

# The Toyota Recall Crisis: Media Impact on Toyota's Corporate Brand Reputation

David Fan, Ph.D.<sup>1</sup>, David Geddes, Ph.D.<sup>2</sup>, Felix Flory, Ph.D.<sup>3</sup>

<sup>1</sup>University of Minnesota, Twin Cities, MN

<sup>2</sup>InfoTrend, Inc., Saint Paul, MN

<sup>3</sup>Evolve24, Fenton, MO

## Abstract

The time trend of public opinion about carmaker Toyota dropped precipitously in early 2010 following a series of quality issues and recalls. The mathematical model of ideodynamics could predict the fall and subsequent rise in Toyota's reputation from coverage of Toyota in blogs, in Internet forums, in print news, and in news websites from January 1, 2009 through March 31, 2011. The model performance was high for all these types of media with  $R^2$  values in the range of 0.7 to 0.8. Information favorable to Toyota was about twice as persuasive as information unfavorable to the company. Blogs had negative coverage of Toyota in the fall of 2009 before other media types but had limited effects on opinion. Impressions of Toyota only showed a notable drop after recall information hit the majority of the other media. The good predictions showed that the media studied could represent the information shaping public opinion even though the messages did not include advertising or broadcast content.

**Key Words:** time series, media, opinion, prediction, Toyota

## 1. Introduction

Toyota built a world-class corporate brand reputation based on its commitment to quality, reliability, continuous improvement, customer focus, and excellence in design and manufacturing (Liker, 2004; Quelch, Knoop & Johnson, 2010; Spear, 2004; Stewart & Raman, 2007). Toyota's reputation brought many benefits including market share, customer loyalty, and financial strength. According to Quelch et al (2010) and Steinmetz (2010), Toyota's rapid growth put strains on design, engineering, and manufacturing leading to a succession of quality issues and recalls beginning in 2003.

National attention began to focus on Toyota's quality problems with the release on September 10, 2009 of a recording of a 911 call of a crash on August 28, 2009 of a car driven by an off-duty California highway patrol officer resulting in the deaths of the officer and his family. This incident due to uncontrollable acceleration led to the recall of 3.9 million vehicles in the U.S. on September 29, 2009 ascribed to floor mat problems leading to sticking accelerator pedals.

The serious nature of Toyota's problems grabbed national attention in late January and early February 2010: An additional 2.3 million vehicles were recalled for sticking accelerator pedals. Toyota suspended sales of eight models in North America, expanded recalls to Europe and China, and shut manufacturing plants. Company President and CEO

Akio Toyoda apologized for the recalls. A third recall involved a company bestseller, the Prius Hybrid, for braking problems. Recalls totalled about eight million vehicles worldwide over 2009 and 2010, including six million in the U.S.

Subsequently, the Department of Transportation and the National Highway Transportation Safety Board increased scrutiny of Toyota. Congressional hearings were held in March 2010. Toyota's strong corporate brand reputation had buffered the company at the start of the crisis (Jones, 2010). However, Toyota's responses were seen as inadequate and began to strain the trust of the public, car buyers, regulators, and government officials. Toyota vehicle sales in the U.S. fell 16% in January 2010 and 8.7% in February compared to the same months in 2009. Toyota shares lost 11.6% through February 23, 2010 at a time when the Dow Jones Industrial Average lost 0.23% (Quelch et al, 2010).

The Toyota crisis presented a case for using the mathematical model of ideodynamics to examine the role of media coverage – including newspapers, online news, blogs, and Internet forums – in shaping corporate reputation (Fan, 1988; Fan & Cook, 2003).

## **2. Predicting public opinion from the news media**

### **2.1 Agenda Setting Theory**

Agenda-setting theory (see McCombs, 2004 and Scheufele & Tewksbury, 2007) has been a prominent theoretical and research approach for studies of relationships between the media and public opinion. The original theory proposed that prominent news topics led the public to place these topics high on the public agenda because the mass media provide the only conduit for persuasive information that is rapid and extensive enough to transmit the cues that can persuade very sizeable proportions of the population.

The theory was subsequently extended to a second level where the media also can change public preferences by giving new information that individuals use to understand, evaluate, and respond to events and issues. In addition, the media can provide top-of-mind information that individuals can use to access relevant information in memory to change opinions and behaviors.

Agenda-setting effects have been documented in hundreds of field studies around the world ranging from elections to issues at the national and local levels around the world (Carroll & McCombs, 2003, 37). In addition, Iyengar & Kinder (1987) and Wang (2000) demonstrated in controlled experiments that exposure to news stories changes the salience of issues.

Carroll (2009) and Carroll and McCombs (2003) broadened agenda setting to the domain of corporate reputation by examining the relationships between sentiment in newspaper coverage and corporate reputation as measured by public opinion surveys.

Thus both theory and research raise the possibility that the media can be used to predict reliably public opinions on issues, political candidates, corporate brand reputations, and other topics of interest on a real-time basis.

## 2.2 The Ideodynamic Model

The ideodynamic model (Fan, 1988, Fan & Cook, 2003) moves agenda-setting theory into the predictive domain. “The model has been used in successful predictions of more than 60 opinion time trends ranging from public concerns that drugs are the most important problems in the United States to polls of political preferences prior to elections in the U.S., Germany and the Netherlands. Behavioral modeling has extended from use of cocaine by high school seniors to infection of gay men by the HIV virus” (Fan and Cook, 2003, 29).

