PREDICTIONS OF CONSUMER CONFIDENCE/SENTIMENT FROM THE PRESS

David P. Fan, University of Minnesota
Dept. Genetics and Cell Biology, 1445 Gortner Ave., St. Paul, MN 55108

KEY WORDS: Consumer, mass media, methodology

Monthly surveys have been conducted for many years on consumer attitudes in the United States. The University of Michigan has computed an Index of Consumer Sentiment from responses to 5 questions on the consumers' perceptions of the economy (Curtin, 1982). The Conference Board has summarized the results from 10 similar questions into a seasonally adjusted Consumer Confidence Index (Linden, 1982; 1990).

It is reasonable that the forces driving changes in index values should be the same as those changing other opinion. A variety of studies, including those in the area of consumer behavior, have argued that the mass media constitute an important source of the persuasive information causing changes in opinions including consumer confidence (see O'Guinn and Faber, 1991 for a recent review). In this connection, it is noteworthy that Throop's (1992) regression analysis found that consumer confidence is little affected by financial assets, indebtedness, and income for which the individual receives key information from personal experience. Instead, confidence is much more affected by inflation, stock prices and the unemployment rate. Individual are much more likely to learn about these numbers through the press. Thus Throop's study supports the idea that press information is likely to be key in setting consumer sentiment.

In fact, earlier studies have already shown the importance of the press by demonstrating that time trend forecasts of consumer confidence/sentiment could be made from Associated Press (AP) stories analyzed by computer (Tims, Fan, and Freeman, 1991; Tims, Faber, Fan and Schram, 1989). For the 1989 article, 1252 AP stories on the American economy were examined at random from the NEXIS electronic database in the time window from January 1, 1977 to August 25, 1988. Paragraphs within the text were scored as describing the economy in favorable and/or unfavorable terms. Then, the scores were entered into the mathematical model of ideodynamics to predict the Index of Consumer Sentiment. For the 1991 paper, the same methods were used to model the Consumer Confidence Index and an ABC/Money Magazine question on the economy. The text used for the analysis was 919 AP stories obtained from the DataTimes electronic database.

However, all those studies involved ex post forecasts in which the values of the parameters were estimated on the basis of opinion data covering the entire time period of the analysis. Also, it was possible that a larger sample of news stories might lead to more accurate forecasts. Therefore, this paper describes a much more robust ex ante test in which computations of consumer confidence/sentiment were made every month from computer analyses of a very large number of news stories, 6840 in all. The analyses were typically performed the weekend before the Conference Board released its Consumer Confidence Index on the last Tuesday of the month. The Michigan values were released even later. Just before the Conference Board release, the media forecasts of consumer confidence/sentiment were faxed to the units at the Conference Board and the University of Michigan generating the indexes as well as to a small number of other interested parties.

In this way, the computations were placed in a true predictive mode since the index numbers were not available at the time that the forecasts were faxed.

Media analysis

The news media stories used to predict the Index values came from the Major Paper library of the NEXIS database. This library contains the full texts of a number of major papers around the country. Since a large number of newspapers have entered this electronic database in recent years, the decision was made to switch from the AP to this library to obtain a more representative set of the news stories which actually appeared in print. The study began in May 1991 with a retrieval of 2000 out of 7850 stories in the Major Paper library from January 1, 1990 to May 12, 1991 (Table 1). The 7850 stories were those which were located using the following search command: (economy or recession) and not ((foreign) or (internat!) or (state) or (global) or (city) or (region!) or (local) or (europe!) or (latin Amer!) or (south amer!) or (central amer!) or (asia!) or (afric!)). In this command, the ! meant that any trailing characters were permitted. Clearly, the goal was to minimize stories discussing the economy or recession in foreign countries and in localized areas in the United States. After that time, a retrieval and analysis was made approximately once a month.

In May 1991, the Major Paper library contained 12 papers including the New York Times, Washington Post, and Los Angeles Times. Toward the end of the analysis in 1993, there were 17 because more papers entered the database. Despite this increase, the entire

Major Paper library continued to be searched in order that the stories should be progressively more representative of the national news structure. The decision was also influenced by earlier findings (Fan and McAvoy, 1989) that the ideodynamic predictions are relatively insensitive to numbers of stories used. The critical aspect is the ratio of favorable to unfavorable coverage.

