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AN ANALYSIS OF THE HOG SEX COUNT SURVEY

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1.0 INTRODUCTION

The hog-sex count survey (HSCS) started in 1970, and was substantially re-structured in 1980. The purpose of the survey has been to provide information on hog slaughter by sex that would serve as a leading indicator of the future course of the hog cycle. The basis of such an indicator is that the slaughter of females reduces the breeding capacity of the swine herd, and consequently future swine production. However, the survey is conducted at considerable cost, and these costs need to be weighed against the perceived benefits of the information provided by it. While the value of improved forecasts which might result from the HSCS information is itself difficult to measure, an important factor in such a measurement is the extent to which forecasts are improved through use of the survey over other forecasting techniques. This is the object of this paper. Specifically the purpose of this paper is to examine the information provided by the revised survey (that is since May 1980), to assess whether or not it provides an indiction of future marketing of hogs.

It needs to be noted at the outset that this paper is limited in terms of complexity and scope. Normally, users of the data examine gilt and sow slaughter estimates in relation to total slaughter and from this information set, and their knowledge of the hog population biological constraints, infer the likely course of future production. No attempt has been made in this paper to explore all possible manipulations of the data, nor to incorporate the data into more complicated transformations such as transfer function type models, spectral/cross-spectral decompositions, or detailed econometric relationships. While such undertakings may prove useful and justifiable, they may not be accessible or understandable to most users of the data. On the other hand it needs to be borne in mind that more simplified approaches may not provide rigorous or rich enough information from which to gauge the potential usefulness of the HSCS data.

This paper is divided into four more sections. Section 2.0 provides a brief historical background to the HSCS and also discusses aspects of the data which need to be clarified. Section 3.0 discusses methodology issues and some descriptive analysis of the data. Section 4.0 provides a regression framework to assess the predictive ability of the survey data. Section 5.0 offers conclusions and recommendations of a tentative nature. It needs to be mentioned here that these do not include statements evaluating the survey in terms of its benefits and costs, but rather statements concerning the ability of the data to provide a leading indicator of hog production.

2.0 THE HOG-SEX COUNT SURVEY

2.1 Historical Background

Canada's hog-sex survey count originated largely at the request of Agriculture Canada officials. The basic objective was to report the number of barrows, gilts, sows and stags slaughtered in each province and to make this information available in order to improve Agriculture Canada's hog marketing forecasts.

The survey began in 1970, and until 1980 was a weekly survey conducted on a quarterly basis. The survey was conducted at all federally inspected and provincially approved hog killing plants in Canada by federal graders in the Livestock and Poultry Division, Food Production and Inspection Branch. During a survey week all barrows, gilts, sows and stags were counted. This one week per quarter survey was considered unsatisfactory and indeed at times was misleading to forecasters, due primarily to the extremely variable nature of hog production and marketing practices. For this reason, in 1979 the Canadian Pork Council made a request to Agriculture Canada that the hog-sex survey be extended to more accurately reflect forthcoming hog production trends. As a result the frequency and methodology of the survey were changed to reflect perceived requirements.

In 1980 the survey frequency was increased to two weeks per month. The counts were bi-weekly in 1980 and 1981, consecutive since then. The survey ceased to be a 100 percent sample from every federally inspected plant. Currently about 16,000 carcasses are sampled from across Canada from the major hog killing plants in each province. The sample size in each province is determined by its share of Canadian hog slaughter.

To ensure a random sample a certain number of carcasses are sampled each hour; for example 25 consecutive carcasses may be sampled each hour. The number selected per hour is designed to spread the sampling throughout the week.

2.2 Data Issues

The data from the survey are presented each month in the Livestock and Meat Trade Report published by Market Information Services of Agriculture Canada. Data from the survey indicate barrow and gilt slaughter from the survey conducted, and actual sow and stag slaughter from the reference period. Data are presented for individual western provinces, Ontario, Quebec, and the Atlantic provinces as a group. A national total is derived by adding up regions. The information includes the ratio of gilt to barrow and gilt slaughter (hereafter referred to as the GBG ratio), and the ratio of sow (hereafter referred to as the ST ratio) and of stag slaughter to total slaughter.

There are a number of issues related to the data that are relevant to the current analysis and also to those who use the survey. These are listed as follows:

1. A number of "Not Available" observations on some survey dates present discontinuities in the data that hinder good statistical analysis. In the current study, such missing data have been filled in using simple interpolation.

2. Several staff working the survey indicate that reporting is "spotty" or problematic. This comment needs to be investigated further. However, it would appear that sampling errors could be high in some cases; for example several observations suggest GBG ratios as high as 54%, and this would appear unlikely. In any case, the quality of the survey is critical to its value in providing indications of the course of the hog industry. Confidence in using the data is also important.

3. The derivation of the Canadian total may provide erroneous indications. Simply adding up regions assumes that the regional sample size is in proportion to total slaughter (which is, in fact, part of the survey design). An examination of the data suggest this is not always the case. The appropriate fix is to use regional data and slaughter and marketing (including exports) data as weights to derive the national total. In this study, regions have been aggregated using marketing data (slaughter plus exports).

4. The survey is conducted over a two week period. Given high monthly variations in marketings and such "short term" information from the survey, the detection of a correspondence between the survey and realized data may be difficult. The fact that the data are currently available for such a relatively short period accentuates this problem. In this study, monthly data have either been smoothed using a centered 3 month moving average, or by transforming the data to a quarterly basis.

These issues tend to obscure the full usefulness of the survey information, and suggest possible refinements to the survey and its presentation to users. The current study proceeds to analyze the data with the alterations as noted.

3.0 METHODOLOGY AND ANALYSIS

The previous section outlined the information set from the HSCS. Since the focus of outlook work with respect to the supply of hogs is the year over year percentage change in marketings, the focus of analysis should be the dynamic relationship between the output of the HSCS and this target outlook variable. The interesting question, of course, is to determine how these variables are related. This is the purpose of this section, and the analysis proceeds by presenting first a naive model of the dynamics of the hog population, and second, by describing various summary statistics that display some of the statistical relationships between variables. It is important to emphasize that the discussion of the hog population dynamics is intended to provide a framework for understanding/interpreting the survey data. This model has not been carried through in detail to the statistical modeling section due to its complexity.

3.1 A Naive Model of the Hog Population

Consider a framework that exploits the information from the biological lag information presented in Chart 1. In this framework, several major assumptions need to be made to simplify analysis. First it has been assumed that the decision to retain gilts for breeding (GFB) is made at 4 months, and that such gilts are bred at 7 months of age. The assumed gestation period is 4 months, and the slaughter age is 5 months. Using these assumptions, the following equations trace the monthly dynamics of the hog population:

(i) Supply - Disposition

$$G_t = G_{t-1} - MG_t + NG_t \quad (1)$$

$$B_t = B_{t-1} - MG_t + NT_t + NB_t \quad (2)$$

$$S_t = S_{t-1} - MS + NS_t \quad (3)$$

$$T_t = T_{t-1} - MT_t + NT_t \quad (4)$$

where G_t is gilt inventory at end of month t

B_t is barrow inventory at end of month t

S_t is sow inventory at end of month t

T_t is stag inventory at end of month t

MG_t is marketings of gilts during t, and similarly MB_t, MS_t, MT_t

NS_t is new sows coming from gilts

NT_t is new stags from barrows

NG_t and NB_t are new gilts and barrows (born)

(ii) Biological Constraints

$$NG_t = p \,.\, f \,.\, L \,.\, S_{t-4} + (1-f) \,.\, L \,.\, NS_t \quad (5)$$

where p is the percentage of sows bred each period

f is the surviving ratio of females to total births

L is the surviving litter size

$$NB_t = p \,.\, (1-f) \,.\, L \,.\, S_{t-4} + (1-f) \,.\, L \,.\, NS_t \quad (6)$$

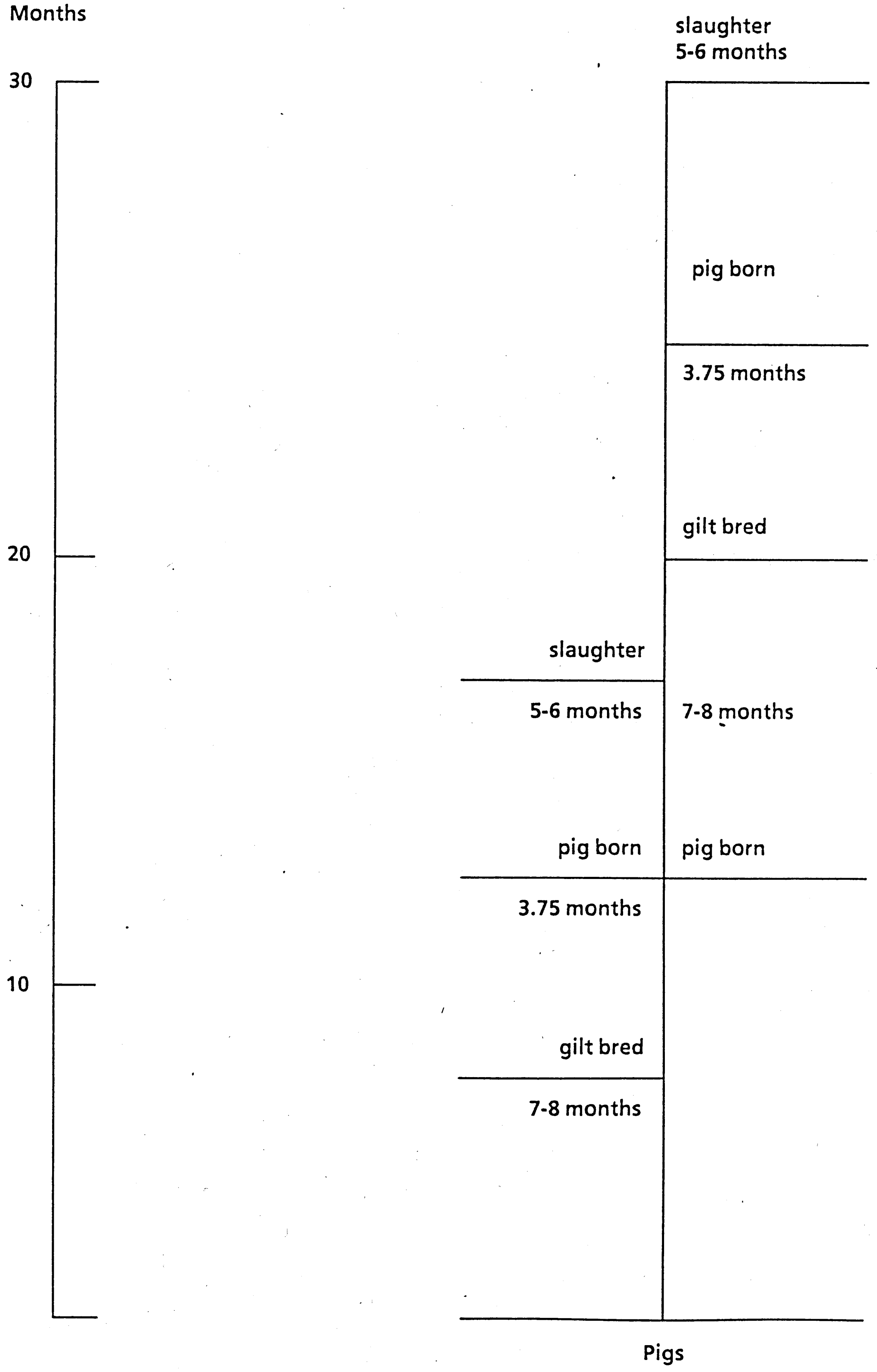
$$NS_t = GFB_{t-7} = n_{t-7}\, NG_{t-11} \quad (7)$$

where GFB_t is gilts retained for breeding

n_t is the retention rate of gilts, decided at 4 months

$$NT_t = BFB_{t-3} = q_{t-3}\, NB_{t-7} \quad (8)$$

Chart 1


Months
30
20
10
slaughter
5-6 months
pig born
3.75 months
gilt bred
slaughter
5-6 months
7-8 months
pig born
pig born
3.75 months
gilt bred
7-8 months
Pigs

where BFB_t is barrows retained for breeding

q_t is the retention rate of barrows, decided at 4 months

$$MG_t = (1-n_{t-1})NG_{t-5} \tag{9}$$

$$MB_t = (1-q_{t-1})NB_{t-5} \tag{10}$$

This basic and somewhat naive model can be used to decompose to marketings as follows:

$$\begin{aligned} M_t &= MG_t + MB_t + MT_t \\ &= (1 - n_{t-1}) \cdot NG_{t-5} + (1 - q_{t-1}) \cdot NB_{t-5} + MS_t + MT_t \\ &= (1 - n_{t-1}) \cdot [p \cdot f \cdot L \cdot S_{t-9} + f \cdot L \cdot n_{t-2} \cdot NG_{t-16}] \\ &\quad + (1 - q_{t-1}) \cdot [p \cdot (1 - f) \cdot L \cdot S_{t-9} + f \cdot L \cdot n_{t-2} \cdot NG_{t-16}] \\ &\quad + MS_t + MT_t \end{aligned} \tag{11}$$

Following (11), one could go on substituting for the NG terms; this would show that <u>current marketings are a function of past levels of sow inventories and retention decisions for gilts, in addition to current sow and stag marketings</u>. Taking the 12th period difference (i.e. yearly change) of equation 11 would illustrate the point that the yearly change in marketings is a function of the slaughter of sows during the period t-9 to t-21 weighted by retention rates during t-1 to t-13 and of slaughter of sows t-15 to t-27, and retention rates during the period t-12 to t-24. (Of course, the change in the marketings of sows and stags is also important).

