WORKING PAPER

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Direction générale de la commercialisation et de l'économie
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AN ANALYSIS OF THE HOG SEX COUNT SURVEY

(Working Paper 13/86)

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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 indication 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

\[ G_t = G_{t-1} - NG_t + NG_t \]  
\[ B_t = B_{t-1} - NG_t + NT_t + NB_t \]  
\[ S_t = S_{t-1} - MS + NS_t \]  
\[ T_t = T_{t-1} - MT_t + NT_t \]

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 \( t \)  
\( NG_t \) 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 coming from barrows  
\( NG_t \) and \( NB_t \) are new gilts and barrows (born)

(ii) Biological Constraints

\[ NG_t = p \cdot f \cdot L \cdot S_{t-4} + (1-f) \cdot L \cdot NS_t \]  

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

\[ NB_t = p \cdot (1-f) \cdot L \cdot S_{t-4} + (1-f) \cdot L \cdot NS_t \]  

\[ NS_t = GFB_{t-7} = n_{t-7} \cdot NG_{t-11} \]

where \( GFB_t \) is gilts retained for breeding  
\( n_t \) is the retention rate of gilts, decided at 4 months

\[ NT_t = BFB_{t-3} = q_{t-3} \cdot NB_{t-7} \]
where \( BFB_t \) is barrows retained for breeding

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

\[
\begin{align*}
MG_t &= (1-n_{t-1})NG_{t-5} \\
MB_t &= (1-q_{t-1})NB_{t-5}
\end{align*}
\]  

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

\[
M_t = MG_t + MB_t + MT_t
\]

\[
= (1 - n_{t-1}) \cdot NG_{t-5} + (1 - q_{t-1}) \cdot NB_{t-5} + MS_t + MT_t
\]

\[
= (1 - n_{t-1}) \cdot \left[ p \cdot f \cdot L \cdot S_{t-9} + f \cdot L \cdot n_{t-2} \cdot NG_{t-16} \right]
\]

\[
+ (1 - q_{t-1}) \cdot \left[ p \cdot (1 - f) \cdot L \cdot S_{t-9} + f \cdot L \cdot n_{t-2} \cdot NG_{t-16} \right]
\]

\[
+ MS_t + MT_t
\]  

Following (11), one could go on substituting for the NG terms; this would show that current marketings are a function of past levels of sow inventories and retention decisions for gilts, in addition to current sow and stag marketings. 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.
\[ GBG = \frac{MG_t}{MG_t + MB_t} = \frac{(1 - N_{t-1})NG_{t-5}}{[(1 - n_{t-1})NG_{t-5} + (1 - q_{t-1})NB_{t-5}]}
\]

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

\[
= \frac{(1 - n_{t-1})}{(1 - n_{t-1})f + (1 - q_{t-1})(1 - f)} \Rightarrow \frac{1 - n_{t-1}}{2 - n_{t-1} - q_{t-1}} \quad (at \; f = .5) \quad (17)
\]

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.

<table>
<thead>
<tr>
<th>Gilt Slaughter Ratio</th>
<th>% Retention rate (for previous month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.50</td>
<td>0.5</td>
</tr>
<tr>
<td>.49</td>
<td>4.4</td>
</tr>
<tr>
<td>.48</td>
<td>8.1</td>
</tr>
<tr>
<td>.47</td>
<td>11.8</td>
</tr>
<tr>
<td>.46</td>
<td>15.2</td>
</tr>
</tbody>
</table>

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:
\[
FR = \frac{(MG + MS)}{(MG + MS + MG + MT)}
\]

\[
= \frac{(NS - NG)}{(NS - NG \ NT - NB - NT)}
\]

\[
= \frac{(-NG)}{(-NG - NB)} = f, \text{ the female ratio at birth}
\]

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 GEG 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 could 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

