



The Toyota recall crisis: Media impact on Toyota's corporate brand reputation

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1. Summary

Toyota, a company that built a world-class corporate brand reputation based on quality, manufacturing and design excellence, reliability, and customer focus, faced a major threat to its corporate brand reputation in 2009-2010 due to quality issues and recalls. ***This research uses a mathematical model of the impact of persuasive information on opinion formation to show how Toyota's corporate reputation, as measured by surveys, can be directly predicted by document sentiment*** in several media channels – newspapers, online news, AP newswire, blogs, and forums – for the 15 month period from January 1, 2009 through March 31, 2011. Model performance was high for newspapers ($R^2=.79$), blogs ($R^2=.75$), forums ($R^2=.82$), and online news ($R^2=.75$). An unweighted “all media” model was most successful ($R^2=.84$).

Information favorable to Toyota is about twice as persuasive as unfavorable information. Blogs appear to be a leading indicator of negative issues, yet have limited impact on Toyota's corporate reputation at the national level. It is only when the recall issues hit the mass media that Toyota's corporate reputation shows significant movement. Further, the research suggests that any representative sample of media outlets can be used to gauge opinion, and that automated sentiment scoring is sufficient.

This research breaks new ground by operationalizing a statistically rigorous, truly predictive mathematical model – grounded in accepted communications and cognitive psychology theory – directly linking media outputs to desired outcomes. This action-oriented model relies on data companies typically have, and can be applied cost-effectively in many areas of public relations.

2. Research program

2.1 Introduction and situation analysis

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 (see Appendix II: Timeline of the Toyota recall crisis).

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

pedals.

The serious nature of Toyota's problems grabbed national attention in late January and early February 2010 as an additional 2.3 million vehicles were recalled for sticking accelerator pedals, Toyota suspended sales of eight models in North America, Toyota expanded recalls to Europe and China, Toyota shut manufacturing plants, and Toyota President and CEO Akio Toyoda apologized for the car recalls. A third recall involved a company bestseller, the Prius Hybrid, for braking problems. Recalls totaled 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 presents a case to examine the role of media coverage – including newspapers, online news, blogs, and forums – in shaping corporate reputation. This paper uses the a mathematical model of the impact of persuasive information on shaping opinions (Fan, 1988; Fan & Cook, 2003) to ***show that Toyota's corporate brand reputation, as measured by public opinion surveys, can be predicted directly by media data.***

2.2 Predicting public opinion from the news media

2.2.1 Agenda setting theory

There has long been an interest in the relationship between the media and public opinion. Agenda-setting theory (see McCombs, 2004 and Scheufele & Tewksbury, 2007) has been one of the most prominent theoretical and research approaches to this question. "The core proposition of agenda-setting theory is that the prominence of elements in the news influences the prominence of those elements among the public" (Carroll & McCombs, 2003). The mass media form the only conduit for persuasive information flow that is rapid and extensive enough to transmit the cues that can persuade the public and thus shape public opinion about companies, brands, and issues.

Originally, agenda setting theory focused on how the media give prominence to stories and issues thereby telling the population what to think about (first level agenda-setting theory). However, the theory has been extended to a second level where the media also can change public preferences by providing cues individuals use to understand, evaluate, and respond to events and issues. The media influence the information individuals have top-of-mind when they make judgments by temporarily increasing the accessibility of knowledge units in the memory of an individual, which makes it more likely that these knowledge units are used in the

reception, interpretation, and judgment of events and issues.

Agenda-setting effects have been documented in hundreds of studies around the world ranging from elections to issues at the national and local levels around the world (Carroll & McCombs, 2003, 37). In addition to numerous field studies around the world that have supported agenda-setting theory (see Carroll & McCombs, 2003, 37), 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) extended 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. These analyses have been largely based on correlations, and have not yielded results that can be used in a predictive manner.

Theory and research studies thus raise the question of whether the media can be used to reliably predict public opinion on issues, political candidates, corporate brand reputation, and other objects of interest on a real-time basis.

2.2.2 The ideodynamic model

The ideodynamic model (Fan, 1988, Fan & Cook, 2003) extends 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 basic structure of the model is that of a commercial aircraft flight following directions from air traffic control (ATC). After leaving the departing airport and reaching an altitude of 10,000 feet at compass heading C, the aircraft is handed off to ATC. All subsequent instructions are given in the form of flying M miles at compass heading C, and ascending or descending F feet. In other words, the flight begins with a starting point, and every subsequent position of the trajectory is specified by a change from the previous position. Thus these trajectories have two key inputs, the initial condition and the instructions for changes that the airplane should make over time.

The ideodynamic model uses differential equations to implement the same strategy to predict opinions through time. The initial conditions are given by constant values in the way that the starting elevation, location, and compass heading are given to the pilot and air traffic controller. The equations of the model are like the rest of the flight trajectory, and only specify changes from one time interval to the next.

This paper uses the ideodynamic model to predict the time trends of public impressions about the Toyota corporate brand reputation as expressed in surveys. The surveys divide opinions into the three categories of positive, neutral, and negative towards Toyota; hence calculations for the model begin with initial percentage values for these three impressions. The time trends

then follow the equations as they specify simultaneous changes in all three opinions to give three time trends for positive, neutral, and negative brand reputation.

In ideodynamics, all changes are modeled to be due to persuasive information moving people from one group to another (Figure 1). At any given time, that information was quantified as the number of media documents scored as favorable (pro-Toyota) and unfavorable (con-Toyota) to Toyota. For this paper, the term *media data* refers to any type of information available to the public at large, and thus includes forums and blogs as well as the news media. Advertising is not included in this analysis.

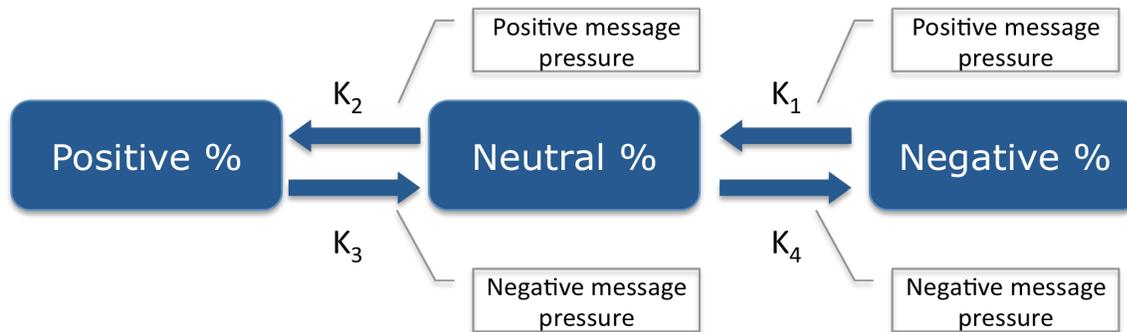


Figure 1: Ideodynamic model with four persuasibility constants, K , for predicting changes over time in the percentage of the population with negative, neutral, and positive impressions. The persuasibility constants K_1 to K_4 giving the weights for pro- and con- persuasive information in converting individuals from one subpopulation to another are discussed in the text.

