Predicting the Index of Consumer Sentiment When It Isn't Measured

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Abstract

Cost and space limitations on questionnaires usually restrict opinion surveys to a small number of topics that are high on the public agenda at polling times. The result is very few time trends with frequently repeated questions. Opinion at times between surveys can be predicted from mass media content that is systematically archived at daily time intervals. Formal statistics has shown that the ideodynamic model can predict from media content alone to opinion with good accuracy over long time intervals. This paper provides empirical demonstrations of that assertion by showing that Washington Post and Associated Press coverage could predict opinion in the form of the Index of Consumer Sentiment with R^2 over 0.7 for time periods in the range of seven years with no loss of precision.

Key Words: Consumer Sentiment, ideodynamics, time trend, mass media, prediction

1. Introduction

Polls on a topic tend to be rare when the salience of the issue either changes slowly or is low on the public agenda. A topic only tends to be surveyed after there is a notable rise in salience.

Sometimes the rise can be anticipated as is true for political elections so pre-election polls can be planned in advance to be more frequent as voting day approaches.

More often, a notable event is required to draw sufficient attention to an issue that researchers will contemplate surveys. Even then, surveys are only conducted after delays associated with planning and resource accumulation.

For example, there was the lag of approximately half a year between the 1982 announcement by the Centers for Disease Control that the disease of AIDS was caused by a virus and the first available polls on this topic. By that time, about half the public had already become aware of major features of the disease. Therefore, early polls were not available for studies of how awareness had begun to rise [3].

In other words, an exploration of an opinion time trend requires opinion values at times when they are typically not measured. At those times, it would be useful to have good predictions that can replace the unmeasured data. Here, prediction will refer to computations of expected opinion percentages during times when survey data are missing but persuasive information affecting the opinion can be found.

Fortunately, formal statistics [4] of the ideodynamic model [2], has shown that opinion predicted from persuasive information in the mass media alone could remain accurate indefinitely even when no empirical opinion is entered into the computation as is done in linear autoregressive models.

The advantage of using the mass media as the predictor is that media content is systematically and continuously archived at daily and more frequent time intervals. Therefore this content can be used as the source of predictors at times without survey data.

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This paper tested the statistical conclusion that adoption could be predicted with high accuracy over long time periods during which the only predictor was persuasive information.

2. Model Testing

2.1 Data

The dependent variable was the University of Michigan's Index of Consumer Sentiment which had quarterly time points in 1977 and monthly values in every year after that. That gave a time trend with hundreds of data points. The Index was obtained from the Reuters/University of Michigan Surveys of Consumers, Institute of Social Research, 426 Thompson Street, Ann Arbor, MI 48106. Index values were assigned to the mid-date of the measurement month or quarter.

The Index was constructed from five questions asking members of public about their impressions of both current and future financial conditions for both individuals and businesses [1].

The predictors came from the same 45,145 Washington Post and Associated Press stories on the economy retrieved from the LexisNexis database from January 1, 1977 to April 30, 2000 as used in [4]. Up to year 2000, newspaper content in this and other aggregator databases generally included all stories in the same way as microfilms did. Thus the stories included those from news wires, other newspapers and free lance writers such as arts reviewers.

An attempt was made to extend the time trend analysis beyond 2000 but the LexisNexis data gradually underwent a profound change following the 2001 U.S. Supreme Court ruling for the case of New York Times Company v. Tasini. That ruling interpreted prior traditional contracts between free-lance writers and news outlets to mean that the writers should be paid for their work that entered news aggregator databases like LexisNexis [5].

That ruling should mainly have affected stories before 1995 because most later contracts were changed so that free-lancers would waive their electronic rights. Unfortunately, news syndicators ranging from news wires to other providers of news content like the New York Times followed the example of the free lancers and blocked the entry of their content into LexisNexis and other databases.

Worse yet, the prohibition was retroactive leading to a general removal from databases of all content not generated by a news outlet's staff writers. The loss of syndicated content meant that it was no longer possible to use the presence of a story in the database as an indicator of public exposure.

