for slaughter (150 lb dressed carcass). Maximum slaughter weight is the maximum weight at which a hog can be slaughtered, due to inefficiencies of continuing feeding (170 lb dressed carcass).

t+11	hogs reach minimum slaughter weight.
t+12	hogs reach average slaughter weight.

<u>If sow was bred in t+8, then</u>:

t+12	second farrowing.
t+14	breed sow or sell sow.
t+17	hogs reach minimum slaughter weight.
t+18	hogs reach average slaughter weight.

<u>If sow was bred at t+14, then</u>:

t+18	third farrowing
t+20	breed sow or sell sow.
t+23	hogs (third farrowing) reach minimum slaughter weight.
t+24	hogs reach average slaughter weight.

<u>If sow was bred at t+20, then</u>:

t+24	fourth farrowing.
t+26	breed sow or sell sow.
t+29	hogs reach minimum slaughter weight.
t+30	hogs reach average slaughter weight.

4.3 The Model

The model developed in this study attempts to represent the production decisions of hog producers in British Columbia through a set of equations based on some production assumptions and parameter values taken from previous studies or arrived at in consultation with B.C. Ministry of Agriculture Hog specialists.[12] The model consists basically of three modules:

[12] A more detailed description of the procedure used to select the parameter values is given in section 5.1.

a) one that provides for responses by farmers to changes induced by stabilization programs.

b) one that describes the stabilization programs themselves, and

c) one that accounts for "summary measures", i.e., statistical parameters used to indicate the degree of stability and the level of those variables regarded as important to policy makers (Kennedy, (1973)).

Within these modules the first one depicting farmer response to stabilization programs is the most important since it portrays farmers' production decisions while the rest only incorporates arbitrarily selected stabilization schemes and "summary measures".

Next, Figure 4.1 gives a simplified version of the steps involved in simulating the response of the British Columbia hog industry given different federal and/or provincial income stabilization schemes, in order to allow a better understanding of the model functioning.

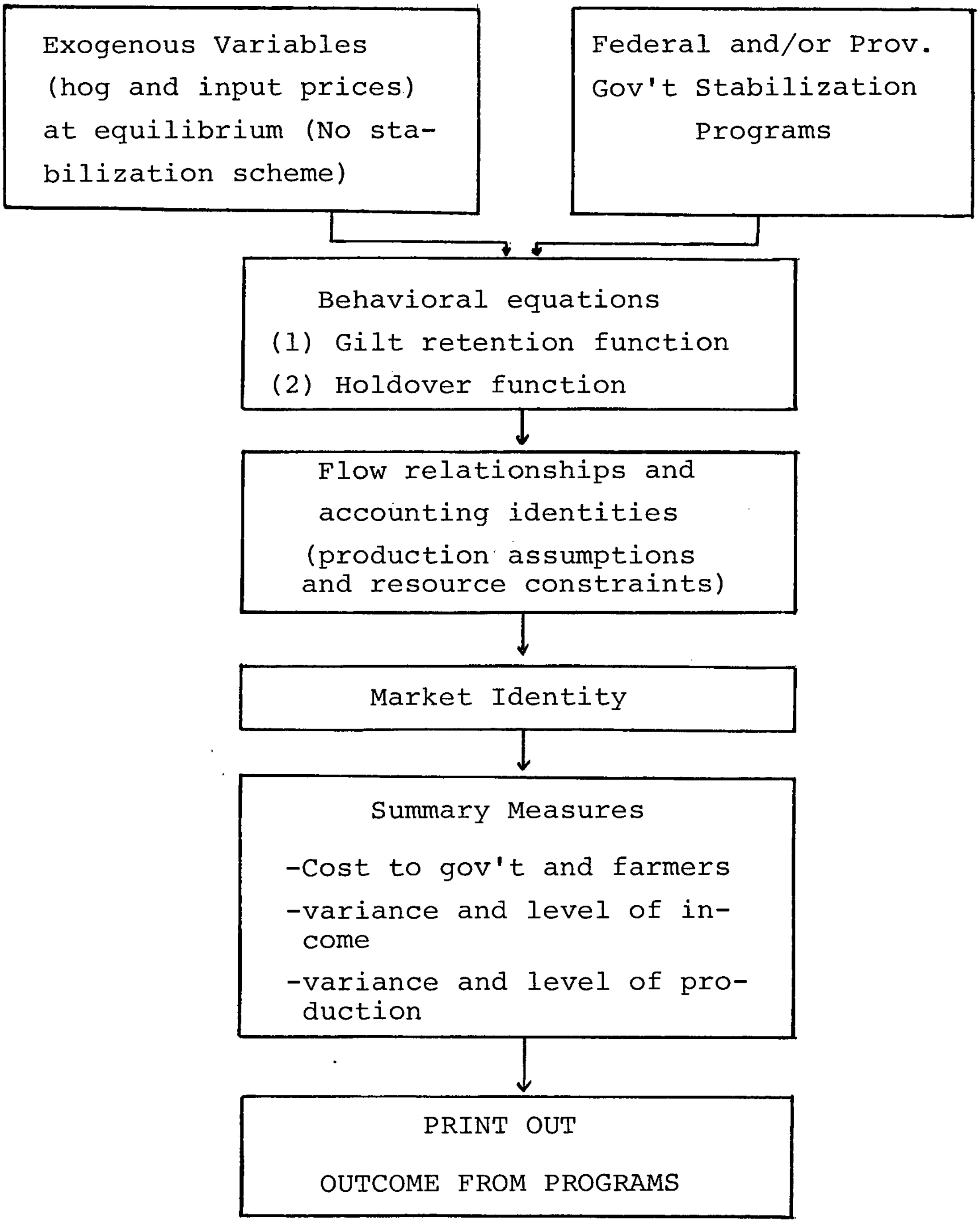

Figure 4.1 Flow Diagram of Simulation Model.

4.3.1 Response by Farmers to Stabilization Programs[13]

The equations in this module, that represent the core of the simulation model, can be grouped into three categories:

(a) Behavioral equations; i.e., those that simulate farmer response to changes in product and/or input prices induced by stabilization programs.

(b) Flow relationships and accounting identities; i.e., those that incorporate the hog production assumptions presented earlier and account for the change in production resulting from the long run farmer response, and

(c) Market identity; ensures that all hogs supplied are purchased in the market.

4.3.1.1 Behavioral Equations

The behavioral equations allow two farmer responses to changes induced by stabilization efforts: a "price effect" and a "non-price effect", with both having short and long run implications. The short run price effect on gilts retained is captured through the parameter α_1 (in equation one), that allows farmers to retain more or less gilts in a month of government interference. The short run price effect on holdovers is accounted for through the parameter α_{14}, in equation two.

A "non-price effect" was included because it is

[13]The portion of the model presented in this section has been adapted from Kennedy (1973).

reasonable to assume that price stabilization programs can induce a shift to the right of the supply curve (Barichello, Just, Kennedy (1973) and Martin and MacLaren). Any program that provides a more stable production environment may induce farmers to increase supplies over and above any increases brought on directly by subsidies. The model incorporates the "non-price effect" by allowing changes in the number of gilts retained, via parameter α_4 in equation one. The short run implication is a change in gilts supplied to market in the particular month. The long run implication is changed hog supply 14 months in the future.

In summary, equations one and two include what can be considered to be the critical behavioral parameters.

4.3.1.1.1 Change in Quantity of Gilts Retained for Breeding

$$\frac{\Delta QGR^t}{QGR^t} = \alpha_1 (PH_s^t - PH_e^t) + \alpha_2 (PI_e^t - PI_s^t) + \alpha_3 G_s^t + \alpha_4 , \qquad (1)$$

where:

ΔQGR^t is the additional quantity (thousands of cwt) of gilts retained for breeding purposes, in month t.

QGR^t is the equilibrium quantity (thousands of cwt) of gilts retained for breeding purposes, in month t.

PH_e^t is the equilibrium British Columbia market price (dollars/cwt) of slaughter hogs (Index 100), in month t.

PH_s^t is the simulated or effective price (dollars/cwt) of slaughter hogs (index 100) received by farmers in month t.

PI_e^t is the equilibrium price (dollars/cwt) of all inputs needed to produce one cwt of hog (dressed carcass).[14]

PI_s^t is the simulated or effective price (dollars/cwt) of all inputs paid by farmers in month t.

G_s^t is the amount of the gilt retention subsidy (dollars/cwt), in month t.

α_1 is the effect of a price change in slaughter hog prices in month t, $(PH_s^t - PH_e^t)$, on additional quantity of gilts retained for breeding purposes.

α_2 is the effect of a price change in total inputs, $(PI_s^t - PI_e^t)$, in month t, on additional quantity of gilts retained for breeding purposes.

α_3 is the effect of a gilt retention subsidy on additional quantity of gilts retained for breeding purposes, in month t.

α_4 is the non-price effect on additional quantity of gilts retained due to government stabilization efforts.

Equation (1) assumes that the additional quantity of gilts retained for breeding purposes is a linear function of the hog and input price changes induced by stabilization efforts. However, given that the monthly figures of the quantities of gilts retained in British Columbia were not obtainable, QGR^t was replaced by Q_e^{t+14} (equilibrium quantity of hogs slaughtered in month t+14), the best available proxy, and the behavioral parameters adjusted accordingly.

---

[14]This price is estimated using as a basis the FIAP cost figures, the B.C. feed prices and the Farm Input Price Index for Western Canada.

The fourteen month lag in production was recommended by the British Columbia Ministry of Agriculture hog specialists, and allows for:

a) the four month waiting period from the time the decision is made until the gilt is bred

b) the four month period from conception until farrowing, and

c) the six month period from farrowing until average slaughter weight is reached.

In the case of no stabilization activity, the equilibrium price equals the simulated price, implying $\Delta QGR^t = 0$, or no change in quantity of gilts retained.

Note that equation (1) includes the separated effects of both product and input prices. The possibility of including a ratio, such as the hog/barley price ratio, was rejected in view of the findings of some hog supply studies (Meilke; West et al, (1974)). West reports that hog supply in British Columbia is more responsive to a change in hog prices than a change in feed prices. Meilke, in his hog supply study for the United States points out that the hog-corn price ratio may provide a good explanation of hog supply when corn prices are constant but not when they are fluctuating. Consequently, since feed prices have fluctuated widely in the past few years, it is felt that consideration should be given to the independent effects of changing hog prices and feed prices on hog supply.

4.3.1.1.2 Holdover Function

It is assumed that slaughter hogs are kept a maximum of two months after reaching minimum slaughter weight because continued feeding leads to inefficiencies and quality deterioration. Assuming that in equilibrium farmers sell market hogs at average weight (i.e. at six months), then in response to price changes caused by stabilization activity, the may hold over market gilts and barrows one additional month (positive holdover) or sell them one month earlier (negative holdover). In other words, selling a five month hog represents a negative holdover. This implies that farmers have a two month flexibility period in which to sell slaughter gilts and barrows, and that a holdover decision may be made at minimum and/or average slaughter weight. The quantity of hogs that can be sold one month early or late is related to total hogs available for holding over (Q_h^t).

$$\frac{\Delta Q_h^t}{Q_h^t} = \alpha_{14}(PH_s^t - PH_e^t) + \alpha_{15}\ (PI_e^t - PI_s^t)\ , \qquad (2)$$

The value of Q_h^t will vary depending on whether Q_h^{t-1} is positive or negative.

$$Q_h^t = (Q_e^t - \Delta QGR^t + \alpha_{16}\ \Delta Q_h^{t-1} + \Delta QOF^t)\ , \qquad (3)^{15}$$

---

[15]Since ΔQ_h^{t-1} is smaller than zero, the expression ($\alpha_{16}\Delta Q_h^{t-1}$) is negative.

$$\text{if } \Delta Q_h^{t-1} < 0$$

$$Q_h^t = (Q_e^t - \Delta QGR^t + \Delta QOF^t) \text{ if } \Delta Q_h^{t-1} \geqq 0 , \qquad (4)$$ [16]

where:

ΔQ_h^t is the quantity (in thousands of cwt) of hogs in month t sold one month before (negative holdover) or one month after (positive holdover) reaching average slaughter weight.

ΔQOF^t is the additional quantity (in thousands of cwt) of slaughter hogs, in month t, produced by additional gilts and sows.

α_{14} is the effect of the price change of slaughter hogs in month t on quantity of holdovers in month t.

α_{15} is the effect of a price change in variable inputs in month t, on quantity of holdovers in month t.

α_{16} accounts for the weight increase, adjusted for death loss, from keeping a slaughter hog an extra month.

4.3.1.2 Flow Relationships and Accounting Identities

Two equations presented in this section calculate the changes in hog production, in terms of additional sows and offspring, resulting from the change in the number of gilts retained some months earlier. Two accounting identities sum up the total output change. Furthermore, since it seems reasonable to assume that farmers have, in the short run, resource constraints, upper limits on the number of gilts retained and the number of hogs held over are incorporated

---

[16] ΔQ_h^{t-1} is not included in equation (4) since the number of hogs heldover in the previous month cannot be held again, having reached maximum slaughter weight.

in the model.

4.3.1.2.1 <u>Output Change from Sale of Additional Sows</u>

According to the hog production assumptions for British Columbia stated before, the extra gilts which farmers retain in month t for breeding purposes (ΔQGR^{t}) will eventually come onto market as QGR^{t-8}, QGR^{t-14} and so on, according to the number of sow cullings per farrowing. (Assumptions 1, 2, 3, and 4).

$$\Delta QSO^{t} = \alpha_6 \Big[\alpha_7 \Delta QGR^{t-8} + \alpha_8 \Delta QGR^{t-14} + \alpha_9 \Delta QGR^{t-20} + \alpha_{10} \Delta QGR^{t-26} + \alpha_{11} \Delta QGR^{t-32} + \alpha_{12} \Delta QGR^{t-38} + (1 - \alpha_7 - \alpha_8 - \alpha_9 - \alpha_{10} - \alpha_{11} - \alpha_{12}) \Delta QGR^{t-44} \Big] - \Delta QGR^{t}, \tag{5}$$

where:

ΔQSO^{t} is the <u>additional</u> quantity (in thousand of cwt) of slaughter hogs (equivalents) in month t, resulting from the sale of additional sows.

ΔQGR^{t-8}, ΔQGR^{t-14}, ..., ΔQGR^{t-44}

are the additional quantities of gilts retained (in thousand of cwt) for breeding purposes in month t-8, t-14, t-20, t-26, t-32, t-38, and t-44 respectively (i.e., held for 1, 2, 3, 4, 5, 6 or 7 litters).

α_6 accounts for the weight increase, adjusted for death loss, from keeping an extra gilt for breeding purposes until it reaches the average sow weight at time of slaughter.

α_7, α_8, α_9, α_{10}, α_{11}, α_{12} and $(1-\alpha_7-\alpha_8-\alpha_9-\alpha_{10}-\alpha_{11}-\alpha_{12})$,

are the proportions of sow cullings per farrowing (first, second, third, fourth, fifth, sixth and seventh farrowing respectively).

4.3.1.2.2 Output Change from Offspring of Additional Gilts Retained

Additional gilts retained in month t produce offspring of average market weight in month t+12 and every six months thereafter.

$$\Delta QOF^t = \alpha_{13}\Big[\Delta QGR^{t-12} + (1-\alpha_7)\,\Delta QGR^{t-18} + (1-\alpha_7-\alpha_8)\Delta QGR^{t-24} + (1-\alpha_7-\alpha_8-\alpha_9)\,\Delta QGR^{t-30} + (1-\alpha_7-\alpha_8-\alpha_9-\alpha_{10})\Delta QGR^{t-36} + (1-\alpha_7-\alpha_8-\alpha_9-\alpha_{10}-\alpha_{11})\Delta QGR^{t-42} + (1-\alpha_7-\alpha_8-\alpha_9-\alpha_{10}-\alpha_{11}-\alpha_{12})\Delta QGR^{t-48}\Big], \quad (6)$$

where:

ΔQOF^t: is the additional quantity (in thousands of cwt) of slaughter hogs in month t, produced by additional gilts and sows.