Every type of document score was multiplied by a persuasibility constant K to give a persuasive force or message pressure. 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 message pressure was favorable to Toyota. That favorable pressure caused some people in target public with a negative opinion to change their minds, and join with the destination population holding a neutral opinion. The message pressure was computed by multiplying the number of favorable documents by persuasibility constant K_1 (Figure 1). Higher K values reflect documents that have greater persuasive power.

The other transitions in Figure 1 are 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 persuasibility constants can have different values, thereby giving four constants to estimate. Conversions to and from all populations can occur simultaneously. The structures of the equations used are obvious given the conversions specified by Figure 1 (see Fan, 1988, Fan & Cook, 2003).

The initial conditions correspond to 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 also assigned to be constants to be estimated. 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-opinion from 100 percent. These two constants together with the four persuasibility constants gave a total of six constants to be estimated.

The predicted opinion time trend began with the initial conditions, and then proceeded with computation of predicted pro-, con-, and neutral opinion every 24 hours assuming that a persuasive message had a decay half-life of zero days. That was consistent with recent studies such as Fan and Cook (2003) showing that persuasive information is very quickly forgotten. In other words, in the face of massive amounts of information from multiple media channels, an individual must first receive, process, and evaluate new information, and then change opinion state immediately, or else the information will be forgotten in favor of newer information. This is consistent with widely accepted theories of cognitive psychology: accessibility models of opinion change such as agenda setting and framing theories, and the elaboration likelihood model (Petty and Cacioppo, 1986).

In this analysis, individuals cannot shift directly from positive to negative in one step; rather, they must transit through a neutral position. Similarly, information unfavorable to Toyota can shift individuals away from their positive stance into a neutral position, and from neutral to a negative position in two steps. The model allows a person to move rapidly through the neutral opinion from one extreme to the other. The essential condition is that the person must receive two pieces of information to transit from one side to its opposite.

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 model does not assume any reinforcement mechanism. Looking at media-influenced shifts in attitudes can be used to predict Toyota corporate brand reputation through time so long as persuasive information data are available.

In the airplane flight scenario, the accuracy of the prediction is likely to degrade as more steps are taken if there are errors in each step. 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 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

This research breaks new ground by applying a statistically rigorous, predictive model directly linking media content to corporate brand reputation. As discussed above, the ideodynamic model has been used successfully for predictions of time trends of opinions and behaviors as varied as political elections (Fan, 1996), the University of Michigan Consumer Sentiment Index (Fan and Cook, 2003), and teenage smoking (Fan et al, 2004).

The three primary research questions addressed in this research are:

- RQ1:** How well does the ideodynamic model use persuasive information alone to predict corporate brand reputation trends?
- RQ2:** What types of persuasive information drive opinion about Toyota given the advent of the Internet and the consequent expansion of communication channels from classical print news to online news, blogs, and online forums?
- RQ3:** For the Toyota corporate brand, does do positive and negative news items have the same or different impact on corporate brand reputation?

2.4 Methods

2.4.1 Corporate brand reputation data

The corporate brand reputation data used in this research were kindly provided by YouGov.com from its ongoing BrandIndex surveys (YouGov, n.d. a & b). 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 with ongoing validation against the U.S. Census Bureau's American Community Survey (<http://www.census.gov/acs/www/>). While use of an opt-in Internet panel is not ideal for many reasons recognized by the authors, the results suggest that, even with these limitations, the BrandIndex survey results are sufficient for the purposes of this research.

The BrandIndex survey tracks public perceptions of corporate brand reputation using questions in the following areas: (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.

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 uses 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.

2.4.2 Media data

This study is 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 (Table 1). Other potentially useful data not included were broadcast television news, Twitter feeds, and advertising. Appendix III contains a list of the media channels included in this research. The media data was kindly provided by evolve24, a Maritz Research company.

Category	Writing style	Source
Newspapers	Professional, journalistic balance	Dialog
AP news wire	Professional, journalistic balance	Dialog
Online news	Professional, journalistic balance	BoardReader
Blogs	Informal, opinionated	BoardReader
Forums	Informal, opinionated, often short	BoardReader

Table 1. Media types included in the Toyota data set (see Appendix III for details).

2.4.2.1 Newspapers

Print newspapers are included because the stories are written by professional journalists, typically include a degree of journalistic balance, pass through a copy editing process, and may accrue the benefit of the credibility of the publication. For this study, 24 leading daily newspapers were included and considered as representative of the daily newspapers to which the American public is exposed. Stories were obtained through a search of Proquest Dialog™, a leading electronic database.

Unfortunately, neither news aggregator databases such as Dialog™, Factiva™, nor Lexis-Nexis™ nor the online editions of newspapers (see Section 2.4.2.2) can be considered a complete archive of stories appearing in the print editions. This gap is important in studies, such as the present research, investigating the impact of news that reached individuals on opinion formation. See Appendix IV for additional discussion of the limitations of the media data.

This means that news databases do not necessarily constitute archives of the whole content of news appearing in a particular news outlet or in a specific news market. This limitation is of particular concern for research requiring accurate assessments of all news in circulation about a particular subject or in a particular media channel, but it is not widely recognized by researchers. It is clear that a good deal of news, especially national news distributed at the local level, is comprised of wire stories that are absent from aggregator databases (Weaver & Bimber, 2008, 517-518).

2.4.2.2 Online news

This study also included the online editions of all newspapers included in this research (e.g., *Los Angeles Times* and latimes.com) because Americans are turning more and more to the Internet as a main source of news. According to a December 2010 Pew Center survey, 41% of Americans say they get most of their national and international news from the Internet compared to 66% for television and 31% for the newspaper, with both television and newspapers on downward trends (Pew Center, 2011). Furthermore, the print and online are likely to reach and appeal to different audiences.