Two other interesting aspects can be gained from this model. The first concerns the relationship of gilt retention rates to the ratio of gilt to barrow and gilt slaughter, and the second concerns the relationship of the female rates of slaughter to changes in marketings information on n and q. Examine the ratio of gilt marketings to total gilt and barrow marketings.

$$GBG = MG_t / (MG_t + MB_t)$$
$$= (1 - N_{t-1})NG_{t-5} / [(1 - n_{t-1})NG_{t-5} + (1 - q_{t-1})NB_{t-5}]$$

$$= \frac{(1 - n_{t-1}) \cdot p \cdot f \cdot L \cdot S_{t-9}}{(1 - n_{t-1}) \cdot p \cdot f \cdot L \cdot S_{t-9} + (1 - q_{t-1}) \cdot p(1-f) \cdot L \cdot S_{t-9}}$$

$$= \frac{(1 - n_{t-1}) \cdot f}{(1 - n_{t-1})f + (1 - q_{t-1})(1 - f)} = \frac{1 - n_{t-1}}{2 - n_{t-1} - q_{t-1}} \text{ (at } f = .5) \qquad (17)$$

Given (17), if the value of q_t were known then n_{t-1} could be computed.

Stag marketings are normally about 0.2% of total. This implies a q in the neighbourhood of 0.4% - 0.5%. Consequently, with a sex ratio at birth of .5, the following table shows the correspondence between the retention rate in the previous period with the gilt ratio observed for a specific month.

Gilt Slaughter Ratio	% Retention rate (for previous month)
.50	0.5
.49	4.4
.48	8.1
.47	11.8
.46	15.2

This table demonstrates how sensitive the retention rate is to movement in the gilt slaughter ratio. In 1984 a retention rate of 1% corresponded to about 70,000 gilts.

The second point concerns the significance of the female ratios of marketings. Using the "equilibrium" condition that inventory levels remain constant and using equations (1) - (4), the female ratio FR in equilibrium will be as follows:

$$FR = (MG + MS) / (MG + MS + MG + MT) \quad (18)$$

$$= (NS - NG) / (NS - NG\ NT - NB - NT)$$

$$= (-NG) / (-NG - NB) = f, \text{ the female ratio at birth}$$

The (somewhat obvious) implication is that for FR below f (say .5) future marketings will be increasing and above f they will be decreasing. This relationship, of course, does not illustrate the time-lag pattern as indicated in the previous equations, and is a long term relation. This can be expressed in another way; with sow slaughter averaging about 2.5% of total slaughter, and stag slaughter at about .2%, assuming a female/male birth ratio of 50% the equilibrium gilt retention rate would be about 5%, which corresponds to a GBG ratio of about 48.8%. Of course, as the sow slaughter ratio changes, the "equilibrium" gilt ratio changes accordingly.

3.2 Descriptive Statistics

The discussion of the equational representation of the dynamics of the hog sector above provides a basis for interpreting data from the survey. On the other hand, the specific detail of the lag specifications as they appear in the equations likely "stress" the statistical accuracy of the survey, and perhaps more importantly the assumptions generating the equations. In this latter case for example, the retention rate decision for gilts, or the slaughter age, may be considerably more flexible than allowed for in the equations. Finally, in the monthly hog marketing data a reasonable amount of statistical noise can be expected, due for example to different marketing days in each month or reporting errors (export data are particularly susceptible to these). Consequently, a tight specification explaining yearly change in hog marketings is not likely possible on a monthly basis (preliminary statistical work showed this). Rather a more prudent approach is to explore the data and derive conclusions accordingly, while at the same time incorporating the "lessons" from the equational approach.

From a descriptive perspective, it is important to review several characteristics of the data. The model described above provides a motivation for the relationship between the change in hog marketings and sow and gilt slaughter. The data from the survey that could be viewed as simpler counterparts of the variables from these equational representations would be (a) sows slaughter relative to total slaughter, (b) gilts slaughtered relative to gilt and barrow slaughter. The basic statistics on these variables are presented in Table 1. Note, as described above, the "outlook" focus variable is hog marketings and the data from the survey derive from slaughter data; exports of live hogs are not included in the survey, but the marketing data include these. This table does not give any information relevant to appropriate lag relationships between the series, but several interesting points are worthy of note. First, in eight of the ten "regions", the female ratio of slaughter, computed from the survey, averaged over 50% during the period May 1980 to December 1985, yet significant positive average growth rates in marketings were observed. This result would seem to contradict the expected result as indicated in the previous section. Second, the variation in the monthly change in year/year marketings is very great, in comparison to the variation either in the female ratio or the gilt ratio data. The sow ratio data exhibits high variation since it would appear that sow slaughter is reasonably stable compared to total slaughter, which fluctuates significantly on a monthly basis. The essential point to be made is that if a relationship between the data exists, it must be very sensitive; that is, small movements in the female ratio cause very large movements in terms of marketing changes, etc. Finally, the gilt ratio data show GBG ratios well above 50% at various times. This <u>could</u> suggest a statistical sampling error in those months; it is difficult to envisage why gilt slaughter would ever be as high as, say, 54% in any region, unless this indicates significant slaughter of gilts above normal slaughter age, before they farrow (i.e. gilts aged 6-11 months), or high retention rates of barrows.

Table 2 presents the correlations between the sow and the gilt ratio, the general hypothesis being that a liquidation or expansion decision should be reflected in both variables during the same months. In all cases the correlations between these variables are quite low, but with Western Canada generally showing a higher correlation than Eastern Canada.

TABLE I. BASIC STATISTICS: HOG SEX COUNT SURVEY, MAY 1980 TO DECEMBER 1985

PERCENTAGES

	MARKETINGS CHANGE YR/YR				FEMALE RATIO				SOW RATIO				GILT RATIO			
	Mean	Cov	Max	Min	Mean	Cov	Max	Min	Mean	Cov	Max	Min	Mean	Cov	Max	Min
	- percent -				- percent -				- percent -				- percent -			
British Columbia	17.4	26.9	128.1	-9.8	50.6	3.9	55.3	44.6	1.9	3.5	3.9	0.8	49.7	4.0	54.5	43.8
Alberta	6.9	11.3	34.1	-15.5	50.0	2.4	53.1	46.7	2.1	26.3	3.8	0.3	49.0	2.3	52.1	45.9
Saskatchewan	3.2	15.9	52.5	-24.0	49.7	3.3	52.5	44.5	1.3	53.5	3.0	0.2	49.2	3.1	51.8	43.9
Manitoba	8.1	9.5	44.1	-10.0	49.9	2.3	53.4	47.4	2.2	21.4	3.4	1.2	49.1	2.2	52.8	46.9
Ontario	2.7	6.4	21.7	-10.7	50.0	1.8	52.0	47.0	2.2	30.2	3.8	0.9	49.0	1.8	51.4	46.6
Quebec	2.6	9.6	30.2	-18.2	51.1	1.6	53.8	49.4	2.7	18.2	3.7	0.3	49.8	1.7	52.5	48.3
Maritimes	6.5	6.7	28.6	-12.5	51.0	2.5	55.2	48.1	2.4	15.7	3.3	1.5	49.8	2.6	54.3	47.2
Canada	4.0	7.0	24.2	-9.0	50.4	0.9	51.4	48.7	2.3	15.1	3.0	1.4	49.4	0.8	50.2	47.8
East	2.7	6.8	22.4	-11.1	50.6	1.1	52.1	48.6	2.5	16.4	3.3	1.0	49.5	1.1	50.6	47.6
West	6.9	9.9	29.8	-10.2	50.0	1.5	51.6	47.4	2.0	17.7	2.9	1.2	49.1	1.5	50.6	46.9

TABLE 2. CORRELATIONS BETWEEN THE RATIO OF SOW SLAUGHTER TO TOTAL SLAUGHTER AND THE RATIO OF GILT TO BARROW AND GILT SLAUGHTER

B.C.	-.111
Alberta	+.219
Saskatchewan	+.303
Manitoba	+.131
Ontario	+.057
Quebec	-.181
Atlantic	-.001
Canada	.074
West	.184
East	.008

These statistics illustrate some general aspects of the data. However, of critical importance is the analysis of the time relationships as described in the equations of the previous section. A useful tool to explore time relations is time correlation analysis - that is, the correlation coefficients between marketings, or the change in marketings, and time lags of the female slaughter ratios as provided by the HSCS. These correlation coefficients are presented in Tables 3, 4 and 5 for the GBG ratio, ST ratio and the overall female ratio respectively. As described in Section 2.2, it needs to be noted that all data were filtered using a moving average of actual data. This was done to smooth out apparently random movements in the data, and to provide more clearly defined correlation patterns. They should not, therefore, be interpreted too precisely.

Table 3 illustrates the negative correlations between lags in the GBG ratios and changes in marketings. Maximum correlations are reached at lag length 6 months for Western Canada, 7 months for Eastern Canada, and 7 months for Canada as a whole. In general, the correlations are greater in absolute value for Western Canada than for Eastern Canada, but are particularly weak for B.C., Manitoba, Ontario and the Atlantic provinces. Table 4 shows similar coefficients as Table 3 except they apply to the relation between marketing changes and the ST ratio. In this case maximum correlations are found at longer lag lengths than for the GBG ratio (Western Canada as an aggregate is an exception); for Canada as a whole a maximum negative correlation of -.69 is obtained with a lag of 13 months. The differing lag response between gilts and sows was indicated in the equational representation of the dynamics of the hog population, but the reverse result was indicated; that is, the negative relationship between sow slaughter and marketings should theoretically have less lag length than for gilts, since the time from the retention decision to birth is longer than the gestation period for sows.

Table 5 shows the time lag correlation coefficients for the female ratio of slaughter and the yearly change in marketings. The female ratio provides some indications of the liquidation position of the breeding stock. The lag correlation coefficients show maximum absolute value at lags of 6-8 months, at -.65. The pattern follows the gilt ratio and sow ratio patterns reasonably closely.

In general, one can conclude with confidence that the female slaughter ratios from the HSCS data do exhibit the expected negative relationship with marketings data. Several comments are in order, however. First, the correlations, while on average reasonably significant, are less in size than what one might hope for. Second, the gilt ratio, sow ratio and female ratio statistics indicate that a six month lead time maximizes predictive ability from the survey, and lags at 13 to 15 months provide additional information. These lags are not as long as one might have expected given the framework in Section 3.0, and it is difficult to explain why this is so. It should be re-iterated at this point that even though there are now almost five years of data available from the survey, this time period is not two complete conventional hog cycles. Given that the hog cycle has been somewhat irregular since 1980, one must be careful in drawing firm conclusions. In short, more time may be needed to examine the survey data.