α_{13}: is the average litter size, adjusted by death loss until offspring reaches average slaughter weight (in number of head).

4.3.1.2.3 Total Output Change Resulting from Change in Breeding Herd Size

$$\Delta QT^t = \Delta QSO^t + \Delta QOF^t , \quad (7)$$

where:

ΔQT^t is the total change (in thousands of cwt) in quantity of slaughter hogs, in month t, resulting from changes in gilt retentions in month t and months prior to t.

4.3.1.2.4 Constraint on Retention of Gilts

It is reasonable to assume that farmers have, in the short run, an upper limit to the change in the quantity of gilts retained for breeding, since there likely exists resource constraints.

$$\text{Max} \quad \Delta QGR^t \leqq \alpha_5 \, QGR^t \, , \tag{8}$$

where:

α_5 is the maximum proportion of gilts that could be added to breeding stock, in month t.

As in the case of equation (1), since QGR^t was not obtainable it was replaced by Q_e^{t+14}, the best available proxy and α_5 adjusted accordingly.

4.3.1.2.5 Holdover Constraint

The quantity of hogs that can be held over is constrained as resources become binding. This implies that, at some point, hogs must be sold even at very low prices. Therefore, it is appropriate that Q_h^t be given an upper limit.

$$\Delta Q_h^t \leqq \alpha_{17} \quad (Q_e^t - \Delta QGR^t + \alpha_{16} \; \Delta Q_h^{t-1} + \Delta QOF^t) \quad , \tag{9}$$

if $\Delta Q_h^{t-1} < 0$

$$\Delta Q_h^t \leqq \alpha_{17} \quad (Q_e^t - \Delta QGR^t + \Delta QOF^t) \quad , \tag{10}$$

if $\Delta Q_h^{t-1} \geqq 0$

where:

α_{17} is the maximum proportion of hogs that can be withheld from market in month t and sold the following month.

4.3.1.2.6 Market Supply of Slaughter Hogs

$$Q_s^t = Q_e^t + \Delta QT^t + \alpha_{16} \Delta Q_h^{t-1} - \Delta Q_h^t \quad , \tag{11}$$

where:

Q_s^t is the total (simulated) quantity (in thousands of cwt) of slaughter hogs supplied in month t.

4.3.1.3 Market Identity

Packer demand function is assumed to be perfectly elastic because market price in British Columbia is determined outside the province.[17] Given that British Columbia's hog production represents only a very small fraction of total Western Canadian production, any change in its volume will have a negligible effect on market prices.

---

[17] Tryfos, Reimer, Dawson and Zwart (1973) conclude that an important percentage of Canadian Livestock price variations can be explained by variations in United States prices.

Given the assumption of a perfectly elastic demand function used in this study, all hogs supplied are purchased in the market, or

$$Q_d^t = Q_s^t , \tag{12}$$

4.3.2 Schemes for Hog Producer Income Stabilization

In section 4.3.1 the explicit functions of the portion of the mathematical model representing farmer responses to stabilization programs were presented. Now, the schemes for hog producer income stabilization discussed in Chapter 3, are presented in mathematical form.

4.3.2.1 Premium-Subsidy Scheme

Under a premium-subsidy scheme[18] on price of slaughter hogs, assuming that both the federal and the provincial programs work on a monthly basis, and that the federal program comes into operation first, the effective price received by farmers (PH_s^t) is equal to the provincial equilibrium price (PH_e^t) less any producer premium, if the provincial equilibrium price exceeds both the federal floor price relevant at the provincial level (P_{ff}^t) and the provincial floor price (P_{fp}^t). If the equilibrium price is less than the federal floor but greater than the provincial floor, the federal government gives a deficiency payment to raise effective price to the federal floor. If the equilibrium price is less than the federal floor, which is less than the provincial floor, then the provincial government makes up the

[18] Some specific formulae to determine the ceiling and floor prices will be discussed in Chapter 5.

difference between the two floors with a deficiency payment. Both cases hold when the equilibrium hog price is less than the predetermined ceiling. If the equilibrium hog price is greater than the ceiling, the effective price to farmers is equal to the ceiling (PH_c^t), less any producer premium.[19]

$$PH_s^t = \max\,(PH_e^t,\ P_{ff}^t,\ P_{fp}^t) - PP^t$$
$$\text{if } PH_e^t < PH_c^t \text{ or } P_{ff}^t < PH_c^t \qquad (13)$$

$$PH_s^t = PH_c^t - PP^t$$
$$\text{if } PH_e^t \geqq PH_c^t \text{ or } P_{ff}^t \geqq PH_c^t \qquad (14)$$

where:

PH_s^t is the simulated or effective price of hogs received by farmers (dollars/cwt), in month t.

P_{ff}^t is the federal floor price of hogs (dollars/cwt), relevant at the provincial level, in month t.

P_{fp}^t is the provincial floor price of hogs (dollars/cwt), in month t.

When federal subsidies are paid with respect to the provincial hog equilibrium price (PH_e^t), the federal floor price relevant at the provincial level (P_{ff}^t) becomes equal to the federal national floor price (P_{ffn}^t). For the case where a deficiency payment is paid with respect to the average national equilibrium hog price (PH_{en}^t), the relevant

---

[19]The level of the floor price for hogs (P_{fp}^t) under any stabilization program, except for the current FIAP, is given by the parameter α_{22}, while the ceiling price is set by increasing the floor price a certain percentage given by the parameter α_{23}.

federal floor price at the provincial level (P^t_{ff}) becomes equal to the provincial equilibrium price plus the federal subsidy. The federal subsidy in this case is equal to the difference between the federal national floor price (P^t_{ffn}) and the national equilibrium hog price (PH^t_{en}).

If restrictions are imposed in a provincial program on what hogs are eligible, the average provincial floor price of hogs (P^t_{fpa}) becomes effective. It represents a weighted average of the equilibrium hog price (PH^t_e) and the effective price for eligible hogs on the program (P^t_{fp}), weighted by the proportion of hogs marketed under the program. In other words, P^t_{fpa} is the effective average price received for all farmers, regardless of whether they qualify or not for the program.[20]

As indicated earlier, both the ASA and the FIAP are product price support programs since they involve only a subsidy option; i.e. farmers are not taxed when equilibrium price exceeds some ceiling.

4.3.2.1.1 Agricultural Stabilization Act

Under the ASA, a subsidy is paid to farmers if the annual average hog price for Canada as a whole is less than the predetermined national floor price. If Canada's average hog price exceeds the floor, no subsidy occurs.

The simulated price for hogs under the ASA is equal

[20] The same reasoning will apply for the case of restrictions on what hogs qualify under a federal program.

to the British Columbia equilibrium price (PH_e^t), regardless of the level of the floor price determined by the program. As indicated earlier, ASA payments are annual and represent an "after the fact" type of subsidy; hence they do not have direct price effects on farmers' gilt retention or holdover decisions (Martin). The ASA may, however, affect supply through the shifter α_4.

Given this consideration, price received by farmers under the ASA is:

$$PH_s^t = PH_e^t \ , \tag{15}$$

4.3.2.1.2 British Columbia Swine Producers Income Assurance Program

Under the British Columbia Swine Producers Income Assurance Program, an indemnity is paid to farmers each time the calculated total cost of production, plus the marketing cost, is greater than the provincial equilibrium market price for hogs. The amount of the indemnity is equal to 75 percent of the return deficit, or the difference between costs and hog price. Therefore, the price received by farmers under the FIAP (P_{fp}^t) equals the British Columbia market price plus the calculated monthly indemnity. However, since the FIAP imposes some restrictions on what hogs are eligible for the program, the average farm level hog price (P_{fpa}^t) becomes effective. Also, the effective producer premium paid is the average producer premium (PP_a^t). PP^t represents farmers' share of the total fixed premium rate paid every month, regardless of whether subsidies are paid that month. Considering that the amount of the premium rate and the producer's share can be modified, PP^t can be regarded as a "policy parameter".[21]

$$PH_s^t = \max\ (PH_e^t,\ P_{fpa}^t) - PP_a^t \qquad (16)$$

$$RD^t = (PI_e^t + C_m^t) - P_{he}^t \qquad (17)^{22}$$

$$IND^t = \alpha_{18}\ RD^t \qquad \text{(since 1975 to date)} \qquad (18)$$

$$IND^t = \alpha_{18}\ PH_e^t \qquad \text{(for the year 1974)} \qquad (19)$$

$$P_{fp}^t = IND^t + PH_e^t \qquad (20)$$

$$P_{fpa}^t = \left[\alpha_{19}\ P_{fp}^t + (1-\alpha_{19})\ PH_e^t\right] \qquad (21)$$

where:

P_{fp}^t is the price received by farmers for hogs eligible for the FIAP, in month t (dollars/cwt).

P_{fpa}^t is the weighted average price for hogs received by farmers, in month t (dollars/cwt).

---

[21] The computer program includes two parameters to account for changes in the farmers' share in total premiums. α_{26} for the case of a fixed premium rate and α_{27} when the premiums are allowed to slide according to the amount of money accumulated in the provincial stabilization fund.

[22] The proportion of fixed costs included in the calculation of the return deficit is given by the parameter α_{24} (i.e., in the extremes, α_{24} equals one for the case of a net margin and zero for the case of a gross margin). Also, the hog price used to calculate the return deficit is allowed to vary according to the parameter α_{25}.

C_m^t is the marketing cost per cwt of hogs sold (dollars/cwt) in month t, as reported by the FIAP.

PP^t is the fixed producer premium (dollars/cwt), in month t.

PP_a^t is the average premium (dollars/cwt), in month t.

IND^t is the indemnity paid by the program (dollars/cwt), in month t.

RD^t is the return deficit, or difference between the total cost of production plus the marketing cost, and the equilibrium hog price (dollars/cwt), in month t.

α_{18} is the proportion of the monthly return deficit guaranteed by the FIAP (currently 75%).

α_{19} is the proportion of hogs eligible for a given program, over the total number of hogs marketed, in any month. In this specific case α_{19} refers to the proportion of hogs eligible for FIAP.

During 1974 (first year of operation of the FIAP), the floor price was calculated assuming $C_m^t = 0$ and α_{18} equal to some accumulated percentage indemnity calculated according to the return deficit.

4.3.2.2 Input Subsidy Schemes

As mentioned in Chapter 3, elsewhere (West et al (1974) and (1973), Meilke) it has been stated that farmers react differently to changes in margin depending on whether hog or feed prices change. Therefore, the model includes the case of an input subsidy scheme on feed price to account for its isolated effects. Under this program the effective feed price paid by farmers (PF_s^t) is equal to the calculated ceiling if the feed equilibrium price (PF_e^t) exceeds the ceiling.

$$PF_s^t = \text{minimum } (PF_e^t, PF_c^t), \tag{22}$$

where:

PF_c^t is the ceiling price of feed[23] needed to produce one cwt of hog dressed carcass (dollars/cwt), in month t.

PF_e^t is the equilibrium price of feed needed to produce one cwt of hog dressed carcass (dollars/cwt), in month t.

PF_s^t is the effective or (simulated) price of feed paid by farmers (dollars/cwt), in month t.

Regarding the gilt retention subsidy program, its effect has already been included in equation (1) through the expression ($\alpha_3 G_s^t$). α_3 represents the effect of the gilt retention subsidy on additional quantity of gilts retained for breeding purposes and G_s^t is the amount of the subsidy. The change in gilts retained is assumed to be proportional to the amount of the subsidy.

4.3.3 Summary Measures

Considering that the computer simulation experiments with the model can generate a profusion of information, it is necessary to summarize it by calculating what is called

---

[23]The level of the ceiling price of feed is set in the computer model by means of the parameter α_{21}.

"summary measures" (Kennedy (1974)). They are statistical parameters (i.e. mean, standard deviation, maximum and minimum values) used to indicate the degree of stability and the level of variables regarded as important to policy makers. Variables such as farmers' income, hog prices, quantity of hogs produced, gross revenue and budgetary cost to government and producers. By comparing the values of the summary measures under no stabilization scheme with the ones of current and proposed programs, it is possible to assess their different impacts on the relevant variables. Summary measures will be calculated based on monthly values over the entire period.

A list of the summary measures used in this study is given below.

I_{fem} (I_{fes}) is the mean (standard deviation) of annual equilibrium hog producer income (thousands of dollars).

I_{fsm} (I_{fss}) is the mean (standard deviation) of annual simulated hog producer income (thousands of dollars).

P_{hem} (P_{hes}) is the mean (standard deviation) of the average monthly value (between years) of equilibrium price (dollars/cwt) of slaughter hogs.

P_{hsm} (P_{hss}) is the mean (standard deviation) of the average monthly value (between years) of simulated price (dollars/cwt) of slaughter hogs.

Q_{hem} (Q_{hes}) is the mean (standard deviation) of the annual equilibrium quantity of slaugher hogs (thousands of cwt).

(Q_{hesm}) is the standard deviation of the monthly value, within years, of equilibrium quantity of slaughter hogs (thousands of cwt).

Q_{hsm} (H_{hss}) is the mean (standard deviation) of the annual simulated quantity of slaughter hogs (thousands of cwt).

(Q_{hssm}) is the standard deviation of the monthly value, within years, of simulated quantity of slaughter hogs (thousands of cwt).

R_{fem} (R_{fes}) is the mean (standard deviation) of the annual equilibrium hog producer gross revenue (thousands of dollars).

R_{fsm}(R_{fss}) is the mean (standard deviation) of the annual simulated hog producer gross revenue (thousands of dollars).

TNSPG is the total net amount of subsidies the provincial government paid to farmers (if negative) or received from them as contributions (if positive) (thousands of dollars).

TFGP is the total amount paid by the federal government as subsidies to farmers (thousands of dollars).

TNF is the total net amount received by farmers as subsidies from the federal and provincial governments (if positive) or the total net amount paid as contributions to the provincial government (if negative) (thousands of dollars).

4.3.3.1 Summary Measures Computation

The mean and standard deviation of the relevant variables are computed using standard statistical procedures. Government payments and farmer contributions are calculated making use of the set of equations detailed below.

4.3.3.1.1 Government Payments

Considering that all present and proposed schemes may include federal and/or provincial payments to farmers, the model needs to account for them.

4.3.3.1.1.1 Federal Government Payments

For the case of a federal price support program that operates on a monthly [(annual)] basis where subsidies are paid to farmers each time the federal floor price, relevant at the provincial level (P_{ff}^{t}), [(P_{ff}^{a})], is greater than the provincial equilibrium hog price (PH_{e}^{t}) [(PH_{e}^{a})], the monthly [(annual)] amount paid equals:

$$FG_{p}^{t} = 0 \qquad \text{if } PH_{e}^{t} \geq P_{ff}^{t}, \tag{23}$$

$$FG_{p}^{t} = Q_{s}^{t}\ (P_{ff}^{t} - PH_{e}^{t}) \qquad \text{if } PH_{e}^{t} < P_{ff}^{t} \tag{24}$$

$$FG_{p}^{a} = 0 \qquad \text{if } PH_{e}^{a} \geq P_{ff}^{a} \tag{25}$$

$$FG_p^a = Q_s^a(P_{ff}^a - PH_e^a) \qquad \text{if} \quad PH_e^a < P_{ff}^a \tag{26}$$

where:

$FG_p^t(FG_p^a)$ is the monthly (annual) federal government payment to farmers (thousands of dollars), in month t (year a).