The online newspaper stories were obtained through Boardreader (www.boardreader.com), a leading Web search engine and document aggregator. Boardreader scans millions of distinct URLs daily, and maintains a complete archive of documents going back four years or more. However, like Dialog and other aggregators, Boardreader removes most if not all syndicated content such as that from the AP and other newspapers for reasons of copyright compliance (Boardreader, personal communication).

Two cautions should be noted for online news. First, no online search engine can claim to be complete, nevertheless we are confident that the material obtained from the newspaper web sites is a reliable reflection of the material to which visitors to those sites would be exposed. Second, as noted above, online news sites are not likely to contain all stories appearing in the print editions of newspapers.

2.4.2.3 News wires

The Associated Press newswire is included because AP stories are a primary source of news articles in newspapers around the United States. The AP submits only its own wire story content, and not that of its members, to aggregator databases like Dialog. Therefore we must recognize that these aggregator databases only provide a small fraction of the AP content that subscribers put in their news stories.

2.4.2.4 Blogs

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

2.4.2.5 Forums

Finally, the media data set includes forums with the highest number of stories related to Toyota. Forums tend to be short texts written in an informal style, and also carry strong

opinions, often highly negative. The forum content was also obtained through Boardreader.

2.4.2.6 Television

Despite the attention paid to online news and social media, 66% of Americans still report that they use television as a major source for their news every day (Pew Center, 2011). This research project could not include broadcast because none of the media aggregators maintain broadcast files beyond 90 days. The results suggest that this is not important for modeling public opinion about corporate brand reputation, for reasons presented in the discussion.

2.4.3 Sentiment analysis

The media documents were analyzed by evolve24 for document sentiment specific to Toyota corporate brand reputation. First, the evolve24 system determined whether a statement 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 assigns 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.

The modeling used the number of positive and negative stories. Neutral stories were not included in the modeling because it is assumed that neutral stories have little or no impact on moving individuals from one position with respect to Toyota.

2.5 Results

Research questions 1 and 2 are addressed by exploring the extent to which different types of persuasive information are able to predict time trends of public opinion. For this purpose, five types of information were explored, that in blogs, in Internet forums, in print editions of newspapers, in online editions of news outlets, and in the AP newswire.

All these documents on Toyota were scored as being pro-, con-, or neutral in their ability to persuade the public to change opinion. The neutral documents were omitted because it was not obvious that they would either increase or decrease favorability toward Toyota. The counts of pro- and con- documents of the various types (Table 2) show that the totals range from a low of 4,557 for blogs to a high of 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, less than half of that of the others. Thus the AP newswire had a much larger proportion of negative stories.

The pro-Toyota and con-Toyota scores from each type of media were used separately to predict simultaneously the time trends of pro-Toyota, con-Toyota, and neutral to Toyota impressions using the model in Figure 1. 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 were independent because the three opinion percentages for pro-, con-, and neutral added to 100 percent. With 226 independent dependent variable data points, there were 220 degrees of freedom given that six constants

were estimated, two initial conditions and four persuasibility constants.

	Pro	Con	Pro+Con	Pro/Con ratio
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

Table 2. Counts of documents used in the Toyota analysis (January 1, 2009 through March 31, 2011).

All estimated persuasibility constants are provided in Table 3, and the performances of the predictions are given both in terms of the root mean squared deviation (RMSD) and the R² value.

The performance was high given the R² values ranging from 0.754 to 0.821 for predictions based on pro-Toyota and con-Toyota scores from blogs, forums, print news, and online news (Table 3). The similarity in performance was consistent with the closeness of the ratios of pro- to con-Toyota scores for the same four data series (Table 3). The AP wire content with more negative stories predicted a little less well with an R² value of 0.657.

In addition to predictions using scores from individual types of messages, 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 2). This prediction without weighting gave an R² 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.

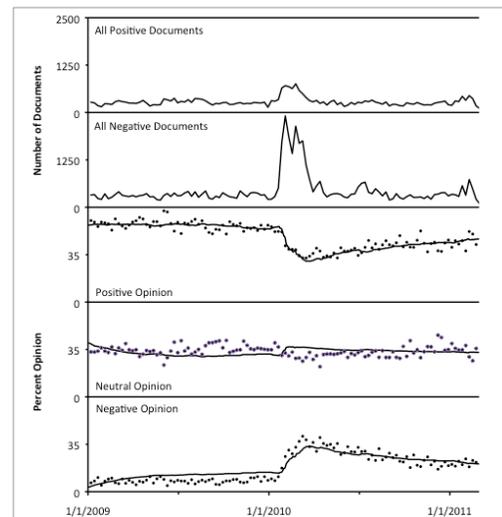


Figure 2. Prediction of Toyota reputation from all documents combined without weighting (R² = 0.840. This figure is identical to Fig. 8.

	Initial Opinion		Persuasibility Constants				R ²	RMSD
	% Pro	% Con	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. Four models for predicting Positive, Neutral, and Negative impressions of Toyota corporate brand reputation as measured in public opinion polls. All persuasibility constants are significant at the 95% confidence level, and are relative to K₁ arbitrarily set to 1.0 for ease of comparison.

The persuasibility constants were relative values normalized to K₁ 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 in all predictions in Table 3. Averaging the two pro-Toyota persuasive constants, K₃ and K₄, and dividing by the average of the two con-Toyota constants, K₁ and K₂, can quantify the effect. This division yields the values in Table 4. This supports research question 3.

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

Table 4. Ratio of average positive to average negative persuasibility constants from Table 3.

If the outlier of 3.7 corresponding to the AP wire is omitted, then the average positive/negative ratio is 2.1 with a standard deviation of 0.2, so that pro-Toyota information is generally about twice as persuasive as con-Toyota messages.

Figure 3 through Figure 8 (Appendix I, pp. 18-23) graph both the scores used in the prediction (survey results from BrandIndex) and the predicted opinion time trends corresponding to the statistics in Table 3. Inspection of the figures for all data types shows that pro-Toyota 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.

During 2009, the predictions of pro-, con-, and neutral opinion were all slowly moving with all trajectories being reasonably similar for all types of input data. Some lines increased or decreased slightly while other lines were closer to flat. First, this suggests that the negative information in the blogs beginning September 2009 did not have a major impact on predictions of opinion. Second, in an industry where recalls are a regular occurrence, the initial Toyota recalls did not have a negative impact on Toyota reputation.