The removal was not trivial because the year 2000 search for the time period 1/1/1999 to 4/30/2000 found 2674 economy stories from the AP and Washington Post while the comparable number was just 426 (16 percent) for a search made in 2009. Since most of the year 2000 stories were from the AP rather than the Washington Post, it appeared that the AP did as other publishers in removing any stories not internally generated. That removal was likely to have included stories from individual newspapers since the AP retransmits stories sent to them by their member news organizations.

Furthermore, the presence and absence of news content in electronic databases is a moving target because contracts allowing or prohibiting retransmissions of news content have continued to be in flux.

To avoid the problem of predictor instability, the data for in this paper were the same as those used by [4] from 1977 to 2000, a time period during which the full

content of a news outlet was available from LexisNexis.

Each retrieved story during the 23 years following 1977 was scored as good or bad for the economy using the InfoTrend computer system for the content analysis of text as described in [4].

Among the 45,145 retrieved stories, 15,374 (34%) were scored as having at least one paragraph that was good for the economy with the comparable number being 19,902 (44%) for stories with at least one negative paragraph.

The final predictors were the total numbers of paragraphs on a given day that were good or bad for the economy.

Therefore, the modeling data included three time trends: the dependent variable of Consumer sentiment timed to the month or quarter, and the two predictors of the numbers of positive and negative media paragraphs timed to the day.

2.2 Modeling

The analysis used the ideodynamic model to predict the time trend of public opinion in response to persuasive information [4].

The process began with the premise that a mass medium message had its maximum impact on its publication date and then declined exponentially over time. This condition led to the construction of persuasive force function $F_G(t)$ with good coverage of the economy at time t according to

$$F_G(t) = k \sum_i C_{i,G} exp(-p(t - t_i)) + \epsilon_G(t) \tag{1}$$

where k is the persuasibility constant, $C_{i,G}$ is the count of the good paragraphs in the ith story at time t_i, p is the persistence constant, and $\epsilon_G(t)$ is an additive error. The comparable function $F_B(t)$ was constructed for bad coverage of the economy with all subscripts G replaced by subscripts B. The formal statistics showed that $F_{(\cdot),t}$ has a stable variance despite its inclusion of information from all prior times [4].

These functions F were entered into the basic ideodynamic differential equation [4] to predict public opinion of good economic conditions $I_G(t)$ using

$$\frac{dI_G}{dt} = F_G(t)(1 - I_G) - F_B(t)I_G. \tag{2}$$

computed every 24 hours. The premise was that good news would only change the minds of those feeling that the economy was doing badly and that bad news would convince those feeling that the economy was doing well to alter their opinion. After all, a person already convinced about an idea is not expected to undergo an opinion change by information favoring that idea.

Explicit integration gives the final modeling form for opinion

$$I_G(t) = \frac{\int F_G(t) e^{\int (F_G(t)+F_B(t))dt} dt}{e^{\int (F_G(t)+F_B(t))dt}} + \frac{c}{e^{\int (F_G(t)+F_B(t))dt}} \tag{3}$$

with c being the constant of integration.

In the final modeling step, the Index of Consumer Sentiment $y(t)$ was assumed to be related linearly with good opinon about the the economy $I_G(t)$ from (3) to give

$$y(t) = \alpha + \beta I_G(t) + \epsilon_y(t) \tag{4}$$

where α and β are constants and $\epsilon_y(t)$ is an additive error. Given these constants, there was no need for good and bad information to be given different persuasibility constants.