<table>
<thead>
<tr>
<th>MARKETINGS CHANGE YR/YR</th>
<th>FEMALE RATIO</th>
<th>SOW RATIO</th>
<th>GILT RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Cov Max Min</td>
<td>Mean Cov Max Min</td>
<td>Mean Cov Max Min</td>
</tr>
<tr>
<td>British Columbia</td>
<td>17.4 26.9 128.1 -9.8</td>
<td>50.6 3.9 55.3 44.6</td>
<td>1.9 3.5 3.9 0.8</td>
</tr>
<tr>
<td>Alberta</td>
<td>6.9 11.3 34.1 -15.5</td>
<td>50.0 2.4 53.1 46.7</td>
<td>2.1 26.3 3.8 0.3</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>3.2 15.9 52.5 -24.0</td>
<td>49.7 3.3 52.5 44.5</td>
<td>1.3 53.5 3.0 0.2</td>
</tr>
<tr>
<td>Manitoba</td>
<td>8.1 9.5 44.1 -10.0</td>
<td>49.9 2.3 53.4 47.4</td>
<td>2.2 21.4 3.4 1.2</td>
</tr>
<tr>
<td>Ontario</td>
<td>2.7 6.4 21.7 -10.7</td>
<td>50.0 1.8 52.0 47.0</td>
<td>2.2 30.2 3.8 0.9</td>
</tr>
<tr>
<td>Quebec</td>
<td>2.6 9.6 30.2 -18.2</td>
<td>51.1 1.6 53.8 49.4</td>
<td>2.7 18.2 3.7 0.3</td>
</tr>
<tr>
<td>Maritimes</td>
<td>6.5 6.7 28.6 -12.5</td>
<td>51.0 2.5 55.2 48.1</td>
<td>2.4 15.7 3.3 1.5</td>
</tr>
<tr>
<td>Canada</td>
<td>4.0 7.0 24.2 -9.0</td>
<td>50.4 0.9 51.4 48.7</td>
<td>2.3 15.1 3.0 1.4</td>
</tr>
<tr>
<td>East</td>
<td>2.7 6.8 22.4 -11.1</td>
<td>50.6 1.1 52.1 48.6</td>
<td>2.5 16.4 3.3 1.0</td>
</tr>
<tr>
<td>West</td>
<td>6.9 9.9 29.8 -10.2</td>
<td>50.0 1.5 51.6 47.4</td>
<td>2.0 17.7 2.9 1.2</td>
</tr>
</tbody>
</table>
TABLE 2. CORRELATIONS BETWEEN THE RATIO OF SOW SLAUGHTER TO TOTAL SLAUGHTER AND THE RATIO OF GILT TO BARROW AND GILT SLAUGHTER