Then, Figure 3 through Figure 8 (Appendix I, pp. 18-23) all show pronounced spikes in negative news beginning in early 2010. In January and early February 2010 Toyota recalled another 2.3 million vehicles (January 21, 2010), suspended sales in North America of eight models (January 26), expanded the recall to Europe and China (January 27), recalled another 1.1 million vehicles (January 27), announced a mechanical fix to accelerator pedals (February 1), and when the Toyota CEO personally apologized for the quality problems and recalls (February 5). In some but not all of the figures, there is also a noticeable rise in pro-Toyota information at the same time. At the time of the surge in negative news, the predictions in the bottom three frames of the figures were for a marked drop in favorable opinion and an accompanying increase in unfavorable impressions. The model predicted approximate constancy for neutral opinion with a sizeable proportion of the population moving from favorable to neutral, and from neutral to negative.

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 a consistently higher volume both pro- and con- after the spike than before. There were also more AP stories than before the shock in coverage 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 as in 2009.

These patterns were consistent with the predictions. For all opinion time trends except that for the AP, there was a gradual rise in favorable opinion accompanied by a drop in negative impressions. As discussed above for the persuasibility constants in Table 3, that increase required that positive information should have about twice the impact of negative text content.

However, the AP had so much negative news from the second quarter of 2010 onwards (Table 2 and Figure 7) that even higher weights for positive news were only able to move people with unfavorable impressions to the neutral position. The lack of increase in favorable opinion was consistent with the lower R^2 value for prediction using AP news as the input.

Since forum content dominated the total volume of unweighted scores used to predict opinion (Table 2) it is not surprising that the predictions for the combined information were closest to the forum results. However, there was a marginal increase in the R^2 values for the combined text scores (Table 3 and Figure 8) so it is possible that forum content does not reflect the entirety of the information used by the public for decision-making about Toyota.

3. Discussion

The Toyota data provided a good test of the impact of information flowing through different channels because all time trends for both information and opinion show periods of relative constancy and periods of change including both rises and falls.

The situation with the AP wire stories is quite different. As noted previously, the AP wire stories were both more negative than the other media channels, and the model has the lowest R^2 (Table 3). AP stories were very rare until the week of January 6, 2010, and negative AP coverage soared beginning the week of January 27, 2010. As illustrated in Figure 7, the AP stories fail to correlate with the drop in positive reputation or the increase in negative reputation.

The overall inference from these studies is that there is remarkable consonance in information in newspapers, online news, blogs, and forums. None of the communication types alone may be complete but all are likely to reflect the bulk of the relevant information used by the public for forming general impressions.

The AP example shows the danger of choosing a communication channel that is too narrow. As discussed above, news providers (newspapers) generally exclude from aggregator databases all content that they do not themselves generate, particularly AP wire stories, other syndicated stories, and stories written by freelance journalists. The higher frequency of negative news in the AP (Table 2 and Figure 7), and conversely the lower frequency of negative stories in the newspapers, could reflect the absence of AP-bylined stories appearing in newspapers in the stories archived in the electronic databases.

In contrast to AP stories, all other types of information in this study included content generated by much large collections of writers. The data in this paper suggests that this heterogeneity is more likely to be reflective of the totality of the information received the public.

Therefore, this study suggests that any broad collection of information can capture the information environment of society. In fact, the predictions had approximately the same R^2 values for total volumes of coverage extending over an approximate ten-fold range. Therefore, as with opinion surveys, there is no need to include all possible members of an information class in an analysis. A sample is fine so long as the sampling method is not biased with respect to the topic under examination. Clearly, the needed sample size will depend on the accuracy needed.

Having established the similarity of information flowing through different channels, a next step will be to explore the reasons given in the texts for favorable and unfavorable views. The content analytic tools used so far are general in nature and therefore only score for text with connotations of positivity and negativity but do not provide the reasons. Other analytic tools will need to be deployed to extract the reasons. These reasons will then be useful for determining communication strategies that succeeded or failed to bring the connotations of favorability into the communication environment.

4. Implications for public relations practice

This research breaks new ground in public relations in several ways. Most importantly, this approach provides PR practitioners with a direct link between media and corporate brand reputation or other attitude and opinion trends. Second, this approach provides a way for determining precisely what is (or is not) actually driving perceptual changes.

To begin, this is the **first predictive model using a rigorous statistical approach**, and grounded in widely accepted communications and cognitive psychological theory, directly linking media outputs alone to desired outcomes, in this case public perceptions of the Toyota corporate brand reputation. Quite simply, the model demonstrates that media relations works. Persuasive information in the media drives opinion formation. The model is truly predictive – not just a correlation – in the sense that this week's media results are used to reliably predict next week's corporate brand reputation (or other attitudinal outcome). Marketing mix models require many additional data streams that may not be available and may entail significant time delays.

Second, the ideodynamic model is **action-oriented, useful for public relations research, planning, and evaluation**, not just useful for academic knowledge. This case features a research method that can be applied widely in public relations. The model can be directly applied in areas that include corporate reputation, brand reputation, marketing communications, media relations, issues management, public affairs, crisis communications, and investor relations.

Third, this is **not a black box model**. The underlying model has been published in peer-reviewed academic journals.

Fourth, this case only looked at the impact of (i) different media types (newspapers, online news, blogs, and discussion groups) and (ii) stories by favorability. The **model can be easily extended** to identify the types of stories – by sentiment, by message content, and by media channel, in particular – that actually drive desired outcomes.

Fifth, implementation of the ideodynamic **model is cost effective** for several reasons. The model can be developed based upon data corporations usually have already: media analysis data and some survey-based data. Once the model is developed, the forecasts of corporate brand reputation can be conducted less frequently. The ideodynamic model is not intended to replace survey research. Rather, the model, once developed, can be used for routine tracking at minimal cost. Survey research can then be used to get greater depth of understanding.

Sixth, this analysis (and others using the ideodynamic model for other purposes) demonstrates that a broad but non-encyclopedic media set can be used to predict corporate brand reputation. This suggests that corporations and media measurement firms can **reduce costs by sampling the media environment**, rather than incurring higher costs by seeking to “get everything.”

Finally, the success of the modeling using **automated sentiment scoring** shows that high quality automated sentiment scoring is certainly adequate for understanding attitudes and opinions held by target audiences.

