AN OPTIMAL POLICY MODEL FOR THE CANADIAN PORK INDUSTRY

Gerald Robertson

October 1983
WP-83-109

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
2361 Laxenburg, Austria

FOREWORD

Understanding the nature and dimensions of the world food problem and the policies available to alleviate it has been the focal point of the IIASA Food and Agriculture Program since it began in 1977.

National food systems are highly interdependent, and yet the major policy options exist at the national level. Therefore, to explore these options, it is necessary both to develop policy models for national economies and to link them together by trade and capital transfers. For greater realism the models in this scheme are being kept descriptive, rather than normative. In the end it is proposed to link models to twenty countries, which together account for nearly 80 per cent of important agricultural attributes such as area, production, population, exports, imports and so on.

As a part of this sytem a national agricultural policy model for Canada is also being developed.

The study by Gerald Robertson described here on the optimal policy for the Canadian pork industry provides insights into policy formulations. These also help us in the development of the Canadian Agricultural Policy Model.

Kirit Parikh
Program Leader

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INTRODUCTION

Canadian agriculture, like that of most developed countries, is characterized by many policies for stabilization, income support and insurance. In spite of all these policies relating to Canadian agriculture, it is still characterized by large cyclic fluctuations in aggregate production and prices, particularly in the livestock sector. These fluctuations can cause not only inefficient use of resources, but also great personal hardship for individual farmers whose production, prices and incomes are likely to fluctuate more than the aggregate. This paper will attempt to analyze in a quantitative model, policies whose objective it is to stabilize the Canadian pork industry.

Pork is an important food and agricultural product. Around 1200 million pounds of pork were produced in 1978, providing about $1300 million in cash receipts. However, both production and prices in the pork sector are cyclic. The cyclical nature of the hog industry is usually attributed to the lag between the production decision and the realization of that production. This lag is long enough that producers' expectations are not usually met. The relatively inelastic supply and demand functions of agriculture generally cause greater price fluctuations than that of nonagriculture goods. This combined with fluctuations in supply for biological reasons, input prices or fluctuations in international demand can cause large fluctuations in price.

PROBLEM STATEMENT

The hog industry experiences cycles of three to four years which can cause economic hardship to hog producers. It can also cause an inefficient use of resources as hog enterprises start and stop in response to the price cycle. The agricultural policy-maker has introduced various policies such as the Agricultural Stabilization Act to deal with these cycles.

In the past, most quantitative policy analysis has been of a "what if" nature. First a model, usually econometric, would be constructed, then a potentially useful policy would be proposed, and finally the model would be simulated to see the effect of the proposed policy. However, for policy formulation, simulation has two limitations. First, the above process may ignore feasible alternatives, some of which might be "better" than those presented. Second, simulation does not allow the policy-maker explicit trade-offs either between the policy instrument and the target variables or between the various target variables.

The general problem of this paper is to use optimal control theory to determine optimal policy rules to stabilize or at least to dampen the cyclical nature of the Canadian hog industry.

THE ECONOMETRIC MODEL

The purpose of this section is to present a quarterly econometric model of the North American pork industry and to show the results of the validation of the model. The model attempts to represent the hog cycle and forms the basis for the policy simulations and the optimal policy analysis. This econometric model is very similar to Zwart and Martin (1974), but is simpler in that the trade flows are determined behaviourally rather than with a spatial equilibrium model. The econometric model is kept simple in that it is linear and that only adaptive expectations are used.

In presenting the results of the estimation and later in the optimal control section, the variables are represented by mnemonics. The mnemonic is made up of three parts. The first part is the economic concept, D for demand or disappearance, Q for quantity or production, I for inventory or stocks, NT for net trade and P for price. The second part is the commodity, for example, PK for pork or HG for hogs. The third part is the region, or regions, (1) for Western Canada, (2) for Eastern Canada, (3) for Canada, and (4) for the United States. There is one exception to this: the policy variable begins with an X. See Table 1 for a complete list of the mnemonics.

The specification of the equations for each of the three regions is basically identical. Each region has a demand equation, a supply response equation, a stocks equation and a closing identity. Each of the regions is joined to the others by a price transmission equation through which directional net trade is determined. The estimation results presented are Ordinary Least Squares. Two-stage least squares and Iterative Instrumental variable estimates were done but proved to be not significantly different and therefore O.L.S. was used for its simplicity. The results for the period 1966 quarter 2 to 1977 quarter 4 are presented in Tables 2 through 6. The model was simulated over the estimation period and over an extra-sample period from 1978 first quarter to 1978 fourth quarter to validate it. The results are presented in Tables 7 and 8.

AGRICULTURAL STABILIZATION ACT POLICY ANALYSIS

This model was used to simulate the effects of the current provisions of the Agricultural Stabilization Act. This simulation represents what would have happened if this policy had been in place over the period from the first quarter of 1970 to the fourth quarter of 1977.

According to the Act, the payment for hogs would be the difference between the current price and 90 percent of a five-year moving average price adjusted for changes in cash costs. Neither the Agricultural Stabilization Act, as passed in 1958, nor its 1975 revisions are very explicit about the objectives of the policy. They do say the objective is to stabilize the industry. However, as shown later, the objective may need to be more specific. For example, is the objective to stabilize price including or excluding the payment, production, stocks, trade, margin or income?

For the simulation of the A.S.A. policy, the payment was calculated as the difference between the current Canadian price and 90 percent of a five-year moving average Canadian price. For purposes of this simulation the cash costs were ignored in calculating the payment. When the simulation was run calculating the payments endogenously (i.e. using simulated prices), there were no payments made. The simulated price never dropped below a 90 percent moving average of the simulated prices. So a second simulation was run, using payments which were calculated exogenously (i.e. using the actual prices), five quarterly payments would have been made from 1970 fourth quarter through 1971 fourth quarter. In reality, this policy as described above was not in place in 1970. However, there was a policy in place in 1970 which did make a payment in 1971.

From the simulation results in Figures 1 and 2 and Table 9, the policy appeared to have little effect on the industry. These results must be critically examined noting that the cash costs were not used in calculating the payment.

The multipliers with respect to a dollar of payout are presented in Table 10. It must be noted that these figures are meant to measure only the effect of the producers' perceived increase in price, not the effect of the decrease in risk as a result of having the policy in place.

OPTIMAL CONTROL ANALYSIS

While optimal control has been used extensively in macroeconomics, there have been very few studies whose purpose was the stabilization of an agricultural commodity (Freebairn, 1972, and Arzac, 1979). Most of these have dealt with the stabilization of a large part of the agricultural sector. This section will present some analysis of the hog cycle using the techniques of optimal control.

In any policy analysis one must begin with an analysis of the objectives of the policy. This is especially true with quantitative policy analysis. Optimal control forces the policy analyst, if not the policy-maker, to be very specific about the objective of the policy and it also forces the construction of a loss function containing the variables of interest.

The results of ten experiments are presented in this paper. The experiments were designed to treat four primary objectives:

1) stabilize the price excluding the payment

2) stabilize the price including the payment

3) stabilize the margin above feed cost excluding the payment

4) stabilize the margin above feed cost including the payment

and one combined objective in which all these objectives were included in the objective function together. Each of these was run with payments only, and also with payments and premiums.

To aid in comparing the various policies which were optimal for different objectives an attempt was made to choose the weights in the objective function, for the payout only experiments, so that the average payments, over the period from the first quarter to 1970 to the fourth quarter of 1977, were all about 20 cents/cwt. The premium/payout policies were run with the same weights as that for the corresponding payout only experiment. The combined objective experiments were run with the weights which were used in each of the primary experiments. In general, the average payout will not be 20 cents/cwt and this should be kept in mind when analyzing the impacts of the various proposed policies.

The targets for the four primary experiments were seasonal trends estimated over the control period, For each of these objectives the experiment would tell us whether the optimal linear feedback rule is stable or not and also whether the rule is different for different objectives.

The results of the experiments are presented in Tables 11 through 13. In Table 11, the first line of each cell is the mean residual (simulated value minus the target value). The second line of each cell is the standard deviation of the residuals. Comparing the standard deviations for all the variables between the base run and the A.S.A. simulation, there appears to be no significant reduction in the standard deviation of any of the variables. Three comments are needed. One that this conclusion assumes that the objective of the A.S.A. policy was to stabilize one of the variables selected about the targets chosen for that variable. The second comment is that the A.S.A. simulation has an average payout of 52 cents/cwt per quarter while the other payout only policies have average payouts of 20 cents/cwt per quarter. The third comment is that the cash costs were not used in calculating the A.S.A. payments.

Comparing the other payout only policies, in every column of the table the standard deviation is the smallest for the all targets policy. This is because the average payout for this experiment was 53 cents/cwt per quarter compared to 20 cents/cwt per quarter for the single variable experiments.