<table>
<thead>
<tr>
<th>Region</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.C.</td>
<td>-.111</td>
</tr>
<tr>
<td>Alberta</td>
<td>+.219</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>+.303</td>
</tr>
<tr>
<td>Manitoba</td>
<td>+.131</td>
</tr>
<tr>
<td>Ontario</td>
<td>+.057</td>
</tr>
<tr>
<td>Quebec</td>
<td>-.181</td>
</tr>
<tr>
<td>Atlantic</td>
<td>-.001</td>
</tr>
<tr>
<td>Canada</td>
<td>.074</td>
</tr>
<tr>
<td>West</td>
<td>.184</td>
</tr>
<tr>
<td>East</td>
<td>.008</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>LAG</th>
<th>B.C.</th>
<th>ALBERTA</th>
<th>SASK.</th>
<th>MANITOBA</th>
<th>WEST</th>
<th>ONTARIO</th>
<th>QUEBEC</th>
<th>ATLANTIC</th>
<th>EAST</th>
<th>CANADA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-0.093</td>
<td>-0.272</td>
<td>0.052</td>
<td>0.299</td>
<td>0.025</td>
<td>-0.068</td>
<td>-0.082</td>
<td>0.300</td>
<td>-0.069</td>
<td>-0.076</td>
</tr>
<tr>
<td>1</td>
<td>0.088</td>
<td>-0.286</td>
<td>0.042</td>
<td>0.311</td>
<td>-0.002</td>
<td>-0.205</td>
<td>0.048</td>
<td>0.323</td>
<td>0.018</td>
<td>-0.004</td>
</tr>
<tr>
<td>2</td>
<td>0.182</td>
<td>-0.343</td>
<td>-0.068</td>
<td>0.304</td>
<td>-0.101</td>
<td>-0.338</td>
<td>0.145</td>
<td>0.335</td>
<td>0.092</td>
<td>-0.014</td>
</tr>
<tr>
<td>3</td>
<td>0.170</td>
<td>-0.411</td>
<td>-0.203</td>
<td>0.106</td>
<td>-0.251</td>
<td>-0.388</td>
<td>0.113</td>
<td>0.181</td>
<td>0.111</td>
<td>-0.120</td>
</tr>
<tr>
<td>4</td>
<td>0.060</td>
<td>-0.508</td>
<td>-0.320</td>
<td>-0.019</td>
<td>-0.391</td>
<td>-0.295</td>
<td>-0.067</td>
<td>0.039</td>
<td>0.035</td>
<td>-0.304</td>
</tr>
<tr>
<td>5</td>
<td>0.052</td>
<td>-0.577</td>
<td>-0.392</td>
<td>-0.124</td>
<td>-0.491</td>
<td>-0.189</td>
<td>-0.348</td>
<td>-0.155</td>
<td>-0.200</td>
<td>-0.492</td>
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<td>-0.089</td>
<td>-0.261</td>
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<td>-0.701</td>
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<td>-0.483</td>
<td>-0.301</td>
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</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>LAG</th>
<th>B.C.</th>
<th>ALBERTA</th>
<th>SASK.</th>
<th>MANITOBA</th>
<th>WEST</th>
<th>ONTARIO</th>
<th>QUEBEC</th>
<th>ATLANTIC</th>
<th>EAST</th>
<th>CANADA</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-0.297</td>
<td>-0.319</td>
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<td>-0.081</td>
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</tr>
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<td>-0.361</td>
<td>-0.331</td>
<td>-0.116</td>
<td>-0.099</td>
<td>0.265</td>
<td>-0.195</td>
<td>0.145</td>
<td>0.057</td>
</tr>
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<td>0.126</td>
<td>-0.291</td>
<td>0.117</td>
<td>-0.006</td>
</tr>
<tr>
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<td>-0.197</td>
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<td>0.061</td>
<td>-0.325</td>
<td>0.020</td>
<td>-0.114</td>
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<td>-0.203</td>
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<td>-0.007</td>
<td>-0.322</td>
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</tr>
<tr>
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<td>-0.319</td>
<td>-0.253</td>
<td>0.287</td>
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<td>-0.666</td>
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<td>-0.372</td>
<td>-0.136</td>
<td>0.320</td>
<td>-0.465</td>
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<tr>
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<td>-0.394</td>
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<td>0.052</td>
<td>-0.542</td>
<td>-0.217</td>
<td>-0.123</td>
<td>-0.341</td>
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<tr>
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<td>-0.524</td>
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<td>0.102</td>
<td>-0.127</td>
<td>-0.174</td>
<td>-0.518</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th></th>
<th>B.C.</th>
<th>ALBERTA</th>
<th>SASK.</th>
<th>MANITOBA</th>
<th>WEST</th>
<th>ONTARIO</th>
<th>QUEBEC</th>
<th>ATLANTIC</th>