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6. Appendix I: Figures

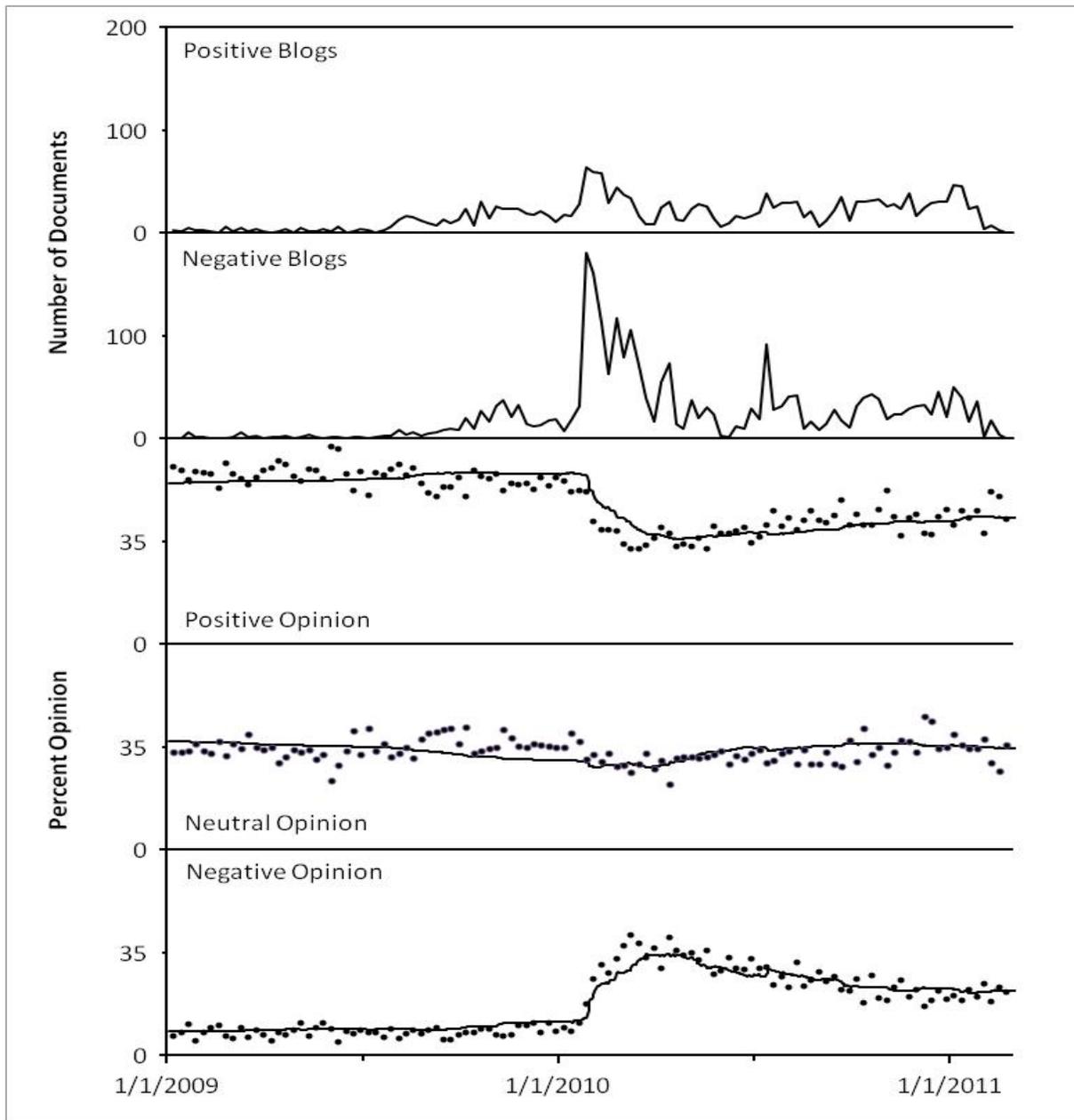


Figure 3. Prediction of Toyota reputation from blogs. The statistics for the prediction are given in the line in **Error! Reference source not found.** labeled blogs. The top two frames give the count of pro-Toyota and con-Toyota blogs summed by the week. The lower three frames give the predicted time trends of opinion in the form of impressions about Toyota. The dots represent the weekly survey data. The solid lines represent the modeled data.