Comparing each of the payout policies, in turn, with its corresponding payin/payout policy, the payin-payout policy was always more effective in reducing the standard deviation than the payout only policy. Also the policies whose objective it was to stabilize the price or the margin including the payment were more successful in stabilizing their variable and they did so at a higher level.

Table 12 presents the results of the experiments on production and trade. For this table, the first line of each cell is the mean of the simulated policy variable and the second line is the standard deviation of the simulated policy variable. For the base run the mean of the variable QPK1 was 112.70, and the standard deviation was 29.07, whereas for the A.S.A. simulation the mean was 113.93 and the standard deviation was 30.11. This means that the A.S.A. simulation generated a higher mean QPK1 but also a higher standard deviation.

In Table 13 the cost of the various policies is presented. The A.S.A. simulated policy cost over $6.2 million over 32 quarters or on average $194 thousand each quarter. In all eight of the single objective experiments the total payout is a little over $2 million or about 67 thousand per quarter. Three of the four policies which also have payins collected money on average for the 1970 to 1977 period.

The four policies with payouts only averaged payments between $67 and $79 thousand per quarter. The four policies with payins and payouts averaged between a payin of $25 thousand and a payout of $35 thousand. Also, as noted earlier, the policies with payins were also in general more effective. The pattern of the payments is shown in Figures 3 and 4.

SUMMARY

The development of econometric commodity models has provided an instrument for studying the simultaneous time-dependent relationships between economic variables and their response to policy variables. In addition, recent advancements in computational algorithms for efficient solution of a set of simultaneous difference equations combined with advances in computer technology has made the computer simulation of econometric models a useful way to compare the dynamic effects of different economic stabilization policies. Although simulation is an extremely useful tool for the planning and analysis of stabilization policies, it does not provide a direct means of obtaining a policy that is optimal with respect to a given set of objectives.

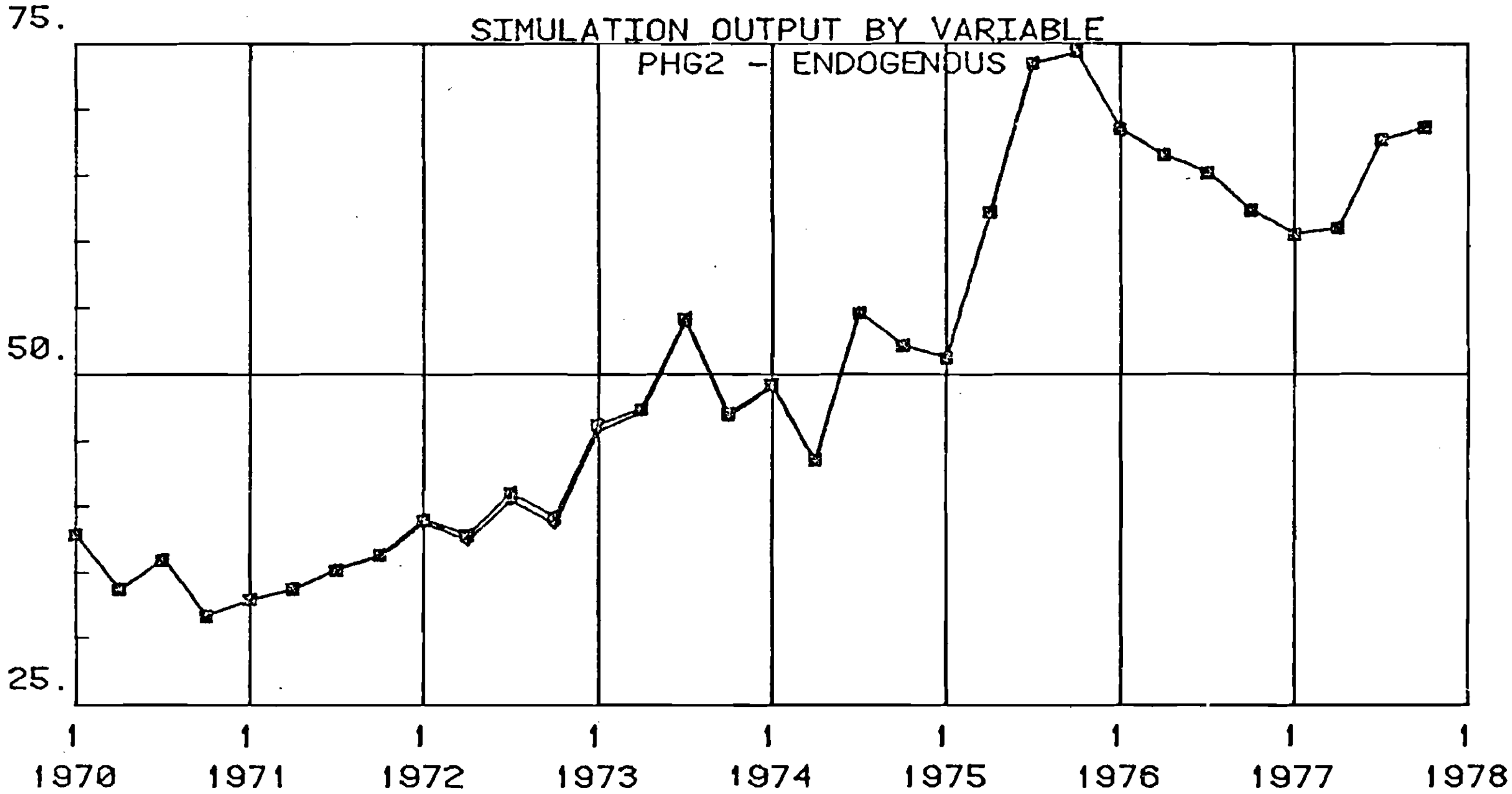
Recently, there has been an interest in optimal control theory as a possible tool for economic policy development. Given an econometric commodity model that one is willing to accept as a reasonable representation of the market, and given an objective function that approximates the goals and objectives of stabilization, then the design of stabilization can easily, and often should, be thought of as an optimal control problem.

In this study some optimal control techniques were used to analyze the structure of the Canadian pork industry and to suggest some alternative policies.

CONCLUSIONS

The first conclusion which can be made from this paper is that optimal control theory is a useful technique for policy formulation. That is not to suggest that the rules which result from an application of optimal control should be put in place without further study, but rather that those policies can be used to indicate where improvements can be made to current policies. The second conclusion is that this analysis suggests that it would appear to be useful for the agricultural policy-maker to consider policies which collect premiums as well as give payouts.

Figure 1. The Effect of the A.S.A. Simulation on the Eastern Canada Hog Price ($/cwt.)