TABLE 3. TIME LAG COEFFICIENTS: CORRELATIONS OF YEARLY MARKETING CHANGES WITH LAGS IN THE RATIO OF GILT TO TOTAL BARROW AND GILT SLAUGHTER

	B.C.	ALBERTA	SASK.	MANITOBA	WEST	ONTARIO	QUEBEC	ATLANTIC	EAST	CANADA
LAG 0	-0.093	-0.272	0.052	0.299	0.025	-0.068	-0.082	0.300	-0.069	-0.076
LAG 1	0.088	-0.286	0.042	0.311	-0.002	-0.205	0.048	0.323	0.018	-0.004
LAG 2	0.182	-0.343	-0.068	0.304	-0.101	-0.338	0.145	0.335	0.092	-0.014
LAG 3	0.170	-0.411	-0.203	0.106	-0.251	-0.388	0.113	0.181	0.111	-0.120
LAG 4	0.060	-0.508	-0.320	-0.019	-0.391	-0.295	-0.067	0.039	0.035	-0.304
LAG 5	0.052	-0.577	-0.392	-0.124	-0.491	-0.189	-0.348	-0.155	-0.200	-0.492
LAG 6	0.077	-0.602	-0.487	-0.064	-0.530	-0.221	-0.558	-0.269	-0.467	-0.630
LAG 7	0.100	-0.567	-0.529	-0.076	-0.515	-0.360	-0.593	-0.251	-0.561	-0.618
LAG 8	-0.060	-0.515	-0.592	-0.107	-0.495	-0.388	-0.380	-0.204	-0.349	-0.441
LAG 9	-0.263	-0.502	-0.615	-0.148	-0.471	-0.259	-0.046	-0.154	0.045	-0.209
LAG 10	-0.378	-0.490	-0.663	-0.128	-0.458	-0.187	0.123	-0.265	0.190	-0.145
LAG 11	-0.353	-0.480	-0.690	0.033	-0.426	-0.170	0.125	-0.365	0.131	-0.181
LAG 12	-0.232	-0.437	-0.722	0.156	-0.382	-0.174	-0.036	-0.361	-0.038	-0.268
LAG 13	-0.196	-0.408	-0.730	0.272	-0.356	-0.089	-0.261	-0.332	-0.146	-0.309
LAG 14	-0.201	-0.338	-0.701	0.272	-0.324	-0.073	-0.483	-0.301	-0.319	-0.372
LAG 15	-0.179	-0.270	-0.670	0.267	-0.289	-0.073	-0.514	-0.302	-0.380	-0.328
LAG 16	-0.033	-0.216	-0.667	0.247	-0.230	-0.078	-0.395	-0.249	-0.273	-0.213

Notes: (1) All data have been smoothed using a three month centered moving average

(2) Data apply for the period 1980 June to 1985 December but the lags involved shorten this period by 16 months to 1981 November to 1985 November.

(3) Marketings are inspected slaughter plus exports.

TABLE 4. TIME LAG COEFFICIENTS: CORRELATIONS OF YEARLY MARKETING CHANGES WITH LAGS IN THE RATIO OF SOW TO TOTAL SLAUGHTER

	B.C.	ALBERTA	SASK.	MANITOBA	WEST	ONTARIO	QUEBEC	ATLANTIC	EAST	CANADA
LAG 0	0.197	0.369	-0.297	-0.319	-0.069	-0.165	0.434	-0.081	0.145	0.107
LAG 1	0.081	0.362	-0.361	-0.331	-0.116	-0.099	0.265	-0.195	0.145	0.057
LAG 2	-0.017	0.332	-0.423	-0.328	-0.157	-0.075	0.126	-0.291	0.117	-0.006
LAG 3	-0.021	0.278	-0.473	-0.306	-0.197	-0.114	0.061	-0.325	0.020	-0.114
LAG 4	-0.043	0.230	-0.503	-0.236	-0.203	-0.193	-0.007	-0.322	-0.134	-0.222
LAG 5	-0.046	0.177	-0.536	-0.186	-0.228	-0.285	-0.045	-0.299	-0.240	-0.313
LAG 6	-0.038	0.139	-0.578	-0.136	-0.245	-0.358	-0.031	-0.331	-0.251	-0.342
LAG 7	0.006	0.075	-0.618	-0.091	-0.284	-0.332	0.125	-0.340	-0.111	-0.277
LAG 8	0.057	-0.005	-0.645	-0.002	-0.319	-0.253	0.287	-0.386	0.040	-0.204
LAG 9	0.048	-0.124	-0.666	0.142	-0.372	-0.136	0.320	-0.465	0.100	-0.195
LAG 10	-0.015	-0.230	-0.679	0.265	-0.441	-0.093	0.234	-0.562	0.027	-0.301
LAG 11	-0.108	-0.311	-0.691	0.315	-0.511	-0.111	0.045	-0.603	-0.152	-0.464
LAG 12	-0.205	-0.353	-0.692	0.256	-0.549	-0.182	-0.101	-0.532	-0.317	-0.607
LAG 13	-0.255	-0.378	-0.694	0.144	-0.560	-0.245	-0.163	-0.442	-0.441	-0.702
LAG 14	-0.248	-0.394	-0.683	0.052	-0.542	-0.217	-0.123	-0.341	-0.439	-0.703
LAG 15	-0.199	-0.411	-0.681	0.002	-0.524	-0.123	0.002	-0.234	-0.336	-0.629
LAG 16	-0.123	-0.415	-0.669	0.009	-0.472	0.022	0.102	-0.127	-0.174	-0.518

Notes: (1) All data have been smoothed using a three month centered moving average

(2) Data apply for the period 1980 June to 1985 December but the lags involved shorten this period by 16 months to 1981 November to 1985 November.

(3) Marketings are inspected slaughter plus exports.

TABLE 5. TIME LAG COEFFICIENTS: CORRELATIONS OF YEARLY MARKETING CHANGES WITH LAGS IN THE RATIO OF FEMALE TO TOTAL SLAUGHTER

	B.C.	ALBERTA	SASK.	MANITOBA	WEST	ONTARIO	QUEBEC	ATLANTIC	EAST	CANADA
LAG 0	-0.056	-0.138	0.008	0.214	0.031	-0.112	0.039	0.290	-0.018	-0.059
LAG 1	0.087	-0.157	-0.013	0.217	-0.004	-0.202	0.122	0.294	0.039	-0.015
LAG 2	0.143	-0.218	-0.130	0.212	-0.102	-0.285	0.183	0.291	0.099	-0.041
LAG 3	0.124	-0.291	-0.263	0.022	-0.245	-0.323	0.128	0.131	0.089	-0.160
LAG 4	0.004	-0.384	-0.379	-0.083	-0.373	-0.269	-0.074	-0.007	-0.024	-0.348
LAG 5	0.002	-0.460	-0.453	-0.174	-0.467	-0.210	-0.367	-0.193	-0.254	-0.528
LAG 6	0.038	-0.492	-0.549	-0.101	-0.503	-0.256	-0.574	-0.312	-0.465	-0.636
LAG 7	0.088	-0.479	-0.601	-0.098	-0.495	-0.347	-0.564	-0.295	-0.477	-0.592
LAG 8	-0.050	-0.454	-0.661	-0.103	-0.483	-0.376	-0.288	-0.257	-0.250	-0.426
LAG 9	-0.250	-0.471	-0.682	-0.097	-0.469	-0.248	0.058	-0.222	0.061	-0.246
LAG 10	-0.376	-0.487	-0.718	-0.043	-0.472	-0.188	0.191	-0.352	0.123	-0.239
LAG 11	-0.364	-0.501	-0.742	0.118	-0.461	-0.170	0.123	-0.461	0.006	-0.325
LAG 12	-0.259	-0.476	-0.770	0.213	-0.438	-0.193	-0.100	-0.449	-0.190	-0.445
LAG 13	-0.224	-0.456	-0.779	0.289	-0.424	-0.126	-0.368	-0.408	-0.316	-0.513
LAG 14	-0.219	-0.392	-0.755	0.271	-0.393	-0.096	-0.601	-0.363	-0.454	-0.564
LAG 15	-0.185	-0.330	-0.737	0.257	-0.357	-0.052	-0.588	-0.348	-0.449	-0.494
LAG 16	-0.027	-0.279	-0.732	0.246	-0.293	0.005	-0.410	-0.275	-0.273	-0.351

Notes: (1) All data have been smoothed using a three month centered moving average

(2) Data apply for the period 1980 June to 1985 December but the lags involved shorten this period by 16 months to 1981 November to 1985 November.

(3) Marketings are inspected slaughter plus exports.

4.0 ASSESSMENT OF PREDICTIVE ABILITY

The model developed in the previous section outlines a detailed framework for the analysis of changes in the hog population and provides a basis for the descriptive analysis of the HSCS. In this section, a simple regression framework is used to explore the predictive ability of the HSCS data, but the time frame and the model framework has been altered slightly. In the first instance, the data have been calculated for a quarterly time frame for two reasons; first, the monthly data exhibit substantial "noise"; and second, a quarterly framework corresponds to an outlook basis that is common to outlook programs at major institutions. (Agriculture Canada, USDA, Chase Econometrics). In the second instance, the framework designed for the regression models is much simpler than the framework presented in section 3.0, but retains some essential aspects. This framework also attempts to use information from the survey, with a one year lag, to provide a longer lead time for prediction (i.e., 1 year ahead). This contrasts with the previous framework in which information and recent lag information were specified.

The following simple model describes the framework used:

$$M_t = f(B_{t-4}) \qquad (1)$$

- M_t is marketings, B_t is female breeding stock

$$B_t = B_{t-1} + GRT_t - SS_t \qquad (2)$$

GRT_t is gilts retained, SS_t is sows slaughtered.

Note from (2) we get the simple notion that the breeding herd is in equilibrium when gilts retained equal sows slaughtered.

From (1) and (2) we can derive the following:

$$M_t - M_{t-4} = d[\text{sum}[(GRT_t\text{:}t=-7 \text{ to } -4) - \text{Sum}\ (SS_t\text{:}t=-7 \text{ to } -4)]] \qquad (3)$$

This framework omits the fact that current marketings do include changes in the proportions of gilts and sows marketed in the current period. If these changes explain a large portion of the variation in marketings then a good leading indicator cannot be isolated unless an auto regressive pattern can be used to predict these current decisions.

The relationship in (3) was estimated for the four western provinces, Ontario, Quebec, and the Atlantic provinces. Data were computed from the survey by apportioning the marketings data using the percentages of slaughter by type from the HSCS. A proxy for gilts retained was nevertheless required and the difference between barrow and gilt slaughter was assumed to be net retentions.

4.1 Estimation Results

The estimation results are listed on the following pages (equation numbers 1-10). Note that the estimated form of these equations is somewhat different than the general form (3) above. Specifically, the assumptions of identical coefficients (but opposite sign) on gilt retentions and sow slaughter, and coefficient of unity for the lagged dependent variable were relaxed. The estimation period for these equations was limited to the range of 1982 quarter 2 to 1985 quarter 4, due to data availability. This period provides 15 observations which is not quite 4 years of data and only about one conventional hog cycle; this must be viewed as too short a period to derive conclusive results.

The results of the regressions, as they indicate the "degree" to which the survey data provide a leading indiator of hog marketings, vary significantly by region. In general the regression results for Alberta, Saskatchewan, and for Western Canada indicate expected signs on the variables and reasonably good fits to the data. Results for other regions, notably for British Columbia, Ontario, Quebec and Eastern Canada are marginal, although the F-Statistic (initial $F(.05) = 3.59$ at 3,11 d.f.) is significant in every case. For Canada (equation 10) as a whole the results indicate a good fit to the data, with sow slaughter and the lagged dependent variable as contributing significantly to the variation in marketings. It is notable that only in the cases of Alberta and Saskatchewan is the gilt retention variable significant;

in all other cases this variable has an incorrect sign or is insignificant. This result may be due to the crude way in which a proxy was derived for this variable. Another reason is that if the gilt retentions decision occurs at 4 months, the period between retention and breeding may also provide a slaughter option that may tend to vary its dynamic relationship with marketings. This problem is difficult to identify and additional information would be required to deal with it. The Durbin Watson statistic indicates autocorrelation was a problem in 5 of the 10 equations; although no account was taken in estimation for these cases, this would tend to improve predictions from the equations. In general it needs to be emphasized that the results are quite sensitive to the regression period primarily because of the few degrees of freedom currently available.