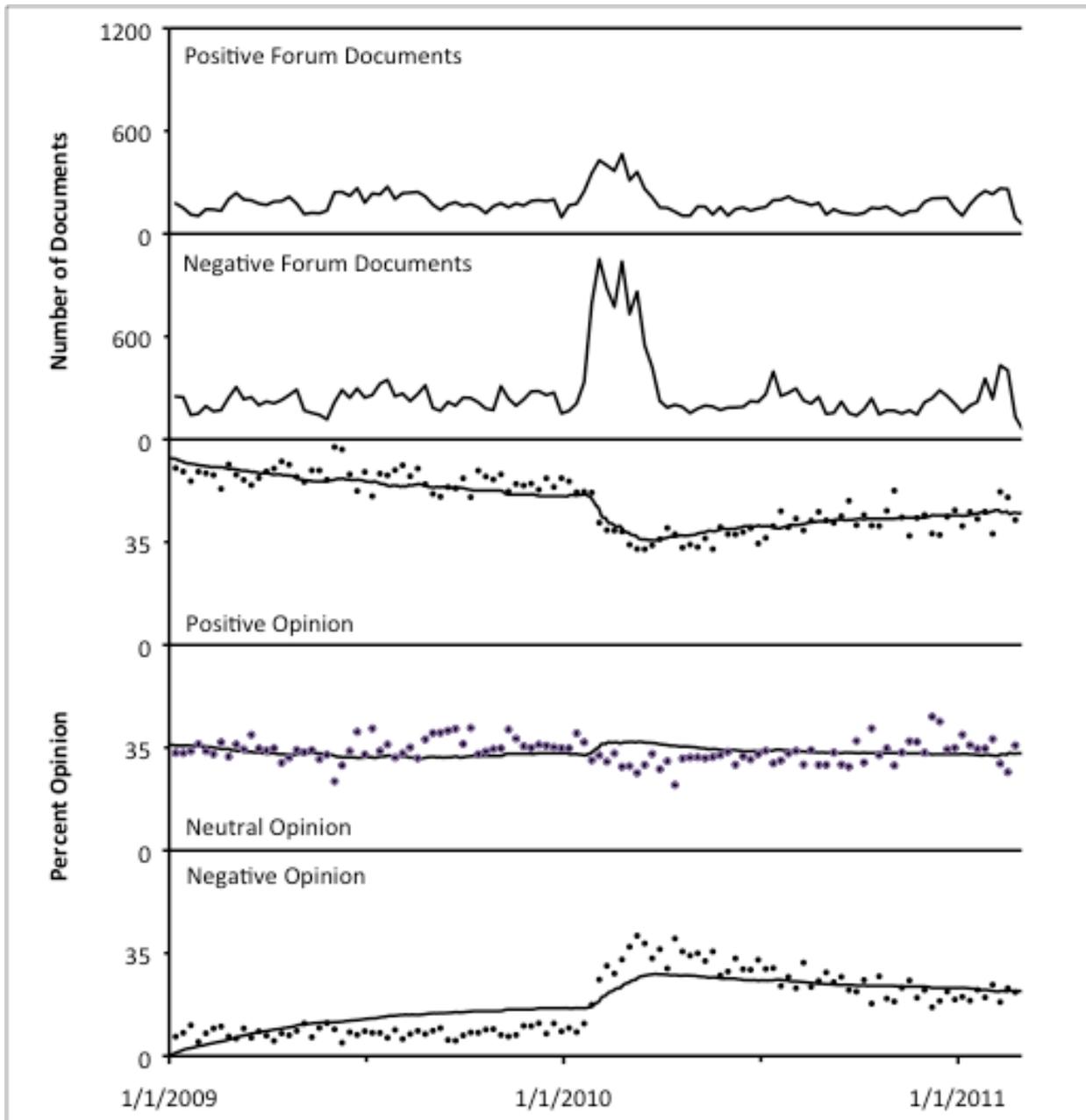


Figure 4: Prediction of Toyota reputation from forum documents.
The layout of this figure is the same as Figure 3.

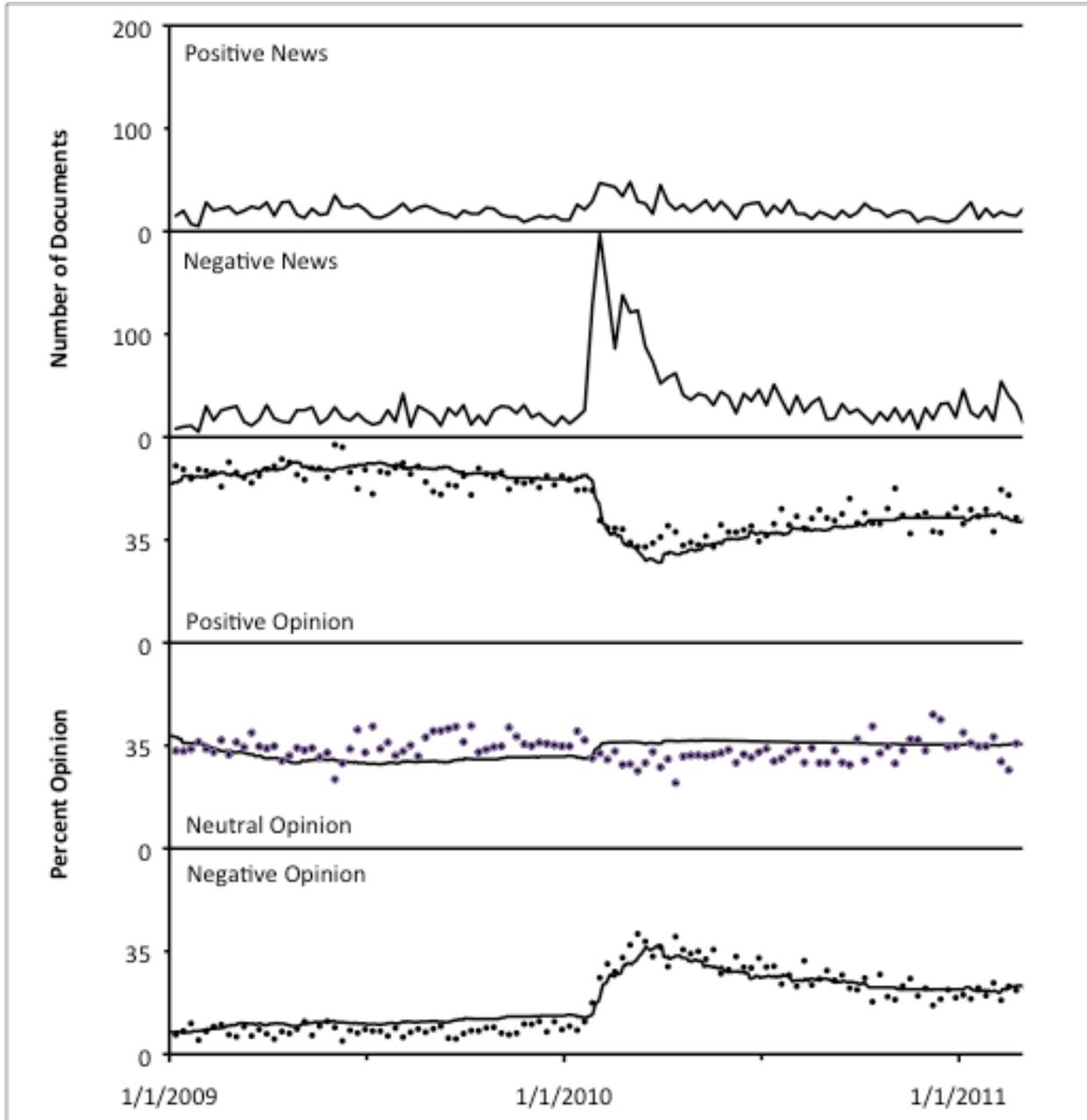


Figure 5: Prediction of Toyota reputation from print newspapers.
 The layout of this figure is the same as Figure 3.