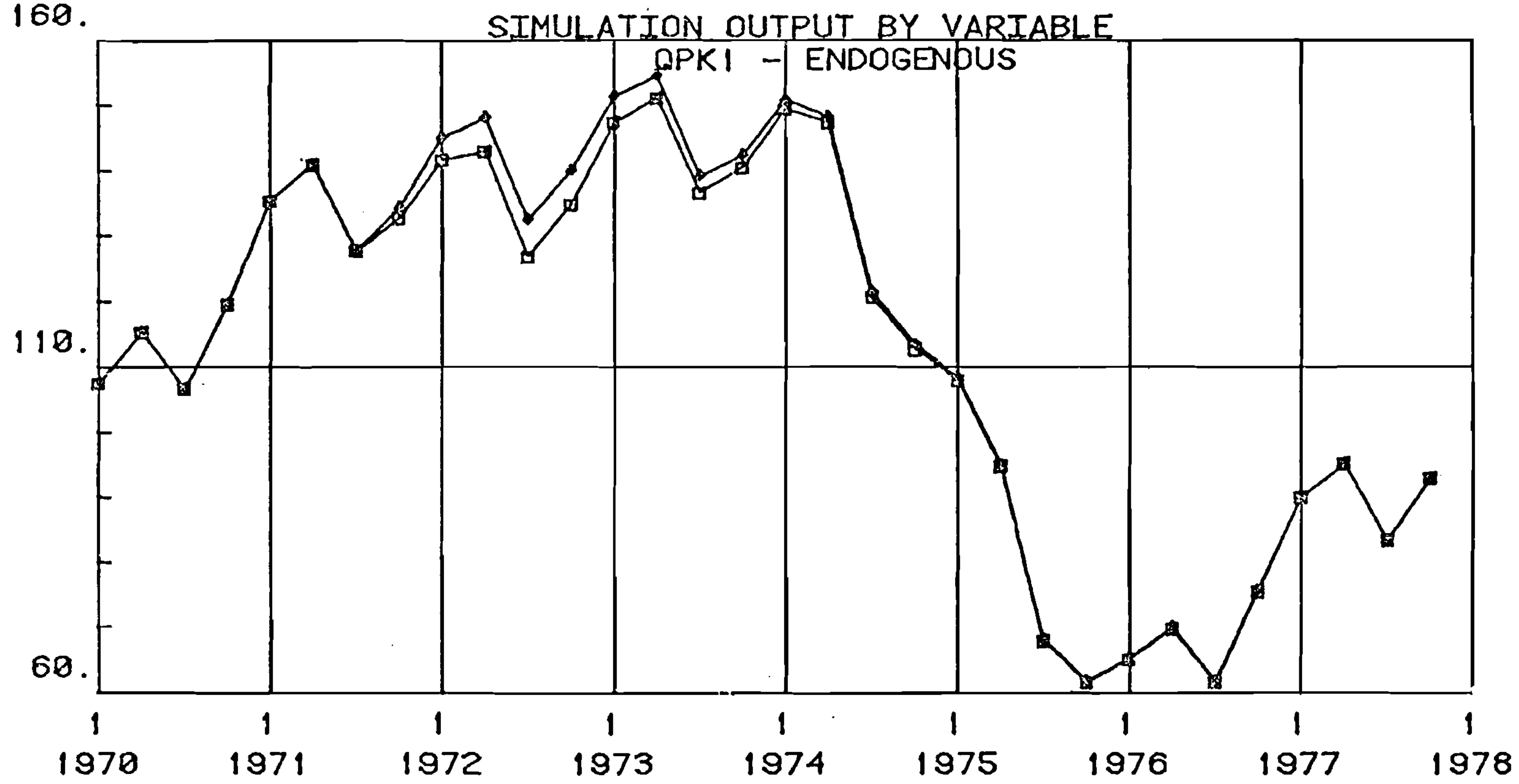


TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL SCALE NAME

□	#1	BASERUN - Baserun
◇	#1	PLPKASA2 - A.S.A. Simulation

Figure 2. The Effect of the A.S.A. Simulation on Western Canada Pork Production (mil. lbs.)



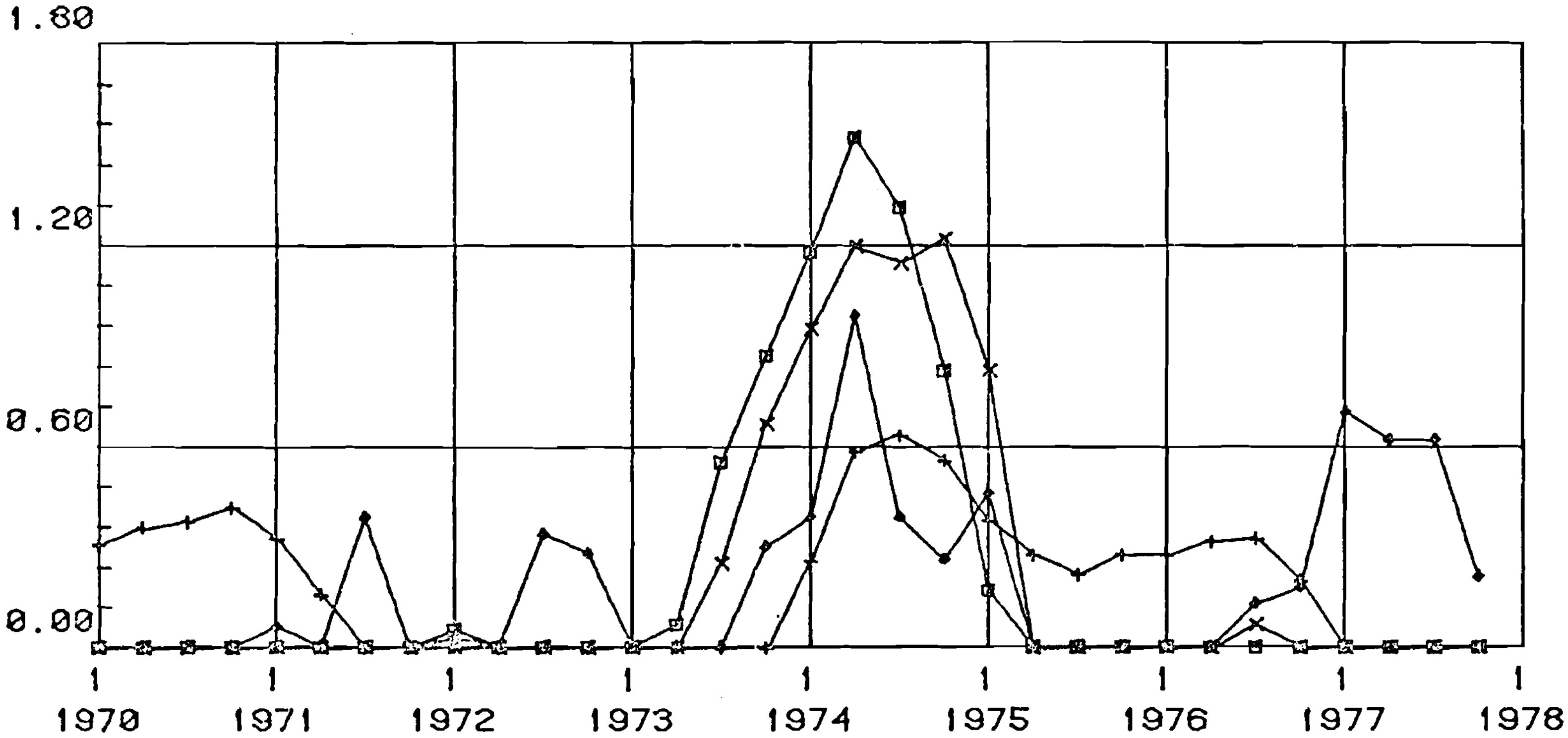
TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL SCALE NAME

□ #1 BASERUN - Baserun

◇ #1 PLPKASA2 - A.S.A. Simulation

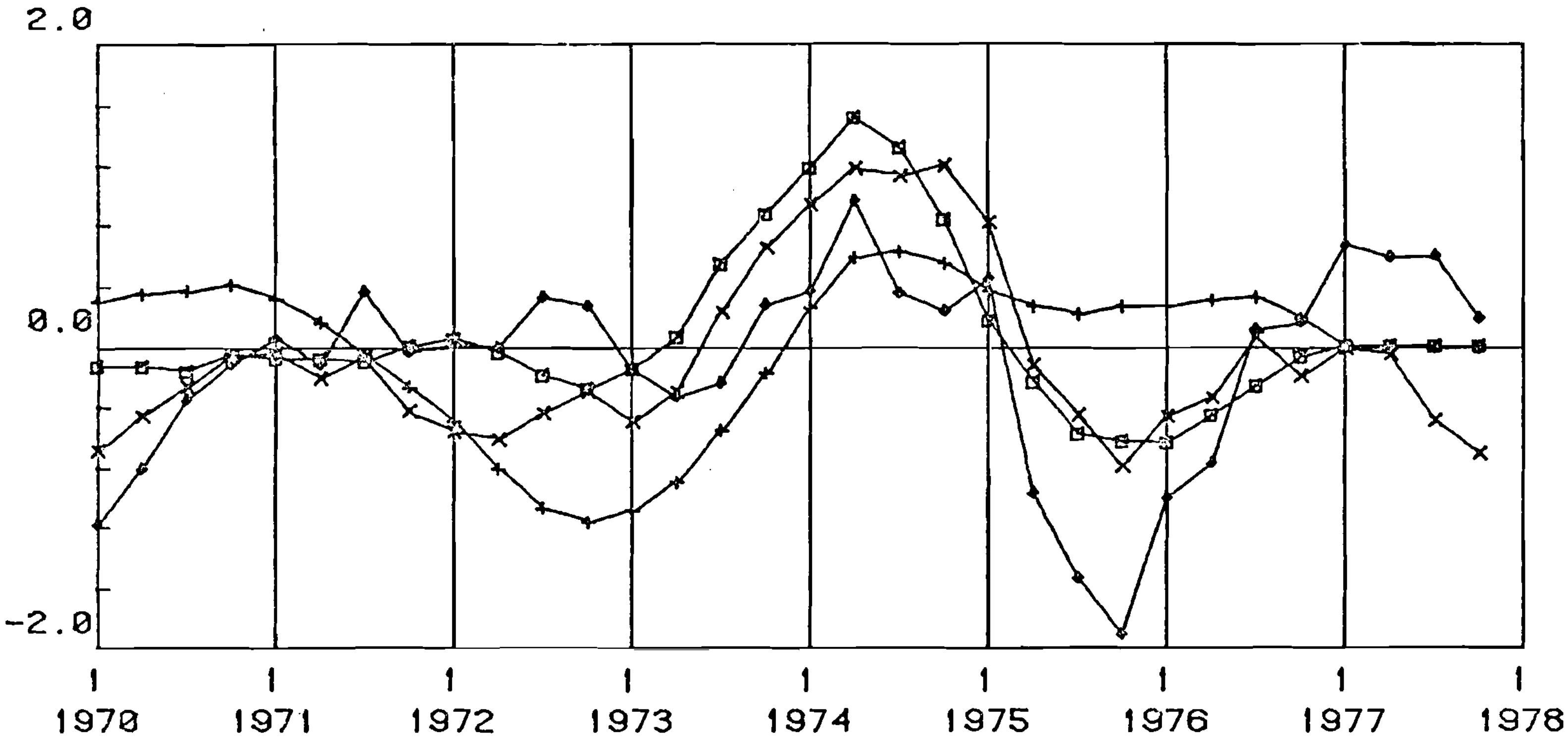
FIGURE 3. PAYMENT PATTERN FOR THE PAYOUT ONLY EXPERIMENTS ($/cwt.)