4.2 Prediction Properties

Charts 1-10 indicate the fit of the predicted versus actual values for each region. Table 6 lists the results of turning point analysis for year over year changes predicted by the model and Table 7 provides Theil inequality coefficients.

The charts indicate that predicted values follow the actual values reasonably well, especially in the cases of Alberta, Saskatchewan, Manitoba, West and the Maritimes. While turning points were often not picked up, they were missed by only a quarter, either leading or lagging. The cases of Ontario and Quebec, which are critical to any national analysis of the hog sector, are perhaps the poorest; however it would appear that these cases are also the most difficult to predict. For the sample period marketings for the western region were marked by a strong upward trend component, whereas the data for Ontario and Quebec illustrate no trend and an irregular cycle.

Table 6 shows how well the predicted series pick up the changes in direction of the percentage year over year changes in the actual series. The results further illustrate the regression results, but provide a more critical test of the models. In short, while the number of turning points predicted are roughly equivalent to the number of actual turning points, those correctly predicted are rare. For directional errors, the models for B.C. and Eastern Canada have predicted directions opposite to the actual in eight of fifteen cases.

TABLE 6. TURNING POINT ANALYSIS FOR YEAR OVER YEAR CHANGES IN MARKETINGS* 1982 2 TO 1985 4

	Turning Points			
	Actual	Predicted	Correctly Predicted	Directional Errors
B.C.	8	7	1	8
Alta.	4	2	1	2
Sask.	4	4	2	2
Man.	1	2	0	2
West	4	2	2	1
Ont.	5	1	0	3
Que.	4	3	0	4
Atlantic	3	3	0	2
East	10	6	0	8
Canada	4	5	2	3

* Based on results from regressions as reported above. A turning point is defined as a change in sign of the 4th period difference in the actual or predicted data. A directional error is registered when the predicted 4 quarter change is opposite in sign to the actual change.

Table 7 shows the Theil coefficients, the interpretation of which is provided at the bottom of the table. The models for Saskatchewan, Alberta, Western Canada and the Maritimes rate reasonably well, according to this measure. The models for B.C., Quebec and Eastern Canada are very poor - worse than a simple naive forecast of a no change prediction; that is, these models perform worse than a forecast based on the assumption that next year's value will be today's value.

TABLE 7. THEIL INEQUALITY COEFFICIENTS*

	Value
B.C.	1.04
Alberta	0.60
Sask.	0.43
Manitoba	0.74
West	0.34
Ontario	0.75
Quebec	1.09
Atlantic	0.43
East	1.09
Canada	0.69

* The coefficients are calculated on the basis of year over year changes. A value of 0 for a coefficient indicates a perfect forecast; a value of 1 indicates a forecast as good as naive forecast, ie $x_t=x_{t-4}$. A value greater than 1 indicates a foreast inferior to a naive model.

4.3 Alternative Models

The issue of whether the survey data is of value or not depends not simply on whether the predictions are more or less accurate, but more importantly on how they perform relative to alternative models or prediction methods. The Theil coefficients, presented in Table 7, for instance compare how well the models work in relation to a no-change model, which can be viewed as perhaps the cheapest possible forecasting framework. But other models are possible that are also worthy of consideration, like ones that use economic variables, for instance, or other Box Jenkins' "ARIMA" type models that use "cycle" type analysis. Comparison with these models enables an understanding of the "value" of the hog-sex survey in terms of its predictive performance. If the information from the survey is costly to obtain, and a cheaper method can be shown to be more accurate then a good argument can be made to discontinue the survey.

In evaluating the hog-sex survey models relative to alternative methods, it was considered appropriate to limit the scope of such analysis to methods using the same range of data. The reason is that although alternative methods could use much longer time series and hence year efficiency, the real issue is how the survey might be relative to other methods and not how good it is now relative to other methods. The presumption here is that as more data become available from the survey more accuracy (efficient estimates) should be possible. However, in limiting the range of data, one effectively limits the range of methods that are possible. Box-Jenkins' models require long time series, and detailed econometric models with numerous explanatory variables also require a large number of degrees of freedom.

Another issue in comparing models relates to "lead time" considerations. The models described earlier provide a one-year lead time in prediction; all information required to make a prediction is available one year in advance. This is a strong requirement for most forecasting methods. For these reasons, it is appropriate to examine alternative methods under similar constraints.

The regresstion models 11, 12 and 13 shown in the following pages list the results of "economic" type models for western Canada, eastern Canada, and Canada. In these regressions, market prices and primary feed costs, lagged four quarters, and a lagged dependent variable were used to predict marketings. These results are to be compared with models 8, 9 and 10 respectively. In all cases these models are inferior to the models provided by the hog-sex survey. The results confirm the difficulties in predicting hog marketings in eastern Canada during this period.

An interesting approach is to blend independent economic information with the hog-sex survey in the attempt of yielding higher prediction ability. Equation 14 show the results of this approach for western Canada. (for eastern Canada and Canada, this approach was not fruitful) The results show the potential value of combining information from different sources. This may be a useful avenue for further work as more information from the survey becomes available.

5.0 CONCLUSIONS

The HSCS provides unique information on slaughter by sex of hog, that in theory could provide a primary leading indicator of the hog cycle. This paper has attempted to examine the data from the survey within a framework of the dynamics of the hog population. The conclusions of this analysis are summarized in the following paragraphs:

1. The HSCS has been conducted on a standard basis for almost five years. This must be considered a short time frame given the dynamics of the hog population. Normal hog cycles have historically lasted 3 to 4 years.

2. Of major concern is the quality of the survey data itself. First, there are a number of non-available observations. Second, the survey sample does not always appear to be proportionate to slaughter (marketings) by province or region. Third, fairly high ratios of gilt slaughter have been reported that appear to be sampling errors. Fourth, the sow slaughter data provides ratios to slaughter often quite different from actual, fully recorded data. The presence in Quebec of high uninspected sow slaughter raises questions about how representative the survey is of sow slaughter in that province. It may be appropriate to use actual inspected and uninspected slaughter data rather than to report survey estimates in this case. Finally, during the sample period high numbers of live hogs have been exported and this may distort the basis of inference from the HSCS, particularly in the cases of Alberta, Manitoba and Ontario.

3. Given these constraints, a statistical, descriptive analysis shows that the survey provides, in the form of female slaughter (gilt, sow and total) ratios, expected negative time correlations with marketings that peak in value at the 6-7 month time lag, and again at the 13-15 month lag. These correlations appear more significant in Western Canada than in Eastern Canada, and are shorter than one might expect given that a hog biological population model would suggest. A chief difficulty in this regard is that current marketings not only represent past herd size decisions, but also present herd size decisions, only the former of which are explainable given past information.

4. Regression models estimated on a quarterly basis indicate that the survey data, cast in the framework discussed in Section 4.0, explains a very high percentage of the variation in quarterly marketings in Western Canada and to a lesser degree for Canada as a whole. However, for Ontario and Quebec the results are marginal. The models estimated follow actual data reasonably well but are not reliable in predicting turning points when they actually occur.

5. The regression models do out-perform simple economic models over the limited available period of study. However, the costs of doing the survey need to be weighed against this performance. Combining information from other sources and the survey information may be useful for the western region, and perhaps should be studied further for the other regions.

6. Further analysis of the data from the HSCS would be useful as more observations become available. Future work might use actual data for sow slaughter, both inspected and uninspected, and attempt to use available information on live sow exports to integrate slaughter and marketing data more fully.

6.0 Regression Results[@]

ORDINARY LEAST SQUARES

MODEL NAME: HGSX British Columbia

1 : SHG11 = F0+F1*SUM(I = -7 TO -4 : GRTBC(I))+F2*SUM(I = -7 TO -4 : SWMBC(I))+F3*SHG11(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4			
RSQ =	0.518	CRSQ =	0.387	F(3/11) =	3.946	PROB>F =	3.903E-02	SER =	3.013
SSR =	99.833	DW(0) =	2.277	COND =	65.120	MAX:HAT =	0.592	RSTUDENT =	-3.426
DFFITS =	-1.597	LHS MEAN =	87.389	SUMR =	6.786E-13				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
F0	53.796	20.993	2.563	2.640E-02	1.000	0.000
F1	-0.274	0.151	-1.812	9.732E-02	1.466	5.945
F2	-0.284	0.649	-0.437	0.671	7.028	1.242
F3	0.418	0.234	1.786	0.102	86.135	3.840

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Alberta

2 : SHG12 = G0+G1*SUM(I = -7 TO -4 : GRTAL(I))+G2*SUM(I = -7 TO -4 : SWMAL(I))+G3*SHG12(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.897	CRSQ =	0.868	F(3/11) =	31.795	PROB>F =	0.000	SER =	23.325
SSR =	5984.510	DW(0) =	1.109	COND =	56.356	MAX:HAT =	0.541	RSTUDENT =	-1.795
DFFITS =	-1.221	LHS MEAN =	457.853	SUMR =	9.663E-13				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
G0	275.994	91.124	3.029	1.147E-02	1.000	0.000
G1	2.091	0.773	2.704	2.053E-02	39.779	18.340
G2	-6.100	1.679	-3.634	3.928E-03	35.665	5.245
G3	0.752	0.341	2.204	4.976E-02	420.641	49.021

[@]Code: SHG - marketings:11-27 corresponds to BC-11, Alberta-12, Sask-13, Man-14, Ont-21, Que-22, Maritimes-27
:1 corresponds to west, 2 to east, and 3 to Canada

GRT - gilt retentions: BC for B.C. ,AL for Alberta etc.

SWM - sow marketings : BC for B.C. etc.

ORDINARY LEAST SQUARES

MODEL NAME: HGSX   Saskatchewan

3 : SHG13 = H0+H1*SUM(I = -7 TO -4 : GRTS(I))+H2*SUM(I = -7 TO -4 : SWMS(I))+H3*SHG13(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.857	CRSQ =	0.818	F(3/11) =	21.987	PROB>F =	0.000	SER =	10.686
SSR =	1256.010	DW(0) =	1.910	COND =	26.254	MAX:HAT =	0.437	RSTUDENT =	2.639
DFFITS =	-1.561	LHS MEAN =	175.621	SUMR =	1.474E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
H0	109.276	32.101	3.404	5.886E-03	1.000	0.000
H1	2.009	0.672	2.991	1.229E-02	13.328	9.276
H2	-0.755	1.673	-0.451	0.660	9.701	3.669
H3	0.281	0.144	1.956	7.637E-02	166.799	20.567

ORDINARY LEAST SQUARES

MODEL NAME: HGSX   Manitoba

4 : SHG14 = I0+I1*SUM(I = -7 TO -4 : GRTM(I))+I2*SUM(I = -7 TO -4 : SWMM(I))+I3*SHG14(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.785	CRSQ =	0.727	F(3/11) =	13.416	PROB>F =	5.389E-04	SER =	27.677
SSR =	8425.960	DW(0) =	1.227	COND =	44.666	MAX:HAT =	0.514	RSTUDENT =	-3.557
DFFITS =	-3.656	LHS MEAN =	379.041	SUMR =	-5.684E-13				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
I0	-61.226	96.847	-0.632	0.540	1.000	0.000
I1	0.631	1.117	0.565	0.583	24.963	7.788
I2	1.475	4.025	0.366	0.721	31.063	2.989
I3	1.103	0.280	3.942	2.304E-03	343.379	39.657

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Ontario

```
5 : SHG21 = B0+B1*SUM(I = -7 TO -4 : GRTO(I))+B2*SUM(I = -7 TO -4 : SWMO(I))+B3*SHG21(-4)
```