Once retrieved, the text was analyzed by computer using the method of successive filtrations. To obtain precision in scoring, the analyst prepares a custom set of computer instructions for each topic. These instructions comprise a dictionary and a set of rules describing how two or more words can be combined to give a complex idea.

The computer loads the instruction file and identifies the dictionary words in the text. Then the computer uses the rules and the orders and distances between the dictionary words to select paragraphs in the text containing the desired ideas. The computer can then write the selected paragraphs to output files.

In the economic analysis, instructions were first written to identify paragraphs specific for the American economy. The machine kept paragraphs on the economy so long as they did not contain a word describing a foreign country or entity or a specific region of the United States or the world. The rules permitted words like "stagflation" to indicate the economy since they were unambiguously about this topic. Also, words like "depression" typically referred to the economy since the original retrieval command insisted that all stories had to contain the word "economy" or "recession." However, to avoid terms like "economies of scale," a rule was written specifying that the meaning of "economy" required that the word "economy" be within 20 characters, not words, of a word like "activity" or "barometer." The instructions were further broadened to specify that reference to foreign or local areas in the story's headline or dateline would cause all paragraphs in the story to be discarded.

Decisions made by the computer were written to screen so the analyst could interactively improve the rules. After the rules looked reasonably satisfactory, the computer used them to sort the entire retrieved text into two sets of files, one containing only text on the American economy and another containing all other text. The output was in the form of ASCII files which the analyst could examine to see if there was systematic misscoring of paragraphs which had been missed during the interactive testing. The rules were revised and rerun on the starting to text until a satisfactory level of accuracy was obtained, typically in the range of 75-90 percent depending on the complexity of the text. Any reader interested in further details on the method and access to the software should contact the author.

The paragraphs selected by the computer as being specific for the American economy were further analyzed for whether the United States economy was described as doing well or badly. The general principle was that the idea of the economy should be modified by words implying good and bad. Also, increases in inflation and joblessness were scored as unfavorable for the economy.

The same paragraphs on the American economy were also scored for whether they discussed employment or consumers. These two scoring schemes gave the salience of different issues in economic coverage.

Ideodynamic modeling

In the final step content analytic step, the computer generated numerical scores for the numbers of paragraphs in each story containing the specified ideas. The scores were plotted as persuasive force functions F (Appendix A) which look like spikes rising to the paragraph value on the day of that paragraph and then dropping by one half with each succeeding day. Fig. 1 plots these scores for newspaper discussion of the economy in good (top frame) and bad (bottom frame) terms. Inspection shows that at all times there was more bad news than good, although there were times when the bad news was even more dominant as in the second half of 1990 when the unfavorable information

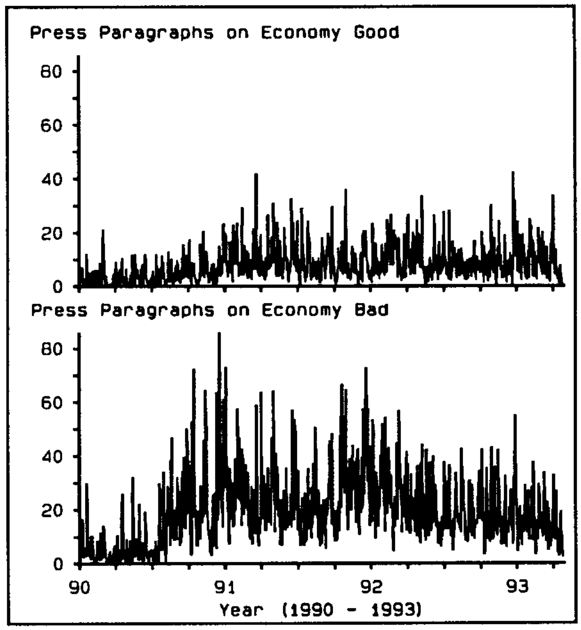

Figure 1: Paragraph scores from the NEXIS Major Paper library describing the United States economy in favorable (upper frame) and unfavorable terms (lower frame).

rose dramatically without much change in the favorable news.