The model uses the perspective of GPS navigational devices found in automobiles. The unit starts at an initial position. Then the device proposes changes from the current position. Thus the entire trajectory has two types of input, the initial condition and instructions for changes at every time point.

The ideodynamic model uses differential equations to implement the same strategy to predict opinion through time. The initial conditions can be given by empirical data values or by constants optimized to give the best fit to actual opinion time trends. The equations of the model then specify how opinion should change upon receipt of new persuasive information, one time unit after another.

This paper used the ideodynamic model to predict the time trends of public opinion about impressions of the Toyota corporate brand as expressed in surveys. Polls divided opinion into the three categories of positive, neutral and negative for Toyota. The calculations for the model begin with estimated initial values for the three opinions.

Subsequent time trends then obeyed the model’s equations implementing the condition that persuasive information should move people from one opinion to another. At any given time, that information was quantified as the number of media documents scored as favorable (pro-) and unfavorable (con-) to Toyota. Documents neutral toward Toyota did not enter the model because they should not change favorability toward the brand.

For this paper, the term *media data* refers to any type of information available to the public at large, and thus includes Internet forums and blogs as well as the news media. Advertising and broadcast were not included in this analysis.

Every type of document score was multiplied by a persuasibility constant  $K$  to give a persuasive force. Then each type of score was modeled to act on a target population to persuade a fraction of its members to move to a destination population.

In one transition, the persuasive force was favorable to Toyota. That force was assumed to cause some people in a target public with a negative opinion to change their minds and join with the destination population holding a neutral opinion. The persuasive force was computed by multiplying the number of favorable documents by persuasibility constant  $K_1$  (Figure 1). Higher  $K$  values resulted in associated documents being more persuasive.

The other transitions in Figure 1 were for movement from neutral to positive opinion due to positive messages with persuasibility constant  $K_2$ , from positive to neutral opinion due to negative messages with persuasibility constant  $K_3$ , and from neutral to negative opinion due to negative messages with persuasibility constant  $K_4$ . All four constants could have different values, thereby giving four constants to estimate. Conversions to and

from all populations could occur simultaneously. The equations following the conversions of Figure 1 are described in Fan (1988) and Fan & Cook (2003).

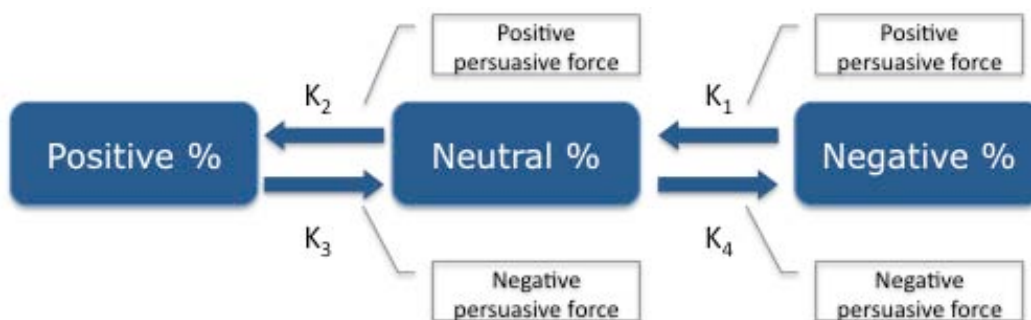
The initial conditions were the percentages of the population in each of the pro-, con-, and neutral subpopulations at the beginning of the modeling on January 1, 2009, nine months before the significant events of the Toyota recall crisis. These percentages were unknowns to be estimated along with the other constants of the model. That added two constants corresponding to pro-opinion and con-opinion for brand impression. The third opinion of neutral impression was computed by subtracting the pro- and con-opinions from 100 percent. These two constants together with the four persuasibility constants led to the estimation of a total of six constants.

The computation began with the initial conditions, and then proceeded with calculations of predicted pro-, con-, and neutral opinion every 24 hours assuming that a persuasive message had a decay half-life of zero days consistent with studies such as Fan and Cook (2003) showing that persuasive information is very quickly forgotten. This condition corresponds to the population acting mainly on new information as seen when news can start a panic. A rapid response means that old information must be quickly erased.

In this analysis, individuals could not shift directly from positive to negative opinion in one step; rather, they must transit through the neutral position. Similarly, information unfavorable to Toyota was modeled to shift individuals away from positive through neutral to the negative stance in two steps. Neutral information should not affect favorability toward Toyota and was therefore omitted from the study. A person could move rapidly through the neutral opinion from one extreme to the other due to receipt of two pieces of information. The model assumed no reinforcement mechanisms.

Obviously, variations in these models could be conceived including the shortcut of moving directly from negative to positive opinion and vice versa. However, the good success with the Figure 1 model indicates that the predicted time trend would not be improved much by alternate models.

The ideodynamic model can predict opinion time trends so long as persuasive information data are available.



**Figure 1:** Ideodynamic model for predicting changes over time in the percentage of the population with negative, neutral, and positive opinions. The persuasibility constants  $K_1$  to  $K_4$  give the weights for pro- and con- messages used for computing the persuasive forces moving individuals from one subpopulation to another as discussed in the text.