$Q_s^t(Q_s^a)$ is the monthly (annual) total or simulated quantity of slaughter hogs supplied, in month t (year a). (thousands of cwt)

$P_{ff}^t(P_{ff}^a)$ is the monthly (annual) federal floor price for hogs, relevant at the provincial level, in month t (year a). (dollars/cwt)

$P_{ffn}^t(P_{ffn}^a)$ is the monthly (annual) federal floor price for hogs (dollars/cwt) at the national level, in month t (year a).

$PH_e^t(PH_e^a)$ is the monthly (annual) provincial equilibrium price of hogs, in month t (year a). (dollars/cwt)

$PH_{en}^t(PH_{en}^a)$ is the monthly (annual) national equilibrium price of hogs, in month t (year a). (dollars/cwt).

As stated before, if subsidies are paid with respect to the provincial equilibrium hog price, for the monthly [(annual)] case, the relevant federal floor price at the provincial level (P_{ff}^t) $\left[(P_{ff}^a)\right]$, becomes equal to the federal national floor price (P_{ffn}^t) $\left[(P_{ffn}^a)\right]$. On the other hand, if subsidies are paid with respect to the average national equilibrium hog price (PH_{en}^t) $\left[(PH_{en}^a)\right]$, the relevant federal floor price is equal to the provincial monthly (annual) average equilibrium price (PH_e^t) $\left[(PH_e^a)\right]$, plus the federal subsidy. The federal subsidy is equal to the difference between the monthly [(annual)] federal floor price (P^t_{ffn}) [P^a_{ffn}] and the monthly [(annual)] national equilibrium price (PH^t_{en}) [(PH^a_{en})].

For the specific case of the Agricultural Stabilization Act, the national federal floor price of hogs is calculated as follows:

$$P^a_{ffn} = \alpha_{20}\ PH^{a5}_e + (PI^a_v - PI^{a5}_v) \quad \text{(from 1975 to date)}, \tag{27}$$

$$P^a_{ffn} = \alpha_{20}\ PH^{a10}_e \quad \text{(from 1958 to 1974)}, \tag{28}$$

where:

PH^{a5}_e	is the five year national moving average hog price (dollars/cwt).
PH^{a10}_e	is the ten year national moving average hog price (dollars/cwt).
PI^{a5}_v	is the five year moving average cash cost needed to produce one cwt of hog dressed carcass (dollars/cwt).
α_{20}	is the proportion of the average national hog price supported under the ASA.

4.3.3.1.1.2 Provincial Government Payments

Given that this study includes product price tax-subsidy as well as input subsidy types of schemes, the model needs to consider any provincial government payment that may occur under any of them.

4.3.3.1.1.2.1 Deficiency Payment Scheme

As in the case above, in months where the British

Columbia market price (PH_e^t) falls below the provincial floor price (P_{fp}^t), and the latter is greater than the federal floor price of hogs, relevant at the provincial level (P_{ff}^t), the provincial government pays a subsidy to farmers.

$$PG_p^t = 0 \quad \text{if } (PH_e^t \geqq P_{fp}^t \text{ or } P_{ff}^t \geqq P_{fp}^t), \tag{29}$$

$$PG_p^t = Q_s^t \left(P_{fp}^t - \max\left[PH_e^t,\ P_{ff}^t\right]\right) \quad \text{if}$$

$$(PH_e^t < P_{fp}^t \text{ and } P_{ff}^t < P_{fp}^t), \tag{30}$$

where:

PG_p^t is the provincial government payment to farmers in month t (thousands of dollars).

4.3.3.1.1.2.2 Input Subsidy

Under an input subsidy program the provincial government pays a subsidy to farmers whenever the market price of feed (P_{fe}^t) is greater than the calculated ceiling (P_{fc}^t).

$$PG_i^t = 0 \quad \text{if } PF_e^t \leqq PF_c^t \tag{31}$$

$$PG_i^t = Q_s^t\ (PF_e^t - PF_c^t) \quad \text{if } PF_e^t > PF_c^t \tag{32}$$

where:

PG_i^t is the provincial government payment to farmers under an input subsidy scheme on feed prices (thousands of dollars).

4.3.3.1.1.2.3 Gilt Retention Subsidy

Under a gilt retention subsidy scheme, assuming that a subsidy is paid on all additional gilts retained, the monthly subsidy is equal to:

$$PG_g^t = 0 \qquad \text{if} \quad \Delta QGR^t \leqq 0 \tag{33}$$

$$PG_g^t = \Delta QGR^t \cdot G_s^t \qquad \text{if} \quad \Delta QGR^t > 0 \tag{34}$$

where:

PG_g^t is the provincial government payment to farmers under a gilt retention subsidy program, in month t (thousands of dollars).

4.3.3.1.1.2.4 <u>Total Monthly Provincial Government Payments</u>

The total amount paid to farmers by the provincial government in any month, is equal to the sum of the payments under a product price subsidy scheme, an input subsidy scheme, and/or a gilt retention one.

$$SPG_{py}^t = PG_p^t + PG_i^t + PG_g^t \tag{35}$$

where:

SPG_{py}^t is the total amount of subsidies paid to farmers by the provincial government, in month t (thousands of dollars).

4.3.3.1.2 <u>Producer Contributions</u>

If any of the programs being considered include producers' premiums, the monthly producer contribution can be calculated as follows:

$$PC^t = (Q_s^t \times PP^t)$$

$$\text{if } P_{ff}^t \leqq PH_c^t \text{ and } PH_e^t \leqq PH_c^t \qquad (36)$$[24]

$$PC^t = Q_s^t \left[\left[\max\ (P_{ff}^t, PH_e^t) - PH_c^t\right] + PP^t\right]$$

$$\text{if } P_{ff}^t > PH_c^t \text{ or } PH_e^t > PH_c^t \qquad (37)$$

where:

PC^t is the producer contribution through premiums, in month t (thousands of dollars).

4.3.3.1.3 Net Monthly Payments to (if negative) or Received from (if positive) Farmers, by the Provincial Government

Under any of the provincial schemes where farmers contribute to the financial support of the program through premiums, the net monthly amount paid by the provincial government[25] is equal to:

$$NSPG^t = PC^t - SPG_{py}^t \qquad (38)$$

where:

$NSPG^t$ is the net amount of subsidies paid to farmers (if negative), or received from them as contributions (if positive), in month t (thousands of dollars).

---

[24] In the case of restrictions on what hogs are eligible for a program, the effective producer premium and hog ceiling price are equal to the weighted average producer premium (PP_a^t) and ceiling price (PH_{ca}^t) respectively.

[25] Note that the monthly amount paid by the provincial government ($NSPG^t$) is net not only of producer contributions but also of federal payments, given the conditions in equations (29) and (30).

For the case of a federal program that works on an annual basis, where federal payments have to be deducted from those of the provincial government paid during the year,[26] the net annual payment by the provincial government to farmers is equal to:

$$NSPG^{a} = \sum_{i=1}^{12} NSPG^{t-i} \quad \text{if} \quad \sum_{i=1}^{12} NSPG^{t-i} \geq 0 \,, \qquad (39)$$

$$NSPG^{a} = \min \left[0, \left(\sum_{i=1}^{12} NSPG^{t-i} + FG_{p}^{a}\right) \right] \quad \text{if} \quad \sum_{i=1}^{12} NSPG^{t-i} < 0, \quad (40)$$

where:

$NSPG^{a}$ is the net amount paid by the provincial government as subsidies (if negative) or received as farmers' contributions (if positive) in year a (thousands of dollars).

Equation (39) is relevant for the case where the provincial government has received a net contribution from farmers, and therefore, any federal payment that might occur has no effect on provincial government expenses. Equation (40) reflects the situation where the provincial government has paid subsidies to farmers amounting to more than the federal subsidies. Here the net amount paid by the provincial government is equal to the annual subsidies paid less the federal payment. Equation (40) also depicts the opposite situation where the total amount of federal subsidies paid

---

[26] This is the case of the current ASA and FIAP, where federal payments are made at the end of the hog production year.

is greater than or equal to the total amount paid by the provincial government. Here, the provincial government recovers what has already been paid and transfers to farmers the excedent (i.e. $NSPG^a = 0$).

4.3.3.1.4 Net Monthly Farmer Contributions to the Provincial Government (if negative) or Subsidies Received from (if positive) the Provincial or Federal Governments

When farmers contribute to a provincial stabilization program and, at the same time, receive subsidies from the federal and/or provincial governments, the net amount paid or received is equal to:

$$NTF^t = SPG^t_{py} + FG^t_p - PC^t \qquad (41)$$

where:

NTF^t is the total net amount received by farmers as subsidies from the federal and provincial governments (if positive) or the total net amount of contributions to the provincial government (if negative), in month t (thousands of dollars).

For the case of a federal annual program, the annual amount paid or received by farmers is equal to:

$$NTF^a = FG^a_p - NSPG^a \qquad (42)$$ [27]

[27] According to equation (40) whenever the amount of federal annual subsidies paid is greater than the provincial subsidies, the net annual amount paid by the Provincial government equals zero.

where:

NTF^a is the total net amount received by farmers as subsidies from the federal and provincial governments (if positive) or the total net amount paid as contributions to the provincial government (if negative), in year a (thousands of dollars).

4.4 Model Validation

Validating a model involves determining the level of agreement between results obtained from the model with those from the real system being simulated (Anderson). To do this, Naylor's (1971) "multistage validation" procedure will be used. It involves the following three steps:

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

(b) An empirical step of subjecting assumptions to empirical testing where possible; and

(c) A positive step of comparing model performance with the real system being simulated (Anderson).

Regarding step (a), the assumptions underlying the present model have been established in accord with economic theory, and in the specific case of the production assumptions, in consultation with B.C.M.A. hog specialists. Parameter values have been based on previous studies wherever possible, or set at reasonable levels according to the advice of experienced people working in the hog industry. Regarding step (b), given budgetary and time constraints, it is impossible to subject the assumptions to empirical test. Therefore, they are left as "tentative postulates" (Naylor, (1971)) because there are no a priori reasons to assume that they are invalid. Regarding step (c), the step of comparing the model performance with the data observed will be undertaken through historical validation, since this study is not intended for forecasting purposes.

Historical validation is possible because the British Columbia Farm Income Assurance Program has operated for almost five years; thus the opportunity exists to compare its actual results with the ones generated by the computer simulation model. For that purpose, the model will be run with zero values of the stabilization parameters for the period January 1964 to December 1973,[28] and with the ones reported in Table 4.1 from January 1974 to December 1976.[29] Later, to assess the degree to which the simulated quantities of hogs produced over the 36 month period conform to the observed real data, statistical tests of "goodness of fit" (the Mann-Whitney Rank Sum Test and Theil's Inequality Coefficient) and a graphical comparison, to check the number, the timing, and direction of turning points, will be performed (Freund, MacAuley, Zwart (1973)).

---

[28] With zero values of the stabilization parameters, the model will reproduce real world data for the period being considered.

[29] The model was validated over this period because it was the one for which FIAP data existed.

However, before applying the validation procedure described above, it is necessary to overcome a problem related to the basic historical data available. Since the quantities of hogs produced during the period January 1974 to December 1976 already include the effects of the operation of the FIAP, it is necessary to design a procedure that allows estimation of the equilibrium quantities of hogs produced without FIAP. Given that the quantities of hogs marketed under the FIAP are known and assuming a certain short run supply elasticity based on previous studies, it is possible to estimate the equilibrium quantities of hogs produced. The relevant equations are as follows:

$$E_{sr} = \frac{\dfrac{Q_{sfi}^{t} - Q_{e}^{t}}{Q_{e}^{t}}}{\dfrac{P_{fpa}^{t} - PH_{e}^{t}}{PH_{e}^{t}}} , \qquad (43)$$

where:

P_{fpa}^{t} is the weighted average price for hogs received by farmers, in month t (dollars/cwt).

Q_{sfi}^{t} is the quantity of hogs produced (thousands of cwt) when the FIAP is in operation.

E_{sr} is the short run hog supply elasticity.

From equation (43), solving for Q_{e}^{t} ,

$$Q_e^t = Q_{sfi}^t \;/\; 1.0 + E_{sr} \left[\frac{P_{fpa}^t - PH_e^t}{PH_e^t} \right], \tag{44}$$

4.4.1 Validation Procedure

According to the validation procedure outlined in the previous section there are two crucial steps involved. First, the selection of parameter values, and second, the comparison of the results generated by the model with observed data. This section concentrates on these two aspects of the validation procedure.

4.4.1.1 Choosing Parameter Values

Modeling hog producers' reactions to stabilization programs (section 4.3.1) needed the specification of seventeen "response" parameters, while the stabilization schemes themselves required ten "policy" parameters.

4.4.1.1.1 "Response" Parameters

"Response" parameters can be classified into three groups:

(a) Behavioral parameters; allow for farmer response to changes in hog prices, input prices, gilt retention subsidies (i.e., price effects) or a more stable (unstable) production environment (i.e., non-price effect). As stated in section 4.3.1.1, both effects can have short and long run implications.

(b) Technical parameters; incorporate the more important technological aspects of the hog production process in British Columbia, and

(c) Identity parameters; account for short run resource constraints.

4.4.1.1.1.1 Behavioral Parameters

The values assigned to the behavioral parameters α_1 and α_2, in the gilt retention equation (equation one), were based on the estimation by West et al (1974) of a hog supply function at the farm level for British Columbia. The calculated short run hog price elasticity of supply of 0.83 and the feed price elasticity of -0.60 were used as starting points. According to the supply equation specified by West et al (1974), the short run elasticities refer to the change in supply of hogs marketed eighteen months later (West et al (1974), page 38). In other words, they reflect changes in hog production in month t+18, resulting from changes in the number of gilts retained in month t due to changes in hog and/or input prices. For this study, estimated values for short run (one month) gilt retention elasticities were needed to assign initial values to the gilt retention parameters which would allow the change in hog production to occur fourteen months later (the lag in production assumed in this study). To estimate short run (one month) gilt retention elasticities, the model was run with all behavioral parameters at zero values and with all technical and identity parameters at values given by the production assumptions. By adjusting the gilt retention subsidy parameter (α_3) the quantity of gilts retained was increased by one percent. The results showed that a one percent increase in gilts retained induced, on average, a three percent increase in hog production. Thus, by making use of the model it was possible to estimate short run hog and feed price gilt retention elasticities.[30] The calculated values were 0.28 and -0.20 for hog and feed prices, respectively. They provided the base to assign the values (reported in Table 4.1) for α_1 and α_2.

Next, since no estimations were available for short run (one month) hog and feed price supply elasticities, the values reported by West et al (1974) were taken as upper bounds and later used to estimate values for α_{14} and α_{15}, the behavioral parameters in the holdover equation (equation two). Given that historical validation was possible, the model was run successively to obtain improved estimates for α_{14} and α_{15}, the parameters reflecting farmer response to changes in hog and input prices, respectively. The estimated values are reported in Table 4.1 and represent a short run elasticity (one month) of supply of 0.4 for hog price and -0.30 for feed price.

These values imply the following about farmer responses to changes in hog prices and input prices. Regarding the gilt retention response, as price of hogs increases or price of inputs falls, farmers will retain more gilts for breeding.

---

[30] The hog and feed price gilt retention elasticities are defined as the percentage change in number of gilts retained over the percentage change in hog or feed prices. Short run in this case refers to a one month period.

Regarding the holdover response as price of hog increases farmers will holdover less hogs. On the other hand, if effective input price were lowered it is assumed that farmers will retain more hogs to take advantage of the lower costs of production.