The content analysis rules files described above were formulated in May 1991 and the equivalent of Fig. 1 was plotted for stories obtained from January 1, 1990 to May 12, 1991. These scores were used in the ideodynamic model (Eq. 5, see Appendix A for the logic and implementation of the model) to compute the media share. The strategy of ideodynamics is to compute an information share time trend which is designed to match opinion. Then this time trend is compared to opinion obtained from survey results. This computation required an initial media share value, set to 39 percent using the method of Convergence from Worst Cases (Fan and McAvoy, 1989). The persuasibility constant k describing the responsiveness of the media share to news stories (Eq. 5) was set to a value such that the fluctuation in the media share line was approximately that observed in previous studies where the ideodynamic computation could be compared with actual survey data (e.g. Tims, et al., 1991; Tims et al., 1989). The value chosen was 0.14 percent media percentage shift per Major Paper paragraph per day.

At this point, the Conference Board and Michigan Indexes were scaled so that they matched the ideodynamic line using the simple formula A + B•(Index value) = (Media share) where A and B are constants. These parameters for the Index of Consumer Sentiment were -22.6 and 0.67, respectively, with the equivalent numbers for the Conference Board Index being 0.14 and 0.36.

Each month, a new fax was sent simply extending the time series with no corrections to the prior data. The only exception was a revision in the content analysis in November 1991 and a revision of the October scores using those content analysis rules. After that time, no revisions were made to the content analysis. All parameters in the model, the initial media share value of 39 percent, the persuasibility constant, and the two scaling constants for the two indexes were kept constant from May, 1991 until April 24, 1993, just before the conference at which these data were presented. The plots (Fig. 2, top 2 frames) show that the content analysis and modeling discussions developed in 1991 continued to give accurate forecasts for the Michigan Index.

After the collection of the April 24, 1993 media stories, the parameters originally set in May 1991 were reestimated and statistical computations were made. In the estimation step, the objective function (Eq. 10, Appendix A) was optimized using the Simplex algorithm (Nelder and Mead, 1965). No stable parameters were found using the Conference Board data as the dependent variable, aside from the degenerate case of B=0 and k=0. Therefore, the analysis for that series is not presented here.

However, the Simplex did give a robust set of parameters for the Michigan data. The new parameters, with 95 percent confidence intervals were: k = 0.087 with interval (0.00053,0.15); A = -18.3 with interval (-19.5,-16.5); and B = 0.62 with interval (0.61,0.64). The very broad confidence interval k, in the range of three-fold, reinforces the statement made earlier in this paper that the ideodynamic computation is relatively insensitive to k with the ratio of pro to con