In linear regression models, the accuracies of predictions degrade as time proceeds if there are errors in media measurements and predicted opinion is based only on media data. Similarly, it might be expected that the ideodynamic predictions would become progressively less certain if the only input is persuasive information measured with error. Fortunately, the statistics of the model shows that the certainty in the prediction does not grow without limit (Fan and Cook, 2003). Instead, the variance converges to a stable value. Therefore, accurate trajectories of all opinion time trends could be computed daily from media data alone because the media were available at those time intervals. The predicted time trends could be compared with measured opinion whenever they were available, namely weekly in this study. The restriction of the predictors to persuasive information alone further makes the prediction exquisitely sensitive to this information because the computation includes no measured opinion unlike the case with linear autoregressive equations much more commonly used in time trend analyses.

### 2.3 Research Questions

The two primary research questions were these:

- RQ1: How well does the ideodynamic model use persuasive information alone to predict opinion time trends for a commercial brand like Toyota, a type of opinion not scrutinized in the past?
- RQ2: What types of media can represent persuasive information able to drive opinion about Toyota given the advent of the Internet and the consequent expansion of media from print news to online news, blogs, and online forums?

## 3. Methods and Data

### 3.1 Corporate Brand Reputation Data

The corporate brand reputation data used in this research were kindly provided by YouGov.com from its ongoing BrandIndex surveys. The data were for the time period from January 1, 2009 through March 3, 2011 for the United States. The BrandIndex survey is conducted over the Internet using an opt-in panel of the general public.

The daily BrandIndex sample was weighted using propensity scores on gender, age, education, race, and income. The sampling frame used for weighting was derived from public use micro-data files of the 2005-2007 U.S. Census Bureau's American Community Survey. For the propensity score weighting, let  $X_i$  denote a vector of measurements on the  $i$ th respondent and  $R_i$  a response indicator for this respondent. We defined the propensity score for the  $i$ th respondent by  $e(X_i) = P\{R_i = 1 \mid X_i\}$  which is often assumed to in the form of a logistic regression. In such cases, case-control methods allowed for estimation of the parameters of the propensity score by combining the self-selected sample with a random sample from the same population.

The key result on propensity scores is due to Rosenbaum and Rubin (1983), who showed that  $R_i$  and  $X_i$  are conditionally independent given the propensity score  $e(X_i)$ . The import of this result is that, in the case of ignorable selection, it suffices to balance a sample on the propensity score. Instead of weighting on a large number of variables, calculations are made for a propensity score and sample weights that approximately balance the sample on the propensity score. This converts a difficult high-dimensional weighting problem into a much simpler and more tractable one-dimensional weighting problem.

The BrandIndex survey tracked public perceptions of corporate brand reputation using questions in the following areas (YouGov.com): (i) quality, (ii) value, (iii) customer satisfaction, (iv) corporate reputation, (v) general impression, (vi) recommendation, (vii) buzz (whether people have heard anything positive or negative about the brand in the media or through word of mouth), and (viii) attention (the percentage of the general public that has heard anything, positive or negative, about the brand in the media through word of mouth).

The respondents for this Toyota project answered questions about companies in the automotive sector. The online survey instrument provided a list of automotive brands to respondents and then presented two questions: (i) “Overall, of which of the following brands do you have a positive impression?” and (ii) “Now which of the following brands do you have an overall negative impression?” Respondents including Toyota in their responses to the first question were assigned to have a positive or “pro” impression of Toyota. Similarly, respondents including Toyota in their responses to the second question respondents were categorized as having a negative or “con” impression of Toyota. Respondents were considered to be neutral if they did not list Toyota for either of these two questions.

The total survey required about eight to ten minutes to complete. The survey also included questions regarding current affairs, respondents’ lives, and personal views on a range of topics, as well as demographic questions about the respondent.

Approximately the same number of responses was obtained for Toyota each day from Monday through Friday including holidays. For the time trend analysis, all responses were aggregated for each Monday to Friday time interval and were assigned to the Wednesday in the middle of the week. The average number of responses per week was 647 with a standard deviation of 76.

BrandIndex used the reciprocal of the square root of the sample size to calculate the confidence interval. The average of 647 respondents per week gives four percent as the approximate 95 percent confidence interval.

### **3.2 Media Data**

This study was based on documents (or texts, these terms are used interchangeably) from five categories of media: (i) print newspapers, (ii) online editions of print newspapers, (iii) the Associated Press newswire, (iv) blogs, and (v) Internet forums. All documents were collected and scored using evolve24’s system as discussed below. Other potentially useful data not included were broadcast television news, Twitter feeds, and advertising. A complete list of media outlets in this research is available from the authors.

#### *3.2.1 Newspapers*

Twenty-five print newspapers were included because the stories were written by professional journalists, typically include a degree of journalistic balance, passed through a copy editing process, and may have benefitted from the credibility of the publication. For this study, 24 leading daily newspapers were included and were considered to be representative of the daily newspapers to which the American public was exposed. Stories were obtained from the leading electronic database Proquest Dialog™.

Unfortunately, no news aggregator database such as Dialog™, Factiva™, or Lexis-Nexis™, or the online editions of newspapers (to be discussed below) can be

considered to be a complete archive of stories appearing in the print editions because “content originating with wire services is typically stripped out of newspapers before stories are archived” (Weaver & Bimber, 2008, 517). This was not a trivial loss because a good deal of news, especially national news distributed at the local level, was comprised of wire stories (Weaver & Bimber, 2008, 517-518). The removal of news content extends beyond wire stories to all documents to which a newspaper does not have clean copyright including the works of freelance journalists who did not give explicit permission.