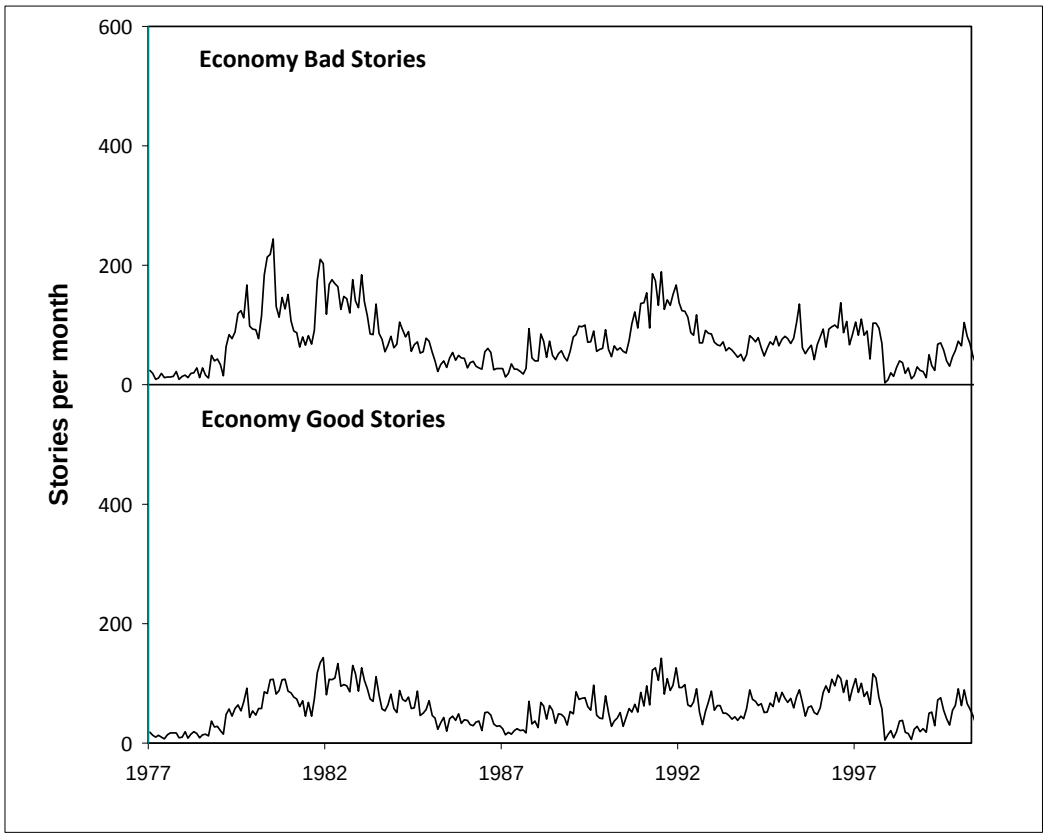

Figure 1: Associated Press and Washington Post news stories in each month with at least one paragraph scored as good (bottom frame) or bad (top frame) for the economy.

3. Results

The predictors for the Index of Consumer Sentiment from press coverage were Washington Post and Associated Press paragraphs scored as good and/or bad for the economy. Visual inspection of the totals of these types of paragraphs each month (Figure 1) showed that both types of paragraphs generally rose and fell together.

Thus economic coverage usually included descriptions of the economy as doing both well and badly. However, there were local and subtle differences in these two types of coverage, and these differences were key for predictions of the Index.

No attempt was made to relate real world events with the generally parallel movement in the coverage trajectories because the goal was to explore the sensitivity of the Index to press paragraphs interpreting the news as good and bad.

The study began with the usual method of predicting the entire time trend from 1/1/1977 to 4/30/2000 (Table 1, Model 1). The Root Mean Squared Deviation (RMSD) was 5.44 percent and the R^2 value was 0.83.

The parameters estimated for this time period showed that the estimated half-life was 10.4 minutes for the continued ability of a paragraph to persuade over time. This half-life was an alternate method for expressing persistence constant p in (1). At 95 percent significance, the half-life was not significantly different from zero but could have been as long as 10.7 hours.