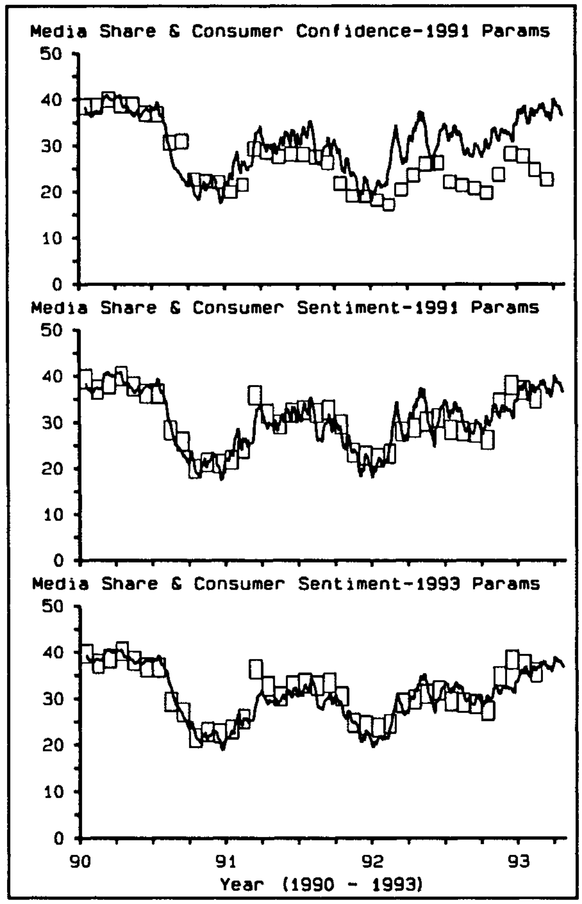

Figure 2: Media share of favorable discussion of the economy compared to survey results. All calculations used media scores shown in Fig. 1. The lines in the top two frames are the same and give the media shares for economic discussion using parameters estimated from press stories from January 1, 1990 to May 12, 1991. The width of each boxes gives the beginning and end of the month for which the Index was computed and the height gives the confidence reported by the survey organizations. The bottom frame used the same data as in the center frame but with parameters estimated from the entire time trend.

news being much more important. In contrast, the confidence intervals for A and B are much tighter. Overall, the parameter estimates from two years earlier were still quite good.

Inspection of the plots (Fig. 2, center and bottom frame) using both the 1991 and 1993 parameters shows close resemblance with similar Root Mean Squared Deviations (RMSDs, see Appendix A) (2.6 and 2.4, respectively) and the same R^2 (0.80). The RMSDs of 2.4 and 2.6 percent can be multiplied by the reciprocal of constant B to give 3.6 and 3.9 as the values in Index points.

Causality and utility of ideodynamics

The data presented above show that the media share moves in concert with the Index of Consumer Sentiment. Causal relationships can be explored using the Granger test (1980, and Appendix A). Such a test showed that the media share is a Granger cause of this Index with an F statistic confidence of 0.042 (Eq. 13, Fig. 4). There was no evidence for a reverse cause (Eq. 14, Fig. 4).

The data on the utility of the ideodynamic computations are even stronger with the F test significance being 0.000012 for the ability of the media share to improve on predictions of the Index over use of just the past history of the index (Eq. 15, Fig. 4).

Assessments of the economic press agenda

The Michigan Index was consistently predicted with high accuracy using k set solely by the criterion that the fluctuations in the line should be comparable to the scatter seen in previous studies and the initial media share value was fixed using the method of Convergence from Worst Cases, also independent of all survey values. Although the absolute values in the media share deviated from the Conference Board numbers, the general trends and timing of turning points were also similar even in Fig. 2. Therefore, the ideodynamic method can give media trends which match survey data without any reference to survey results.

With this in mind, a study was made of various topics on the media agenda relative to the economy. The same methods were also used to analyze the results of media discussion of jobs and consumers in paragraphs also referring to the economy. The resulting time trends (Fig. 3) show that the media share of discussion of consumers stayed in the 5 to 10 percent range throughout the study while concern about jobs increased from 5 percent in 1990 to approximately 15 percent in early 1993.

Discussion

The data in this paper show that computer content analysis of newspaper stories followed by ideodynamic modeling could predict the Michigan Index of Consumer Sentiment from January 1990 to April 1993 with an accuracy of 3.9 points without changing any conditions first set in May 1991. Parameters reoptimized at the end of the study were close to the unchanged for the Michigan Index. As was true for the 1992 presidential election (Fan, 1993), both Granger and utility analyses showed significant impact of the news on opinion, in this case, Consumer Sentiment.

As expected from earlier studies showing great tolerance for changes in the persuasibility constant, the only media modeling parameter, the computations in this paper were so robust that there was no need to correct for more newspapers entering the database during the course of the study.

The studies also illustrate the usefulness of the methods for assessing the extent to which different issues are prominent on the media agenda. In particular, the low salience of the consumer on the economic agenda (Fig. 3) is consistent with the Index of Consumer Sentiment not being a Granger cause of media coverage (Eq. 14, Fig. 4).