This inability of electronic databases to represent the news that readers see originated with the U.S. Supreme Court ruling in *New York Times Co. v. Tasini*, 533 U.S. 483 in favor of freelancers (Freeman, 2001). The unrepresentativeness of news aggregator databases has not been widely recognized by researchers.

### 3.2.2 Online News

This study also included the online editions of all print newspapers included in this research (e.g., *Los Angeles Times* and [latimes.com](http://latimes.com)). Online and print versions of newspapers are similar but not identical (Paterson & Domingo, 2008).

According to a December 2010 Pew Center survey, 41% of Americans said they got most of their national and international news from the Internet compared to 66% from television and 31% from newspapers, with both television and newspapers on downward trends (Pew Center, 2011). Furthermore, the print and online could reach and appeal to different audiences.

The online newspaper stories were obtained through Boardreader ([www.boardreader.com](http://www.boardreader.com)), a leading Web search engine and document aggregator. Boardreader scanned millions of distinct URLs daily, and maintained a complete archive of documents going back four years or more. However, like Dialog and other aggregators, online news from Boardreader was also stripped of syndicated content such as that from the AP and other newspapers.

### 3.2.3 News Wires

The Associated Press newswire from Dialog was included because AP stories were a primary source of news articles in newspapers around the United States. As noted above, databases like Dialog contained original stories written by the AP wire, but few of the other AP stories that readers see in print and online news stories.

### 3.2.4 Blogs

The media data included the 11 blogs with the highest number of posts or articles about Toyota. These were all automotive blogs. The blog content was obtained through the Boardreader search engine as described above.

### 3.2.5 Internet Forums

Finally, the media data set from Boardreader included texts from 12 Internet forums with the highest numbers of posts related to Toyota. These texts tended to be short, to be written in an informal style and to carry strong opinions.

## 3.3 Text Analysis

The media documents were analyzed by evolve24 for document sentiment specific to the reputation of the Toyota. First, evolve24 determined whether a sentiment is fact or opinion. Factual sentences were considered neutral for purposes of this study. Second,

evolve24 used a statistical model to identify and match subjective patterns within a document, and assigned a tone (positive, negative, neutral) to each sentence. The sentence-level sentiment scores were then aggregated at the document level, giving a document-level sentiment score for Toyota. Each document was assigned to be positive, negative or neutral and all documents were given the same weight regardless of length. Persuasive forces were computed from numbers of positive and negative stories.

#### 4. Results

Both research questions were addressed by exploring the extent to which the ideodynamic analysis of Figure 1 could predict time trends of public opinion from five types of information: blogs, Internet forums, print editions of newspapers, online editions of news outlets, and the AP newswire.

The numbers of documents scored as pro- and con- for Toyota (Table 1) ranged from 4,557 for blogs to 50,979 for forums. The ratios of pro- to con- information were all in the range of 0.6 to 0.7 with the outlier being the AP newswire with the value of 0.3.

The pro- and con-Toyota scores from each type of media were used separately to predict simultaneously the time trends of impressions of Toyota. With three time trends over the 113 weeks of the study, there were a total of 339 data points for the estimation of constants in the model. However, only two-thirds of the data points (226) were independent because the three opinion percentages for pro-, con-, and neutral added to 100 percent thereby giving 220 degrees of freedom for the six constants estimated, namely the two initial conditions and the four persuasibility constants.

**Table 1.** Counts of documents used in the Toyota analysis (January 1, 2009 through March 31, 2011).

<i>Media type</i>	<i>Pro</i>	<i>Con</i>	<i>Pro+Con</i>	<i>Pro/Con ratio</i>
Blog	1,927	2,630	4,557	0.733
Forum	20,864	30,115	50,979	0.693
Newspaper	2,321	3,750	6,071	0.619
Online news	5,227	7,856	13,083	0.665
Wire	16,06	5,260	6,866	0.305
Total	31,945	49,611	81,556	0.644

All estimated persuasibility constants in Table 3 are provided together with their 95 percent confidence intervals. The performances of the predictions are given both in terms of the root mean squared deviation (RMSD) and the  $R^2$  value.

The model performance was good given the high  $R^2$  values ranging from 0.754 to 0.821 for predictions based on pro- and con-Toyota scores from blogs, forums, print news, and online news (Table 2). The similarity in performance was consistent with the closeness of the ratios of pro- to con- scores for the same four data series (Table 3). The AP wire content with more negative stories predicted a little less well with  $R^2$  value of 0.657 (Table 2).



**Table 2.** Models for predicting Positive, Neutral, and Negative impressions of Toyota. All persuasibility constants are significant at 95% confidence and are relative to  $K_1$  arbitrarily set to 1.0 for ease of comparison.