NOB = 15		NOVAR = 4		RANGE:	1982 2 TO 1985 4				
RSQ =	0.701	CRSQ =	0.620	F(3/11) =	8.604	PROB>F =	3.176E-03	SER =	34.965
SSR =	13448.100	DW(0) =	2.247	COND =	76.633	MAX:HAT =	0.590	RSTUDENT =	2.909
DFFITS =	1.659	LHS MEAN =	1127.860	SUMR =	5.059E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	MEAN	STDEV
B0	954.111	289.483	3.296	7.129E-03	1.000	0.000
B1	-0.696	0.558	-1.247	0.238	80.038	23.596
B2	-2.171	1.049	-2.070	6.276E-02	98.214	14.248
B3	0.405	0.169	2.398	3.535E-02	1093.380	70.012

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Quebec

```
6 : SHG22 = C0+C1*SUM(I = -7 TO -4 : GRTQ(I))+C2*SUM(I = -7 TO -4 : SWMQ(I))+C3*SHG22(-4)
```

NOB = 15		NOVAR = 4		RANGE:	1982 2 TO 1985 4				
RSQ =	0.658	CRSQ =	0.565	F(3/11) =	7.068	PROB>F =	6.462E-03	SER =	32.273
SSR =	11456.700	DW(0) =	3.179	COND =	61.371	MAX:HAT =	0.512	RSTUDENT =	-2.326
DFFITS =	-2.384	LHS MEAN =	1154.140	SUMR =	2.387E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	MEAN	STDEV
C0	719.976	208.246	3.457	5.358E-03	1.000	0.000
C1	0.600	0.425	1.412	0.186	20.794	20.292
C2	-3.643	1.354	-2.690	2.101E-02	125.802	6.997
C3	0.760	0.181	4.209	1.462E-03	1157.160	52.454

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Maritimes

```
7 : SHG27 = D0+D1*SUM(I = -7 TO -4 : GRTAT(I))+D2*SUM(I = -7 TO -4 : SWMAT(I))+D3*SHG27(-4)
```

NOB = 15		NOVAR = 4		RANGE:	1982 2 TO 1985 4				
RSQ =	0.923	CRSQ =	0.902	F(3/11) =	43.997	PROB>F =	0.000	SER =	2.964
SSR =	96.623	DW(0) =	2.726	COND =	52.769	MAX:HAT =	0.619	RSTUDENT =	-3.074
DFFITS =	-2.599	LHS MEAN =	145.861	SUMR =	6.999E-13				

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	MEAN	STDEV
D0	95.598	17.608	5.429	0.000	1.000	0.000
D1	-1.549E-02	0.302	-5.137E-02	0.960	1.916	4.047
D2	-6.135	0.773	-7.937	0.000	12.675	1.228
D3	0.913	0.110	8.334	0.000	140.234	10.586

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Western Canada

8 : SHG1 = A0+A1*SUM(I = -7 TO -4 : GRTW(I))+A2*SUM(I = -7 TO -4 : SWMW(I))+A3*SHG1(-4)

```
NOB = 15                NOVAR = 4               RANGE:  1982 2  TO  1985 4
RSQ =          0.971 CRSQ =          0.964 F(3/11) =      124.197 PROB>F =         0.000 SER =           26.941
SSR =       7983.750 DW(0) =         1.608 COND =          53.226 MAX:HAT =        0.638 RSTUDENT =      -2.319
DFFITS =      -1.306 LHS MEAN =   1099.900 SUMR =     -1.251E-12
```

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
A0	983.208	112.656	8.728	0.000	1.000	0.000
A1	0.910	0.495	1.838	9.322E-02	79.484	24.551
A2	-14.258	1.703	-8.371	0.000	83.457	5.555
A3	1.214	0.125	9.691	0.000	1016.950	106.319

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Eastern Canada

9 : SHG2 = J0+J1*SUM(I = -7 TO -4 : GRT2(I))+J2*SUM(I = -7 TO -4 : SWM2(I))+J3*SHG2(-4)

```
NOB = 15                NOVAR = 4               RANGE:  1982 2  TO  1985 4
RSQ =          0.727 CRSQ =          0.653 F(3/11) =        9.788 PROB>F =     1.942E-03 SER =           62.028
SSR =      42322.100 DW(0) =         3.004 COND =          70.381 MAX:HAT =        0.599 RSTUDENT =       1.925
DFFITS =       1.709 LHS MEAN =   2427.850 SUMR =      1.711E-11
```

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
J0	1342.660	455.821	2.946	1.331E-02	1.000	0.000
J1	-0.195	0.670	-0.290	0.777	102.748	28.338
J2	-2.150	0.895	-2.401	3.516E-02	236.692	21.290
J3	0.675	0.152	4.445	0.000	2390.770	109.848

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Canada

10 : SHG3 = E0+E1*SUM(I = -7 TO -4 : GRT3(I))+E2*SUM(I = -7 TO -4 : SWM3(I))+E3*SHG3(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.889	CRSQ =	0.859	F(3/11) =	29.400	PROB>F =	0.000	SER =	85.501
SSR =	80414.100	DW(0) =	2.618	COND =	54.603	MAX:HAT =	0.404	RSTUDENT =	1.735
DFFITS =	1.389	LHS MEAN =	3527.760	SUMR =	2.785E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
E0	1853.560	488.781	3.792	2.983E-03	1.000	0.000
E1	0.299	0.572	0.523	0.611	182.232	48.343
E2	-4.330	1.001	-4.325	1.205E-03	320.149	25.522
E3	0.882	0.127	6.943	0.000	3407.720	198.543

Alternative Models

ORDINARY LEAST SQUARES

MODEL NAME: HGSX   Western Canada (hog price Alberta, barley price Alberta)

11 : SHG1 = A0+A1*PHG1(-4)+A2*OPBA1(-4)+A3*SHG1(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.828	CRSQ =	0.781	F(3/11) =	17.602	PROB>F =	1.649E-04	SER =	66.056
SSR =	47997.600	DW(0) =	1.134	COND =	49.204	MAX:HAT =	0.441	RSTUDENT =	-3.668
DFFITS =	-3.108	LHS MEAN =	1099.900	SUMR =	7.333E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
A0	440.665	357.550	1.232	0.243	1.000	0.000
A1	-1.150	2.368	-0.485	0.637	73.009	9.170
A2	-4.537	1.296	-3.501	4.964E-03	104.977	14.794
A3	1.199	0.200	5.991	0.000	1016.950	106.319

ORDINARY LEAST SQUARES

MODEL NAME: HGSX   Eastern Canada (hog price Ontario, corn price Chatham)

12 : SHG2 = A0+A1*PHG2(-4)+A2*FPCO2(-4)+A3*SHG2(-4)

NOB = 15		NOVAR = 4		RANGE: 1982 2 TO 1985 4					
RSQ =	0.574	CRSQ =	0.458	F(3/11) =	4.945	PROB>F =	2.059E-02	SER =	77.529
SSR =	66117.500	DW(0) =	2.241	COND =	97.506	MAX:HAT =	0.458	RSTUDENT =	1.948
DFFITS =	1.172	LHS MEAN =	2427.850	SUMR =	1.501E-11				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
A0	471.039	796.845	0.591	0.566	1.000	0.000
A1	1.409	3.209	0.439	0.669	75.160	9.173
A2	-9.726E-02	0.982	-9.902E-02	0.923	134.149	25.496
A3	0.780	0.235	3.324	6.783E-03	2390.770	109.848

ORDINARY LEAST SQUARES

MODEL NAME: HGSX   Canada (hog price Canada, corn price, barley price)

13 : SHG3 = A0+A1*PHG3(-4)+A2*FPCO2(-4)+A3*OPBA1(-4)+A4*SHG3(-4)

NOB = 15		NOVAR = 5		RANGE: 1982 2 TO 1985 4					
RSQ =	0.837	CRSQ =	0.772	F(4/10) =	12.832	PROB>F =	5.976E-04	SER =	108.741
SSR =	1.182E+05	DW(0) =	2.561	COND =	82.377	MAX:HAT =	0.457	RSTUDENT =	-2.469
DFFITS =	-2.042	LHS MEAN =	3527.760	SUMR =	-2.899E-12				

COEF	ESTIMATE	STER	TSTAT	PROB>|T|	MEAN	STDEV
A0	523.139	861.098	0.608	0.557	1.000	0.000
A1	2.198	4.226	0.520	0.614	74.430	9.098
A2	2.347	1.365	1.719	0.116	134.149	25.496
A3	-7.364	2.130	-3.458	6.144E-03	104.977	14.794
A4	0.968	0.174	5.571	0.000	3407.720	198.543

ORDINARY LEAST SQUARES

MODEL NAME: HGSX Western Canada (mixed model: survey data, hog and barley price)

```
14 : SHG1 = A0+A1*SUM(I = -7 TO -4 : GRTW(I))+A2*SUM(I = -7 TO -4
: SWMW(I))+A3*PHG1(-4)/OPBA1(-4)+A4*SHG1(-4)
```

NOB = 15		NOVAR = 5		RANGE:	1982 2 TO 1985 4
RSQ =	0.990	CRSQ =	0.986	F(4/10) =	242.069
PROB>F =	0.000	SER =	16.870	SSR =	2.8E+03
DW(0) =	2.486	COND =	77.050	MAX:HAT =	0.697
RSTUDENT =	1.853	DFFITS =	-1.080		

COEF	ESTIMATE	STER	TSTAT	PROB>ITI
A0	601.003	114.315	5.257	0.000
A1	1.425	0.333	4.279	1.6E-03
A2	-11.411	1.260	-9.059	0.000
A3	166.034	39.077	4.249	1.7E-03
A4	1.199	7.8E-02	15.277	0.000