Finally, the values of the response parameter to a gilt retention subsidy (α_3) and the gilt retention shift parameter (α_4) were chosen in an ad-hoc manner, lacking previous estimates of these parameters. The values reported in Table 4.1 thus represent only approximations; they should, however, provide insights as to the likely effects of these parameters.

Next, an experiment where two behavioral parameters were allowed to vary was undertaken to assess the extent to which values assigned to them (in Table 4.1) were crucial in determining the results obtained. In other words, to determine if the results apply only for the case of the single runs reported or whether they apply over a wide range of parameter values. The behavioral parameters selected were those considered most important in influencing farmer production decisions. The parameters chosen[31] and the range over which they were varied were:

---

[31] α_4, the gilt retention shifter, was not included because its effects are known _a priori_. In fact, α_4 will shift the number of gilts retained any desired proportion and direction depending only on the value assigned to it in the model.

α_1 : accounts for the effect of a change in slaughter hog prices, in month t, on additional quantity of gilts retained for breeding purposes. Its selected range was from 0.0003 to 0.0027 (i.e., a range in terms of elasticities of 0.09 to 0.84).

α_{14}: accounts for the effect of a change in slaughter hog prices, in month t, on quantity of holdovers. Its selected range was from 0.0033 to 0.030 (i.e., a range in terms of elasticities of 0.13 to 1.20).

Having selected a central composite design to select the values of the two parameters, the model was run nine times under different sets of parameter combinations. The results of each run and the level of the behavioral parameters varied are given in Appendix D, Table D-1. The results are consistent with the ones obtained on the basis of a single run. In fact, viewing the experiment's results it can be seen that in all nine runs the levels of farmer income and hog production are above its equilibrium level. Also, relative variation (measured through the coefficient of variation) falls consistently below its equilibrium value. Because these results occurred under each parameter combination of the experiment, they give confidence to the results obtained from a single run; in other words, the specific parameter values chosen for α_1 and α_{14} do not appear critical in determining the results of the model. The value of absolute variation in farmer income, however, in some runs is inconsistent with the previous results. This finding indicates that more careful consideration should be given to the analysis before drawing general conclusions regarding absolute variation of farmer income.[32]

4.4.1.1.1.2 Technical and Identity Parameters

All technical and identity parameter values presented in Table 4.1 were arrived at through consultation with British Columbia Ministry of Agriculture hog specialists.[33]

4.4.1.1.1.3 Policy Parameters

Values for policy parameters can be manipulated by policy makers, such as a floor or ceiling price for hogs. Their values are held constant in each simulation run and may be changed between runs to assess their effects on the relevant summary measures. Values for policy parameters relevant to current programs (FIAP and ASA) reported in Table 4.1 are the values currently in effect.

---

[32] The results show that when the gilt retention parameter is above 0.0015 (i.e., an elasticity of 0.47) the value of the absolute variation of farmer income (measured in standard deviations) tends to increase above the equilibrium value. Therefore, the more responsive farmers are in terms of gilts retained, the more de-stabilizing the effects on producer income (in absolute terms).

[33] The use of constant values for the parameters representing the production assumptions and a constant input mix needed to produce one hundred weight of hog (dressed carcass), over the thirteen year period being simulated, implies that no technological improvement or substitution between inputs, due to changes in relative prices, was allowed. This assumption would be particularly unrealistic for the case of a feed price subsidy. Removal of this assumption would have required capturing hog producers investment decisions over time and, hence, more sophisticated modelling.

TABLE 4.1

VALUES OF THE PARAMETERS

Symbol	Value	Parameter Type	Definition
α_1	0.0009	Behavioral	Gilt retention response to a change in hog prices.
α_2	0.0008	Behavioral	Gilt retention response to a change in input prices.
α_3	0.00002	Behavioral	Gilt retention response to a gilt retention subsidy.
α_4	0.0037	Behavioral	Gilt retention response induced by stabilization efforts.
α_5	0.0125	Identity	Gilt retention constraint.
α_6	1.80	Technical	Weight increase from keeping an extra gilt until it reaches average sow weight at time of slaughter.
α_7	0.10	Technical	Proportion of sow culling after first farrowing.
α_8	0.20	Technical	Proportion of sow culling after second farrowing.
α_9	0.25	Technical	Proportion of sow culling after third farrowing.
α_{10}	0.20	Technical	Proportion of sow culling after fourth farrowing.
α_{11}	0.15	Technical	Proportion of sow culling after fifth farrowing.
α_{12}	0.05	Technical	Proportion of sow culling after sixth farrowing.
α_{13}	7.75	Technical	Average litter size surviving until average slaughter weight.

Symbol	Value	Parameter Type	Definition
α_{14}	-0.01	Behavioral	Holdover response to a change in hog prices.
α_{15}	0.01	Behavioral	Holdover response to a change in input prices.
α_{16}	1.05	Technical	Weight increase from keeping slaughter hog an extra month.
α_{17}	0.10	Identity	Holdover constraint.
α_{18}	0.75	Policy	Proportion of return deficit guaranteed by the current FIAP.
α_{19}	-	Policy	Proportion of hogs eligible under any given program.
α_{20}	0.90	Policy	Level of support of the A.S.A.
α_{21}	0.90	Policy	Level of support of the input (feed) subsidy program.
α_{22}	0.75	Policy	Determines the floor price of hogs under the product price and product price premium subsidy schemes.
α_{23}	1.00	Policy	Determines the ceiling price of hogs under the product price premium subsidy schemes.
α_{24}	1.00	Policy	Proportion of fixed cost considered to calculate the return deficit.
α_{25}	1.00	Policy	Hog grade used to determine British Columbia market return.

Symbol	Value	Parameter Type	Definition
α_{26}	1.00	Policy	Change in the premium rate paid by farmers with respect to the FIAP value in 1975, assuming that premium are a fixed annual amount.
α_{27}	0.00	Policy	Proportion of premium paid by farmers assuming a sliding premium rate.
ESR	0.40	Behavioral	Short run (one month) hog price elasticity of supply.

4.4.1.2 Results of the Validation Procedure

For validation purposes, the model was used to generate monthly levels of hog production from January, 1974 through December, 1976, using values assigned to the parameters in Table 4.1. Later, the generated values were compared to actual levels of production over the same period.

To determine the ability of the model to reproduce the real observed data, the Mann-Whitney (Sum Rank) Test was performed (Freund) and Theil's U inequality coefficient was calculated (Zwart, (1973)). Given that both tests measure only the overall ability of the model to reproduce reality, not giving insights about the degree of over or underestimation, a graphical comparison was performed to show the ability of the model to predict turning points (Zwart, (1973)). Results of the real and simulated monthly levels of hog production under the FIAP are given in Appendix B, Tables B-2 and B-3, and a graphical comparison is given in figure 4.2.

The calculated value of the coefficient of the Mann-Whitney (Sum Rank) Test was $\pm$ 0.46. This means that at a 99% level of significance the null hypothesis cannot be rejected (i.e., that both samples come from the same population, having equal means and dispersion). Theil's U coefficient was 0.029, indicating that the model has the ability to reproduce reality,[34] while the graphical analysis

[34] A coefficient of zero indicates perfect ability to predict or reproduce reality; a coefficient of one, a complete lack of ability.

Monthly Hog Production

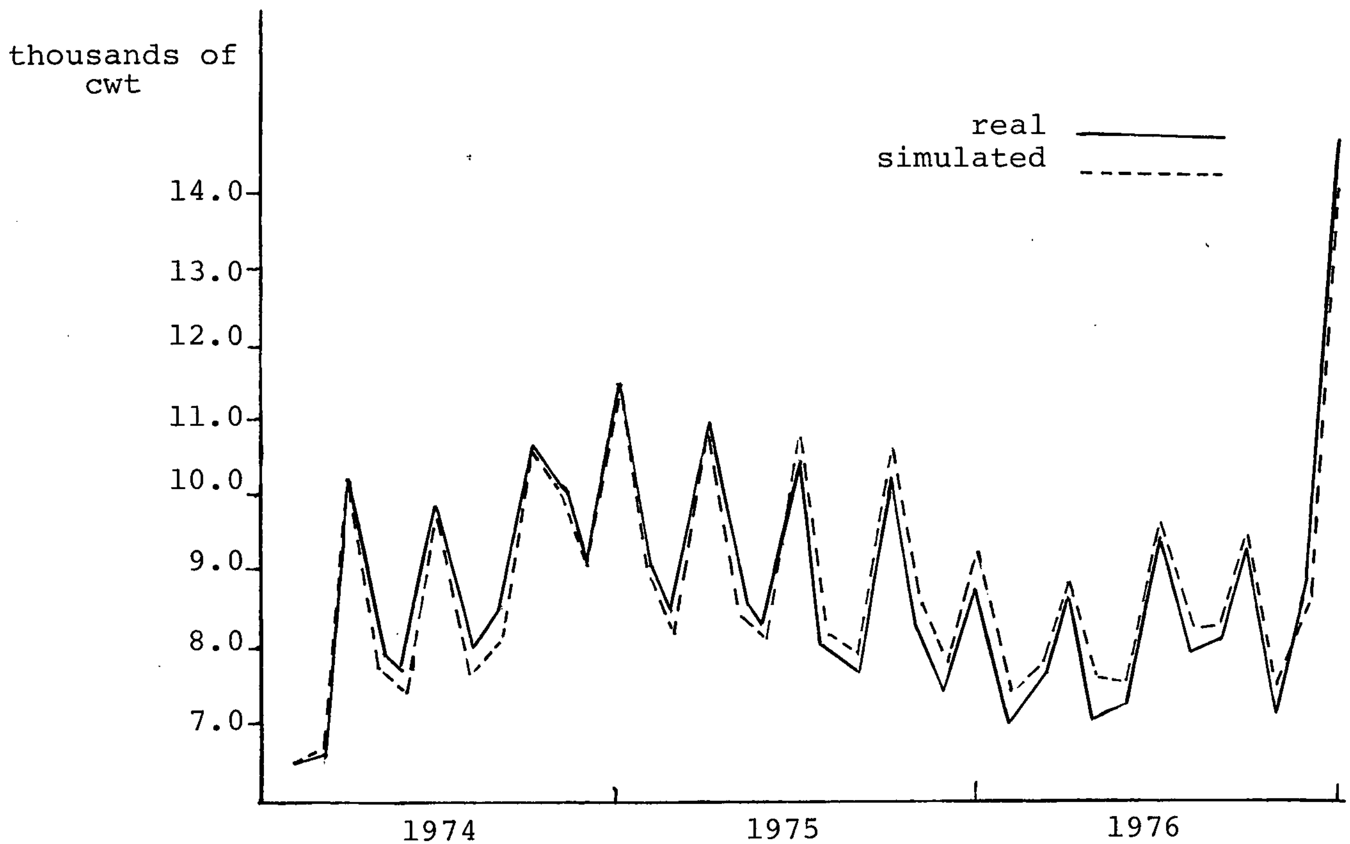

Figure 4.2 Model Validation (1974-1976)

showed that in 97 percent of the cases it was able to accurately predict the direction of turning points. The rather unusual ability of the model to reproduce reality, as indicated by statistical tests and graphical analysis, deserves some comments. Two facts are relevant: a) the model was built to predict only marginal or additional changes in hog production rather than total supply, and b) although the values assigned to the behavioral parameters α_1 and α_2 were set according to West's estimates (West _et al_ (1974)), the values of α_{14} and α_{15} were arrived at from successive runs of the model to achieve a good fit. In other words, the way the validation procedure was conducted induced, to some extent, the good results of the statistical tests. However, it should not be forgotten that the results are also heavily dependent on the so-called technical and identity parameters.

In summary, the results of both the statistical tests and the graphical analysis imply that the model is an accurate representation of the British Columbia hog industry and, therefore, can be used to derive conclusions which are applicable to the real world.

Chapter 5

THE RESULTS

This chapter illustrates results that can be obtained by using the model to simulate some of the different approaches to hog producer income stabilization presented in Chapter 3. It begins by outlining the analytical procedure followed and then presents results thought to be relevant for policy makers.

5.1 Analytical Procedure

The analysis of the simulated outcome of current and alternative schemes for hog producers' income stabilization will comprise two stages: one which involves a single run of the model with the basic values of the parameters, to estimate the impact of alternative schemes and the other which involves the estimation of performance functions (Candler and Cartwright; Chudleigh; Kennedy (1973)).

5.1.1 Comparing Effects of Alternative Schemes

As pointed out above, the first stage of analysis involves only a single run of the model, under different stabilization schemes, in order to evaluate program effects on the previously specified summary measures (e.g., government budgetary cost, producer income stability, etc.). Being able to compare alternative stabilization schemes, without having to put them into effect in the real world, was one of the reasons for choosing simulation. The model can be run, for example, under identical conditions except for the formula that determines the level of support; therefore, any difference in results can be attributed to the formula. Another aspect of this stage is to perform more detailed comparative analyses in the sense of being able to evaluate the effect, on the summary measures, of a change in one specific parameter.

5.1.2 Performance Functions

The estimation of performance functions, as described by Candler and Cartwright, complements the simulation analysis by allowing more general relationships between parameters and summary measures to be obtained without having to re-run the model each time the value of a parameter is changed. It is assumed that some functional relationship exists between the parameters varied and the summary measures; the performance function technique attempts to approximate that true function by means of regression analysis.

The derivation of a performance function implies several steps that can be summarized as follows (Candler and Cartwright):

(1) Choose the parameters and the range over which they will be varied. The parameters chosen are those considered to importantly affect the summary measures. The range selected determines the parameter values over which inference can be made without extrapolation.

(2) Set the level of parameters which will remain

constant. For the present case, these values are reported in Table 4.1 and discussed in section 4.4.1.1.

(3) Choose a functional form for the approximating function. Since no a priori information is available that allows selection of a specific functional form, following previous studies (Candler and Cartwright; Chudleigh; Kennedy (1973)) a second order polynomial will be used initially. If it does not closely approximate the true function using the coefficient of multiple determination (R^2) as a measure, alternative functional forms need to be tried. Candler and Cartwright indicate that careful consideration should be given to the least square estimates of the coefficients for the polynomial, and the coefficient of multiple determination (R^2).[35]

In general form, the performance function can be written as:

---

[35]"Note that the observations were known with certainty, so that the regression model was actually non-stochastic and did not conform to all the assumptions of the General Linear Model. Nevertheless, in these circumstances, it is permissible to use a least-squares procedure provided the coefficient of multiple determination is regarded as a measure of the adequacy of the polynomial in approximating the shape of the actual function. In a non-stochastic model, the standard errors obtained from least-squares regression have no meaning" (Candler and Cartwright, page 164).

$$S_i = f_i\ (x_j)\ ;\quad i = 1,\ldots,n \quad \text{and } j = 1,\ldots,m\quad , \tag{45}$$

where:

S_i is the summary measure being considered

x_j are the parameters to be varied

If the performance function in (45) is approximated by a second order polynomial and two parameters are varied, the estimated function will be as follows:

$$S = b_0 + b_1x_1 + b_2x_2 + b_3x_1^2 + b_4x_2^2 + b_5x_1x_2\ , \tag{46}$$

where:

$b_0 \ldots b_5$ are the regression coefficients to be estimated.

(4) According to some experimental design,[36] define values of the parameters to be varied and the number of observations on the response surface needed to fit the selected functional form. In this study a central composite design was chosen because "the central composite design appears to be particularly suitable when the function to be fitted is given and the number of observations is fixed" (Candler and Cartwright, page 163).[37]

---

[36] For a more detailed discussion about selecting the appropriate functional form and experimental design, see Heady.