<th>EAST</th>
<th>CANADA</th>
</tr>
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<tbody>
<tr>
<td>LAG 0</td>
<td>-0.056</td>
<td>-0.138</td>
<td>0.008</td>
<td>0.214</td>
<td>0.031</td>
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<td>0.039</td>
<td>0.290</td>
<td>-0.018</td>
<td>-0.059</td>
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<tr>
<td>LAG 1</td>
<td>0.087</td>
<td>-0.157</td>
<td>-0.013</td>
<td>0.217</td>
<td>-0.004</td>
<td>-0.202</td>
<td>0.122</td>
<td>0.294</td>
<td>0.039</td>
<td>-0.015</td>
</tr>
<tr>
<td>LAG 2</td>
<td>0.143</td>
<td>-0.218</td>
<td>-0.130</td>
<td>0.212</td>
<td>-0.102</td>
<td>-0.285</td>
<td>0.183</td>
<td>0.291</td>
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<td>-0.041</td>
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<tr>
<td>LAG 3</td>
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<td>-0.263</td>
<td>0.022</td>
<td>-0.245</td>
<td>-0.323</td>
<td>0.128</td>
<td>0.131</td>
<td>0.089</td>
<td>-0.160</td>
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<tr>
<td>LAG 4</td>
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<td>-0.384</td>
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<td>-0.373</td>
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<td>-0.007</td>
<td>-0.024</td>
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<td>LAG 5</td>
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<td>-0.174</td>
<td>-0.467</td>
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<td>-0.367</td>
<td>-0.193</td>
<td>-0.254</td>
<td>-0.528</td>
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<tr>
<td>LAG 6</td>
<td>0.038</td>
<td>-0.492</td>
<td>-0.549</td>
<td>-0.101</td>
<td>-0.503</td>
<td>-0.256</td>
<td>-0.574</td>
<td>-0.312</td>
<td>-0.465</td>
<td>-0.636</td>
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<tr>
<td>LAG 7</td>
<td>0.088</td>
<td>-0.479</td>
<td>-0.601</td>
<td>-0.098</td>
<td>-0.495</td>
<td>-0.347</td>
<td>-0.564</td>
<td>-0.295</td>
<td>-0.477</td>
<td>-0.592</td>
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<tr>
<td>LAG 8</td>
<td>-0.050</td>
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<td>-0.661</td>
<td>-0.103</td>
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<td>-0.376</td>
<td>-0.288</td>
<td>-0.257</td>
<td>-0.250</td>
<td>-0.426</td>
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<tr>
<td>LAG 9</td>
<td>-0.250</td>
<td>-0.471</td>
<td>-0.682</td>
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<td>-0.469</td>
<td>-0.248</td>
<td>0.058</td>
<td>-0.222</td>
<td>0.061</td>
<td>-0.246</td>
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<tr>
<td>LAG 10</td>
<td>-0.376</td>
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<td>-0.718</td>
<td>-0.043</td>
<td>-0.472</td>
<td>-0.188</td>
<td>0.191</td>
<td>-0.352</td>
<td>0.123</td>
<td>-0.239</td>
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<td>-0.461</td>
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<td>-0.325</td>
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<td>LAG 12</td>
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<td>-0.476</td>
<td>-0.770</td>
<td>0.213</td>
<td>-0.438</td>
<td>-0.193</td>
<td>-0.100</td>
<td>-0.449</td>
<td>-0.190</td>
<td>-0.445</td>
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<tr>
<td>LAG 13</td>
<td>-0.224</td>
<td>-0.456</td>
<td>-0.779</td>
<td>0.289</td>
<td>-0.424</td>
<td>-0.126</td>
<td>-0.368</td>
<td>-0.408</td>
<td>-0.316</td>
<td>-0.513</td>
</tr>
<tr>
<td>LAG 14</td>
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<td>-0.392</td>
<td>-0.755</td>
<td>0.271</td>
<td>-0.393</td>
<td>-0.096</td>
<td>-0.601</td>
<td>-0.363</td>
<td>-0.454</td>
<td>-0.564</td>
</tr>
<tr>
<td>LAG 15</td>
<td>-0.185</td>
<td>-0.330</td>
<td>-0.737</td>
<td>0.257</td>
<td>-0.357</td>
<td>-0.052</td>
<td>-0.598</td>
<td>-0.348</td>
<td>-0.449</td>
<td>-0.494</td>
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<tr>
<td>LAG 16</td>
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<td>0.246</td>
<td>-0.293</td>
<td>0.005</td>
<td>-0.410</td>
<td>-0.275</td>
<td>-0.273</td>
<td>-0.351</td>
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</table>