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME	
□	#1	PCON_XDPHG3	- Stabilize Price Excluding the Payment
◇	#1	PDPCON_XDPHG3	- Stabilize Price Including the Payment
+	#1	MRCON_XDPHG3	- Stabilize Margin Excluding the Payment
×	#1	MRDPCON_XDPHG3	- Stabilize Margin Including the Payment

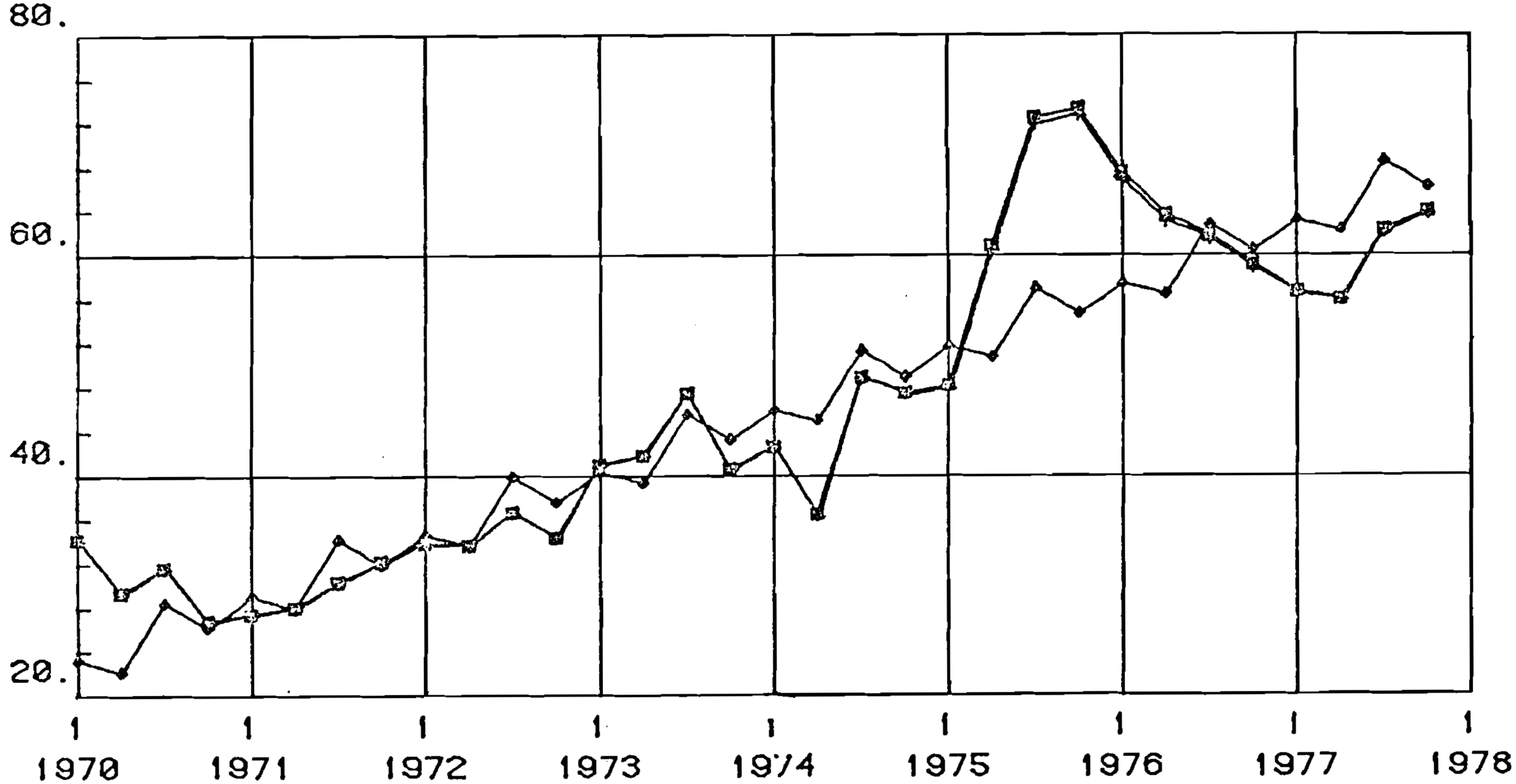
FIGURE 4. PAYMENT PATTERN FOR THE PAYIN-PAYOUT EXPERIMENTS ($/cwt.)



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME	
□	#1	PUN_XDPHG3	- Stabilize Price Excluding the Payment
◆	#1	PDPUN_XDPHG3	- Stabilize Price Including the Payment
+	#1	MRUN_XDPHG3	- Stabilize Margin Excluding the Payment
×	#1	MRDPUN_XDPHG3	- Stabilize Margin Including the Payment

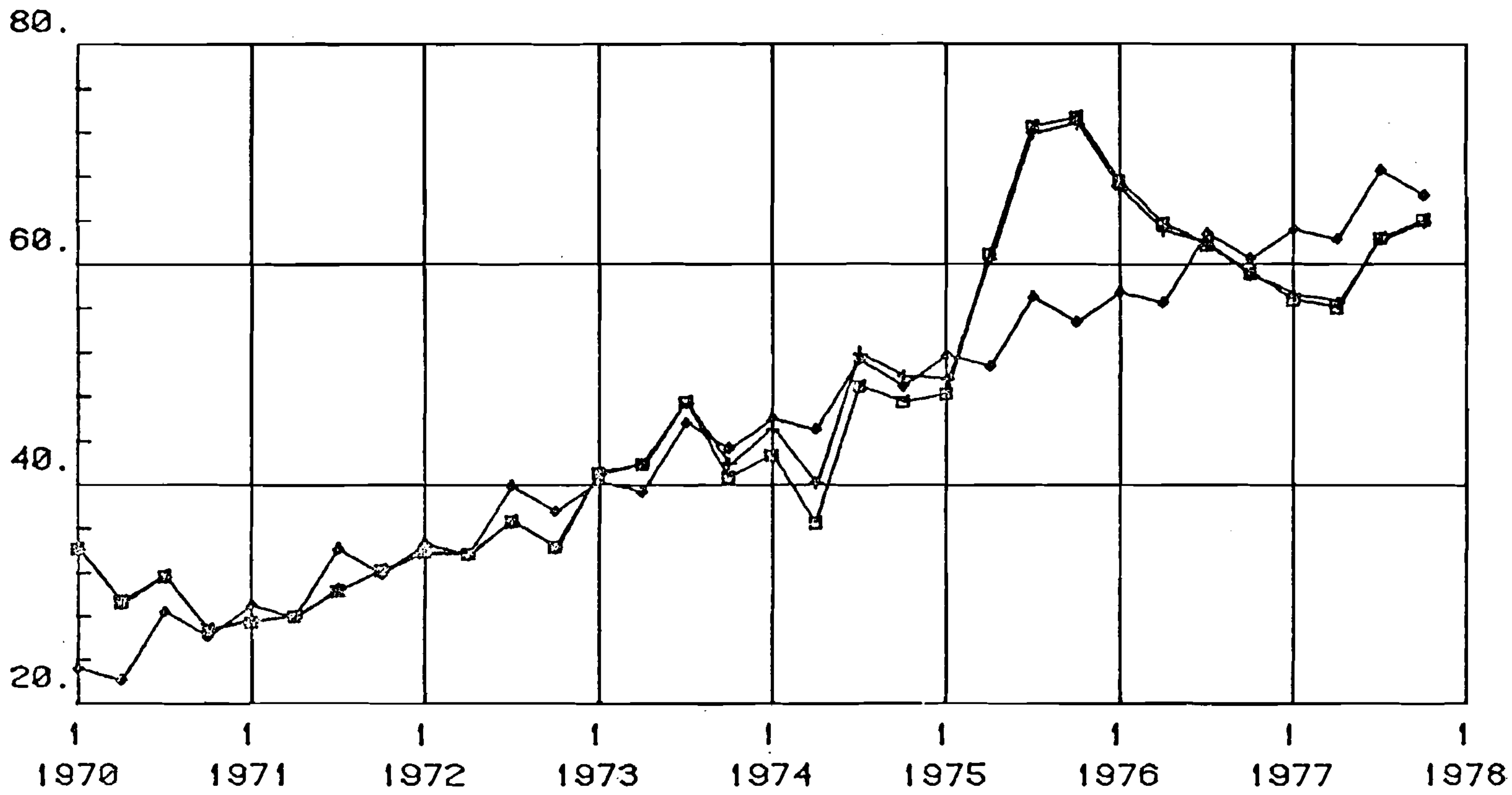
Figure 5. The Effect of the All Target Variables With Payouts Only Experiment on the Price



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME	
◻	#1	BASERUN_PHG1 - Baserun Price	($/cwt.)
◆	#1	NEWPORK_PHG1TAR - Target Price	($/cwt.)
+	#1	ALLCON_PHG1 - Experiment Price	($/cwt.)