Chart 1
Marketings: Fitted vs. Actual
British Columbia

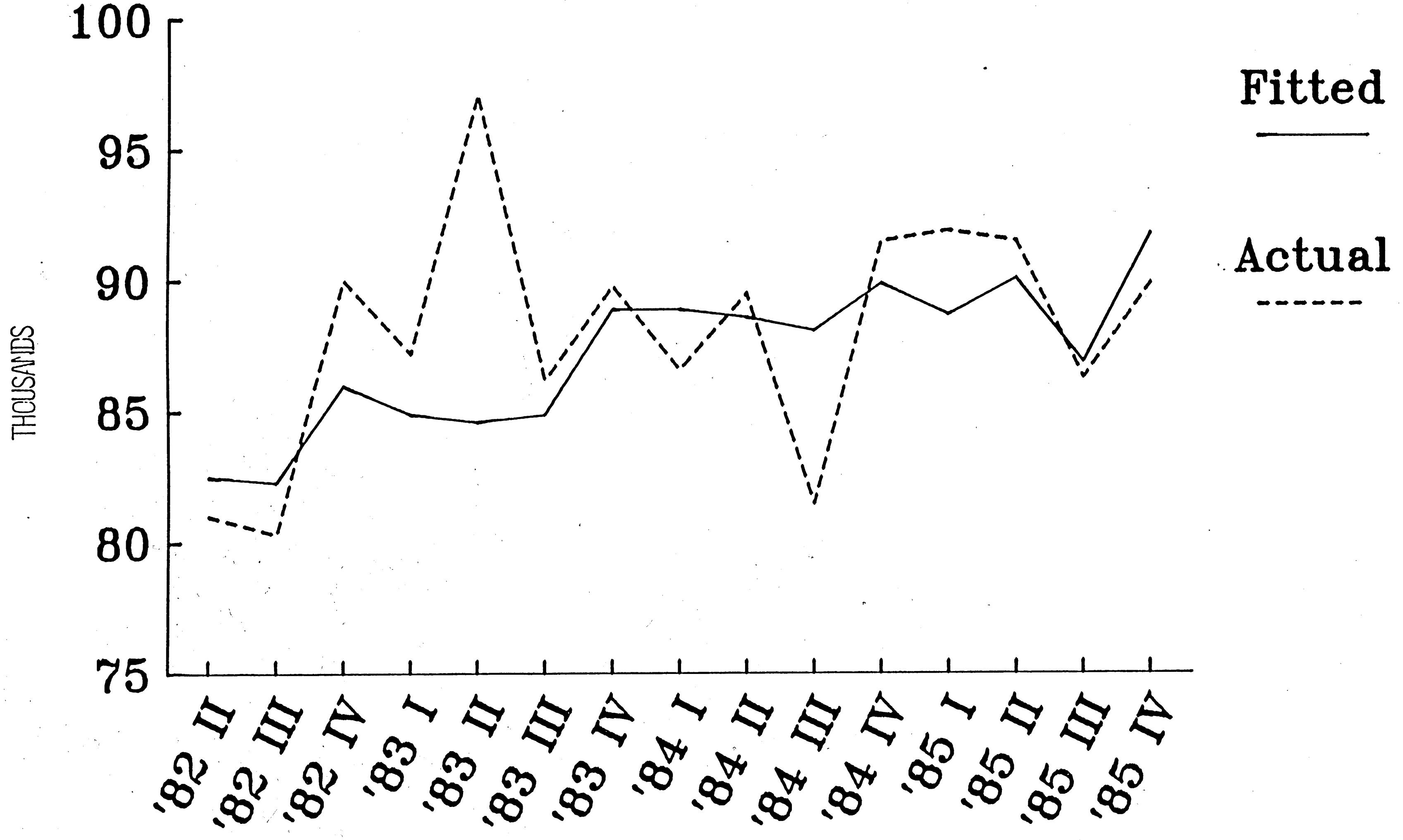


Chart 2
Marketings: Fitted vs. Actual
Alberta

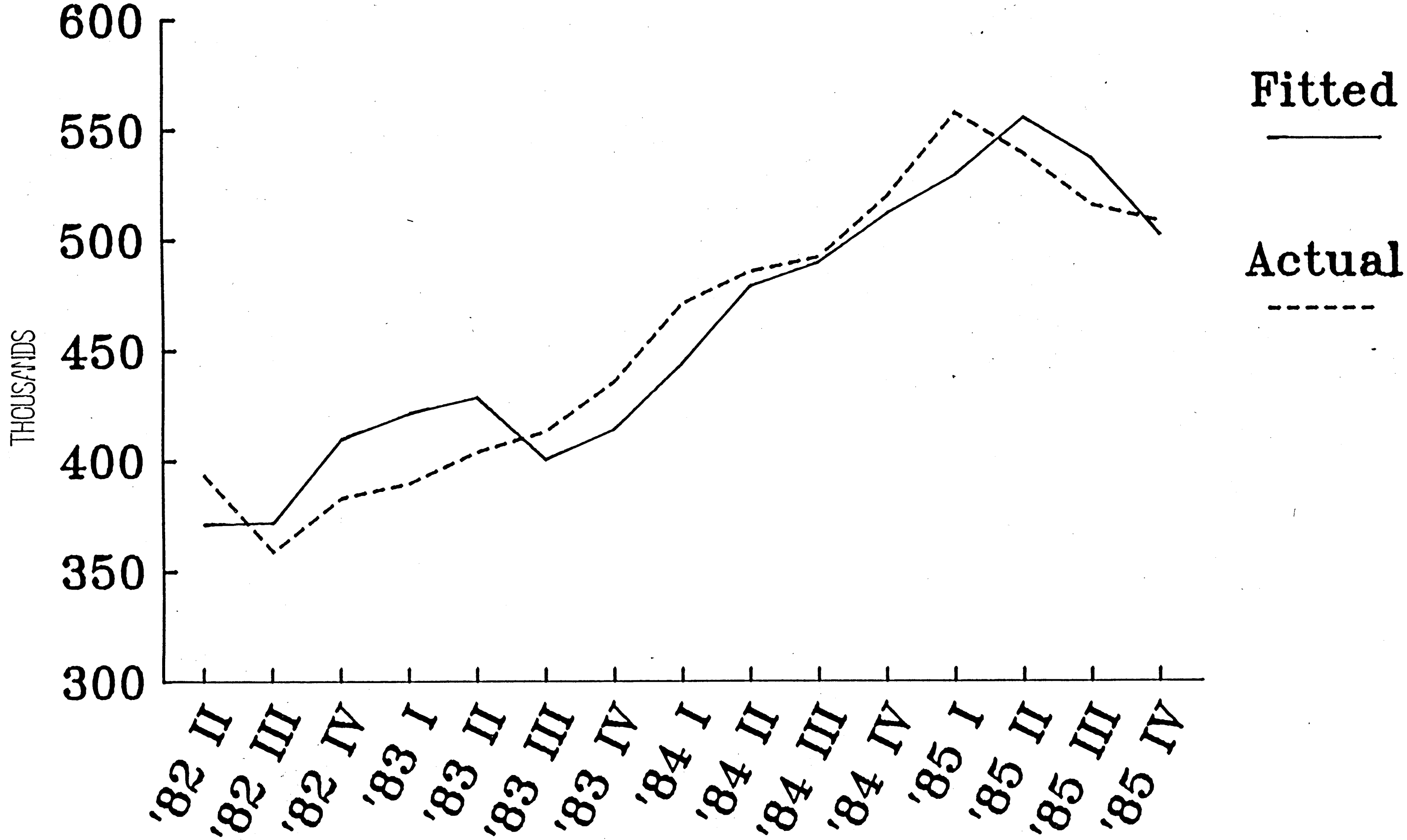


Chart 3
Marketings: Fitted vs. Actual
Saskatchewan

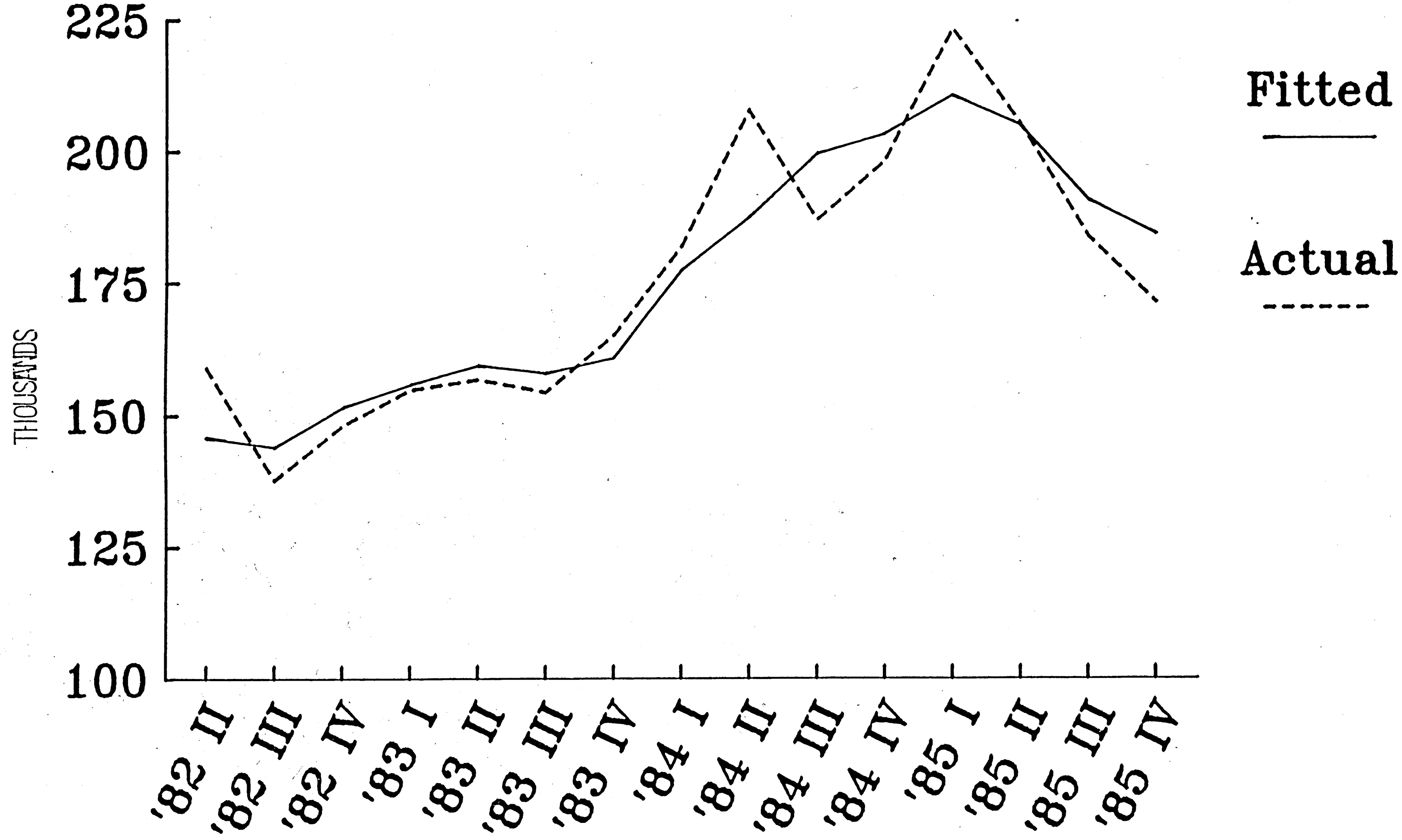


Chart 4
Marketings: Fitted vs. Actual
Manitoba