Such a short half-life indicates that information must change opinion in the

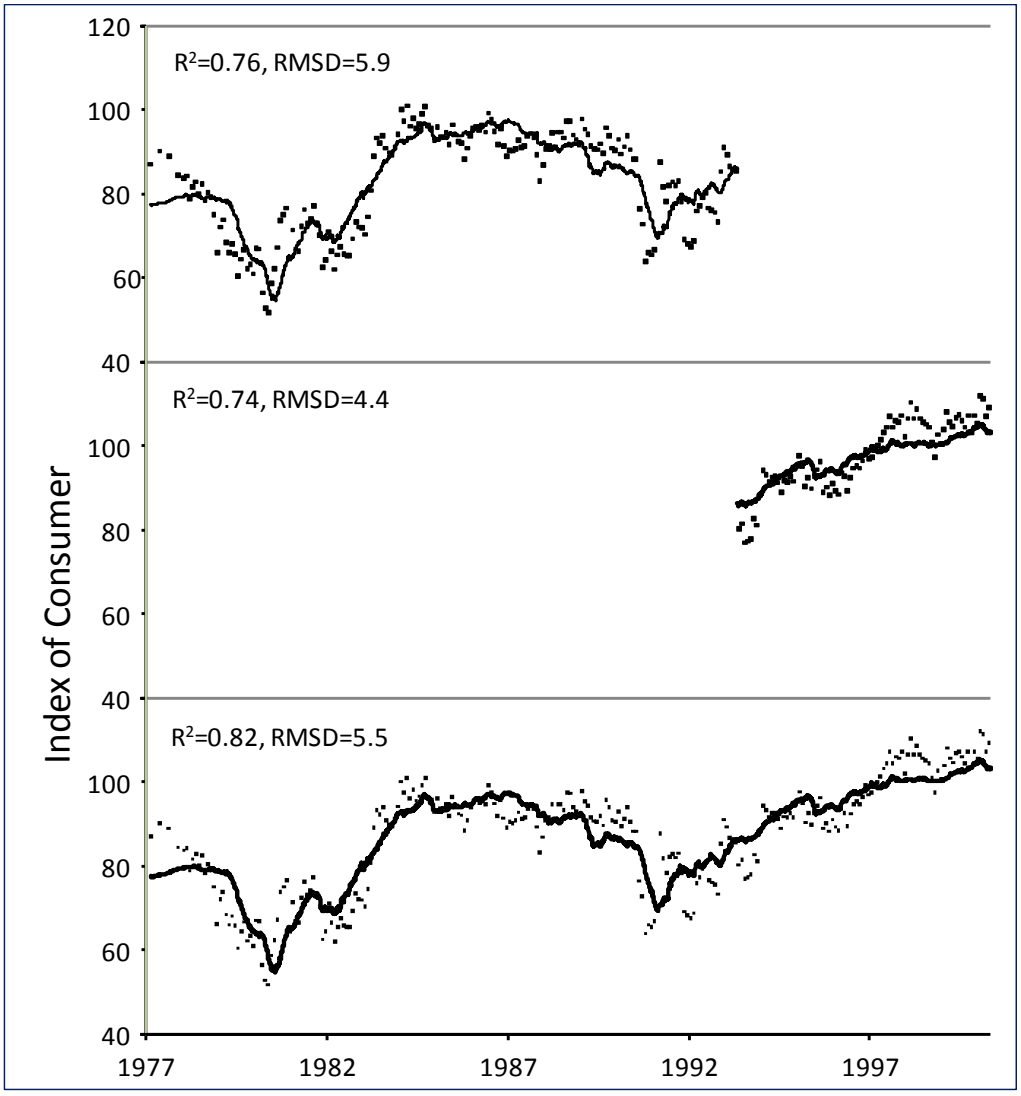

Figure 2: Predictions of the Index of Consumer Sentiment from news text alone from parameters estimated using Model 2 in Table 1 with no Index values as the dependent variable from 5/1/1993 to 4/30/2000. *Top frame:* Predictions for the time period indicated for Model 2 during which Index values were used as the dependent variable. *Center frame:* Predictions for the time period during which no Index values were used as the dependent variable. *Bottom frame:* Predictions for the entire time period. The measured Index values are shown by the symbols and the prediction is the solid line.