[37] A central composite design requires nine, fifteen, and twenty five repetitions to estimate a second degree polynomial where two, three, or four parameters are allowed to vary (Heady, page 137).

(5) Run the model for each set of parameter combinations and compute the relevant summary measures.

(6) Estimate the coefficients of the functional form by means of regression analysis. In the present case, because the polynomial to be fitted is linear in the regression coefficients to be estimated, Ordinary Least Squares can be used.

As pointed out above, performance functions permit the estimation of summary measures, over the range the selected parameters are allowed to vary, without having to re-run the computer model. Performance functions can also be used to:

(a) determine the magnitude and direction of change in the values of summary measures given a marginal change in the value of a particular parameter. In other words, sensitivity analysis can be performed by taking the partial derivative of a summary measure (dependant variable) with respect to any parameter (independent variable), while holding all other independent variables constant; and

(b) locate "break-even" points, i.e., values of the parameters that give a zero value (or some predetermined value) of a particular summary measure.

5.2. Outcome of Simulated Hog Producer Income Stabilization Programs

In Chapter 1, it was stated that British Columbia hog producers have traditionally faced a problem of income instability which has given rise to a government goal of reducing it. Consequently, the main objective of this study focussed on estimating the cost and effectiveness of existing and alternative stabilization programs. The present section reports the estimated outcome for some of these schemes from simulating the mathematical model presented in Chapter 4. In particular, it reports results from simulating the following three stabilization schemes:[38]

(1) The British Columbia Swine Producers Income Assurance Program as it existed in 1975 (referred to as "FIAP (1975)");

(2) A modified Swine Producers Income Assurance Program (referred to as "modified FIAP"); and

(3) A premium/subsidy program.

The effects of each of these schemes as predicted by the model are presented below. The effects are measured in terms of their impact on what are considered to be key policy variables. All schemes were run on a monthly basis over a thirteen year period, January, 1964 to December, 1976. The length of the simulation period was chosen so that it

---

[38] This section reports only on the effects of provincial stabilization schemes since the federal ASA never came into effect during the period being simulated (see Appendix B, Table B-4).

comprised at least two to three phases (peaks and troughs) of the three to four year hog production cycle in British Columbia (West *et al* (1974)). Each scheme was run once with the parameter values reported in Table 4.1, and resulting summary measures compared to the ones obtained from a run with no stabilization program in operation (i.e. with the market equilibrium values of the variables).[39] Any differences in the computed summary measures can be attributed to the particular scheme in operation. Next, for the case of the modified FIAP, a detailed comparative analysis was performed to estimate the likely impact of each individual modification on the summary measures. Finally, to make the results more general and useful to policy makers, performance functions were estimated.

5.2.1 Effects of the British Columbia Swine Producers Income Assurance Program

The present section reports the estimated effects of the FIAP (1975) on farmer income stability and other summary measures, had it begun in January, 1964 and ended in December, 1976. In other words, the model was used to simulate the outcome of the FIAP (1975) over this thirteen year period. Next, a comparison between its results with those obtained in the absence of FIAP provides an estimation of its likely impact.

---

[39] The results of the run with the equilibrium values are reported under "No scheme" in Table 5.1.

For the initial run, the main features of the FIAP (1975) were: (a) farmers and the provincial government both pay a per hundredweight premium on slaughter hogs on a 1/3 to 1/2 basis; in 1975, the farmer premium was $1.50/cwt and the government premium was $2.25/cwt; and (b) farmers receive an indemnity when market price of slaughter hogs falls below a computed support level. The support level equals 75% of the return deficit, where return deficit is the difference between cost of production (including return to land and management fee) and the market price of slaughter hogs (index 100).

If a stabilization program such as FIAP (1975) is perceived as providing a more stable production environment, it is reasonable to assume that a rightward shift in the supply function would result. To account for this, the parameter α_4, in the gilt retention equation, was given a value ranging from zero to 0.0037, equivalent to an annual average increase in gilts retained equal to 1.5% and an annual increase in hog production equal to 4.5 percent.[40]

The results presented in Table 5.1 indicate that the FIAP (1975) would be capable of achieving the provincial government goal of reduced income variability for hog producers. Absolute variation of annual gross income would be reduced, shown by a fall in standard deviation of 14 thousand dollars.

[40] The increase in hog production was assumed to be greater in the first years of operation of the program; more precisely, 9 percent for the first three years, 6 percent for the next three, 3 percent for the next five years and zero for the last two.

Table 5.1 Estimated Effects of FIAP (1975), 1964-1976.

Variables	No Scheme	FIAP[a] (1975)	Difference
1. LEVEL OF HOG PRODUCER INCOME (average per year in thousand dollars)	631	818	187
2. ABSOLUTE VARIATION OF HOG PRODUCER INCOME (average st. dev. per year in thousand dollars)	526	512	-14
3. RELATIVE VARIATION OF HOG PRODUCER INCOME (average coefficient of variation)	83	63	-20
4. LEVEL OF HOG PRODUCTION (average per year in thousand lbs.)	8,509	9,136	627
5. GOVERNMENT PREMIUM (thousand dollars/period)	0	1,194	1,194
6. GOVERNMENT ADVANCE (thousand dollars/period)	0	504	504
7. TOTAL NET GOVERNMENT PAYOUTS (thousand dollars/period)	0	1,698	1,698

[a] Includes a parameter shifter in the gilt retention equation, to account for an assumed more stable production environment.

Source: Appendix C, Tables C-1 and C-2.

Relative variation of annual gross income would also be reduced, shown by a fall of 20 in the coefficient of variation.

In addition to stabilizing producer income, FIAP (1975) would have raised producer income 187 thousand dollars per year, or 30 percent. On average, hog prices increased by 3 percent while hog production increased slightly over seven percent.[41] From the standpoint of the budgetary cost to the provincial government, this program would have represented a total net payment to farmers over the thirteen year period of 1.7 million dollars (1.2 million in government premiums and 0.5 million in government advance).

5.2.2 Effects of a Modified British Columbia Swine Income Assurance Program

Having estimated the effects of FIAP (1975), the next step in the analytical procedure involved estimating the effects of a modified FIAP. The modified FIAP to be considered incorporates the following four modifications of FIAP (1975):

(1) Support level increased to 100% of return deficit;

(2) Farmer premium increased 50%; government premium lowered 50% (i.e., share basis 1/2;1/2);

(3) Land return and management fee removed from cost of production calculations; and

---

[41] The seven percent increase in hog production is comprised of 4.5 percent increase due to the shift in the supply function and a 2.8 percent increase due to higher hog prices. This latter figure implies a price elasticity of supply of 0.93, slightly greater than the one reported by West et al (1974) of 0.83.

(4) Market price of slaughter hogs changed to index 103.

The first three modifications have been suggested by the British Columbia Minister of Agriculture.[42] The fourth modification was incorporated into the existing British Columbia Swine Producers Income Assurance Program in 1977.

First, the effects of each modification alone will be presented, followed by the combined effects of all four modifications.

5.2.2.1 Effects of Isolated Modifications

The results of running the model for each modification in isolation are reported in Table 5.2.[43] They illustrate the usefulness of the model in providing policy makers with information about the impact of specific changes in the operation of a particular stabilization scheme. For example, if the only modification to FIAP (1975) was an increase in the support level from 75% to 100% (modification (1)), this would have an increasing effect on hog producer income amounting to 69 thousand dollars per year, or 8.8 percent. Absolute variation of annual gross income would be increased, shown by an increase in standard deviation of 13 thousand dollars, while relative variation would be decreased slightly,

---

[42] A clarification of points regarding these proposals can be found in British Columbia Ministry of Agriculture News Release, February 23, 1978.

[43] Since the different modifications could have varying effects on the supply curve, the shift parameter α_4 was set equal to zero for the runs reported in Table 5.2.

shown by a fall of 4 in the coefficient of variation. Provincial government budgetary cost would be increased considerably compared to the cost under FIAP (1975) (750 additional thousand dollars, or 46%).

Each of the other modifications ((2), (3), (4)) would have a lowering effect on producer income. Raising the farmer premium from 1/3 to 1/2 share, for example, would lower producer income 26 thousand dollars per year. Interestingly enough, this reduction in producer income due to increased farmer premium is less than the reduction caused by removing land return and management fee (43 thousand dollars) as well as increasing index to 103 (29 thousand dollars).

Modifications (2), (3),[44] and (4) each would have reduced absolute variation of hog producer income, but not relative variation. Also, each of these modifications would have reduced total net government payouts.

The reasons that support modification (3) are well known. Elsewhere (Hudson, Barichello) it has been indicated that where fixed costs are included in determining the support level, a problem of endogeneity of costs appears. Excess profit earned due to the operation of the program will be capitalized into

---

[44] Among the proposed changes to FIAP (1975), removing of some items (management fee and return to land) from the calculated fixed cost used to determine the return deficit is an important one. According to the 1975 FIAP cost structure removing the above mentioned items represents a reduction in the fixed cost figure entering the return deficit calculation of about 17%.

the value of the fixed assets thus increasing average cost. As a consequence, the support level, which is determined in part by fixed cost, will be increased too.

5.2.2.2 Combined Effects of Modifications

This section presents the results of the combined effects of the four modifications to FIAP (1975), listed above; these results are also given in Table 5.2. The level of hog producer income, for example, would have averaged 734 thousand dollars per year, had the modified FIAP operated from 1964-1976. Comparing the two sets of effects implies certain conclusions regarding the likely impact of the combined modifications relative to FIAP (1975). The combined modifications would have:

(1) a lowering effect on the level of hog producer income relative to FIAP (1975) (on average, 49 thousand dollars less per year);

(2) a stabilizing effect with respect to absolute variability of hog producer income (average standard deviation falls 19 thousand dollars per year);

(3) a de-stabilizing effect with respect to relative variability of hog producer income (average coefficient of variation increases by 2 per year);

(4) a lowering effect on the level of hog production (on average, 79 thousand lbs. less per year);

(5) a lowering effect on cumulative government premium (295 thousand dollars less);

Table 5.2 Comparative Effects of Proposed Modified FIAP, 1964-1976[a]

Variables	FIAP	Modified FIAP	Differences Due to Total Modifications	Effect of Isolated Modifications: 75%-100% Level Support	1/3 to 1/2	Removal Land Return and Management fee	Index 100 to 10,3
1. LEVEL OF HOG PRODUCER INCOME (average per year in th. dollars)	783	734	- 49	69	- 26	- 43	- 29
2. ABSOLUTE VARIATION OF HOG PRODUCER INCOME (average st. dev. per year in th. dollars)	500	481	- 19	13	- 15	- 5	- 5
3. RELATIVE VARIATION OF HOG PRODUCER INCOME (coefficient of variation)	64	66	2	-4	0	3	2
4. LEVEL OF HOG PRODUCTION (average per year in th. lbs.)	8,719	8,640	- 79	96	- 38	- 65	- 45
5. GOVERNMENT PREMIUM (th. dollars/ period)	1,146	851	-295	14	-292	- 10	- 8
6. GOVERNMENT ADVANCE (th. dollars/ period)	485	234	-251	736	0	-454	-310
7. TOTAL NET GOVERNMENT PAYOUTS (th. dollars/ period)	1,631	1,085	-546	750	-292	-464	-318

[a]Assuming a zero supply response to government intervention.

(6) a lowering effect on cumulative government advance (251 thousand dollars less);

(7) a lowering effect on total net government payouts (546 thousand dollars less).

5.2.3 Effects of a Premium/Subsidy Scheme

Given a goal of producer income stability, it seems logical to require farmers to pay a premium in times of high hog prices (or wide margin) but not require them to pay a premium when prices are low. Hudson (1977) recognized this logic in his proposal of an "Agricultural Stabilization Fund". Below a description of a premium/subsidy scheme which incorporates this thinking is given.

A floor price for slaughter hogs would be pre-determined, possibly related to cost of production. When market price fell below the floor price, farmers would receive a subsidy from a stabilization fund to raise effective price received to the floor. The stabilization fund could be initiated with a government advance. There would be no government premium, only a farmer premium. When market price exceeded the ceiling, farmers would pay premiums into the stabilization fund so that the effective price they receive equals the ceiling. The operation of the scheme is portrayed in Figure 3.1.

The estimated effects of a premium/subsidy scheme, had one operated from 1964-1976, are reported in Table 5.3. The floor price was set equal to the support level of FIAP (1975)- i.e., 75% of return deficit, where return deficit equals cost of production (including return to land and management fee) minus market price of slaughter hogs (index 100). The ceiling price was set 2.5% above the floor price. The results of no scheme and FIAP (1975) from Table 5.1 are also reported in Table 5.3 for comparative purposes. The results of a premium/subsidy scheme can be summarized as follows:

(1) Average level of hog producer income would be increased markedly, from 631 to 818 thousand dollars per year;

(2) Absolute variability of hog producer income would be reduced, shown by a drop in standard deviation from 526 to 481 thousand dollars per year;

(3) Relative variability of hog producer income would also be reduced, shown by a drop in coefficient of variation from 83 to 59;

(4) Level of hog production would be increased from 8,509 to 9,123 thousand pounds per year;

(5) Total net government payouts would be approximately 1.7 million dollars.

In comparing the effects of a premium/subsidy scheme with those of FIAP (1975) in Table 5.3, it can be seen that both schemes would have cost the government about 1.7 million dollars over the period 1964-1976. The two schemes would have led to identical levels of hog producer income and almost identical levels of hog production. However, the schemes would have differed with respect to their effects on variability of hog producer income - a premium/subsidy scheme would have

Table 5.3 Comparative Effects of a Premium/Subsidy Scheme, 1964-1976

Variables	No Scheme	FIAP (1975)	Premium/Subsidy Scheme
1. LEVEL OF HOG PRODUCER INCOME (average per year in thousand dollars)	631	818	818
2. ABSOLUTE VARIATION OF HOG PRODUCER INCOME (average st. dev. per year in thousand dollars)	526	512	481
3. RELATIVE VARIATION OF HOG PRODUCER INCOME (average coefficient of variation)	83	63	59
4. LEVEL OF HOG PRODUCTION (average per year in thousand lbs.)	8,509	9,136	9,123
5. TOTAL NET GOVERNMENT PAYOUTS (thousand dollars/period)	0	1,698	1,682

Source: Appendix C, Table C-1, C-2 and C-4.

caused a greater reduction in both absolute and relative variability. Since net government payouts would be almost the same for both schemes, the model results suggest a premium/subsidy scheme would achieve a greater reduction in the variability of producer income per dollar of government expenditure than would FIAP (1975).

5.2.4 Self-Financing Stabilization Schemes

Through relatively minor adjustments the stabilization schemes compared above could be made self-financing. For the case of FIAP (1975), this could be done by increasing the farmer premium commensurate with government advances. Similarly, for a premium/subsidy scheme, as government advances became large the floor and ceiling could be lowered to reduce government subsidies and increase farmer premiums.

Below, the effects of adjusting FIAP (1975) so that it approaches self-financing, are examined. In years following a government advance, the farmer premium was increased by an amount determined by dividing an existing government advance by expected production the coming year. Results for a run incorporating this adjustment, with support level remaining at 75% of return deficit, are reported in Table 5.4. For comparative purposes the results of FIAP (1975) without a sliding premium (from Table 5.1) are also reported in Table 5.4.

Table 5.4 Comparative Effects of FIAP (1975) and FIAP (1975) With Sliding Premium, 1964-1976.