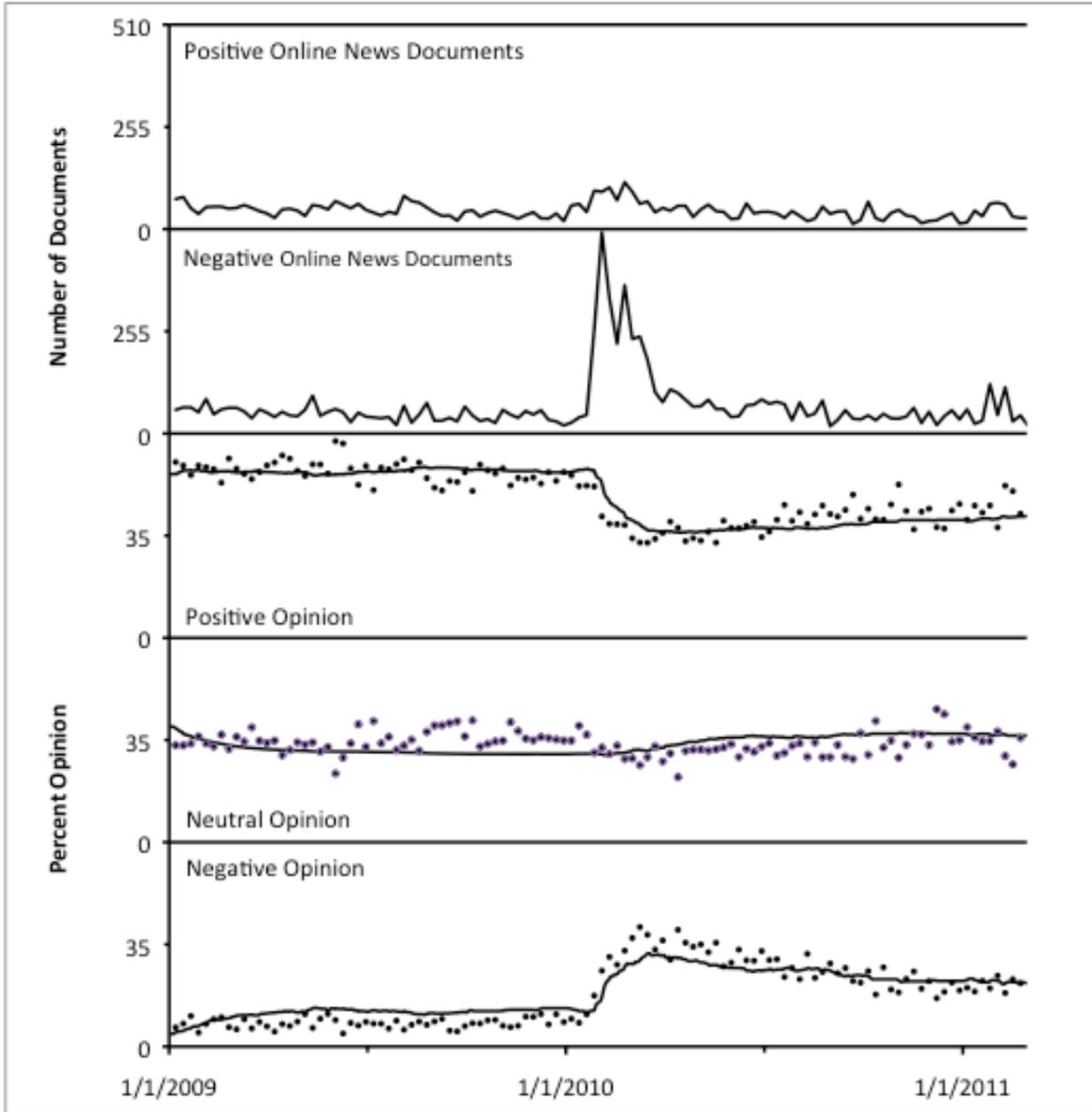


Figure 6. Prediction of Toyota reputation from online news from the web.
The layout of this figure is the same as Figure 3.

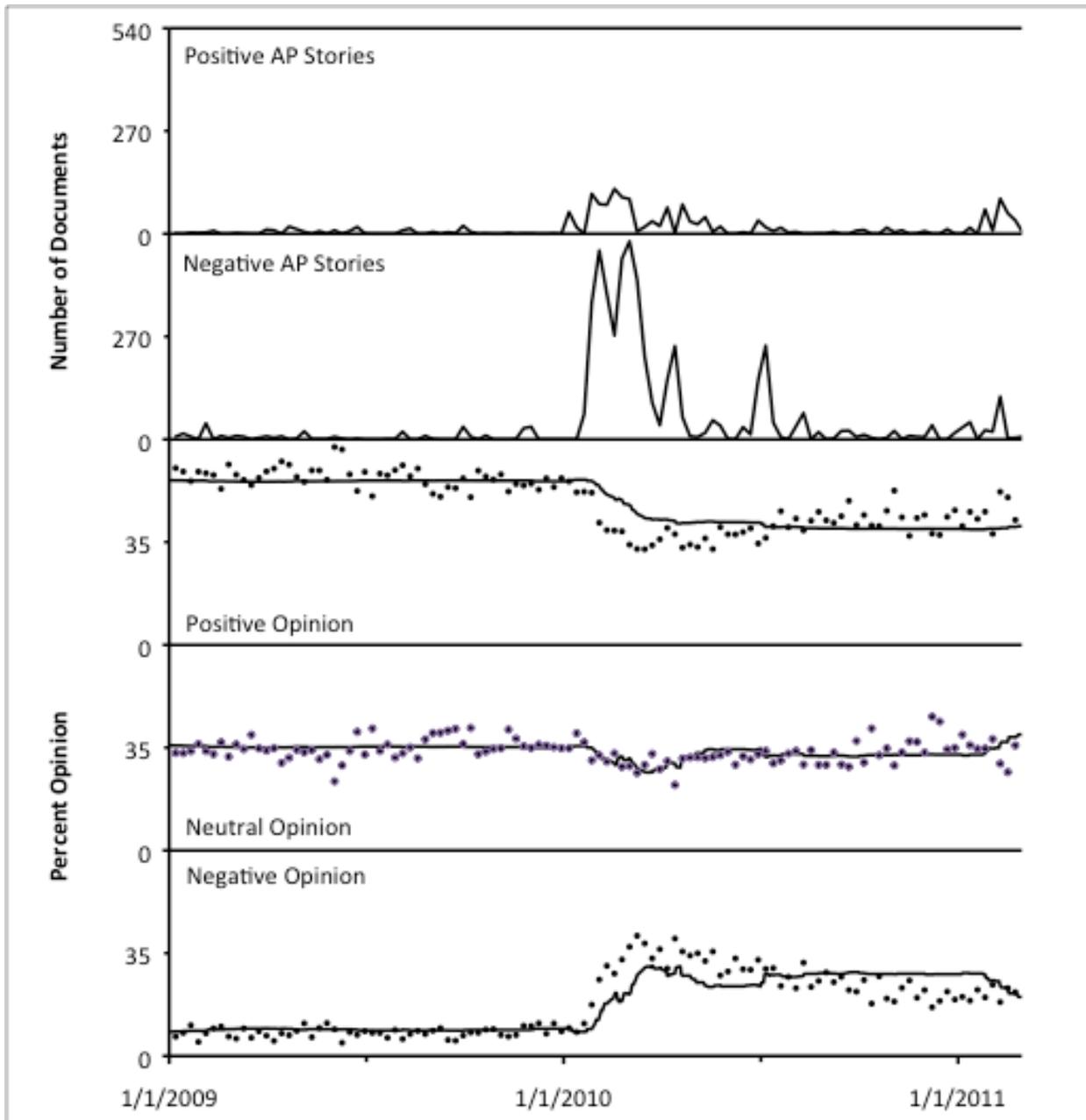


Figure 7: Prediction of Toyota reputation from AP news.
The layout of this figure is the same as Figure 3.