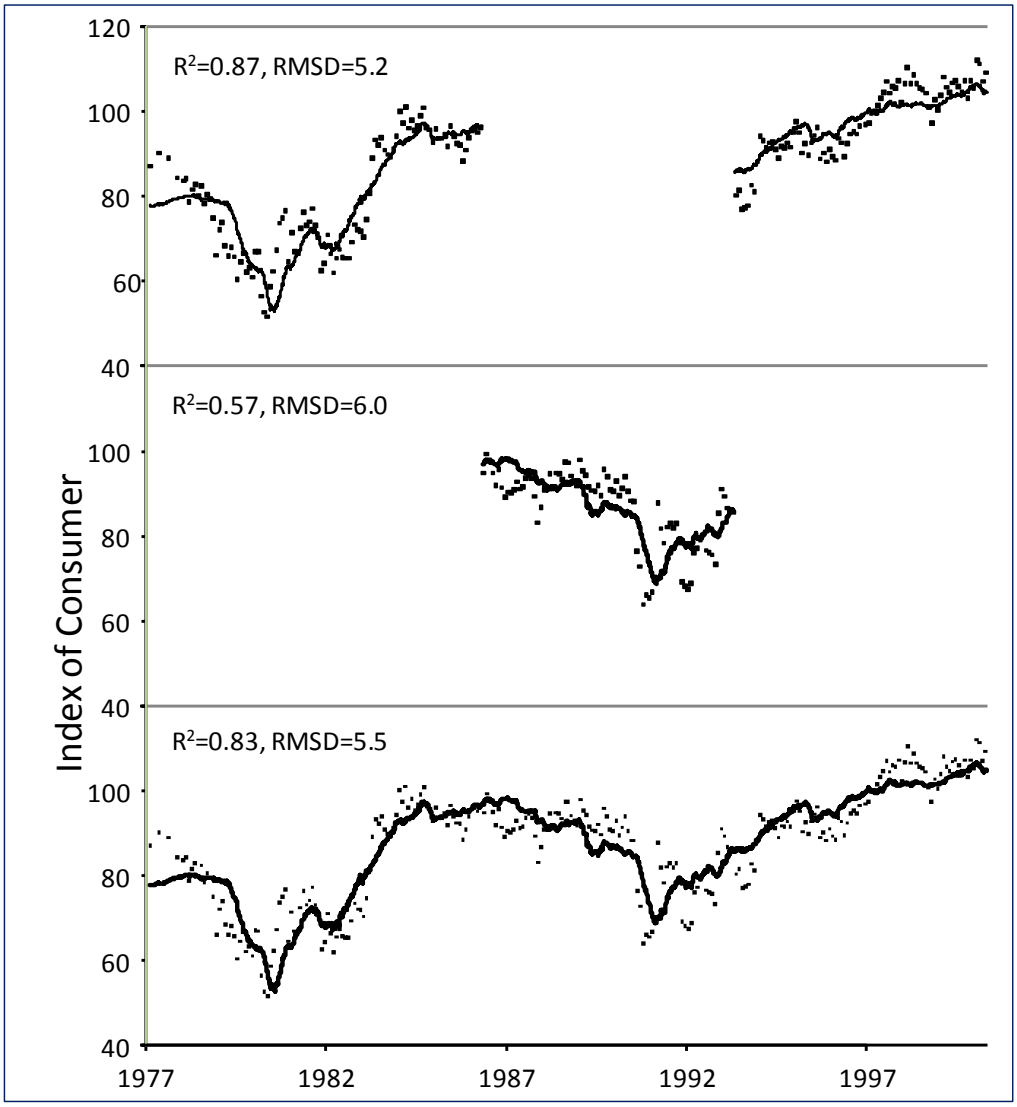

Figure 3: Predictions of the Index of Consumer Sentiment from news text alone using parameters estimated from Model 3 in Table 1 with no Index values as the dependent variable from 5/1/1986 to 4/30/1993. The three frames were as in Table 2.