Variables	No Scheme	FIAP (1975)	FIAP(1975)with Sliding Premium
1. LEVEL OF HOG PRODUCER INCOME	631	818	693
(average per year in thousand dollars)			
2. ABSOLUTE VARIATION OF HOG PRODUCER INCOME	526	512	427
(average st. dev. per year in thousand dollars)			
3. RELATIVE VARIATION OF HOG PRODUCER INCOME	83	63	62
(average coef. of variation)			
4. LEVEL OF HOG PRODUCTION	8,509	9,136	8,961
(average per year in thousand lbs.)			
5. TOTAL NET GOVERNMENT PAYOUTS	0	1,698	246
(thousand dollars/period			

Source: Appendix C, Tables C-1, C-2 and C-5

From Table 5.4 it can be seen that the sliding premium adjustment largely achieves self-financing, as total net government payouts over the period 1964-1976 are reduced from 1,698 to 246 thousand dollars. One result of the reduced government cost is lowered hog producer income, from 818 to 693 thousand dollars per year. Note, however, that the resulting level of income (693) is higher than that of the no scheme situation (631). Even at the lower government cost, the sliding premium enhanced the ability of FIAP (1975) to reduce both absolute and relative income variability. The sliding premium reduced standard deviation of hog producer income from 512 to 427 thousand dollars per year and the coefficient of variation from 63 to 62. The sliding premium had little effect on level of hog production.

5.3. Performance Functions

The final stage in the analytical procedure involved the estimation of performance functions to make the results more general and useful. The performance functions were estimated following the steps outlined in section 5.1.2.

5.3.1 Performance Functions to Assess Modifications to FIAP (1975)

This section reports on the estimation of performance functions to assess the effect of changes in two policy parameters on farmer income level and stability, hog production level, and provincial government budgetary cost, assuming that a program similar to FIAP (1975) was in operation. The estimated performance functions are reported in Appendix D.

5.3.1.1 Change in Policy Parameters

Performance functions, where two policy parameters were allowed to vary, were estimated. Having selected a second degree polynomial to approximate the true function,[45] and a central composite design to select the values of the two parameters, the model was run nine times under different parameter combinations. The result of each run and the level of the policy parameters varied are reported in Appendix D, Table D-2. Performance functions relating the two policy parameters to selected summary measures were estimated using Ordinary Least Squares. They are given in Appendix D, Table D-3.

The policy parameters varied were those considered important in determining the values of the summary measures. The policy parameters varied and the range over which they were varied were:

α_{22} : the percentage of the return deficit supported by the provincial government. Its range was from 0.75 (current FIAP) to 1.00 (proposed modified FIAP).

α_{24} : the percentage of the fixed costs allowed to enter the calculation of return deficit. Its selected range was from 0.75 to 1.00 (net margin).

Next, an example of each of the possible uses of performance functions (indicated in section 5.1.2) is given to illustrate their usefulness.

---

[45]Since all performance functions showed coefficients of multiple determination ranging from 0.985 to 0.999, a second degree polynomial can be regarded as a good approximation of the true function.

5.3.1.1.1 Summary Measure Estimation

If, for example, policy makers were interested in assessing the effect on the provincial government budgetary cost of a change in α_{22} and/or α_{24}, they could make use of the following performance function. From Appendix D, Table D-3, column four, the performance function that depicts the relationship between the provincial government budgetary cost and the two selected parameters can be written as follows:

$$\text{Prov. Gov. Cost} = 331 - 2359\ \alpha_{22} - 469\ \alpha_{24} + 1092\ \alpha_{22}^2 +$$

$$+ 4\alpha_{24}^2 + 3874\ \alpha_{22}\alpha_{24} \quad , \tag{47}$$

If, for illustrative purposes, the two parameters were arbitrarily given values of $\alpha_{22} = 0.85$ and $\alpha_{24} = 0.80$, after substituting those values in equation (47) the provincial government budgetary cost, over the thirteen year period being simulated, would equal 1.4 million dollars.

5.3.1.1.2 Sensitivity Analysis

Sensitivity analysis can be carried out by taking the partial derivative of a summary measure (dependant variable) with respect to any parameter (explanatory variable), holding all other parameters constant. As an example, the effect on the level of farmer income of a unit change in the level of provincial government support (α_{22}) can be calculated as follows:

$$\frac{\partial \text{ farmer income}}{\partial \alpha_{22}} = -168 + 177\,\alpha_{22} + 323\alpha_{24}\,, \tag{48}$$

If the prevailing values of the current FIAP were used (α_{22} = 0.75 and α_{24} = 1.00), annual average producer income would have increased by 3.0 thousand dollars for each unitary increase in the support level (e.g., from 75 to 76 percent).

Finally, as a summary, the gross income, absolute and relative variation of income, provincial government budgetary cost and hog production elasticities with respect to α_{22} and α_{24} are presented in Table 5.5. It shows, for example, that a one percent increase in the support level would cause a 0.32 percent increase in farmer gross income and a 1.22 percent increase in provincial government cost.

Table 5.5 Gross Income, Absolute and Relative Variation of Income, Prov. Gov. Budgetary Cost and Hog Production Elasticities with respect to α_{22} and α_{24}.

Parameters	Gross Income per year	Absolute Variation of Income sd. dev. per year	Relative Variation of Income coef. of variation	Prov.Gov. Cost per period	Hog Prod. per year
α_{22}[a]	0.32	0.02	0.23	1.22	0.02
α_{24}[b]	0.24	-0.05	-0.23	1.78	0.03

[a] α_{22} : percent of return deficit supported by the Prov. government.

[b] α_{24} : percent of fixed costs that enter return deficit calculations. Note that the figures in Table 5.5 measure the effect of an <u>increase</u> in the percentage of the fixed costs that enter the return deficit calculation. For a <u>reduction</u>, the signs must be reversed.

5.3.1.1.3 "Break-even" Points

Location of "break-even" points allows determination of parameters values that give some predetermined value of relevant summary measures. For example, if policy makers wanted to know what level of support (α_{22}), under the current FIAP (i.e., $\alpha_{24} = 1.0$), gives a cost to the government of 1.0 million dollars, equation (47) becomes a quadratic form in α_{22}. It may be written as:

$$1.0 = -134 + 1515 \alpha_{22} + 1092 \alpha_{22}^2 , \tag{49}$$

Solving the quadratic equation for α_{22}, the positive root gives a value of 0.52. In other words, a support level of 52 percent of the return deficit, under the conditions of FIAP (1975), will represent a cost to the provincial government equal to one million dollars.

5.3.2 Comparison of Performance Function Estimates with Results from Actual Runs of the Model

To determine how good the estimates obtained from the performance functions are, estimates were obtained directly from the model. To obtain comparative results directly from the the model the following three runs were made:

(1) Support level (α_{22}) was raised to 85 percent of the return deficit and the fixed cost entered in its calculation (α_{24}) reduced to 80 percent. Next the provincial government cost was computed.

(2) To estimate the effect on farmer income of a change of one percent in the level of support, α_{22} was set equal to 76 percent of the return deficit, and

(3) Given that the performance function estimation indicated that a 52 percent support level represents a cost to the provincial government equal to 1.0 million dollars, the model was run under this condition.

The results from these runs are reported in Table 5.6.

Table 5.6 Comparison of Performance Function Estimates with Results from Actual Runs of the Model.

Use of Perf. Function	Summary Measure	Perf. Function Estimate	Model Result
(1) Summary measure estimation with α_{22}=0.85 and α_{24}=0.80	government cost	1.47 million dollars	1.37 million dollars
(2) Sensitivity analysis (change in support level (α_{22}) from 75 to 76 percent)	Change in farmer income	2.8 th dollars	3.0 th dollars
(3) "Break-even" Point (α_{22} = 52 percent)	Gov. cost	1.0 million dollars	0.99 million dollars

With a support level of 85 percent, the model estimates government cost to be 1.37 million dollars while an estimate of 1.47 million dollars was obtained from the performance function. From Table 5.6 it can be seen that the estimates obtained from performance functions are very good approximations of results obtained from the model.

Chapter 6

CONCLUSIONS

This chapter will summarize the most important conclusions that can be drawn from this study. They include methodological aspects, conclusions resulting from the comparison of the stabilization schemes discussed in the text and some extentions for further research.

6.1 Methodological Aspects

(1) Since this study concentrated on assessing the effects of alternative stabilization schemes under different sets of assumptions, it consistently followed a "positive" economic approach. In fact, its aim was only to provide policy makers with a wide range of results so that more informed decisions can be made, rather than attempt to determine an "optimal" plan.

(2) Simulating a mathematical model of the B.C. hog industry proved to be an effective way of determining the likely impact of alternative stabilization schemes.

(3) As pointed out above, the model[46] was built to be general and flexible. It can determine the effects

---

[46] The computer model used in this study is available from the Department of Agricultural Economics, University of British Columbia.

of a number of stabilization schemes in addition to provincial deficiency payments programs, including the ASA, a gilt retention subsidy program, and a feed subsidy program. Its flexibility allows it to: (a) calculate three, four, or five year moving average prices and/or margins; (b) work with a gross margin, a net margin, or any proportion of fixed cost considered relevant to calculate return deficit; (c) impose restrictions on the number of hogs that qualify for any federal and/or provincial stabilization program; and (d) be run for each federal or provincial program separately or in any desired combination.

(4) Some important conclusions emerged from the validation procedure. They can be summarized as follows:

(a) the validation results give support to the estimates of West et al (1974) of a short run (18 month) hog and feed elasticity of supply for British Columbia (0.83 and -0.60 respectively). This is an indication that hog producers in British Columbia are more responsive to changes in hog and feed prices than those in other Canadian regions;

(b) it was possible to obtain a preliminary estimate for a hog and feed price elasticity of gilt retention (0.28 and -0.20 respectively);

(c) it was also possible to "estimate" a short-run (one month) hog and feed price elasticity of supply (0.4 and -0.3 respectively); and

(d) the values assigned to the technical and identity parameters representing the main production characteristics of hogs in British Columbia, and the assumed lag of 14 months in production, appear valid.

(5) Making use of the mathematical model of the British Columbia hog industry presented some problems regarding parameters' values and other basic information. Although it was possible to assign values to the crucial behavioral parameters (in equation one and two) using West's *et al's* (1974) estimates of a hog supply function for British Columbia as a starting point, and later refining them by means of the validation procedure, further research to check the validity of these preliminary estimates would be useful. Estimations were not available for the response parameter to a gilt retention subsidy (α_3) and the shift parameter to account for a more stable production environment (α_4) so they were assigned ad-hoc values. Empirical estimates of these parameter values would be useful for further research.

Regarding basic information needed, given that the FIAP uses negotiated monthly cost of production figures instead of a pre-determined formula based on published data, it was necessary to estimate the cost series used in this study. The estimation proved to be difficult and time consuming. In fact, it was necessary to take the cost structure reported by FIAP for 1975 as a basis and then, through successive iteration estimate the inputs supposedly used in the monthly FIAP negotiations. The result of each iteration was validated against an 18 month period (January 1975 through June 1976) of known FIAP cost data. Once the estimated cost showed not to be significantly different (in a statistical sense) from the known figures, the remaining years were estimated by means of the <u>Farm Input Price Index.</u>[47]

(6) Performance functions were estimated and shown to be a convenient mechanism for producing information of interest to policy makers, without having to re-run the model. The comparison of performance function estimates with results from actual runs of the model showed that they are very good approximations of the results obtained directly from the model.

---

[47] The exact formula used to calculate the cost figures is presented in Appendix A.

6.2 Conclusions Drawn from the Comparative Analysis of the Alternative Stabilization Schemes

As pointed out earlier, the results of this study are dependant on the values assigned parameters and the particular model used. Reasonable values were assigned parameters by reviewing all available sources of information. Moreover, the experiment performed with the critical behavioral parameters showed that the results obtained from the model applied over a wide range of parameter values. Finally, the historical validation procedure showed the ability of the model to reproduce real world conditions. Given the caveat that the results of this study are dependent on a number of assumptions and the model used, and given a government goal of income stability for hog producers, policy makers are offered the following conclusions:

(1) If the government wished to support hog producer income, as well as stabilize it, a premium/subsidy scheme would be preferred to FIAP (1975). For a given government expenditure, both schemes are equally capable of increasing income; however a premium/subsidy scheme is advantageous in terms of reducing income variability. A premium/subsidy scheme reduces variability not only through subsidizing farmers in times of low prices but by also requiring them to pay a premium in times of high prices; in other words, it collects farmer premiums in a stabilizing way.

(2) If the government wished to achieve income stability at low cost, modified FIAP would be preferable to FIAP (1975). Cost over the period 1964-1976 would be 33% less for modified FIAP than for FIAP (1975).

(3) If the government wished to reduce cost further, this could be done through introducing a sliding premium into FIAP (1975). By allowing farmer premiums to slide upwards in response to government advances, cost of FIAP (1975) would be reduced 85%. Not only would government cost be reduced substantially by allowing the premium to slide, but a greater reduction in income variability would result than for either FIAP (1975) without a sliding premium or modified FIAP.[48] The price of reduced government cost and reduced income variability due to the sliding premium would be a lower level of income for hog producers. (However, it increases the level of producer income over the equilibrium situation).

In summary, to the extent that income support is the predominant government goal, the premium/subsidy scheme is the preferred choice. To the extent that reduced government cost is the predominant goal, FIAP (1975) with a sliding premium could achieve this.

---

[48] The sliding farmer premium was thus a stabilizing influence on producer incomes. This occurred because years of increased farmer premiums happened to coincide with years of high hog prices. Were the price cycle different (as it is for beef), the sliding premium could well be de-stabilizing.

6.3 Extensions of the Model

Some useful extensions of the model are:

(1) Government stabilization programs for hog producers can be expected to have an impact beyond the farm gate. Thus, the farm level model developed in this study could be usefully extended to include the processing and retail levels of the hog industry.

(2) With some minor modifications, the computer model developed in this study could be used to study income stabilization programs for beef producers. This would involve a new subroutine incorporating the relevant production assumptions for beef as well as the appropriate set of basic data.

(3) Since the model is an aggregate one it does not identify individual beneficiaries of various stabilization programs. A number of economic studies suggest that such programs have regressive distributional effects (Barichello).[49] In fact, considering that there exists some indication that a fairly small percentage of hog producers have recieved a relatively large proportion of indemnity payments (Hudson), it would be of interest to extend the model in order to allow a quantitative evaluation of distributional effects.

---

[49] A well documented review of this topic can be found in D. Gale Johnson, World Agriculture in Disarray, (London, 1973), MacMillan Press, Chapter 9.

LIST OF REFERENCES

Agarwala, R. "A Simulation Approach to the Analysis of Stabilization Policies in Agricultural Markets: A Case Study". Journal of Agricultural Economics, Vol. XXII, No. 1, January, 1971

Agriculture Canada. Canada Livestock and Meat Trade Report. Livestock Division, Production and Marketing Branch.

________________. Annual Reports. Livestock Division, Production and Marketing Branch.

Anderson, Jock R. "Simulation: Methodology and Application in Agricultural Economics". Review of Marketing and Agricultural Economics, Vol. 42, No. 1, March, 1974.

Barichello, Richard. "An Economic Analysis of the Dairy Farm Income Assurance Program", Department of Agriculture Economics Research Bulletin, University of British Columbia, September, 1977.

British Columbia Ministry of Agriculture, British Columbia Federation of Agriculture and British Columbia Swine Producers Association. "British Columbia Swine Producers Income Assurance Program". Mimeograph. 1974.

____________. "Agricultural Development Policy Proposals". Cabinet Committee on Planning and Priorities. Mimeograph. March, 1977.

____________. "Agricultural Development Policy Proposals". Cabinet Committee on Economic Development. Mimeograph. December, 1976.

____________. "Background Paper on Agricultural Development Opportunities in British Columbia to 1986." Mimeograph, 1976.