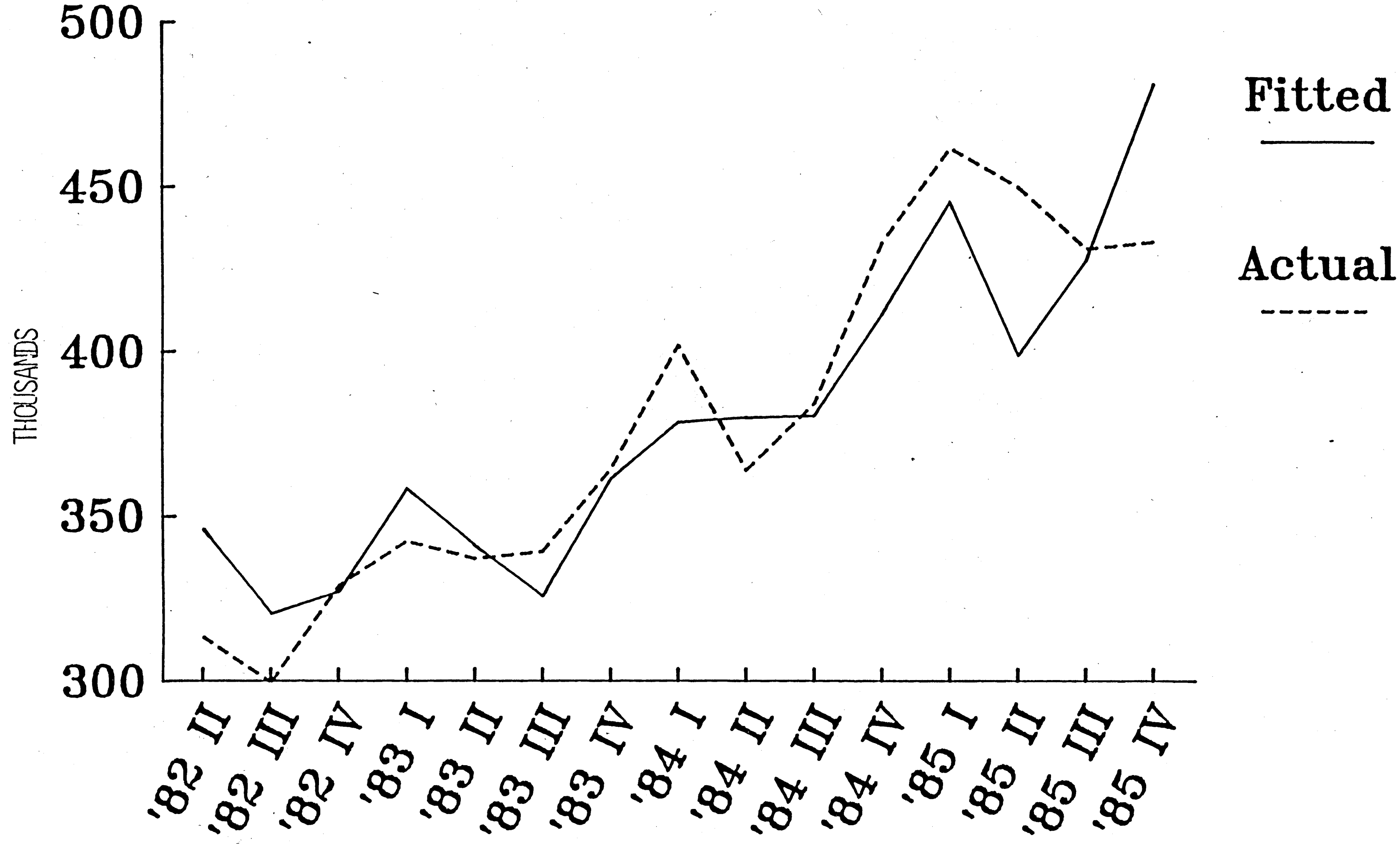


Chart 5
Marketings: Fitted vs. Actual
Ontario

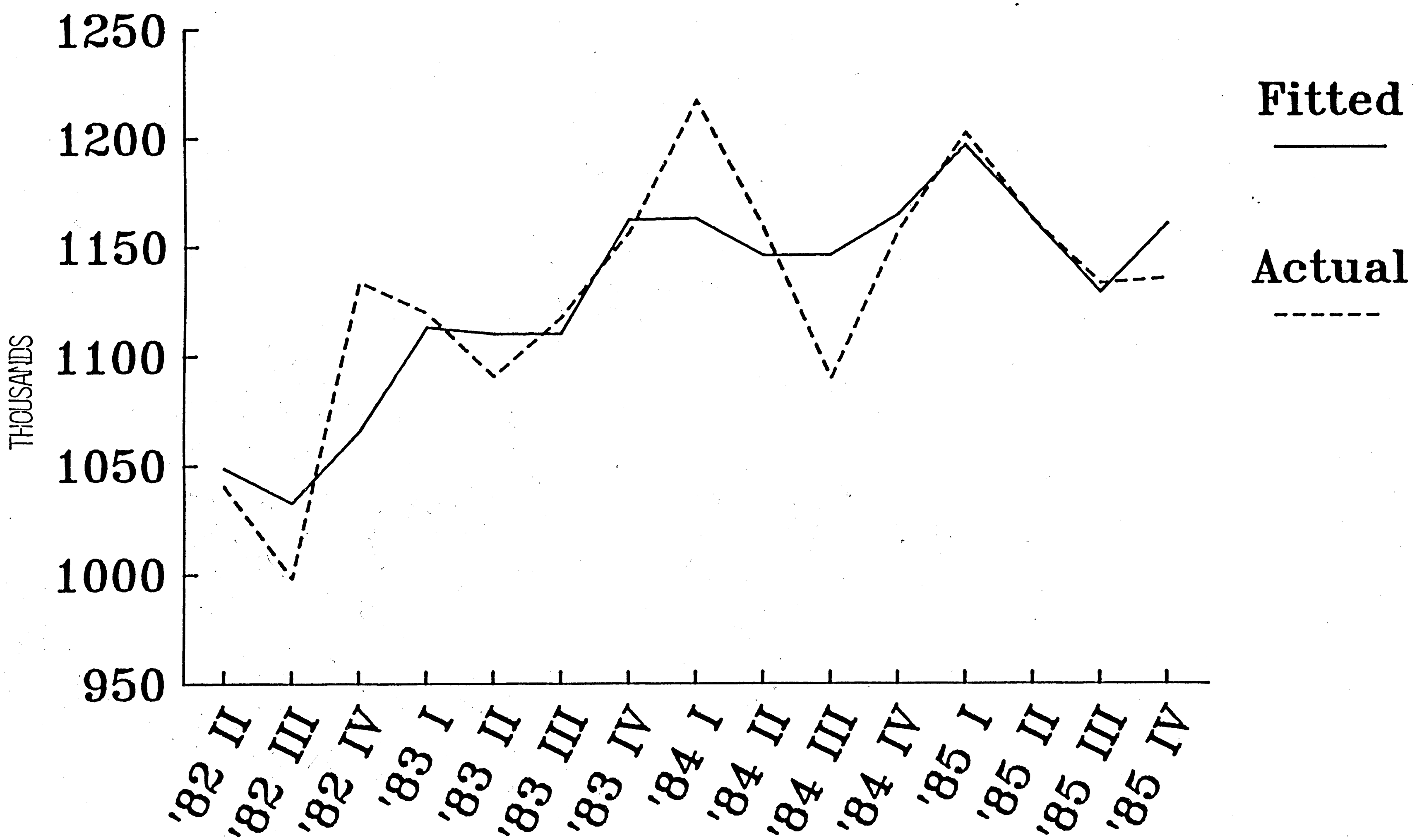


Chart 6
Marketings: Fitted vs. Actual
Quebec

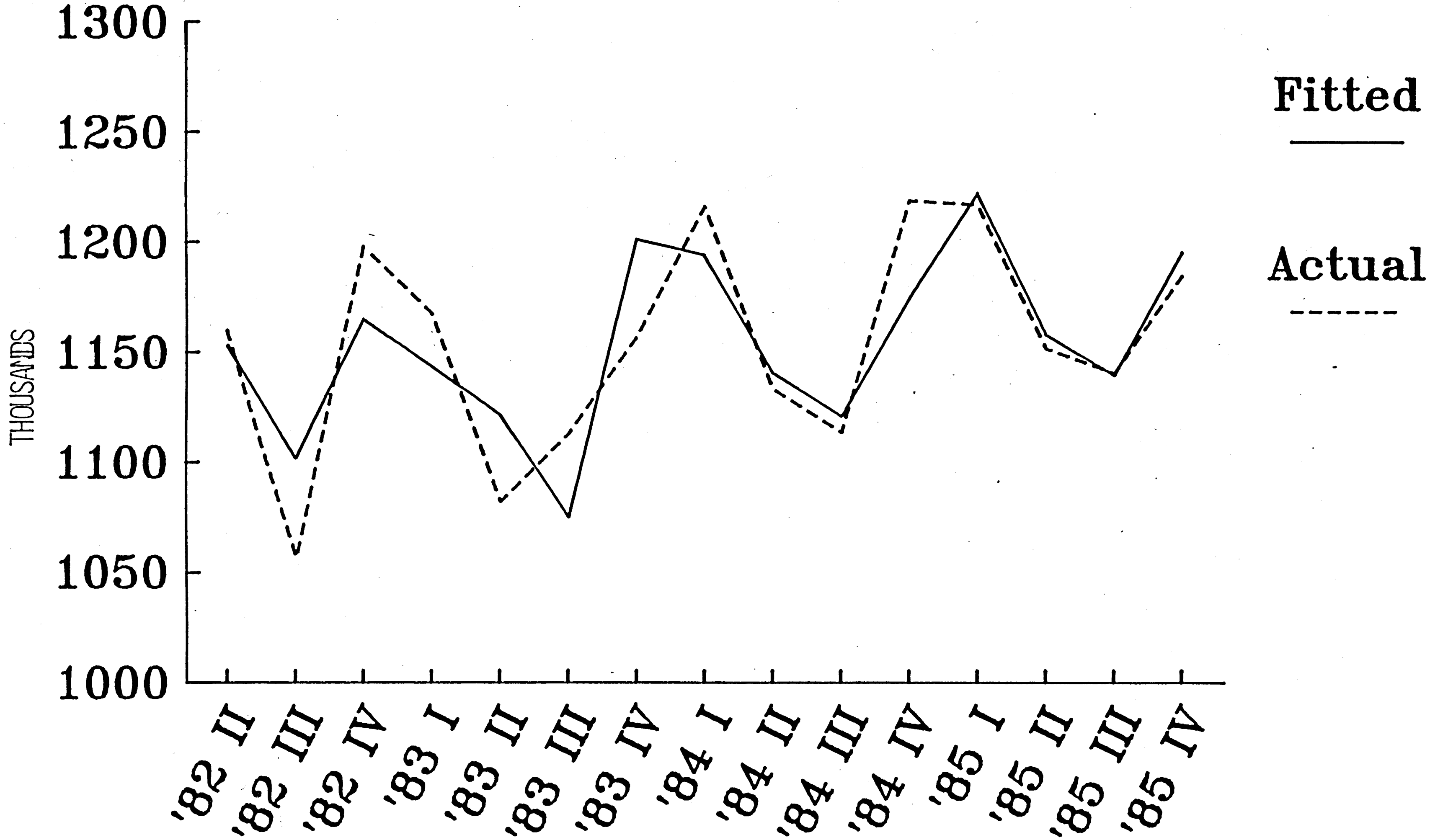


Chart 7
Marketings: Fitted vs. Actual
Maritimes

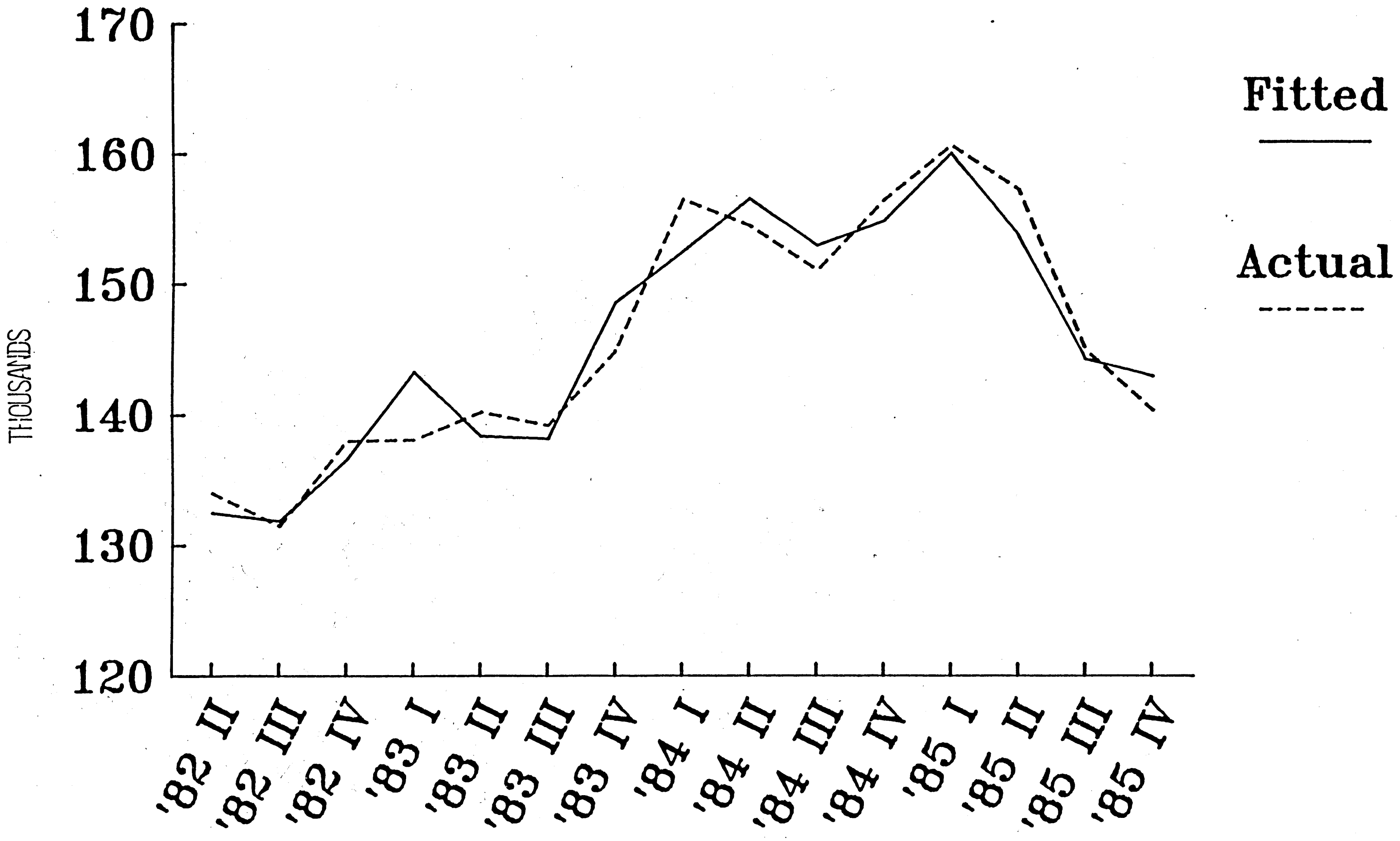


Chart 8