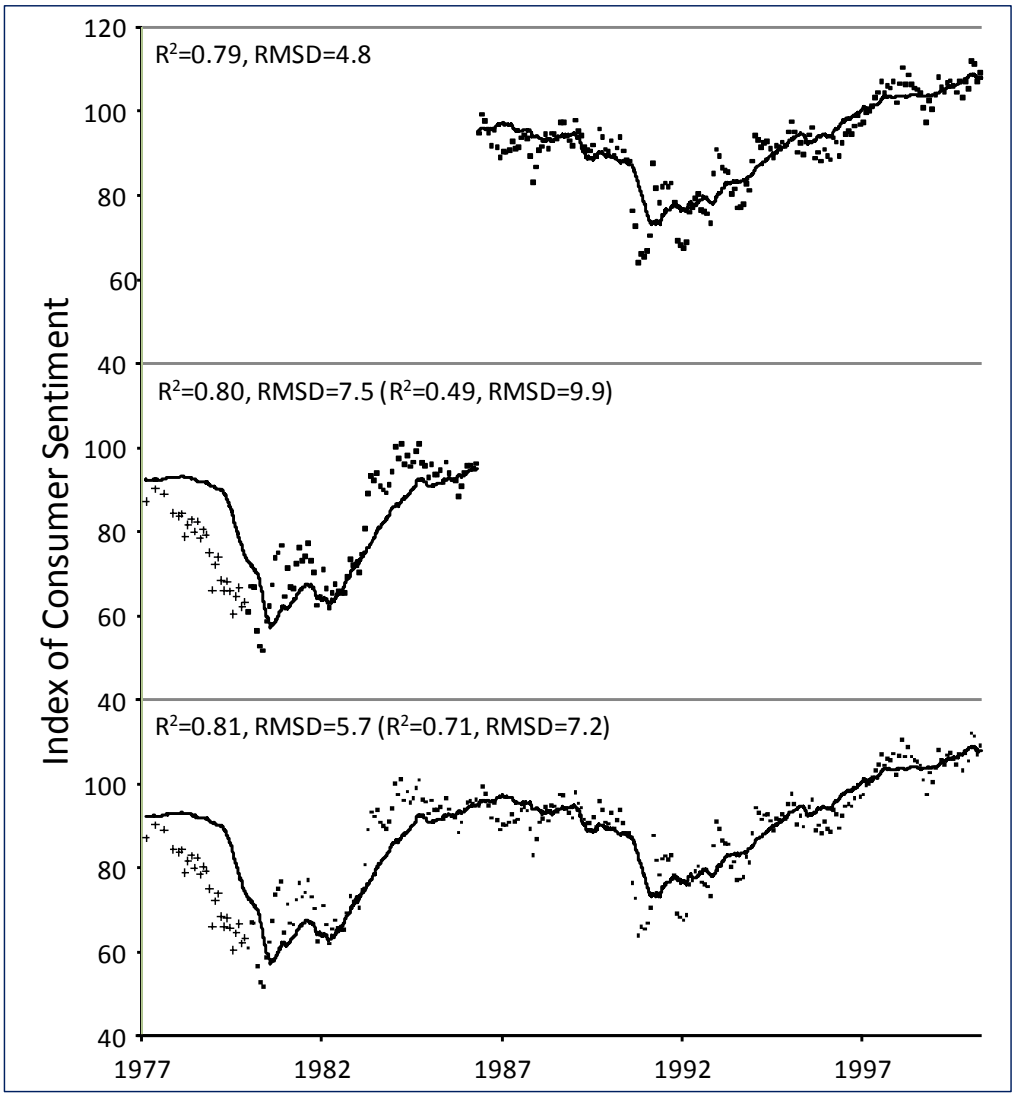

Figure 4: Predictions of the Index of Consumer Sentiment from news text alone from parameters estimated from Model 4 in Table 1 with no Index values as the dependent variable from 1/1/1977 to 4/30/1986. The three frames were as in Table 2. In the center and bottom frames, the R^2 and RMSD values on the left before the parentheses were for calculations begun in 1/1/1980 while those in parentheses were for calculations begun in 1/1/1977.

Table 1: Parameters and other statistics for predicting the Index of Consumer Sentiment using the equations in this paper. Persistence constant p was converted to a half-life. The stars indicate 95 percent confidence. The maximum half-life is for 95 percent significance. The date 1977 refers to 1/1/1977. All other dates refer to 4/30 of the indicated year.