Boehlje, Michael. "Optimization and Decision Models: The Use of Statistical Search Procedures". Canadian Journal of Agricultural Economics, Vol. 21, No. 2, July, 1973.

Boswell, A.M. "Cycles in Production and Prices of Hogs in Canada and United States, 1953 to 1967", Canadian Farm Economics, Vol. 3, No. 3, August, 1968.

Candler, W. et al. "The Substitution of Analytic for Simulation Algorithms: A Comment". American Journal of Agricultural Economics, Vol. 55, No. 2, May, 1973.

Candler, W. and Cartwright, R.W. "Estimation of Performance Functions for Budgeting and Simulation Studies". American Journal of Agricultural Economics, Vol. 51, No. 1, February, 1969.

Candler, W. and Kennedy, G. "A Simulation Analysis of Alternative Price Ceilings for Pork." Purdue University, Agricultural Experimental Station Bulletin No. 88, July, 1975.

Chudleigh, Peter. "Model of the Small Scale Dairying Enterprise: An Aid to Resource Allocation in Agricultural Development". Agricultural Systems, Vol. 2, No. 1, January, 1977.

Clarkson, G. and Simon, H. "Simulation of Individual and Group Behavior". American Economic Review, Volume L, No. 5, December, 1960.

Dawson, J.L. "Canadian Hog Prices Within a North American Market," Canadian Farm Economics, Vol. 7, No. 4, October, 1972.

Eyvindson, R.K. and Kerr, T.C. "Contrast between Federal and Provincial Stabilization Policies and Programs". Canadian Journal of Agricultural Economics, C.A.E.S. Proceedings, March, 1976.

Freund, John E. Modern Elementary Statistics. Prentice-Hall, Inc., Englewood Cliffs, N.J., U.S.A. 1967 (Third Edition).

Furniss, I. "Resource Use in Canadian Agriculture," The Agrologist, Vol. 6, No. 1, Winter, 1977.

Harrington, D.H. "Research tools needed to evaluate policy alternatives for stabilization of the agricultural sector." Canadian Journal of Agricultural Economics, C.A.E.S. Proceedings, 1974.

Heady, E.O. and Dillon, J.L. Agricultural Production Functions. Iowa State University Press, Ames, Iowa, 1961.

Hedley, D. and Cushen, H. "A Hog Model for Evaluation of Stabilization Alternatives." Canadian Journal of Agricultural Economics, C.A.E.S., Proceedings, 1974.

Houck, J.P. "Some Economic Aspects of Agricultural Regulation and Stabilization." American Journal of Agricultural Economics, A.A.E.E., 1974 Proceedings Issue. Vol. 56, No. 5, December, 1974.

Hudson, S.C. "A Review of Farm Income Stabilization in British Columbia." Mimeograph. October, 1977.

Just. R.E. "Risk Response Models and Their Use in Agricultural Policy Evaluation." American Journal of Agricultural Economics, Vol. 57, December, 1975.

Kennedy, George. "The Possibility of a Futures Market in Farm Cost Indexes." Dept. of Agricultural Economics, University of British Columbia, Mimeograph, 1977.

__________. "A Simulation Analysis of Alternative Stabilization Schemes for Hog-Pork Prices." Unpublished Ph.d. Thesis, Department of Agricultural Economics, Purdue University, 1973.

Kulshreshta, S.N. and Wilson, A.G. "A Harmonic Analysis of Cattle and Hog Cycles in Canada." Canadian Journal of Agricultural Economics, Vol. 21, No. 3, November, 1973.

MacAuley, T.G. "The Timing of Deficiency Payments for Stabilization." Canadian Journal of Agricultural Economics, Vol. 25, No. 1, February, 1977.

Martin, L. and MacLaren, D. "Market Stabilization by Deficiency Payment Program: Theoretical Analysis and its Application to the Canadian Pork Sector." Canadian Journal of Agricultural Economics, Vol. 24, No. 2, July, 1976.

Martin, L. "An Analysis of the Amended Agricultural Stabilization Act with Reference to the Livestock Industry." Ontario Agricultural College, University of Guelph, Technical Bulletin AEEE/76/11.

Meilke, K.D. "Another Look at the Hog-Corn Ratio." American Journal of Agricultural Economics, Vol. 59, No. 1, February, 1977, pages 216-219.

Naylor, Thomas H. Computer Simulation Experiments with Models of Economic Systems, New York, John Wiley & Sons, 1971

Naylor, T.H. et al. Computer Simulation Techniques, New York, John Wiley and Sons, 1968.

Orcutt, Guy H. "Simulation of Economic Systems." American Economic Review, Vol. L, No. 5, December, 1960.

Petrie, T.M. "Seasonal, Cyclical and Trend Variations in the Hog Industry." Agriculture Canada, Economics Branch Publication No. 74/20, November, 1974.

Reimer, E.R. "An Econometric Model of the Canadian Livestock-Feed Grains Sector. Unpublished M.Sc. Thesis, University of Saskatchewan. Mimeograph. May, 1973.

Statistics Canada. 1971 Census of Agriculture-British Columbia, Catalogue 96-711, Vol. IV, Part 3, May, 1973.

________________. Farm Input Price Index, Catalogue 62-004, Quarterly.

________________. Farm Cash Receipts, Catalogue 21-201, 1975.

________________. Price and Price Indexes, Catalogue 62-002.

________________. Industry Price Indexes, Catalogue 62-011.

Shubik, Martin. "Simulation of the Industry and the Firm." American Economic Review, Vol. L, No. 5, December, 1960.

Tryfos, P. "The Determinants of Price and Employment in the Canadian Meat Industry". Canadian Journal of Agricultural Economics, Vol. 21, No. 2, July, 1973.

Tweeten, L. and J.S. Plaxico. "Long Run Outlook for Agricultural Adjustments Based on National Growth." Journal of Farm Economics, XLIV, December, 1964.

Tyner, F. and Tweeten, L. "Simulation as a Method of Appraising Farm Programs." American Journal of Agricultural Economics, Vol. 50, No. 1, February, 1968.

West, D.A. and Chin, S.B. "Factors Affecting the Supply of Hogs at the National and Regional Level." Canadian Farm Economics, Vol. 10, No. 2, April, 1975.

West, D.A. and Smith, H.W. "Instability in the Hog Pork Industry." Canadian Farm Economics, Vol. 8, No. 2, April, 1973.

West, D.A., Chin, S.B., and Pando, J.L. "National and Regional Hog Supply Functions." Agriculture Canada, Economics Branch Publication No. 74/15, September, 1974.

Zwart, A. and Martin L. "The North-American Pork Sector - Analysis of its Economic Interrelationships and a Model for Policy Evaluation." Ontario Agricultural College, University of Guelph, Technical Bulletin AE/74/10.

Zwart, Anthony C. "A Recursive Spatial Analysis of the North American Pork Sector." Unpublished M.Sc. Thesis. University of Guelph, August, 1973.

APPENDICES

APPENDIX A

CALCULATION OF COST FIGURES USED IN THE ANALYSIS

Cost Figures Calculations

The cost figures needed to produce one cwt of hog dressed carcass, reported in tables A-1, A-2 and A-3 were estimated as follows:

1. Total Variable Cost was decomposed into three items: feed cost, labour cost and other costs.

   1.1. Feed Cost was estimated using a rate of conversion of 4.375 lbs. of feed to produce one pound of pork (or 3.50 lbs. to produce one pound of live hog). This rate of conversion excludes sow and boar feed, estimated to be 0.95 lbs. In other words, to produce 160 lbs. of pork (dressed carcass weight) it was assumed that 852 lbs. of feed were needed. This figure was taken from FIAP calculations and can be decomposed as follows:

   50 lbs of starter mash and creep feed
   650 lbs grower mash
   152 lbs ground barley
   852 lb in total.

   Price of grower mash and ground barley are British Columbia retail prices taken from Statistics Canada Publication, Price and Price Indexes, Catalogue 62-002 (from 1964 until October, 1975) and from Industry Price Indexes, Catalogue 62-011, starting November, 1975 until

December, 1976.

Since FIAP calculations include bulk feed prices of 10 TON loads which are approximately 83% of the retail prices, in the case of grower mash, wholesale prices were obtained by multiplying grower mash prices by 0.83. In the case of ground barley, retail prices were obtained by increasing grower mash prices by 20 percent.

1.2. Cost of labour. To estimate the cost of labour, the average wage rate of $5.37 per hour used by the FIAP in 1975 was taken as a base. Later, by means of the Index of Farm Labour (hourly rated) for Western Canada, taken from Statistics Canada Publications, Farm Input Price Index, Catalogue 62-004, the rest of the period being simulated was estimated.

1.3. Other Variable Cost. Based on the 1975 FIAP cost calculation it was estimated that other variable costs such as veterinary and medicine, insurance, sow and boar replacement, etc., were equivalent to 4% of the labour plus feed cost.

2. Total Fixed Cost. The total fixed cost was also estimated by means of the average figure reported by the FIAP for 1975, and the Land and Farm Building Index, taken from Statistics Canada, Farm Input Price Index. The average fixed cost calculated by FIAP for 1975 was $20.93 per hog

or \$13.08 per cwt. The Land and Farm Building Index for Western Canada includes: building replacement, building repair, fencing construction and repair, mortgage credit, property taxes and farm rent.

*** TABLE A-1 ***

PRICE OF FEED NEEDED TO PRODUCE ONE HUNDRED WEIGHT OF HOG DRESSED CARCASS

1964-1976

DOLLARS PER HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	17.21	17.18	17.22	17.22	17.24	17.14	17.11	17.13	17.15	17.23	17.19	17.22
1965	17.29	17.19	17.22	17.23	17.23	17.28	17.33	17.37	17.42	17.37	17.38	17.45
1966	17.49	17.57	17.73	18.04	18.11	18.21	18.60	18.75	18.70	18.60	18.38	18.41
1967	18.39	18.40	18.52	18.51	18.54	18.63	18.72	18.61	18.69	18.74	18.74	18.74
1968	18.78	18.85	18.88	18.92	18.92	19.02	18.99	19.08	18.79	18.37	18.31	18.26
1969	18.25	18.34	18.25	18.41	18.35	18.48	18.48	18.51	18.47	18.35	18.00	18.14
1970	18.29	18.25	18.57	18.69	18.54	18.56	18.83	18.90	18.48	18.53	18.86	18.89
1971	18.92	19.19	19.31	19.23	19.38	19.29	19.26	19.24	18.96	19.13	19.01	18.80
1972	19.06	18.98	18.84	19.18	19.08	19.06	19.15	19.11	19.38	19.59	19.63	19.89
1973	21.09	22.73	23.81	24.58	24.79	25.55	27.98	28.40	31.84	33.44	33.33	33.58
1974	34.16	35.30	36.14	36.82	37.55	37.46	36.63	36.82	38.99	40.65	40.86	40.70
1975	40.55	41.38	40.48	40.58	39.49	39.18	39.11	39.34	40.03	39.79	39.15	38.43
1976	37.45	37.82	37.82	37.82	38.77	39.49	38.87	39.84	39.89	38.94	38.56	38.24

SOURCE:STATISTIC CANADA : PRICE AND PRICE INDEXES, CATALOGUE 62-002 AND INDUSTRY PRICE INDEXES,CATALOGUE 62-011. ESTIMATION BASED ON THE 1975 F.I.A.P. COST STRUCTURE.

*** TABLE A-2 ***

PRICE OF ALL VARIABLE INPUTS NEEDED TO PRODUCE ONE HUNDRED WEIGHT OF HOG DRESSED CARCASS

1964-1976

DOLLARS PER HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	21.54	21.51	21.55	21.62	21.63	21.52	21.52	21.54	21.57	21.66	21.62	21.65
1965	21.77	21.66	21.69	21.74	21.74	21.79	21.96	22.01	22.06	22.07	22.07	22.14
1966	22.25	22.33	22.50	22.90	22.97	23.07	23.59	23.74	23.69	23.66	23.43	23.47
1967	23.54	23.55	23.67	23.74	23.76	23.86	24.01	23.90	23.97	24.08	24.08	24.08
1968	24.16	24.23	24.25	24.32	24.32	24.43	24.41	24.51	24.21	23.83	23.77	23.72
1969	23.75	23.84	23.75	24.01	23.94	24.08	24.16	24.20	24.15	24.07	23.71	23.85
1970	24.02	23.98	24.31	24.45	24.31	24.32	24.67	24.74	24.31	24.40	24.74	24.77
1971	24.87	25.15	25.28	25.24	25.40	25.30	25.39	25.36	25.08	25.27	25.15	24.92
1972	25.41	25.32	25.18	25.60	25.51	25.48	25.70	25.67	25.94	26.35	26.39	26.66
1973	28.10	29.80	30.93	31.85	32.07	32.86	35.78	36.22	39.79	41.77	41.65	41.91
1974	42.79	43.98	44.85	45.90	46.66	46.56	46.11	46.31	48.56	50.90	51.13	50.96
1975	51.07	51.92	50.99	51.63	50.49	50.17	50.49	50.73	51.45	51.55	51.00	50.25
1976	49.34	49.72	49.72	49.95	50.95	51.70	51.53	52.54	52.59	52.15	51.75	51.42

SOURCE:STATISTIC CANADA : PRICE AND PRICE INDEXES, CATALOGUE 62-002 AND INDUSTRY PRICE INDEXES,CATALOGUE 62-011. ESTIMATION BASED ON THE 1975 F.I.A.P. COST STRUCTURE.

*** TABLE A-3 ***

PRICE OF TOTAL INPUTS NEEDED TO PRODUCE ONE HUNDRED WEIGHT OF HOG DRESSED CARCASS

1964-1976

DOLLARS PER HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1964	27.71	27.68	27.72	27.82	27.84	27.73	27.74	27.75	27.78	27.88	27.85	27.88
1965	28.57	28.46	28.50	28.56	28.56	28.62	28.79	28.84	28.89	28.91	28.92	28.99
1966	29.78	29.86	30.03	30.46	30.52	30.63	31.17	31.32	31.27	31.25	31.02	31.06
1967	30.39	30.40	30.53	30.62	30.65	30.74	30.91	30.80	30.88	30.98	30.98	30.98
1968	31.25	31.33	31.35	31.45	31.45	31.56	31.55	31.65	31.35	30.98	30.92	30.87
1969	31.33	31.42	31.33	31.68	31.61	31.75	31.79	31.83	31.78	31.75	31.38	31.53
1970	31.59	31.54	31.88	31.99	31.84	31.86	32.21	32.28	31.85	31.96	32.31	32.33
1971	32.56	32.85	32.98	32.98	33.13	33.04	33.18	33.16	32.87	33.10	32.99	32.76
1972	34.48	34.40	34.25	34.72	34.62	34.60	34.89	34.85	35.13	35.63	35.67	35.94
1973	37.97	39.67	40.81	41.82	42.03	42.82	45.79	46.23	49.81	51.85	51.74	52.00
1974	53.71	54.89	55.77	57.03	57.80	57.70	57.34	57.54	59.79	62.11	62.34	62.17
1975	63.97	64.82	63.89	64.62	63.48	63.17	63.65	63.89	64.60	64.92	64.26	63.50
1976	62.91	63.29	63.29	63.68	64.67	65.42	65.30	66.30	66.36	66.04	65.64	65.31

SOURCE:STATISTIC CANADA : PRICE AND PRICE INDEXES, CATALOGUE 62-002 AND INDUSTRY PRICE INDEXES,CATALOGUE 62-011. ESTIMATION BASED ON THE 1975 F.I.A.P. COST STRUCTURE.