	<i>Initial Opinion</i>		<i>Persuasibility Constants</i>				$R^2$	<i>RMSD</i>
	<i>% Pro</i>	<i>% Con</i>	$K_1$	$K_2$	$K_3$	$K_4$		
Blog	54.72	8.20	1.00	2.55	4.66	1.66	0.754	4.1%
Forum	63.63	3.86	1.00	0.56	1.24	1.91	0.821	4.8%
News	54.22	7.46	1.00	0.99	2.59	2.00	0.790	4.5%
Web	56.00	4.24	1.00	2.00	4.81	1.86	0.766	4.6%
Wire	56.04	8.23	1.00	3.72	15.39	1.90	0.657	5.0%
Combined	56.78	3.35	1.00	0.73	1.78	2.05	0.840	4.5%

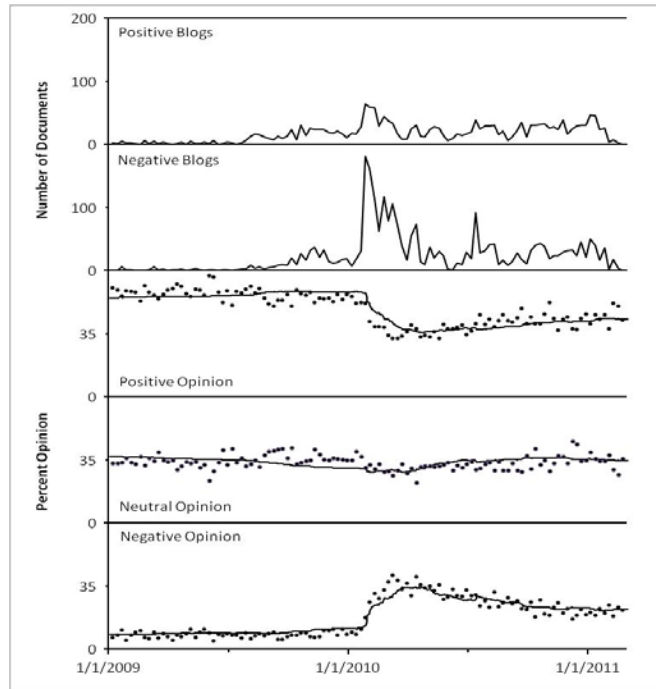
**Table 3.** Ratio of average positive to negative persuasibility constants from Table 2.

<i>Media channel</i>	<i>Positive/negative</i>
Blog	1.8
Forum	2.0
Newspaper	2.3
Online newspaper	2.2
Wire	3.7
All media combined	2.2

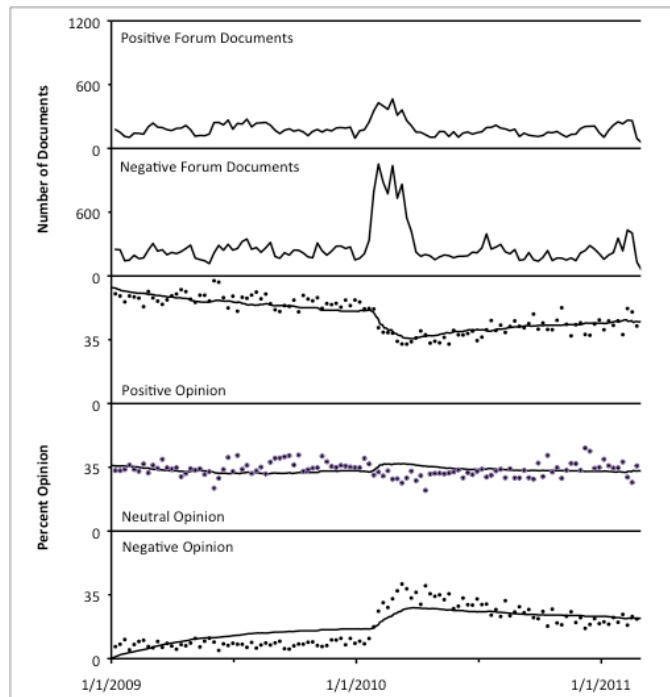
In addition to predictions using scores from individual types of media, a prediction was also made with all types of scores unweighted and combined into the same time series. That meant that forum scores were almost ten times more prevalent than those from blogs, print news, online news, or AP wire content (Table 1). This prediction without weighting gave an  $R^2$  value of 0.840, a result so high that no attempt was made to improve the fit by allowing each type of score to have its own separate weight.

For ease of comparison, all persuasibility constants were relative values normalized to  $K_1$  with that constant given the arbitrary value of 1.0. One striking feature was that the pro-Toyota scores were consistently more persuasive than con-Toyota scores for all predictions in Table 3. The effect can be quantified by averaging the two pro-Toyota persuasive constants,  $K_3$  and  $K_4$ , and dividing by the average of the two con-Toyota constants,  $K_1$  and  $K_2$ . This division yields the values in Table 3. If the outlier of 3.7 corresponding to the AP wire is omitted, then the average is 2.1 times with a standard deviation of 0.2 so that pro-Toyota information is generally about twice as persuasive as con-Toyota messages.