Model	1	2	3	4
Index values used for estimation				
Counts of Index values	272	188	188	168
Dates of Index values	1977-2000	1977-1993	1977-1986 and 1993-2000	1986-2000
Estimated constants				
α	-16.68*	-8.440*	-16.14*	-57.72*
β	2.451*	2.245*	2.431*	3.439*
$I(0)$ (Percent)	38.47*	38.27*	38.67*	43.65*
k (Percent/Paragraph)	0.0001926*	0.0002265*	0.0002154*	0.0001103*
Estimated Half-life (minutes)	10.4	22.0	32.5	2.9
(Maximum half-life (hours))	10.7	14.7	11.4	9.3

mass public very quickly or it will be forgotten and will no longer affect the Index. Although the duration of its action is short, information can have a lasting effect because (2) specifies that an opinion change due to earlier information will persist unless new information arrives to alter opinion further.

Among the other parameters, constants α and β in (4) are just scaling constants and have no substantively interesting meaning. Although the precise value of constant β is not important, it must be significantly different from zero or there would be no movement of the predicted Index over time. In fact, constant β was significant in all models tested.

The R^2 value is typically used when the goal is to understand the extent to which the predictors can explain the movement of a time trend.

However, this paper had an additional goal, namely to predict adoptions at times when survey data were not available but persuasive information was. A more useful value for a prediction is the Root Mean Squared Deviation (RMSD) which quantifies the extent to which a predicted value deviates from a measurement.

The RMSD is more useful than the R^2 for assessing the predictive power of a model because a completely accurate prediction of a constant value is still a useful prediction. In contrast, lack of change does not provide a meaningful R^2 value because there is no variance over time to explain. For this reason, the RMSD is reported along with the R^2 as a performance measure.

The key goal of this paper was to test for the ability to predict opinion from persuasive information at times when the dependent variable was not used for the parameter estimations.

This paper tested for the ability of the methodology to predict time trends of seven years or longer during which no dependent variable data entered the computation. Tests were made by removing dependent variable data from 1993 to 2000 (Figure 2; Table 1, Model 2), from 1986 to 1993 (Figure 3; Table 1, Model 3) and from 1977 to 1986 (Figure 4; Table 1, Model 4).

Generally, the fit of the predicted time trend to actual Index values was close to the same visually. This impression was confirmed by R^2 values of greater that 0.7 for most time segments in the three figures regardless of whether Index data were

or were not used as dependent variables during the time periods shown.

One exception was in the center frame of Figure 3 and even there the RMSD of 6.0 percent was in the same range as that of the other time segments tested.

Only in the center and bottom frames of Figure 4 were the Index values consistently too high in the early portion of the time trends.

This was not surprising because formal statistics [4] showed that errors in the current value of the Index were mainly affected by recent past errors in input information with earlier values contributing progressively less. A manifestation was that the predicted Index values were consistently too high for 1977 to 1980, several years before the first Index value in 1986 used for the parameter estimations.

As expected, the prediction became better as time increased toward the 1986 starting date of the parameter estimations. From 1980 to 1986, the R^2 increased to 0.80-0.81 and RMSD dropped to 5.7-7.5 Index points for the bottom two frames of Figure 4. As is also seen visually, these values are within the range of the predictions for the other gap analyses.

In contrast, predictions remained accurate when enough prior Index time points were employed for estimating the constants that were then used for making later predictions (Figs. 2 and 3).

4. Discussion

This paper explored the ability of mass media coverage to predict public opinion at times when survey data were not available. The study was based on predictions of the Index of Consumer Sentiment for which 272 values were available over 23 years.

The Index was one of the rare opinion time series for which the study could be performed because the Index was systematically available every month or quarter over many years. The Index allowed for critical tests because it displayed marked and irregulars swings during the time trend so that predictions could be tested for their ability to follow the swings both up and down. In addition, the large number of data points meant that many dependent variable values could be removed during the estimation of the five constants of the model and then used for evaluating the quality of predictions using parameters estimated for other time periods.

This paper confirmed empirically calculations from the formal statistics showing that the ideodynamic model could predict opinion time trends for periods approaching a decade using as predictors nothing more than persuasive information in the press scored by computer using instructions generated only from text in the time period 1990-1991 [4].

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