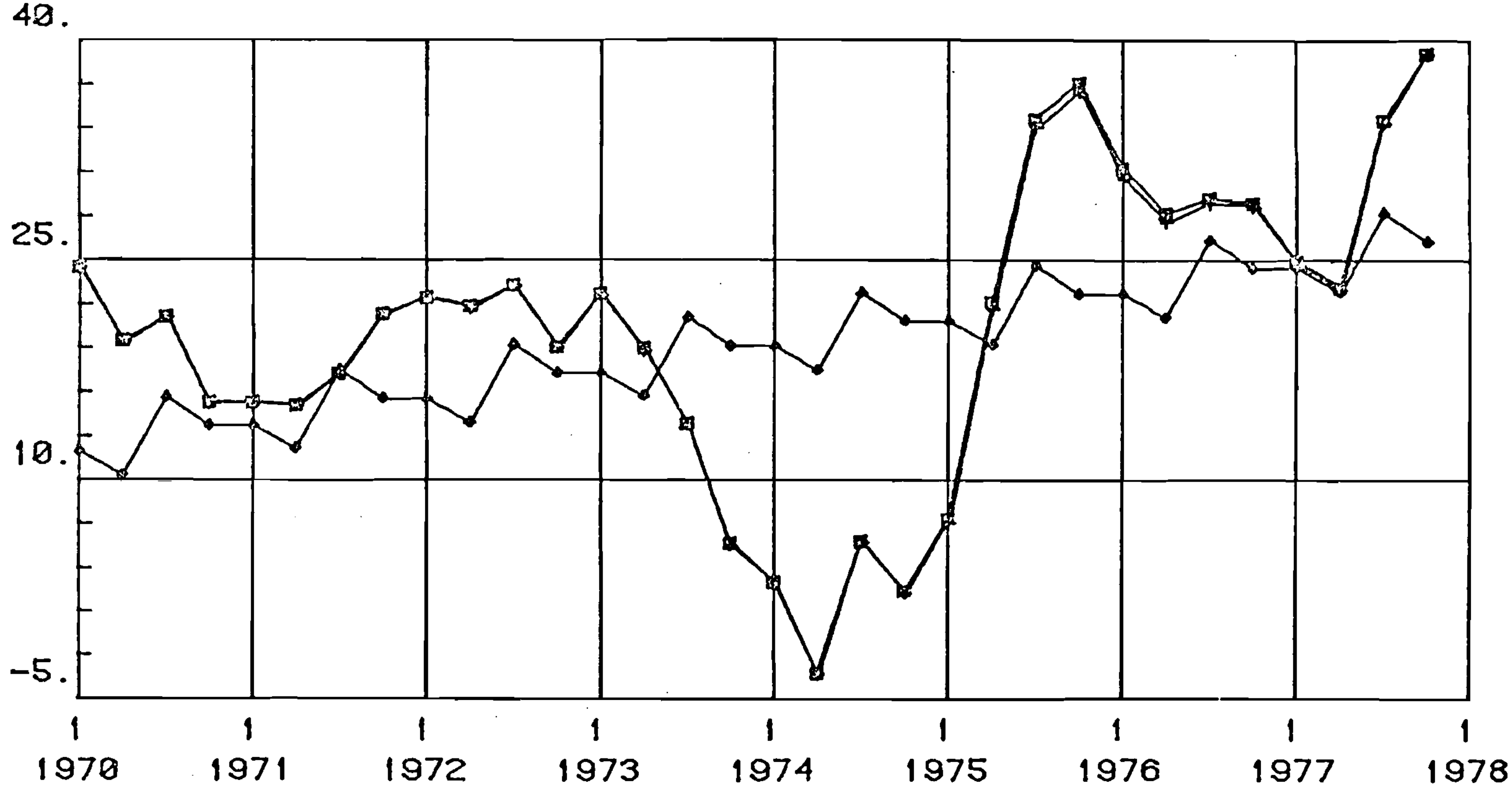
Figure 6. The Effect of the All Target Variables With Payouts Only Experiment on the Price & Payment



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME
□	#1	BASERUN_PHG1 - Baserun Price & Payment ($/cwt.)
◆	#1	NEWPORK_PHG1TAR - Target Price & Payment ($/cwt.)
+	#1	ALLCON_PHG1DP -- Experiment Price & Payment($/cwt.)

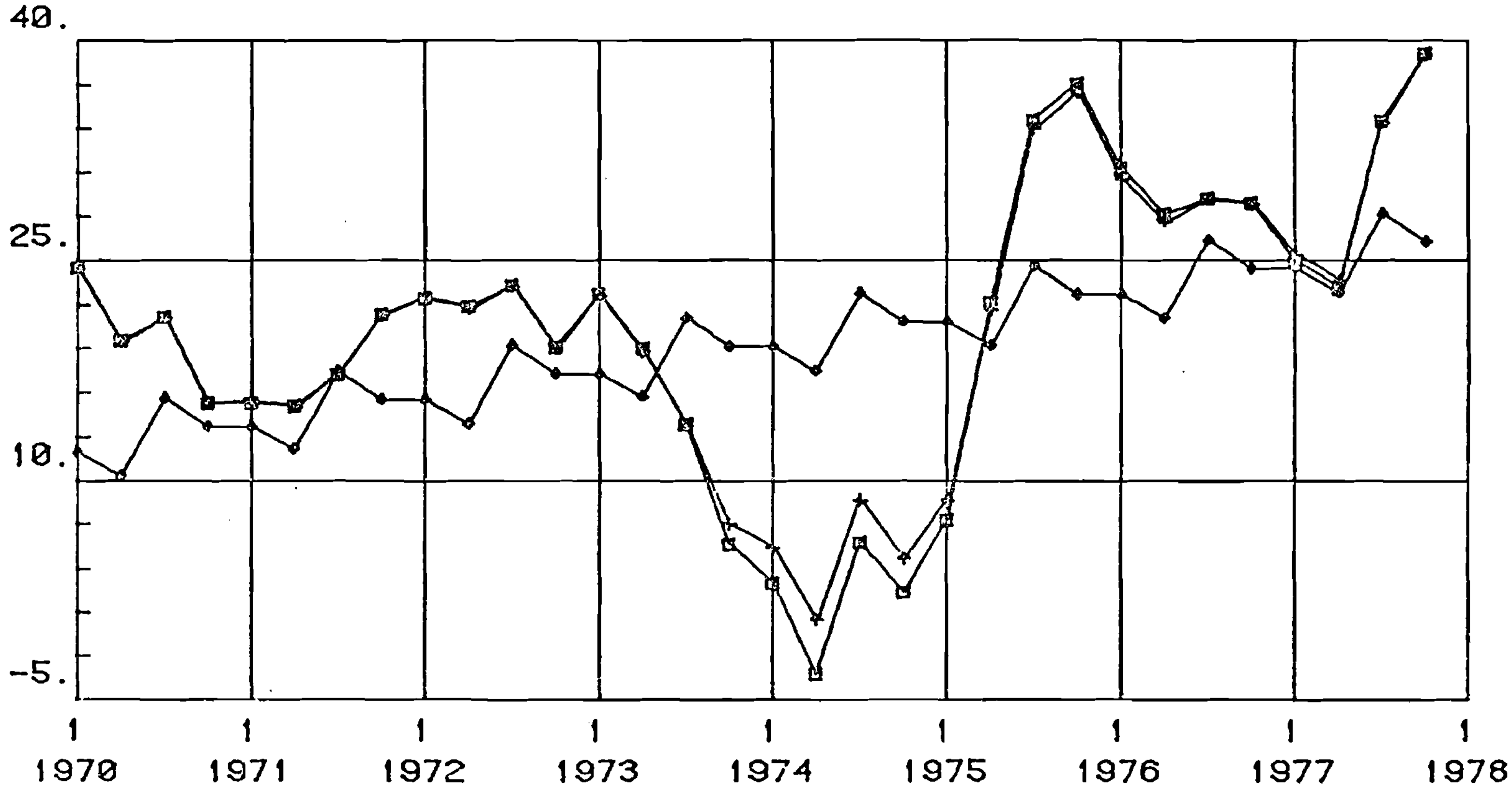
Figure 7. The Effect of the All Target Variables With Payouts Only Experiment on the Margin



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME	
□	#1	BASERUN_MRHG1 - Baserun Margin	($/cwt.)
◆	#1	NEWPORK_MRHG1TAR - Target Margin	($/cwt.)
+	#1	ALLCON_MRHG1 - Experiment Margin	($/cwt.)