**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:

\[ M_t = f(B_{t-4}) \]  

- \( M_t \) is marketings, \( B_t \) is female breeding stock

\[ B_t = B_{t-1} + GRT_t - SS_t \]  

\( GRT_t \) 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:

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

(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 indicator 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 $F(0.05) = 3.59$ 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

<table>
<thead>
<tr>
<th></th>
<th>Actual</th>
<th>Predicted</th>
<th>Correctly Predicted</th>
<th>Directional Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.C.</td>
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<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Alta.</td>
<td>4</td>
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<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sask.</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Man.</td>
<td>1</td>
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<td>0</td>
<td>2</td>
</tr>
<tr>
<td>West</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ont.</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Que.</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Atlantic</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>East</td>
<td>10</td>
<td>6</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Canada</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

* 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*

<table>
<thead>
<tr>
<th>Region</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.C.</td>
<td>1.04</td>
</tr>
<tr>
<td>Alberta</td>
<td>0.60</td>
</tr>
<tr>
<td>Sask.</td>
<td>0.43</td>
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<tr>
<td>Manitoba</td>
<td>0.74</td>
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<tr>
<td>West</td>
<td>0.34</td>
</tr>
<tr>
<td>Ontario</td>
<td>0.75</td>
</tr>
<tr>
<td>Quebec</td>
<td>1.09</td>
</tr>
<tr>
<td>Atlantic</td>
<td>0.43</td>
</tr>
<tr>
<td>East</td>
<td>1.09</td>
</tr>
<tr>
<td>Canada</td>
<td>0.69</td>
</tr>
</tbody>
</table>

* 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, i.e. \( x_t = x_{t-4} \). A value greater than 1 indicates a forecast 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 regression 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 : \( \text{SHG11} = F0 + F1 \times \sum_{I = -7}^{-4} GRTBC(I) + F2 \times \sum_{I = -7}^{-4} SWMBC(I) + F3 \times \text{SHG11}(-4) \)

- **NOB = 15**
- **NOVAR = 4**
- **RANGE: 1982 2 TO 1985 4**
- **RSQ = 0.518**
- **RSD = 0.387**
- **F(3/11) = 3.946**
- **PROB>F = 3.903E-02**
- **SER = 3.013**
- **DFFITS = -1.597**
- **LHS MEAN = 87.389**
- **SUMR = 6.786E-13**

<table>
<thead>
<tr>
<th>COEF</th>
<th>ESTIMATE</th>
<th>STER</th>
<th>TSTAT</th>
<th>PROB&gt;IT</th>
<th>MEAN</th>
<th>STDEV</th>
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<tbody>
<tr>
<td>F0</td>
<td>53.796</td>
<td>20.993</td>
<td>2.563</td>
<td>2.640E-02</td>
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<td>0.000</td>
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<tr>
<td>F1</td>
<td>-0.274</td>
<td>0.151</td>
<td>-1.812</td>
<td>9.732E-02</td>
<td>1.466</td>
<td>5.945</td>
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<tr>
<td>F2</td>
<td>-0.284</td>
<td>0.649</td>
<td>-0.437</td>
<td>0.671</td>
<td>7.028</td>
<td>1.242</td>
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<tr>
<td>F3</td>
<td>0.418</td>
<td>0.234</td>
<td>1.786</td>
<td>0.102</td>
<td>86.135</td>
<td>3.840</td>
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</table>

**ORDINARY LEAST SQUARES**

**MODEL NAME: HGSX  Alberta**

2 : \( \text{SHG12} = G0 + G1 \times \sum_{I = -7}^{-4} GRTAL(I) + G2 \times \sum_{I = -7}^{-4} SWMAL(I) + G3 \times \text{SHG12}(-4) \)

- **NOB = 15**
- **NOVAR = 4**
- **RANGE: 1982 2 TO 1985 4**
- **RSQ = 0.897**
- **RSD = 0.868**
- **F(3/11) = 31.795**
- **PROB>F = 0.000**
- **SER = 23.325**
- **DFFITS = -1.221**
- **LHS MEAN = 457.853**
- **SUMR = 9.663E-13**

<table>
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<tr>
<th>COEF</th>
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<th>STER</th>
<th>TSTAT</th>
<th>PROB&gt;IT</th>
<th>MEAN</th>
<th>STDEV</th>
</tr>
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<tbody>
<tr>
<td>G0</td>
<td>275.994</td>
<td>91.124</td>
<td>3.029</td>
<td>1.147E-02</td>
<td>1.000</td>
<td>0.000</td>
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<tr>
<td>G1</td>
<td>2.091</td>
<td>0.773</td>
<td>2.704</td>
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<td>39.779</td>
<td>18.340</td>
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<tr>
<td>G2</td>
<td>-6.100</td>
<td>1.679</td>
<td>-3.634</td>
<td>3.928E-03</td>
<td>35.665</td>
<td>5.245</td>
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<tr>
<td>G3</td>
<td>0.752</td>
<td>0.341</td>
<td>2.204</td>
<td>4.976E-02</td>
<td>420.641</td>
<td>49.021</td>
</tr>
</tbody>
</table>