APPENDIX B

MODEL VALIDATION:
REAL AND SIMULATED QUANTITIES OF
HOGS PRODUCED UNDER
THE FIAP

*** TABLE B-1 ***

SIMULATED FLOOR PRICE FOR HOGS

FARM INCOME ASSURANCE PROGRAM

(RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROGRAM)

DOLLARS PER HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	51.46	50.57	47.13	45.21	43.16	42.75	45.61	53.21	55.83	55.68	54.43	56.48
1975	58.25	59.53	56.45	58.65	63.59	68.76	75.02	77.44	84.52	79.22	72.76	72.73
1976	70.77	71.41	68.91	65.23	66.57	66.27	66.10	64.39	63.63	59.45	56.11	58.58

SOURCE: TABLE A-1 FOR COST DATA AND AGRICULTURE CANADA, LIVESTOCK AND MEAT TRADE REPORT, FOR EQUILIBRIUM HOG PRICES. F.I.A.P. FIGURES FOR THE NUMBER OF HOGS MARKETED UNDER THE PROGRAM.

*** TABLE B-2 ***

QUANTITIES OF HOG PRODUCED UNDER THE FARM INCOME ASSURANCE PROGRAM

1974-1976

THOUSANDS OF HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	6.39	6.75	9.87	7.97	7.75	10.06	8.12	8.43	10.92	10.06	9.07	11.50
1975	9.20	8.49	11.10	8.78	8.43	10.72	8.13	7.72	10.56	8.35	7.52	9.05
1976	7.08	7.49	8.64	7.05	7.31	9.57	8.05	8.12	9.37	7.19	8.98	14.70

SOURCE : AGRICULTURE CANADA LIVESTOCK AND MEAT TRADE REPORT

*** TABLE B-3 ***

SIMULATED QUANTITIES OF HOG PRODUCED

FARM INCOME ASSURANCE PROGRAM

(RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROGRAM)

THOUSANDS OF HUNDRED WEIGHT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	6.39	6.77	9.86	7.83	7.44	9.69	7.67	8.27	10.69	10.04	9.03	11.41
1975	9.17	8.23	10.97	8.57	8.23	11.01	8.38	7.94	10.67	8.68	7.85	9.36
1976	7.50	7.86	8.99	7.65	7.54	9.79	8.38	8.43	9.52	7.37	8.63	14.16

*** TABLE B-4 ***

AGRICULTURAL STABILIZATION ACT FLOOR PRICE FOR HOGS AND PER UNIT FEDERAL SUBSIDY

1964-1976

DOLLARS PER HUNDRED WEIGHT

YEAR	EQUI. PRICE	FLOOR PRICE	FED.SUB.
1964	25.3900	20.6920	0.0000
1965	34.4900	20.5544	0.0000
1966	32.1000	21.5168	0.0000
1967	27.6000	21.9752	0.0000
1968	30.6600	21.7184	0.0000
1969	36.0200	21.9312	0.0000
1970	26.9600	23.1160	0.0000
1971	25.4900	23.3264	0.0000
1972	38.6100	23.3864	0.0000
1973	51.7900	24.2352	0.0000
1974	48.5700	26.3288	0.0000
1975	69.2900	45.6656	0.0000
1976	57.7200	50.7970	0.0000

APPENDIX C

RESULTS OF ALTERNATIVE STABILIZATION SCHEMES

*** TABLE C 1 ***

MARKET EQUILIBRIUM VALUES.

MEAN AND STANDARD DEVIATION OF HOG PRICES.QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	85.09	3369.90	630.81
MEAN (MONTHLY AVERAGE)	30.64	38.43	7.09	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	16.68	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.39	----	----
STAND. DEV. (ANNUAL AVERAGE)	----	----	23.53	1793.46	526.18

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
	THOUSANDS OF DOLLARS	
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	0.000	0.000
B.C. HOG PRODUCERS	0.000	0.000

SOURCE : AGRICULTURE CANADA LIVESTOCK AND MEAT TRADE REPORT.
RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).

*** TABLE C 2 ***

PRODUCT PRICE SUPPORT PROGRAM.

MEAN AND STANDARD DEVIATION OF HOG PRICES, QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	91.36	3755.30	818.08
MEAN (MONTHLY AVERAGE)	30.64	39.59	7.61	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	16.35	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.63	----	----
STAND. DEV. (ANNUAL AVERAGE)	----	----	25.10	1979.58	512.24

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
	THOUSANDS OF DOLLARS	
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	-2294.748	-1697.753
B.C. HOG PRODUCERS	-596.993	1697.753

INCLUDES A SHIFTER PARAMETER OF THE SUPPLY FUNCTION TO ACCOUNT FOR A MORE STABLE (IF POSITIVE) OR UNSTABLE (IF NEGATIVE) PRODUCTION ENVIROMENT, DUE TO STABILIZATION EFFORTS.
NO FEDERAL STABILIZATION SCHEME INCLUDED.
PROVINCIAL SUPPORT LEVEL AT 75.0% OF NET MARGIN OR RETURN DEFICIT.
RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
PRODUCER PREMIUM INCLUDED IN ALL MONTHS.
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).
RETURN DEFICIT USED TO CALCULATE THE FLOOR AND CEILING PRICES FOR HOGS BASED ON INDEX 100 HOG PRICES.

*** TABLE C 3 ***

PRODUCT PRICE SUPPORT PROGRAM.

MEAN AND STANDARD DEVIATION OF HOG PRICES,QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	90.56	3677.58	767.03
MEAN (MONTHLY AVERAGE)	30.64	39.12	7.55	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	16.26	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.60	----	----
STAND. DEV. (ANNUAL AVERAGE)	----	----	24.73	1938.21	493.15

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
	THOUSANDS OF DOLLARS	
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	-2013.863	-1126.633
B.C. HOG PRODUCERS	-887.228	1126.633

INCLUDES A SHIFTER PARAMETER OF THE SUPPLY FUNCTION TO ACCOUNT FOR A MORE STABLE (IF POSITIVE) OR UNSTABLE (IF NEGATIVE) PRODUCTION ENVIROMENT, DUE TO STABILIZATION EFFORTS.
NO FEDERAL STABILIZATION SCHEME INCLUDED.
PROVINCIAL SUPPORT LEVEL AT 100.0% OF NET MARGIN OR RETURN DEFICIT.
RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
PRODUCER PREMIUM INCLUDED IN ALL MONTHS.
PRODUCER PREMIUM CHANGED BY 50.0% ,COMPARED TO THE 1976 FIAP RATE OF $1.5 PER CWT OF HOG PRODUCED (DRESSED CARCASS).
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).
RETURN DEFICIT USED TO CALCULATE THE FLOOR AND CEILING PRICES FOR HOGS BASED ON INDEX 103 HOG PRICES.
NET MARGIN CALCULATED AFTER REDUCING THE TOTAL AMOUNT OF FIXED COSTS TO A 83.0% OF THE FIAP FIGURES.

*** TABLE C 4 ***

PREMIUM-SUBSIDY PROGRAM.

MEAN AND STANDARD DEVIATION OF HOG PRICES, QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	91.23	3748.10	817.53
MEAN (MONTHLY AVERAGE)	30.64	39.54	7.60	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	16.03	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.59	----	----
STAND. DEV. (ANNUAL AVERAGE)	----	----	24.90	1957.99	480.83

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
	THOUSANDS OF DOLLARS	
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	-2280.930	-1681.581
B.C. HOG PRODUCERS	-599.348	1681.581

INCLUDES A SHIFTER PARAMETER OF THE SUPPLY FUNCTION TO ACCOUNT FOR A MORE STABLE (IF POSITIVE) OR UNSTABLE (IF NEGATIVE) PRODUCTION ENVIROMENT, DUE TO STABILIZATION EFFORTS.
NO FEDERAL STABILIZATION SCHEME INCLUDED.
PROVINCIAL SUPPORT LEVEL AT 75.0% OF NET MARGIN OR RETURN DEFICIT AND CEILING 2.5% ABOVE THE FLOOR PRICE.
RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
NO FIXED PRODUCER PREMIUM INCLUDED.
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).
RETURN DEFICIT USED TO CALCULATE THE FLOOR AND CEILING PRICES FOR HOGS BASED ON INDEX 100 HOG PRICES.

*** TABLE C 5 ***

SELF-FINANCING PRODUCT PRICE SUPPORT PROGRAM

MEAN AND STANDARD DEVIATION OF HOG PRICES, QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	89.61	3563.23	692.86
MEAN (MONTHLY AVERAGE)	30.64	38.49	7.47	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	15.91	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.53	----	----
STANC. DEV. (ANNUAL AVERAGE)	----	----	24.25	1842.34	427.49

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
	THOUSANDS OF DOLLARS	
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	-2236.160	-244.956
B.C. HOG PRODUCERS	-1991.201	244.956

INCLUDES A SHIFTER PARAMETER OF THE SUPPLY FUNCTION TO ACCOUNT FOR A MORE STABLE (IF POSITIVE) OR UNSTABLE (IF NEGATIVE) PRODUCTION ENVIROMENT, DUE TO STABILIZATION EFFORTS.
NO FEDERAL STABILIZATION SCHEME INCLUDED.
PROVINCIAL SUPPORT LEVEL AT 75.0% OF NET MARGIN OR RETURN DEFICIT.
RESTRICTICNS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
PRODUCER PREMIUM INCLUDED IN ALL MONTHS.
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).
RETURN DEFICIT USED TO CALCULATE THE FLOOR AND CEILING PRICES FOR HOGS BASED ON INDEX 100 HOG PRICES.
SLIDING PREMIUM WITH FARMERS CONTRIBUTING 100.0% AND THE PROV. GOV. 0.0% OF THE TOTAL PREMIUMS PAID.

*** TABLE C 6 ***

SELF-FINANCING PREMIUM-SUBSIDY PROGRAM.

MEAN AND STANDARD DEVIATION OF HOG PRICES,QUANTITIES OF HOG PRODUCED AND FARMERS INCOME AND REVENUE.

	VAR. INPUT PRICES $/CWT	HOG PRICES $/CWT	HOG PRODUCTION TH. CWT	TOTAL REVENUE TH. $	GROSS INCOME TH. $
MEAN (ANNUAL AVERAGE)	----	----	89.18	3543.14	687.29
MEAN (MONTHLY AVERAGE)	30.64	38.35	7.43	----	----
STAND. DEV. (MONTHLY AVERAGE BETWEEN YEARS)	12.33	15.51	----	----	----
STAND. DEV. (MONTHLY AVERAGE WITHIN YEARS)	----	----	2.39	----	----
STAND. DEV. (ANNUAL AVERAGE)	----	----	23.84	1815.49	409.79

FEDERAL GOVERNMENT TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS.

PROV. GOV. TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM FARMERS AND/OR THE FED. GOV.

FARMERS TOTAL AND NET CONTRIBUTIONS TO OR RECEIPTS FROM THE PROV. GOV. AND/OR THE FED. GOV.

THOUSANDS OF DOLLARS

	TOTAL PAYMENTS (-) AND/OR RECEIPTS (+).	NET PAYMENTS (-) AND/OR RECEIPTS (+).
FED. GOV. ANNUAL PROGRAM	0.000	----
FED. GOV. MONTHLY PROGRAM	0.000	----
PROV. GOV. MONTHLY PROGRAM	-1585.072	-254.517
B.C. HOG PRODUCERS	-1330.554	254.517

INCLUDES A SHIFTER PARAMETER OF THE SUPPLY FUNCTION TO ACCOUNT FOR A MORE STABLE (IF POSITIVE) OR UNSTABLE (IF NEGATIVE) PRODUCTION ENVIROMENT, DUE TO STABILIZATION EFFORTS.
NO FEDERAL STABILIZATION SCHEME INCLUDED.
PROVINCIAL SUPPORT LEVEL AT 75.0% OF NET MARGIN OR RETURN DEFICIT AND CEILING 1.5% ABOVE THE FLOOR PRICE.
RESTRICTIONS ON WHAT HOGS QUALIFY FOR THE PROVINCIAL PROGRAM.
SLIDING PREMIUM WITH FARMERS CONTRIBUTING 100.0% AND THE PROV. GOV. 0.0% OF THE TOTAL PREMIUMS PAID.
NO FIXED PRODUCER PREMIUM INCLUDED.
PRICE OF HOGS BASED ON HOGS INDEX 100 (DRESSED CARCASS WEIGHT).
RETURN DEFICIT USED TO CALCULATE THE FLOOR AND CEILING PRICES FOR HOGS BASED ON INDEX 103 HOG PRICES.
NET MARGIN CALCULATED AFTER REDUCING THE TOTAL AMOUNT OF FIXED COSTS TO A 85.0% OF THE FIAP FIGURES.

APPENDIX D

NUMERICAL RESULTS OF SIMULATION RUNS AND ESTIMATED REGRESSION COEFFICIENTS

Table D-1 Numerical Results of Simulation Runs for FIAP (1975)
Change in Behavioral Parameters
(1964-1976)

Run	Independant Variables		Summary Measures				
	α_1	α_{14}	Average Gross Income per year (th of dollars)	Absolute Variation of Income (st.dev in th of dollars)	Relative Variation of Income (Coef. of Variation)	Net Prov. Gov.Payouts (th of dollars per period)	Hog Production (th of lbs)
1	0.00235	-0.0072	854	547	64	1,707	9,418
2	0.00235	-0.0261	854	547	64	1,716	9,418
3	0.00065	-0.0072	810	504	62	1,694	9,077
4	0.00065	-0.0261	810	503	62	1,703	9,077
5	0.00150	-0.0134	835	530	63	1,705	9,267
6	0.00270	-0.0134	861	552	64	1,712	9,470
7	0.00030	-0.0134	799	491	61	1,694	8,996
8	0.00150	-0.0033	835	531	63	1,699	9,267
9	0.00150	-0.0300	835	530	63	1,712	9,268

Table D-2 Numerical Results of Simulation Runs for FIAP (1975)
Change in Policy Parameters
(1964-1976)

Run	Independant Variables		Summary Measures				
	α_{22}	α_{24}	Average Income per year (th of dollars)	Absolute Variation of Income (Average dev.in th of dollars	Relative Variation of Income (Coef. of Variation)	Net Prov. Gov.Payouts (th of dollars per period)	Hog Production (th of lbs)
1	0.963	0.963	865	519	60	2,215	9,197
2	0.963	0.787	808	512	63	1,584	9,114
3	0.787	0.963	818	512	63	1,694	9,134
4	0.787	0.787	771	508	66	1,183	9,066
5	0.875	0.875	815	512	63	1,661	9,126
6	1.000	0.875	854	517	61	2,086	9,183
7	0.750	0.875	779	508	65	1,271	9,076
8	0.875	1.000	845	517	61	1,988	9,166
9	0.875	0.750	785	509	65	1,335	9,087

Table D-3 Estimated Regression Coefficients of Performance Functions for the FIAP (1975)

Change in Policy Parameters (1964-1976)

Independant Variables	Summary Measures				
	Average Gross Income Per Year (th of dollars)	Absolute Variation of Income (sd.dev. in th of dollars)	Relative Variation of Income (Coef.of Variation)	Net Prov. Gov.Pay-outs (th of dollars)	Hog Production (th of lbs)
Intercept	654.3	602.9	91.9	331.0	9,030.7
α_{22}	-167.9	-107.5	-16.5	-2,358.8	-431.7
α_{24}	- 1.8	-165.5	-16.5	- 469.1	- 94.6
$(\alpha_{22})^2$	88.5	32.1	0.0009	1,091.5	217.1
$(\alpha_{24})^2$	- 7.5	64.2	0.001	3.5	24.6
$\alpha_{22}\ \alpha_{24}$	322.8	96.9	0.0005	3,873.9	484.3
R^2	0.988	0.997	0.999	0.988	0.978