Figure 8. The Effect of the All Target Variables With Payout Only Experiment On the Margin & Payment



TIME BOUNDS: 1970 1ST TO 1977 4TH

SYMBOL	SCALE	NAME
□	#1	BASERUN_MRHG1 - Baserun Margin & Payment ($/cwt.)
◆	#1	NEWPORK_MRHG1TAR - Target Margin & Payment ($/cwt.)
+	#1	ALLCON_MRHG1DP -- Experiment Margin & Payment($/cwt.)

TABLE 1 VARIABLE DEFINITIONS

ENDOGENOUS:

CRHG1	-	CASH RECEIPTS FOR HOGS, WESTERN CANADA (MIL. $)
CRHG2	-	CASH RECEIPTS FOR HOGS, EASTERN CANADA (MIL. $)
CRHG3	-	CASH RECEIPTS FOR HOGS, CANADA (MIL. $)
DPK1	-	DISAPPEARANCE OF PORK WESTERN CANADA (MIL. LBS.)
DPK2	-	DISAPPEARANCE OF PORK EASTERN CANADA (MIL. LBS.)
DPK4	-	DISAPPEARANCE OF PORK U.S.A. (MIL. LBS.)
IPK1	-	CLOSING INVENTORY OF PORK WESTERN CANADA (MIL. LBS.)
IPK2	-	CLOSING INVENTORY OF PORK EASTERN CANADA (MIL. LBS.)
IPK4	-	CLOSING INVENTORY OF PORK U.S.A. (MIL. LBS.)
NT1PK2	-	NET TRADE (EX-IM) IN PORK EAST CANADA TO WEST CANADA (MIL. LBS.)
NT1PK4	-	NET TRADE (EX-IM) IN PORK WESTERN CANADA TO U.S.A. (MIL. LBS.)
NT2PK4	-	NET TRADE (EX-IM) IN PORK EASTERN CANADA TO U.S.A. (MIL. LBS.)
PHG1	-	PRICE OF INDEX 100 HOGS WESTERN CANADA ($/CWT.)
PHG2	-	PRICE OF INDEX 100 HOGS EASTERN CANADA ($/CWT.)
PHG4	-	LIVE SLAUGHTER HOG PRICES AT SEVEN MARKETS U.S.A. (US$/CWT.)
QPK1	-	PORK PRODUCTION WESTERN CANADA (MIL. LBS.)
QPK2	-	PORK PRODUCTION EASTERN CANADA (MIL. LBS.)
QPK4	-	PORK PRODUCTION U.S.A. (MIL. LBS.)

EXOGENOUS:

DY3	-	DISPOSABLE INCOME, CANADA (MIL. DOLLARS)
DY4	-	DISPOSABLE INCOME, U.S.A. (MIL. DOLLARS)
D19712	-	DUMMY FOR UNUSUAL RECORDED MARKETINGS, ALL REGIONS
ER34	-	EXCHANGE RATE (CAN$/US$)
FPC02	-	CHATHAM CORN PRICE ($/TONNE)
JS1	-	FIRST QUARTER SEASONAL DUMMY
JS2	-	SECOND QUARTER SEASONAL DUMMY
JS3	-	THIRD QUARTER SEASONAL DUMMY
NT1PK9	-	NET TRADE (EX-IM) IN PORK WESTERN CANADA TO R.O.W. (MIL. LBS.)
NT2PK9	-	NET TRADE (EX-IM) IN PORK EASTERN CANADA TO R.O.W. (MIL. LBS.)
NT4PK9	-	NET TRADE (EX-IM) IN PORK U.S.A. TO R.O.W. (MIL. LBS.)
OPBA3	-	OFF BOARD BARLEY PRICE IN CANADA ($/TONNE)
PC04	-	U.S.A. PRICE OF CORN, CHICAGO ($/TONNE)
PSS1	-	STEER PRICE, WESTERN CANADA ($/CWT.)
PSS2	-	STEER PRICE, EASTERN CANADA ($/CWT.)
PSS3	-	STEER PRICE, U.S.A. ($/CWT.)
XDPHG3	-	THE PREMIUM/SUBSIDY PAYMENT -

TABLE 2 ESTIMATED DEMAND EQUATIONS FOR CLOSING PORK STOCKS FOR WESTERN CANADA, EASTERN CANADA AND THE UNITED STATES[a]

Equation (Dependent Variable)	Variables									
	Constant	JS1	JS2	JS3	D19712	QPK1 (mil.lb.)	IPK1(-1) (mil.lb.)	$\bar{R}^{2}$[b] (S.E.R.)	D.W. (h)	F.
Stock Demand for Pork										
Western Canada IPK1 (mil.lb.)	-0.44 (-0.27)[c]	2.77 (3.13)	1.06 (1.05)	-3.85 (-3.34)	7.96 (3.44)	0.062 (3.42)	0.40 (3.57)	0.81 (2.09)	1.47 (2.83)	34.16 -
Eastern Canada IPK2 (mil.lb.)	-7.67 (-1.32)	3.38 (4.02)	1.07 (0.97)	-1.38 (-1.10)	12.91 (5.98)	0.080 (2.14)	0.53 (5.37)	0.81 (2.01)	1.61 (1.81)	34.56 -
United States IPK4 (mil.lb.)	35.35 (0.68)	1.18 (0.08)	-18.22 (-1.02)	-100.62 (-5.02)	109.72 (3.58)	0.029 (1.65)	0.60 (5.73)	0.83 (27.22)	1.31 (3.41)	37.63 -

[a] Estimated over the period from the second quarter of 1966 to the fourth quarter of 1977 using O.L.S.

[b] $\bar{R}^2$ is the R^2 value adjusted for degrees of freedom.

[c] t statistics is in parentheses

TABLE 3 ESTIMATED PORK DEMAND EQUATIONS FOR WESTERN CANADA, EASTERN CANADA, AND THE UNITED STATES[a]

Equation (Dependent Variable)	Variables									
	Constant	JS1	JS2	JS3	PHOG/[d] DPK ($/cwt) (mil.lb.)	PSS ($/cwt)	DY (mil. $)	$\bar{R}^{2}$[b] (S.E.R.)	D.W.	F.
Consumption Demand for Pork										
Western Canada DPK1 (mil.lb.)	61.07 (32.95)[c]	0.64 (0.64)	-5.30 (-5.35)	-6.16 (-6.21)	-0.82 (-16.85)	0.71 (9.73)	0.0012 (13.78)	0.91 (2.41)	0.89 -	75.69 -
Eastern Canada DPK2 (mil.lb.)	173.55 (32.97)	1.45 (0.54)	-12.31 (-4.65)	-14.97 (-5.53)	-2.45 (-17.04)	2.30 (10.82)	0.0029 (11.57)	0.89 (6.46)	0.89 -	65.39 -
United States PHG4[d] ($/cwt.)	35.55 (9.94)	-1.31 (-1.49)	-4.40 (-4.91)	-2.51 (-2.74)	-0.01 (-15.21)	0.89 (12.31)	0.00006 (7.25)	0.97 (2.07)	1.58 -	224.66 -

[a] Estimated over the period from the second quarter of 1966 to the fourth quarter of 1977 using O.L.S.

[b] $\bar{R}^2$ is the R^2 value adjusted for degrees of freedom

[c] t statistic is in parentheses

[d] The United States equation was estimated price dependent.

TABLE 4 ESTIMATED SUPPLY RESPONSE EQUATIONS FOR PORK FOR WESTERN CANADA, EASTERN CANADA, AND THE UNITED STATES[a]

Equation (Dependent Variable)	Variables									
	Constant	JS1	JS2	JS3	PHOG(-4) ($/cwt)	PCO(-4) ($/tonne)	QPK(-1) (mil.lb)	$\bar{R}^2$[b] (S.E.R.)	D.W. (h)	F
Pork Supply										
Western Canada										
QPK1	20.18	5.03	-1.12	-19.18	0.45	-0.33[d]	0.86	0.93	2.23	97.98
(mil.lb.)	(2.99)[c]	(1.68)	(-0.37)	(-6.39)	(3.54)	(-5.08)	(18.88)	(7.13)	(-0.83)	-
Eastern Canada										
QPK2	48.70	-12.89	-19.84	-21.42	0.28	-0.11	0.77	0.80	2.04	30.91
(mil.lb.)	(4.05)	(-4.64)	(-7.44)	(-8.62)	(2.70)	(-1.90)	(.975)	(5.96)	(-0.16)	-
United States										
QPK4	1,062.82	-570.58	-501.89	-628.38	11.39	-4.75	0.81	0.84	1.75	40.76
(mil.lb.)	(4.75)	(-8.23)	(-8.04)	(-10.17)	(3.21)	(-3.61)	(12.24)	(147.64)	(0.96)	-

[a]Estimated over the period from the second quarter of 1966 to the fourth quarter of 1977 using O.L.S.