@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**

\[ 3 : \text{SHG13} = H_0 + H_1 \times \text{SUM}(I = -7 \text{ TO } -4 : \text{GRTS}(I)) + H_2 \times \text{SUM}(I = -7 \text{ TO } -4 : \text{SUMS}(I)) + H_3 \times \text{SHG13}(-4) \]

- **NOB** = 15
- **NOVAR** = 4
- **RANGE**: 1982 2 TO 1985 4

\[ \text{RSQ} = 0.857 \quad \text{CRSQ} = 0.818 \quad F(3/11) = 21.987 \quad \text{PROB}>F = 0.000 \quad \text{SER} = 10.636 \]

\[ \text{SSR} = 1256.010 \quad \text{DW}(0) = 1.910 \quad \text{COND} = 26.254 \quad \text{MAX:HAT} = 0.437 \quad \text{RSTUDENT} = 2.639 \]

\[ \text{DFITS} = -1.561 \quad \text{LHS MEAN} = 175.621 \quad \text{SUHR} = 1.474E-12 \]

| COEF | ESTIMATE | STER | TSTAT | PROB>|TI| | MEAN | STDEV |
|------|----------|------|-------|-------|---------|-------|-------|
| \(H_0\) | 109.276 | 32.101 | 3.404 | 5.886E-03 | 1.000 | 0.000 |
| \(H_1\) | 2.009 | 0.672 | 2.991 | 1.229E-02 | 13.328 | 9.276 |
| \(H_2\) | -0.755 | 1.673 | -0.451 | 0.660 | 9.701 | 3.669 |
| \(H_3\) | 0.281 | 0.144 | 1.956 | 7.637E-02 | 166.799 | 20.587 |

### Ordinary Least Squares

**Model Name: HGSX Manitoba**

\[ 4 : \text{SHG14} = H_0 \times \text{SUM}(I = -7 \text{ TO } -4 : \text{GRTM}(I)) + H_1 \times \text{SUM}(I = -7 \text{ TO } -4 : \text{SUMS}(I)) + H_2 \times \text{SHG14}(-4) \]

- **NOB** = 15
- **NOVAR** = 4
- **RANGE**: 1982 2 TO 1985 4

\[ \text{RSQ} = 0.785 \quad \text{CRSQ} = 0.727 \quad F(3/11) = 13.416 \quad \text{PROB}>F = 5.389E-04 \quad \text{SER} = 27.677 \]

\[ \text{SSR} = 8425.960 \quad \text{DW}(0) = 1.227 \quad \text{COND} = 44.666 \quad \text{MAX:HAT} = 0.514 \quad \text{RSTUDENT} = -3.557 \]

\[ \text{DFITS} = -3.656 \quad \text{LHS MEAN} = 379.041 \quad \text{SUHR} = -5.684E-13 \]

| COEF | ESTIMATE | STER | TSTAT | PROB>|TI| | MEAN | STDEV |
|------|----------|------|-------|-------|---------|-------|-------|
| \(I_0\) | -61.226 | 96.847 | -0.632 | 0.540 | 1.000 | 0.000 |
| \(I_1\) | 0.631 | 1.117 | 0.565 | 0.583 | 24.963 | 7.788 |
| \(I_2\) | 1.475 | 4.025 | 0.366 | 0.721 | 31.063 | 2.989 |
| \(I_3\) | 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
RNO = 0.701
RSQ = 0.620
F(3/11) = 8.604
PROB>F = 3.17E-03
SER = 34.955

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
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 : GRTO(I))+C2*SUM(I = -7 TO -4 : SWMO(I))+C3*SHG22(-4)