Appendix A: Ideodynamic Modeling

The model for this paper is

$$I_{G,t} = I_{G,t-1} + kF_{G,t}I_{B,t-1} - kF_{B,t}I_{G,t-1} + \epsilon_t \qquad (1)$$

where I refers to information share, where subscript t to time, and where subscripts G and B refers to good and bad, respectively. Thus $I_{G,t}$ is the information share for favorable economic performance at time t. Variable F is the persuasive force due to persuasive information

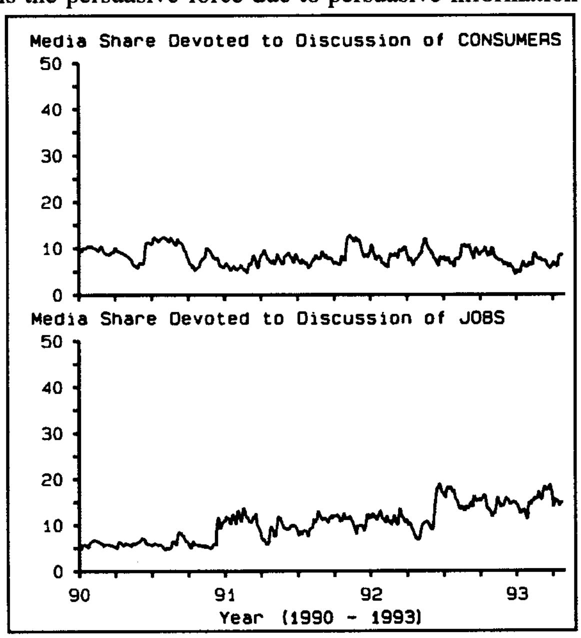

Figure 3: Media share of United States economic coverage devoted to jobs and consumers. The plots are like those in Fig. 2.

so $F_{B,t}$ is the persuasive force due to unfavorable economic news. Since persuasive information in this paper is measured in paragraphs, F has units of paragraphs. Each paragraph in a story is given its value on date of that story with that value decreasing by one-half with each succeeding day corresponding to an exponential decay with a one day half-life (Fan, 1988). Functions $F_{G,t}$ and $F_{B,t}$ are plotted in the top and bottom frames, respectively, in Figs. 1. The model has one parameter, k, the persuasibility constant describing the change in information share due the typical news paragraph. Since this paper only scored mass media stories, the information share is equivalent to a media share.

The first term on the right (Eq. 10) states that media share $I_{G,t}$ will be the same as $I_{G,t-1}$ if there is no new persuasive information i.e. $F_{G,t} = F_{B,t} = 0$.

The next two terms extend the arguments used to derive the logistic equation for the diffusion of innovations (Fan, 1988). The postulate for the logistic is that change in the adoption of an innovation, and hence opinion, is proportional to two factors simultaneously. One factor is the force of persuasive information about the innovation or opinion. The other is the number people who have not yet been persuaded and who are therefore available for conversion. The two factors appear as product terms in the equation to give the necessary result that there will be little change if there is either little information and many potential converts or if there are large persuasive forces and few people who have not already been convinced. Since information share I is designed to match opinion, there are equivalent multiplicative terms in Eq. 1. Thus, in the second term on the right in this equation, persuasive force $F_{G,t}$ favorable to the economy is multiplied by information share $I_{B,t-1}$ about a bad economy. Since recruitment requires time, t-1 is used for $I_{B,t-1}$.

The third term derives from conversion of good share $I_{G,t-1}$ in the opposite direction due to bad economic news $F_{B,t}$. The ϵ_t is an additive error term.

For implementation, the total media share is defined to sum to 100 percent in analogy to the population staying constant in size during the time period analyzed. Therefore, $I_{G,t} + I_{B,t} = 1$. Substituting this equation in Eq. 1 gives

$$I_{G,t} = kF_{G,t} + D_t I_{G,t-1} + \epsilon_t \quad (2)$$

where $D_t = 1 - kF_{G,t} - kF_{B,t}$ is a "damping term" because (details from author) $|D_t| \leq 1$.