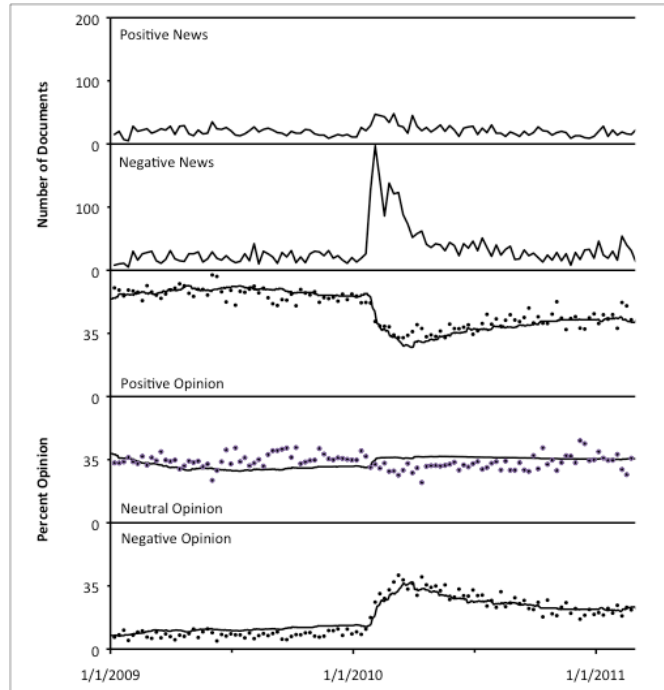
Figures 2-7 give both the scores used in the prediction and the opinion time trends predicted using the estimated constants of Table 2. Inspection of the figures for all media types shows that pro- and con-Toyota news changed little throughout 2009. A noteworthy difference was the rarity of both pro- and con- coverage in blogs and the AP wire in this time period relative to the other types of documents. However, the volume of both pro- and con- content in the blogs did climb a small amount toward the end of 2009 following a succession of Toyota announcements: the September 29, 2009 recall of 3.8 million vehicles, the November 2 recall of floor mats, and the November 25 announcement of measures to prevent floor mat interference with accelerator pedals.



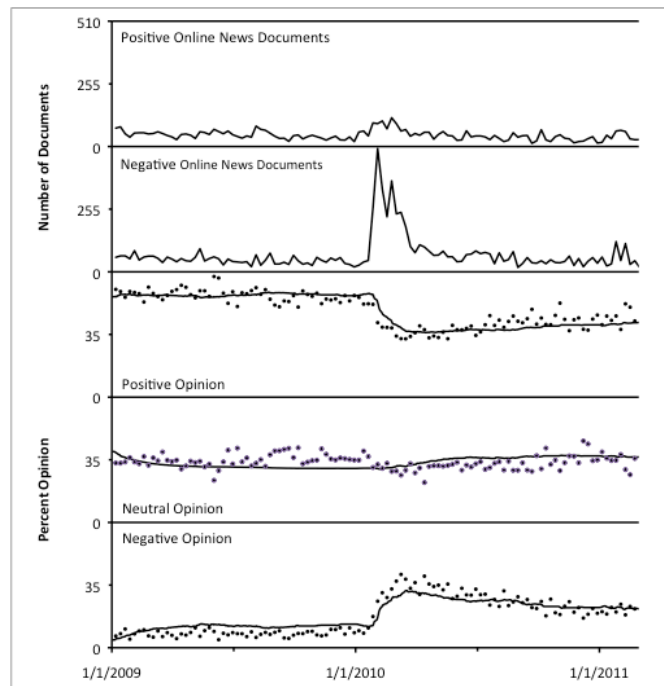
**Figure 2.** Prediction of impressions of Toyota from blogs. Statistics for the prediction are in the line in Table 2 labeled blogs. The top two frames give the count of pro-Toyota and con-Toyota blogs summed by the week. The lower three frames give predicted time trends of opinion about Toyota.



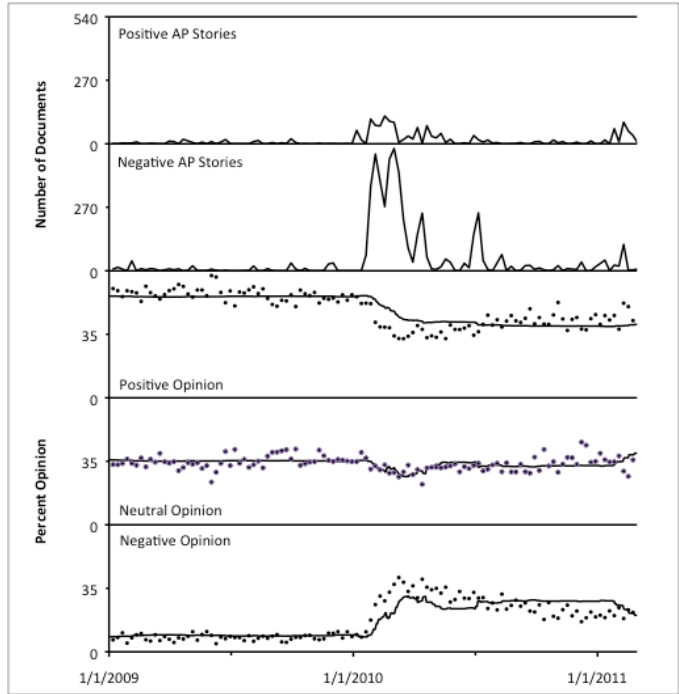
**Figure 3.** Prediction of impression of Toyota from forum documents. The layout of this figure is the same as in Figure 2.