NOB = 15
NOVAR = 4
RNO = 0.658
RSQ = 0.565
F(3/11) = 7.068
PROB>F = 6.462E-03
SER = 32.273

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
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 : GRTO(I))+D2*SUM(I = -7 TO -4 : SWMO(I))+D3*SHG27(-4)

NOB = 15
NOVAR = 4
RNO = 0.923
RSQ = 0.592
F(3/11) = 43.997
PROB>F = 0.000
SER = 2.964

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  0.980  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**

\[
8 : \text{SHG}_1 = A_0 + A_1 \times \text{SUM}(I = -7 \text{ to } -4 \times \text{GRTU}(I)) + A_2 \times \text{SUM}(I = -7 \text{ to } -4 \times \text{SWMM}(I)) + A_3 \times \text{SHG}_1(-4)
\]

- **NOB = 15**  
- **NOVAR = 4**  
- **RANGE:** 1982 2 TO 1985 4

<table>
<thead>
<tr>
<th>COEF</th>
<th>ESTIMATE</th>
<th>STD</th>
<th>TSTAT</th>
<th>PROB</th>
<th>MEAN</th>
<th>STDEV</th>
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<tbody>
<tr>
<td>A0</td>
<td>983.208</td>
<td>112.656</td>
<td>8.728</td>
<td>0.000</td>
<td>1.000</td>
<td>0.000</td>
</tr>
<tr>
<td>A1</td>
<td>0.910</td>
<td>0.495</td>
<td>1.838</td>
<td>9.322E-02</td>
<td>79.484</td>
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<tr>
<td>A2</td>
<td>-14.258</td>
<td>1.703</td>
<td>-8.371</td>
<td>0.000</td>
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<td>A3</td>
<td>1.214</td>
<td>0.125</td>
<td>9.691</td>
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<td>1016.950</td>
<td>106.3</td>
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</table>

### Ordinary Least Squares

**Model Name:** HGSX  
**Eastern Canada**

\[
9 : \text{SHG}_2 = J_0 + J_1 \times \text{SUM}(I = -7 \text{ to } -4 \times \text{GRT2}(I)) + J_2 \times \text{SUM}(I = -7 \text{ to } -4 \times \text{SWMM}(I)) + J_3 \times \text{SHG}_2(-4)
\]

- **NOB = 15**  
- **NOVAR = 4**  
- **RANGE:** 1982 2 TO 1985 4

<table>
<thead>
<tr>
<th>COEF</th>
<th>ESTIMATE</th>
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<th>TSTAT</th>
<th>PROB</th>
<th>MEAN</th>
<th>STDEV</th>
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<tr>
<td>J0</td>
<td>1342.660</td>
<td>455.821</td>
<td>2.946</td>
<td>1.331E-02</td>
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<tr>
<td>J1</td>
<td>-0.195</td>
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<td>-0.290</td>
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<tr>
<td>J2</td>
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<td>0.000</td>
<td>2390.770</td>
<td>109.848</td>
</tr>
</tbody>
</table>
ORDINARY LEAST SQUARES

MODEL NAME: HGSX  Canada

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

NOB = 15  NOVAR = 4  RANGE: 1982 2 TO 1985 4
R2O = 0.889  CR2O = 0.859  F(3/11) = 29.400  PROB>F = 0.000  SER = 85.501
SSR = 80414.100  DW(0) = 2.618  COND = 54.603  MAXHAT = 0.404  RSTUDENT = 1.735
DFFITS = 1.389  LHS MEAN = 3527.760  SUHR = 2.786E-12

| COEF | ESTIMATE | STER | TSTAT | PROB>|T| | MEAN | STDEV |
|------|----------|------|-------|------|-----|------|-------|
| E0   | 1853.560 | 488.781 | 3.792 | 2.93E-03 | 1.000 | 0.000 |
| E1   | 0.299    | 0.572  | 0.523 | 0.611 | 182.232 | 48.343 |
| E2   | -4.320   | 1.001  | -4.325 | 1.205E-03 | 326.149 | 25.522 |
| E3   | 0.882    | 0.127  | 6.943 | 0.000 | 3407.720 | 198.543 |
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
RSQ = 0.828 CRSSQ = 0.781 F(3/11) = 17.602 PROB>F = 1.649E-04 SER = 11.056
SSR = 47997.600 DW(0) = 1.134 COND = 49.204 MAX:HAT = 0.441 RSTUDENT = -3.668
DIFFITS = -3.108 LHS MEAN = 1099.900 SUMR = 7.333E-12