Marketings: Fitted vs. Actual
Western Canada

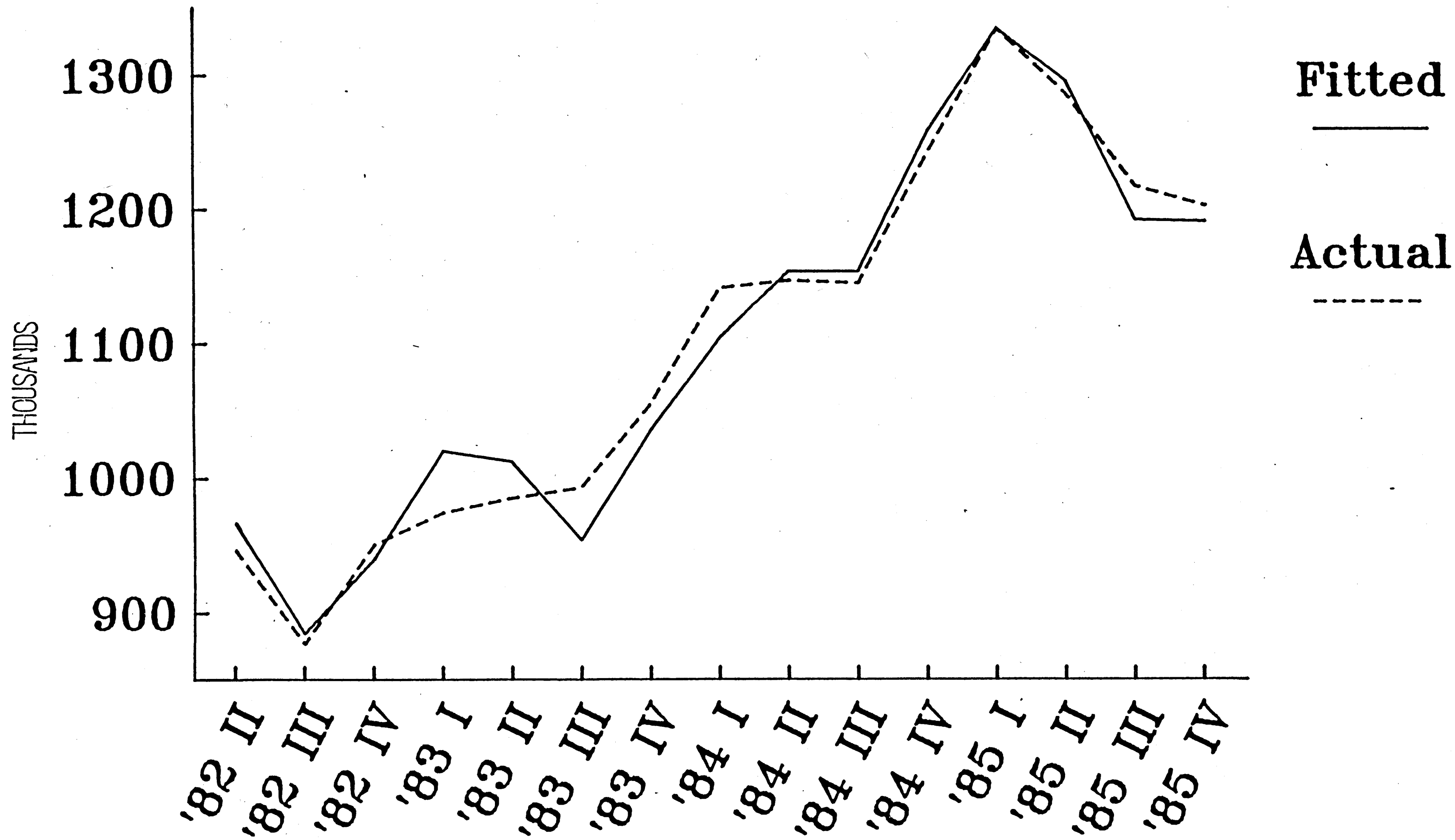


Chart 9
Marketings: Fitted vs. Actual
Eastern Canada

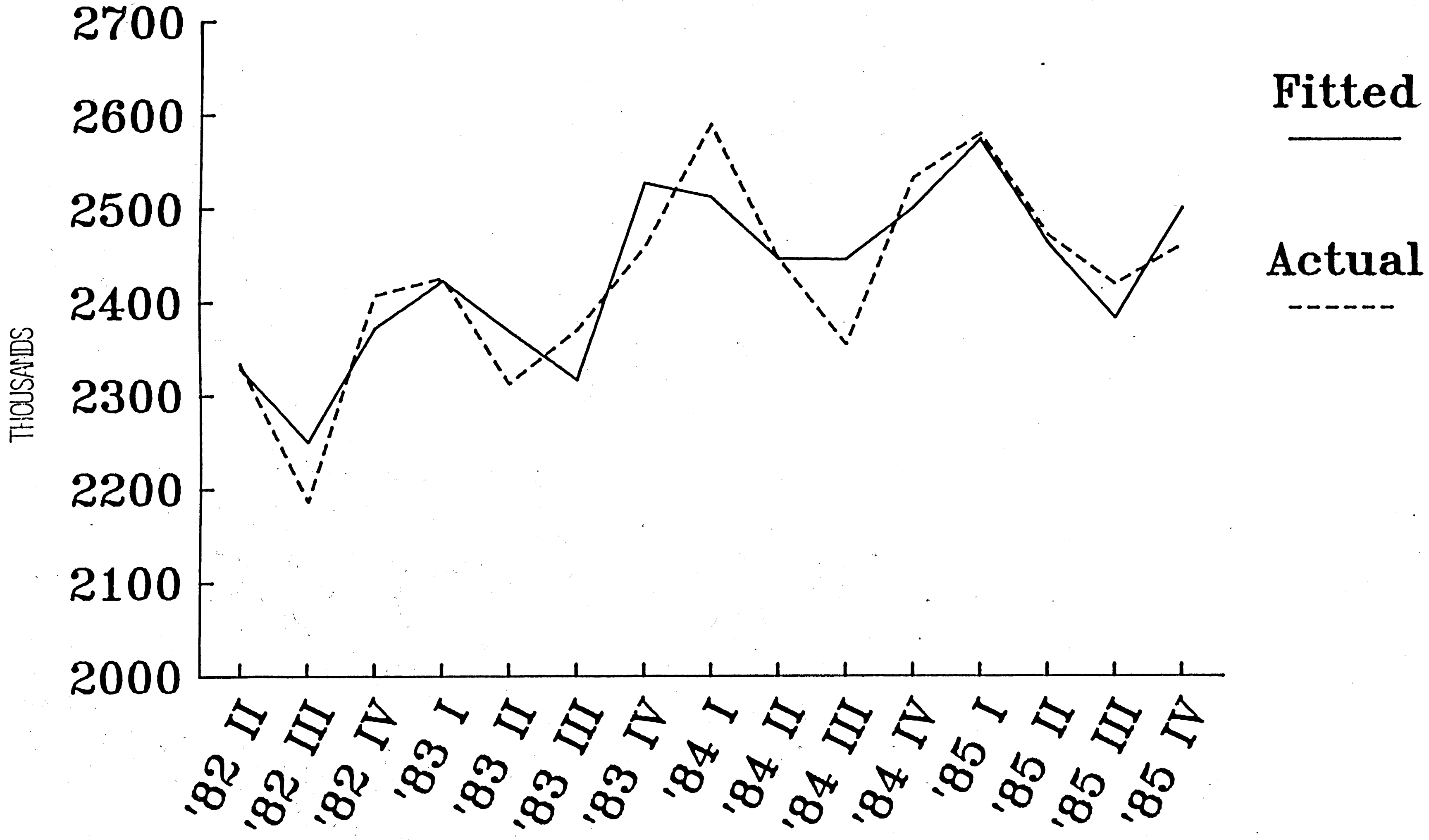
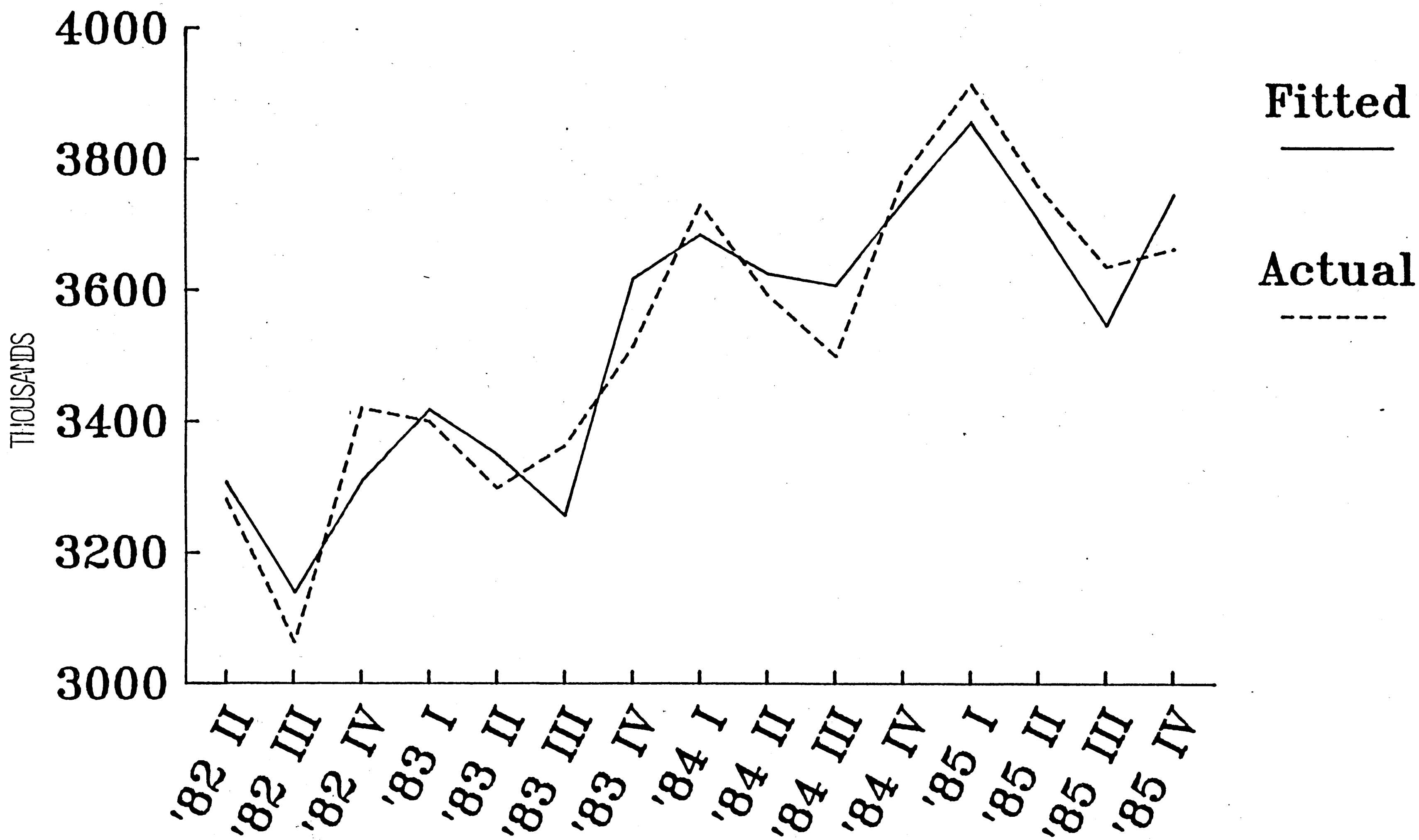


Chart 10
Marketings: Fitted vs. Actual
Canada



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