[b]$\bar{R}^2$ is the R^2 value adjusted for degrees of freedom

[c]t statistic is in parentheses

[d]In Western Canada the off Board Price of Barley was used.

TABLE 5 ESTIMATED PRICE TRANSMISSION EQUATIONS, AND WESTERN CANADA TO EASTERN CANADA NET TRADE[a]

Equation (Dependent Variable)	Variables										
	Constant	JS1	JS2	JS3	PHG4 ($/cwt)	ER34	NTiPK4 (mil.lb)	PHG(-1) ($/cwt.)	$\bar{R}^{2b}$ (S.E.R)	D.W. (h)	F
Price of Index 100 Hogs											
Western Canada PHG1 ($/cwt)	-24.38 (-3.77)[c]	-1.11 (-1.93)	1.65 (-2.91)	-0.56 (-0.90)	1.09 (23.60)	24.94 (4.34)	-0.127 (-4.08)	0.16 (4.02)	0.99 (1.34)	1.30 (2.50)	851.3 -
Price of Index 100 Hogs											
Eastern Canada PHG2 ($/cwt)	-15.51 (-2.48)	-0.90 (-1.48)	-1.33 (-2.21)	-0.36 (-0.53)	1.08 (21.65)	18.77 (3.29)	-0.153 (-5.03)	0.16 (3.76)	0.99 (1.42)	1.67 (1.18)	749.6 -
	Constant	JS1	JS2	JS3	PHG1		PHG2	NTIPJ2(-1)	$\bar{R}^{2b}$ (S.E.R.)	D.W. (h)	F
Western to Eastern Canada Trade of Pork											
NTIPK2 (mil.lb.)	4.10 (1.23)	6.24 (3.43)	3.80 (2.13)	-2.48 (-1.38)	-1.11 (-1.85)	-	0.99 (1.68)	0.83 (13.67)	0.89 (4.33)	1.41 (2.23)	63.5 -

[a] Estimated over the period from the second quarter of 1966 to the fourth quarter of 1977 using O.L.S.

[b] $\bar{R}^2$ is the R^2 value adjusted for degrees of freedom

[c] t statistic is in parentheses

TABLE 6 ESTIMATED CASH RECEIPTS FOR PORK FOR WESTERN CANADA, AND EASTERN CANADA[a]

Equation (Dependent Variable)	Variables									
	Constant	JS1	JS2	JS3	PHG ($/cwt.)	QPK (mil.lb)	CRHG(-1) (mil.lbs.)	$\bar{R}^{2}$[b] (S.E.R.)	D.W. (h)	F
Cash Receipts Western Canada										
CRHG 1	-25.22 (-4.54)[c]	1.54 (0.77)	-0.72 (-0.37)	-0.61 (-0.32)	0.72 (6.16)	0.28 (5.94)	0.39 (4.17)	0.93 (4.67)	1.14 (3.86)	97.87
Cash Receipts Eastern Canada										
CRHG 2	-60.95 (-7.59)	-1.72 (-1.35)	-2.89 (-2.10)	-2.63 (-1.38)	1.78 (17.94)	0.35 (7.63)	0.22 (4.76)	0.99 (2.98)	1.13 (3.14)	1077.4

[a]Estimated over the period from the second quarter of 1966 to the fourth quarter of 1977 using O.L.S.

[b]$\bar{R}^2$ is the R^2 value adjusted for degrees of freedom

[c]t statistic is in parentheses.

TABLE 7 SOME VALIDATION RESULTS

Variable	Intra-Sample 1966 2 to 1977 4					Extra-Sample 1978 1 to 1978 4				
	Mean	AE[a]	RMSE	APE	RMSPE	Mean	AE[a]	RMSE	APE	RMSPE
CRHG1	56.739	-0.375	6.377	0.789	10.448	86.260	2.437	7.708	3.482	9.711
CRHG2	95.242	0.296	8.905	1.683	13.398	202.779	-15.582	19.458	-7.290	8.651
CRHG3	151.981	-0.079	14.253	1.051	11.281	289.039	-13.145	22.283	-4.132	6.969
DPK1	74.355	-0.196	4.759	0.098	6.103	85.939	-1.072	3.041	-1.170	3.581
DPK2	201.521	-0.377	12.801	0.195	6.022	223.269	-2.283	6.463	-0.953	2.939
DPK4	3327.74	-9.004	258.717	0.156	7.335	3305.500	54.469	93.065	1.585	2.687
IPK1	10.962	-0.129	2.550	2.923	25.222	7.094	1.967	2.692	26.672	36.557
IPK2	14.067	-0.004	2.532	4.502	20.538	16.944	-0.102	2.030	0.001	11.611
IPK4	262.127	-2.715	36.704	1.059	14.005	223.500	14.010	16.702	6.480	7.683
NT1PK2	29.896	-0.374	7.390	3.878	26.243	10.560	5.629	6.473	64.482	78.951
NT1PK4	1.728	-0.630	7.291	63.553[b]	218.673[b]	-10.142	0.621	4.097	2.944	46.724
NT2PK4	-6.768	-0.069	6.487	-97.425[b]	350.633[b]	-6.604	-24.666	27.022	4334.870	7805.070
PHG1	40.147	0.240	4.870	2.502	15.372	67.980	8.528	9.165	12.591	13.587
PHG2	44.076	0.154	4.685	1.922	13.622	69.575	12.142	13.417	17.576	19.550
PHG4	30.478	0.127	3.927	2.379	15.115	48.463	6.793	7.234	14.002	14.924
QPK1	110.434	-1.194	11.950	-0.602	10.872	90.416	5.667	6.848	6.434	7.754
QPK2	167.663	-0.082	7.793	0.167	4.746	220.691	-33.333	35.253	-14.882	15.573
QPK4	3277.770	-6.845	254.177	0.240	7.339	3301.250	82.475	117.146	2.415	3.359

[a] AE refers to average error and RMSE to root mean square error and APE refers to average percent error and RMSPE to root mean square percent error.

[b] These numbers are large since the actual trade is near zero.

Table 8 Theil's Inequality Coefficient and its Decomposition

Variable	Intra-Sample 1966 2 to 1977 4				Extra-sample 1978 1 to 1978 4			
	U^a	U^M	U^S	U^C	U	U^M	U^S	U^C
CRHG1	0.108	0.003	0.149	0.848	0.089	0.100	0.120	0.780
CRHG2	0.088	0.001	0.019	0.980	0.095	0.641	0.193	0.166
CRHG3	0.089	0.000	0.035	0.965	0.077	0.348	0.229	0.423
DPK1	0.064	0.002	0.064	0.934	0.035	0.124	0.031	0.845
DPK2	0.063	0.001	0.118	0.881	0.029	0.124	0.146	0.730
DPK4	0.077	0.001	0.056	0.943	0.028	0.343	0.633	0.024
IPK1	0.213	0.003	0.089	0.908	0.378	0.534	0.368	0.098
IPK2	0.171	0.000	0.327	0.673	0.119	0.003	0.004	0.993
IPK4	0.135	0.005	0.218	0.777	0.074	0.704	0.002	0.706
NT1PK2	0.227	0.003	0.167	0.830	0.585	0.756	0.002	0.242
NT1PK4	0.690	0.007	0.218	0.775	0.393	0.023	0.020	0.957
NT2PK4	0.539	0.000	0.001	0.999	2.996	0.833	0.001	0.166
PHG1	0.114	0.002	0.013	0.985	0.135	0.866	0.015	0.119
PHG2	0.101	0.001	0.030	0.969	0.193	0.319	0.045	0.136
PHG4	0.121	0.001	0.037	0.962	0.149	0.882	0.065	0.053
QPK1	0.105	0.009	0.009	0.982	0.076	0.685	0.013	0.302
QPK2	0.046	0.000	0.093	0.907	0.159	0.894	0.037	0.069
QPK4	0.077	0.001	0.061	0.938	0.035	0.496	0.405	0.099

a U refers to Theil's inequality coefficient, $U=\sqrt{\frac{1}{n}\sum(P_i-A_i)^2} \Big/ \sqrt{\frac{1}{n}\sum A_i^2}$ where P_i is the predicted and A_i is the actual
U^M refers to the bias proportion
U^S refers to the variance proportion, and
U^C refers to the covariance proportion.

Table 9. Simulation of Effect of the Agricultural Stabilization Act.