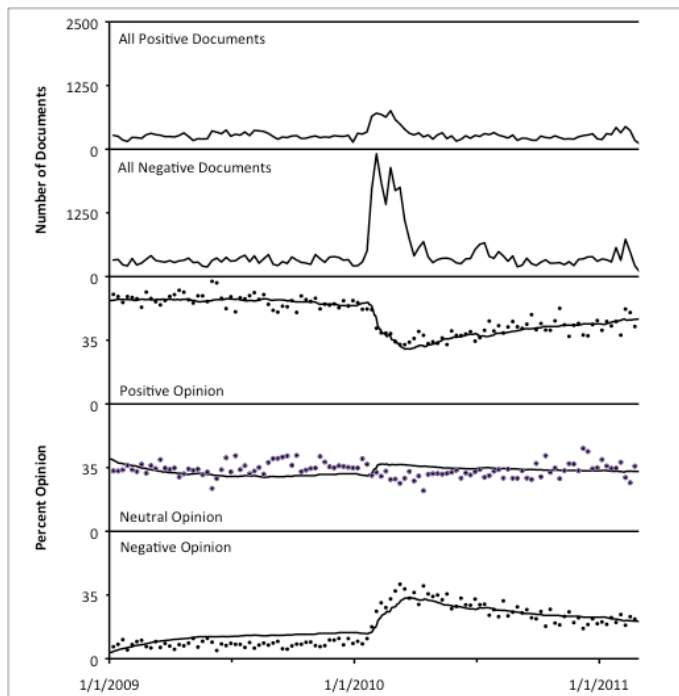
**Figure 4.** Prediction of impressions of Toyota from print newspapers. The layout of this figure is the same as in Figure 2.



**Figure 5.** Prediction of impressions of Toyota reputation online news (web editions of newspapers). The layout of this figure is the same as in Figure 2.



**Figure 6.** Prediction of impressions of Toyota from AP news wire stories. The layout of this figure is the same as in Figure 2.



**Figure 7.** Prediction of impressions of Toyota from all documents combined without weighting. The layout of this figure is the same as in Figure 2.

During 2009, the predictions of pro-, con-, and neutral opinion moved slowly with all trajectories being reasonably similar for all types of media. Some lines rose or fell slightly while other lines were closer to flat. The negative information in the automotive blogs toward the end of 2009 was not echoed by the other media and hence did not have a major impact on opinion. The non-blog media seemed to have ignored the recalls in the fall of 2009 because recalls in the auto industry are a regular occurrence.

Predictions from all media types (Figures 2-7) showed pronounced spikes of negative news beginning in early 2010. Toyota recalled another 2.3 million vehicles on January 21, 2010, suspended sales in North America of eight models on January 26, expanded the recall to 1.1 million vehicles on January 27 to include Europe and China, announced a mechanical fix to accelerator pedals on February 1 with the Toyota CEO personally apologizing for the quality problems and recalls on February 5. In some but not all of the figures, there was also a noticeable rise in pro-Toyota information at the same time. During the surge in negative news, the predictions were for marked drops in favorable opinion and an accompanying increase in unfavorable impressions (bottom 3 frames of Figures 2-7). The model predicted approximate constancy for neutral opinions.

After the first quarter of 2010, information about Toyota both decreased in volume and approached a steady state again. However, the patterns were not the same across all information types. Blog posts had consistently higher volumes both pro- and con- after the spike relative to before. There were also more AP stories than before the shock, but there continued to be a larger proportion of negative than positive stories. Text from forums, print newspapers and online news returned to the approximate volumes of early 2009.

Predicted opinion time trends for all media except the AP showed a gradual rise in favourable impressions accompanied by a drop in negative opinion. However, the AP had so much negative news from the second quarter of 2010 onwards (Table 1 and Figure 6) that the positive news was unable to increase favorable opinion consistent with the lower  $R^2$  value for prediction using AP news for the predictors.

Since forum content dominated the total volume of unweighted scores used to predict opinion (Table 1) it is not surprising that the predictions for the combined information was closest to the forum results. However, there was a marginal increase in the  $R^2$  values for the combined text scores (Table 2 and Figure 7) so it is possible that forum content does not reflect the entirety of the information used by the public for making decisions about Toyota.

## 5. Discussion

Research Question 1 asked about the ability of the ideodynamic model to predict opinion over time about the commercial brand of Toyota for which advertising was a major source of information. This paper shows that the predictions were quite good with  $R^2$  values in the range of 0.8 when media coverage alone was used for the predictors. These  $R^2$  values actually do represent the ability of information to move the public because none of the predictors were empirically measured opinion in contrast to linear autoregressive models.

Research Question 2 asked about the extent to which different types of media were good predictors. Any set of predictors is necessarily incomplete because it is not practical to include all communications within a population. Therefore, all media studies are based on samples. The key requirement is that a sample should be unbiased for the topic under study and hence representative of the information environment used by the public for the opinion formation. Similar to the case with opinion polls, the size of the requisite media sample depends on the accuracy needed for the analysis.

The unanticipated finding of this paper was that good predictions could be made from a variety of media channels including newspapers, online news, blogs, and forums. Thus the sample sizes of Table 1 were of adequate size, and there was remarkable consonance in the information from all these sources. The good predictions further meant that the major impacts of broadcast and advertising came from their content being integrated into the general information climate and being echoed by the news and Internet content.

The ability of a media source to reflect society's information depends on a wide variety of publications and writers in the sample. If a source is too narrow and contains content from only a few writers, then the medium can be biased. That was found with relatively poor predictions from the AP alone because AP text in databases is generated mainly by the AP's own writers and not by their member newspapers as is discussed above.