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	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
RSQ = 0.574 CRSSQ = 0.458 F(3/11) = 4.945 PROB>F = 2.059E-02 SER = 177.529
SSR = 66117.500 DW(0) = 2.241 COND = 97.506 MAX:HAT = 0.458 RSTUDENT = 1.948
DIFFITS = 1.172 LHS MEAN = 2427.650 SUMR = 1.501E-11

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	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
RSQ = 0.837 CRSSQ = 0.772 F(4/10) = 12.832 PROB>F = 5.976E-04 SER = 108.741
SSR = 1.182E+05 DW(0) = 2.561 COND = 92.377 MAX:HAT = 0.457 RSTUDENT = -2.469
DIFFITS = 2.042 LHS MEAN = 3527.760 SUMR = -2.899E-12

COEF	ESTIMATE	STER	TSTAT	PROB>ITI	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)

\[ \text{SHG1} = A0 + A1 \cdot \text{SUM}(I = -7 \ TO \ -4) \cdot \text{GRTW}(I) + A2 \cdot \text{SUM}(I = -7 \ TO \ -4) \cdot \text{SWMW}(I) + A3 \cdot \text{PHG1}(-4)/\text{OPBA1}(-4) + A4 \cdot \text{SHG1}(-4) \] 

NOB = 15
NOVAR = 5
RANGE: 1982 2 TO 1985 4

RSQ = 0.990
CRSQ = 0.986
F(4/10) = 242.069

SER = 2.486
SSR = 77.050

COMB = 1.853
BEFIT = 1.080

| COEF | ESTIMATE | TIER | TSTAT | PROB>|TI|
|------|----------|------|-------|-------|
| A0   | 601.003  | 114.315 | 5.257 | 0.000 |
| A1   | 1.425    | 0.333 | 4.279 | 0.000 |
| A2   | -11.411  | 1.260 | -9.059 | 0.000 |
| A3   | 166.034  | 39.077 | 4.249 | 0.000 |
| A4   | 1.199    | 7.0E-02 | 15.277 | 0.000 |
Chart 1
Marketings: Fitted vs. Actual
British Columbia

THOUSANDS

Fitted
Actual
Chart 2
Marketings: Fitted vs. Actual
Alberta

Fitted

Actual
Chart 3
Marketings: Fitted vs. Actual
Saskatchewan

Fitted
Actual
Chart 4: Marketings: Fitted vs. Actual

Manitoba

Fitted

Actual

Thousands

1982
1983
1984
1985
I
II
III
IV
1986
I
II
III
IV
1987
I
II
III
IV
1988
I
II
III
IV
1989
I
II
III
IV
1990
I
II
III
IV
1991
1992
Chart 5
Marketings: Fitted vs. Actual
Ontario
Chart 6
Marketings: Fitted vs. Actual
Quebec

Fitted
Actual
Chart 7
Marketings: Fitted vs. Actual
Maritimes

THOUSANDS

Fitted

Actual
Chart 8
Marketings: Fitted vs. Actual
Western Canada

1300
1200
1100
1000
900

THOUSANDS

'82 II  '82 III  '82 IV  '83 I  '83 II  '83 III  '83 IV  '84 I  '84 II  '84 III  '84 IV  '85 I  '85 II  '85 III  '85 IV
Chart 9
Marketings: Fitted vs. Actual
Eastern Canada
Chart 10
Marketings: Fitted vs. Actual
Canada

Fitted

Actual
LIST OF WORKING PAPERS PUBLISHED IN 1986


No. 6 Agricultural Marketing Legislation in the United States and Western Europe. Pamela Cooper and Brian Davey. April 1986.

No. 7 Structural Change in the Canadian Dairy Farm Sector. Ralph E. Cotterill. April 1986.


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