The computation begins at t=0 with an initial assigned value $I_{G,0}$ so

$$I_{G,1} = kF_{G,1} + D_1 I_{G,0} + \epsilon_0 \quad (3)$$

upon writing Eq. 2 for time t=1. Then the computation advances one time unit with computed value of $I_{G,1}$ being used for $I_{G,2}$, so Eq. 3 is substituted in Eq. 2 to give

$$I_{G,2} = kF_{G,2} + D_2(kF_{G,1} + D_1 D_{G,0} + \epsilon_0) + \epsilon_1. \quad (4)$$

Continued recursive substitutions gives this equation which yields an information share time trend driven entirely by persuasive information as manifested in functions F:

$$I_{G,t} = kF_{G,t} + \sum_{j=1}^{t-1} kF_{B,j} \prod_{i=j+1}^{t} D_i + I_{G,0} \prod_{i=1}^{t} D_i + \sum_{j=1}^{t-1} \epsilon_j \prod_{i=j+1}^{t} D_i + \epsilon_t \quad (5)$$

This equation is then tested by comparison with measured opinion values $y_{G,m}$ at all times m when $y_{G,m}$ is actually measured so

$$y_{G,m} = I_{G,m} + \epsilon_{y,m} \quad (6)$$

where $\epsilon_{y,m}$ includes errors in the measurement of $y_{G,m}$. Rewriting gives

$$y_{G,m} = i_{G,m} + e_m \quad (7)$$

where $i_{G,m}$ is the deterministic portion of Eq. 5 corresponding to the top line on the right and e_m is the cumulative error including the bottom line of Eq. 5 plus $\epsilon_{y,m}$ from Eq. 6.

If the previous time at which survey data are available is time t=m-m', then writing Eq. 5 for t=m and subtracting the same equation written for t=t-m' after multiplication by term $\rho_{m-m'}$ gives

$$y_{G,m} - \rho_{m-m'} y_{G,m-m'} = i_{G,m} - \rho_{m-m'} i_{G,m-m'} + \sum_{j=m-m'+1}^{m-1} \epsilon_j \prod_{i=j+1}^{m} D_i + \epsilon_{y,m} + \rho_{m-m'} \epsilon_{y,m-m'} \quad (8)$$

where

$$\rho_{m-m'} = \prod_{i=m-m'+1}^{m} D_i \quad (9)$$

Note that Eq. 8 has no autocorrelation in the errors since the error summation term begins with j=m-m'+1 and includes no contributions from data before previous measurement time m-m'. Also, the differences between the information share line and the Michigan index boxes (Fig. 2) are reasonably homoscedastic. Therefore, the first order approximation can further be made that the error terms are normal with a common variance. With these assumptions, a least squares estimate of the parameters in the model can be made according to standard nonlinear statistics. The method is to minimize this objective function based on the maximum likelihood (Cook and Weisberg, 1990):

$$S(k,A,B) = \sum_{J=G,B} \sum_{m=1}^{M} \{[y_{J,m} - \rho_{m-m'} y_{J,m-m'} - b_{J,m}(k,A,B) - \rho_{m-m'} b_{J,m-m'}(k,A,B)]\}^2 \quad (10)$$

The summation is for all values of m at which y_m

Granger regressions for media share on Index of Consumer Sentiment and vice versa:

$$y_t = \underset{(2.8)}{8.4} \quad \underset{(2.7)}{+0.59y_{t-1}} \quad \underset{(-0.8)}{-0.18y_{t-2}} \quad \underset{(2.6)}{+0.74i_{G,t-1}} \quad \underset{(-1.8)}{-0.42i_{G,t-2}} \qquad (13)$$

$F(2,31) = 3.5$ $(P < 0.042)$ $\bar{R}^2 = 0.69$ $Q(18) = 18.6$ $(P < 0.42)$

$$i_{G,t} = \underset{(1.6)}{4.0} \quad \underset{(4.5)}{+1.0i_{G,t-1}} \quad \underset{(-2.4)}{-0.46i_{G,t-2}} \quad \underset{(1.6)}{+0.29y_{t-1}} \quad \underset{(0.21)}{+0.038y_{t-2}} \qquad (14)$$

$F(2,31) = 1.6$ $(P < 0.22)$ $\bar{R}^2 = 0.82$ $Q(18) = 10.3$ $(P < 0.92)$

Utility regression for information share improving Index of Consumer Sentiment estimates:

$$y_{G,t} = \underset{(1.8)}{4.0} \quad \underset{(1.7)}{+0.30y_{G,t-1}} \quad \underset{(5.6)}{+0.89i_{G,t}} \quad \underset{(-1.7)}{-0.31i_{G,t-1}} \qquad (15)$$