	Average Difference	Std dev of Difference	Average Percent Difference	Std dev of Percent Difference
CRHG1	0.40	0.65	0.59	0.98
CRHG2	-0.02	0.09	-0.01	0.10
CRHG3	0.38	0.66	0.23	0.42
DPK1	0.11	0.22	0.15	0.29
DPK2	0.27	0.49	0.13	0.24
DPK4	0.74	2.29	0.02	0.07
IPK1	0.13	0.21	1.02	1.68
IPK2	0.09	0.16	0.59	1.16
IPK4	-0.05	0.08	-0.02	0.03
NTIPK2	0.28	0.42	0.88	1.16
NT1PK4	0.83	1.55	5.46	12.24
NT2PK4	0.52	0.91	13.56[a]	67.64
PHG1	-0.14	0.27	-0.37	0.74
PHG2	-0.11	0.20	-0.25	0.48
PHG4	-0.01	0.03	-0.04	0.11
QPK1	1.23	2.14	0.93	1.56
QPK2	0.51	1.07	0.30	0.63
QPK4	-0.62	1.19	-0.02	0.03

[a]The percentage figures for trade are articially high since the average of net trade is near zero.

TABLE 10. THE EFFECT OF A ONE DOLLAR PAYMENT (INTERIM MULTIPLIER)

	Mean[a]	Quarters 0-3	4	5	6	Long Run
CRHG1	65.39 (mil. $)	0	.088	.193	.296	0.7807
CRHG2	108.46 (mil. $)	0	.032	.049	.053	-0.0400
CRHG3	173.86 (mil. $)	0	.120	.242	.348	0.7407
DPK1	78.15 (mil. lb)	0	.044	.088	.125	0.2216
DPK2	210.15 (mil. lb)	0	.092	.183	.264	0.5147
DPK4	3409.12 (mil. lb)	0	.547	1.000	1.390	1.4226
IPK1	12.23 (mil. lb)	0	.029	.064	.100	0.2503
IPK2	15.84 (mil. lb)	0	.022	.051	.079	0.1630
IPK4	269.44 (mil. lb)	0	0	0	0	-0.0889
NTIPK2	33.34 (mil. lb)	0	.023	.065	.118	0.5577
NTIPK4	0.31 (mil. lb)	0	.357	.654	.900	1.6117
NT2PK4	-9.01 (mil. lb)	0	.190	.350	.490	1.0157
PHG1	45.07 ($/cwt.)	0	-.054	-.107	-.153	-0.2711
PHG2	49.31 ($/cwt.)	0	-.037	-.075	-.108	-0.2097
PHG4	34.79 (US$/cwt.)	0	-.008	-.014	-.020	-0.0201
QPK1	118.30 (mil. lb)	0	.045	.842	1.178	2.3911
QPK2	172.12 (mil. lb)	0	.281	.497	.665	0.9727
QPK4	3361.03 (mil. lb)	0	0	0	0	-1.2048

[a] Mean over the period 1970:1 to 1977:4

TABLE 11. THE RESULTS OF THE EXPERIMENTS: THE EFFECT ON VARIABLES WITH TARGETS

($/cwt.)

	XDPHG3	PHG1	PHG2	PHG1DP	PHG2DP	MRHG1	MRHG2	MRHG1DP	MRHG2DP
Baserun	- -	1.05 6.46	1.10 5.37	1.05 6.46	1.10 5.37	1.05 9.66	1.10 8.74	1.04 9.66	1.10 8.74
<u>Experiments to Stabilize</u>									
ASASIM[a]	0.52 1.40	0.91 6.50	0.99 5.39	1.42 6.51	1.51 9.50	0.91 9.64	0.99 8.72	1.42 9.80	1.51 8.94
Price with Payouts Only	0.20 0.44	0.99 6.40	1.07 5.32	1.19 6.27	1.27 5.24	0.99 9.64	1.06 8.73	1.19 9.27	1.26 8.36
Price with Payins and Payouts	0.07 0.53	1.02 6.38	1.09 5.31	1.09 6.10	1.16 5.10	1.01 9.64	1.08 8.73	1.09 9.17	1.15 8.28
Price + Payment with Payout Only	0.20 0.26	1.01 6.44	1.09 5.35	1.21 6.26	1.28 5.16	1.01 9.65	1.08 8.73	1.21 9.51	1.27 8.59
Price + Payment with Payins and Payouts	-0.11 0.66	1.08 6.40	1.14 5.31	0.97 5.74	1.02 4.67	1.08 9.67	1.13 8.74	0.97 9.29	1.01 8.40
Margin with Payouts Only	0.20 0.20	1.00 6.45	1.08 5.36	1.19 6.49	1.26 5.40	1.00 9.64	1.07 8.72	1.19 9.56	1.25 8.62
Margin with Payins and Payouts	0.00 0.51	1.05 6.44	1.12 5.35	1.05 6.55	1.11 5.45	1.05 9.57	1.11 8.67	1.05 9.45	1.10 8.52
Margin + Payment with Payouts Only	0.20 0.41	0.99 6.41	1.07 5.33	1.19 6.28	1.26 5.23	0.99 9.64	1.06 8.72	1.19 9.27	1.25 8.35
Margin + Payment with Payin and payouts	-0.07 0.57	1.05 6.38	1.11 5.32	0.98 6.13	1.04 5.10	1.05 9.61	1.11 8.71	0.98 0.05	1.03 8.13
All Target Variables With Payouts Only	0.53 1.00	0.92 6.33	1.02 5.29	1.45 5.96	1.54 4.99	0.92 9.60	1.01 8.70	1.45 8.71	1.53 7.81
All Target Variables With Payins and Payouts	-0.09 1.47	1.06 6.26	1.12 5.24	0.97 5.36	1.03 4.44	1.07 9.54	1.12 8.66	0.97 8.23	1.02 7.37

Note: The first element of each cell is the mean of the residuals between the target and the simulated policy. The second element of each cell is the standard deviation of those residuals.

[a] The ASASIM experiment was run with exogenously calculated payments and no adjustment was made for changes in cash costs.

TABLE 12. THE RESULTS OF THE EXPERIMENTS: THE EFFECT ON PRODUCTION AND TRADE
(mil. lbs.)

	QPK1	QPK2	NT1PK2	NT1PK4	NT2PK4
Baserun	112.70 29.07	171.36 9.00	29.25 11.45	0.13 17.14	- 9.93 10.94
Experiments to Stabilize					
ASASIM[a]	113.93 30.11	171.86 9.04	29.53 11.62	0.96 17.82	- 9.40 11.33
Price With Payout Only	113.14 28.53	171.56 8.89	29.37 11.33	0.44 16.74	- 9.77 10.81
Price With Payins and Payouts	112.91 28.60	171.45 8.82	29.33 11.35	0.28 16.80	- 9.86 10.88
Price + Payment with Payout Only	112.97 28.86	171.48 8.97	29.33 11.94	0.32 16.98	- 9.84 10.88
Price + Payment with Payins and Payouts	112.38 29.07	171.21 8.84	29.23 11.44	0.10 17.14	-10.09 11.02
Margin With Payouts Only	113.08 28.88	171.54 9.00	29.35 11.40	0.40 17.00	- 9.79 10.89
Margin with Payins and Payouts	112.61 28.77	171.34 8.97	29.25 11.40	0.08 17.02	- 9.99 10.96
Margin + Payment with Payouts Only	113.12 28.52	171.55 8.91	29.36 11.33	0.43 16.74	- 9.77 10.79
Margin + Payment with Payin and Payouts	112.65 28.41	171.35 8.83	29.27 11.32	0.10 16.70	- 9.97 10.63
All Target Variables With Payouts Only	113.75 27.78	171.84 8.78	29.49 11.18	0.87 16.23	- 9.50 10.63
All Target Variables With Payins and Payouts	112.50 27.85	171.27 8.54	29.25 11.23	0.00 16.40	-10.03 10.88

Note: The first element of each cell is the mean of the simulated policy variable.
The second element of each cell is the standard deviation of the simulated policy variable.

[a] The ASASIM experiment was run with exogenously calculated payments and no adjustment was made for changes in cash costs.

TABLE 13. THE RESULTS OF THE EXPERIMENTS: THE EFFECT ON THE COST OF THE POLICY
(000 $)

	Total Payout	No. of Payouts	Total Payin	No. of Payins	Average Payout
Baserun	0.0	-	0.0	-	0.0
Experiments to Stabilize					
ASASIM[a]	6226.99	5	0.0	27	194.59
Price with Payouts Only	2519.56	9	0.0	-	78.74
Price with Payins and Payouts	2535.63	9	1332.36	18[b]	37.60
Price + Payment with Payout Only	2294.88	17	0.0	-	71.72
Price + Payment with Payins and Payouts	2173.06	17	2973.55	15	-25.02
Margin with Payouts Only	2164.08	18	0.0	-	67.63
Margin with Payins and Payouts	2173.07	18	2497.27	10	-10.13
Margin + Payment with Payouts Only	2391.92	8	0.0	-	74.74
Margin + Payment with Payins and Payouts	2357.22	8	2893.07	24	-16.75
All Target Variables With Payouts Only	6387.87	15	0.0	-	199.62
All Target Variables With Payins and Payouts	6155.71	14	6634.62	18	-14.97

[a] The ASASIM experiment was run with exogenously calculated payments and no adjustment was made for changes in cash costs.

[b] The number of payouts plus the number of payins may not add to 32 if in some periods a payout or payin of zero is made.