This paper has demonstrated the similarity of information flowing through different channels and the completeness of these channels for carrying information representative of persuasive information used by the public. A next step will be to explore the reasons given in the media for favorable and unfavorable views. The content analytic tools used so far have been general in nature and have only scored texts for connotations of positivity and negativity without concern for the underlying reasons. Other analytic tools will need to be deployed to extract the rationales. These reasons will then be useful for determining communication strategies that succeeded or failed in bringing the connotations of favorability into the communication environment.

## References

- Carroll, C.E. & McCombs M.E. (2003). Agenda-setting effects of business news on the public's images and opinions about major corporations. *Corporate Reputation Review*, 6 (1), 36-46.
- Carroll, C. (2009). The relationship between firms' media favorability and public esteem. *Public Relations Journal*, 3 (4).
- Fan, D.P. (1988). *Predictions of Public Opinion from the Mass Media: Computer Content Analysis and Mathematical Modeling*. New York: Greenwood Press.
- Fan, D.P. (1996). Predictions of the Bush-Clinton-Perot presidential race from the press. *Political Analysis*, 6, 67-105.
- Fan, D.P., & Cook, D.R. (2003). A differential equation model for predicting public opinions and behaviors from persuasive information: application to the Index of Consumer Sentiment. *Journal of Mathematical Sociology* 27, 29-51.
- Fan, D.P., Nordgren, L.D., & Finnegan Jr., J.R. (2004). Impact of news coverage, the Internet, the difficulty of getting cigarettes, and cigarette prices on smoking time trends. *University of Minnesota Supercomputing Institute Research Report UMSI 2004/226*.

- Iyengar, S., and Kinder, D.R. (1987). *News That Matters: Television and American Opinion*. Chicago: University of Chicago Press.
- Jones, J.M. (2010). Americans, Toyota owners still confident in Toyota vehicles. USA Today/Gallup poll. Retrieved from <http://www.gallup.com/poll/126236/americans-toyota-owners-confident-toyota-vehicles.aspx>. Accessed April 27, 2010.
- Liker, J. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. New York: McGraw-Hill.
- McCombs, Maxwell. (2004). *Setting the Agenda — The Mass Media and Public Opinion*. Malden, MA: Blackwell.
- MSNBC.COM. (2010). Toyota recall timeline. Retrieved from <http://www.msnbc.msn.com/id/35240466/ns/business-autos/>. Accessed April 27, 2011.
- Freeman, E.H. (2001). Electronic reprints of freelance works: New York Times v. Tasini. *Publishing Research Quarterly* 17, 50-55.
- Paterson, C. & Domingo, D. (2008). *Making Online News: The Ethnography of New Media Production*. New York: Peter Lang.
- Nstein Technologies. Discover the tone of documents and individual entities. Retrieved from <http://www.nstein.com/en/products-and-technologies/text-mining-engine/linguistic-modules/sentiment-analysis.php>. Accessed April 27, 2011.
- Owles, Eric and McDermon, Daniel. (2010). A Toyota timeline. NYTimes.com, February 10, 2010. Retrieved from [http://www.nytimes.com/interactive/2010/02/10/business/20100210\\_TOYOTA\\_TIMELINE2.html](http://www.nytimes.com/interactive/2010/02/10/business/20100210_TOYOTA_TIMELINE2.html). Accessed April 27, 2011.
- Pew Center for People and the Press. (2011). Internet gains on television as public's main news source. Washington, D.C.: Pew Research Center. January 4, 2011. Retrieved from <http://people-press.org/2011/01/04/internet-gains-on-television-as-publics-main-news-source/>. Accessed April 27, 2011.
- Quelch, J., Knoop, C.-I., & Johnson, R. (2011). Toyota Recalls (A): Hitting the Skids. HBS Case 9-511-016. Boston: Harvard Business School Publishing.
- Rosenbaum, P.R., & Rubin, D.B. (1983). The central role of the propensity score in observational studies for causal effects, *Biometrika* 70, 41–55.
- Steinmetz, K. (2010). Toyota's safety problems: a checkered history. *Time*, February 10, 2010. Retrieved from <http://www.time.com/time/business/article/0,8599,1962218,00.html?xid=rss-topstories>. Accessed April 27, 2011.
- Tims, A.R., Fan, D.P., & Freeman, J. (1989). The cultivation of consumer confidence: a longitudinal analysis of news media influence on consumer sentiment. *Advances In Consumer Research*, 16, 758-770.
- Spear, S.J. (2004). Learning to lead at Toyota. *Harvard Business Review*, 82 (5), 78-86.
- Stewart, T.A. & Raman, A. (2007). Lessons from Toyota's long drive. *Harvard Business Review*, 85 (7), 74-76.
- Weaver, D.A. & Bimber, Bruce. (2008). Finding news stories: a comparison of searches using Lexis-Nexis and Google News. *Journalism and Mass Communications Quarterly* 85(3), 517-532.
- YouGov. (a). YouGov BrandIndex. Retrieved from <http://www.brandindex.com/about>. Accessed April 27, 2011.
- YouGov. (b). What is BrandIndex? Retrieved from <http://www.brandindex.com/about/what-is-brandindex>. Accessed April 27, 2011.