$F(2,33) = 16.3$ $(P < 0.000012)$ $\bar{R}^2 = 0.81$ $Q(18) = 16.7$ $(P < 0.54)$

Figure 4: Regressions for the impact of the press on Consumer Sentiment. Term i is as in Eq. 7; y = -18.3 +0.62•(Index). The t statistics are in (). The F values are for all lags of the independent variable combined.

exists. Besides parameter k, there are two others, A and B, arising from the fact that the comparison is not directly to opinion $y_{G,m}$ but rather to the Michigan index assumed to be related linearly with $y_{G,m}$ by $y_{G,m} = A + B\bullet$(Michigan index). Errors in this relationship are also absorbed into $\epsilon_{y,m}$ in Eq. 6.

The estimated variance for Consumer Sentiment is $s^2 = S(\hat{k}_2)/35$ since there are 35 degrees of freedom with 38 index values and three parameters. The $(1 - \alpha)$ likelihood based confidence region for the parameters is obtained by inverting the appropriate likelihood ratio. The result is $K(k,A,B) = [S(k,A,B) - S(\hat{k},\hat{A},\hat{B})]/s^2$ with the confidence surface for the parameters described by

$$\{(k,A,B) \mid K(k,A,B) \le \chi^2_\alpha(3)\} \qquad (11)$$

where the χ^2 is with 3 degrees of freedom with 3 parameters being estimated (Eq. 5 in Cook and Weisberg, 1990). Confidence intervals are given for individual parameters at optimal values for the others.

Since function $i_{G,m}$ in equation 7 only has media variables, this function was used to represent the media in Granger (1980) causality tests for the news affecting Consumer Sentiment (Eq. 13, Fig. 4) using equation

$$y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1,i} y_{t-i} + \sum_{i=1}^{n} \beta_{2,i} i_{G,t-i} + \epsilon_{G,t} \qquad (12)$$

noting that y is linear in the Michigan index so this regression in y behaves the same as one in the Index. The reverse test was also performed (Eq. 14, Fig. 4).

The RMSD between y_t and $i_{G,t}$ gives one estimate for the ability of the media to forecast opinion (Pindyck and Rubinfeld, 1981). Another method is to run utility regressions using Eq. 12 in which the summation in $i_{G,t}$ term begins with $i=0$. The finding of significant contributions by $i_{G,t-i}$ showed that y_t estimated from all previous y_{t-i} can be improved by adding information from the media (Eq. 15, Fig. 4)

References

Cook, R.D., and S. Weisberg. 1990. J. Amer. Statis. Assn. 85, 544-551.

Curtin, R.T. 1982. Pub. Opin. Quart. 46:340-352.

O'Guinn, T.C., and R.J.Faber 1991. in Handbook of Consumer Behavior, eds. T.S. Robertson and H.H. Kassarjian, Englewood Cliffs, NJ: Prentice-Hall, 349-400.

Fan, D.P. 1988. Predictions of public opinion from the mass media. Westport, CT: Greenwood Press.

Fan, D.P. 1993. Predictions of the Bush-Clinton-Perot presidential race from the press. Elsewhere in this volume.

Fan, D.P. and G. McAvoy. 1989. J. Sex Res. 26:159-187.

Granger, C.W.J. 1980. J. Econ. Dynam. Control 2:329-352.

Linden, F. 1982. Pub. Opin. Quart. 46:353-360.

Linden, F. 1990. Pub. Perspective 1:(2) 10-11.

Nelder, J., and R. Mead. 1965. Computer J. 7:308-313.

Pindyck, R.S., and D.L. Rubinfeld. 1981. Econometric models and economic forecasts, 2nd edition. New York: McGraw-Hill.

Throop, A.W. 1992. Econ. Rev.: Fed. Res. Bank San Francisco. 1 (Winter),35-59.

Tims, A.R., R.J. Faber, D.P. Fan and K.G. Schram. 1991. Paper presented Internat. Assn. Res. Econ. Psych. Stockholm, Sweden, 1991.

Tims, A.R., D.P. Fan, and J.R. Freeman. 1989. Adv. Consumer Res. 16:758-770.