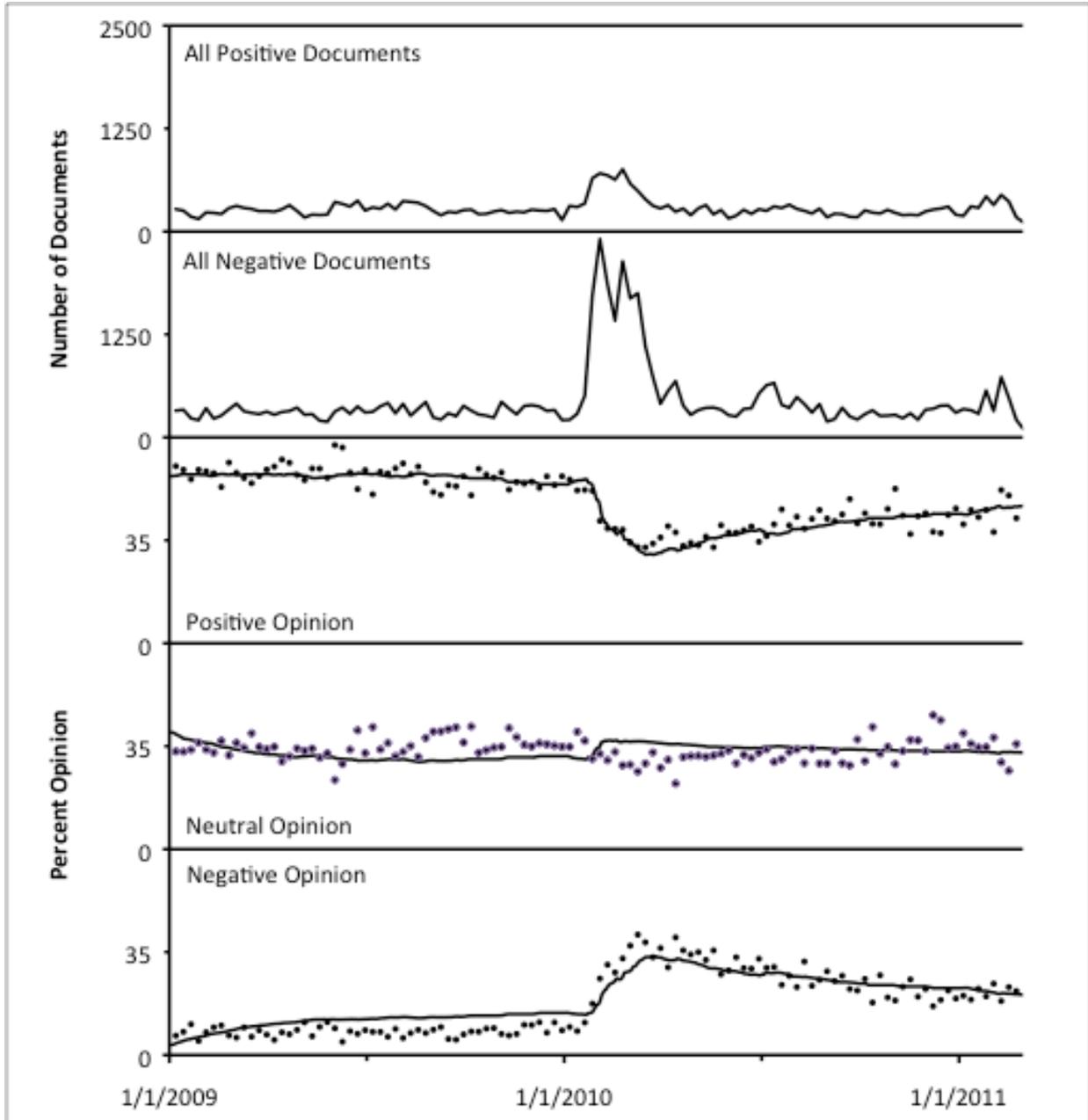


Figure 8: Prediction of Toyota reputation from all documents combined without weighting.
The layout of this figure is the same as Figure 3.

7. Appendix II: Timeline of the Toyota recall crisis

March 2007	Toyota begins investigation of whether floor mats may be jamming accelerators based on five complaints from owners of 2007 Lexus ES 350 cars.
March 29, 2007	NHTSA opens preliminary investigation about all weather floor mats jamming accelerators.
July 26, 2007	In San Jose, Camry crashes into another car, killing the driver of the second car, possibly linked to accelerator problems.
September 13, 2007	NHTSA determines that the San Jose crash was caused by the entrapment of the accelerator pedal by all-weather floor mats, and informs Toyota that a recall is required.
September 26, 2007	Toyota announces the recall of 55,000 floor mats that were sold as optional equipment on 2007-2008 Camry and Lexus ES models. NHTSA advises owners to remove or properly secure the floor mats. NHTSA closes its investigation.
April 19, 2008	A 2005 Camry, a model not covered by a recall related to pedals, accelerates out of control and crashes into a tree. The crash is now being investigated as a possible example of problems with the electronic system that controls the throttle and engine speed. Toyota denies there is a problem with the electronic systems
June 2008	After years of complaints about acceleration problems, Toyota concludes that the accelerator pedal feeling could change under certain conditions, but that this is a driving issue not a safety issue.
April 27, 2009	Toyota engineers in Europe send reports of sticking accelerator problems in Galway, Ireland to Toyota engineers in Los Angeles.
July 2009	In a confidential presentation listing legislative and regulatory “wins,” Toyota estimates it saved \$100 million by negotiating with regulators to limit a previous recall to 2007 Camry and Lexus ES models for sudden acceleration.
August 28, 2009	Four people die in the crash of a Lexus ES 350 driven by an off-duty California Highway Patrol officer after the car accelerates out of control.
September 10, 2009	Public release of the 911 audio and transcript from the August 28 crash.
September 29, 2009	Toyota announces recall of 3.8 million U.S. vehicles because floor mat problems could cause accelerator to stick. Toyota excludes a “vehicle-based cause” for the problem. NHTSA advises owners to remove the floor mats.
November 2, 2010	Toyota announces a voluntary recall of floor mats, and claims that NHTSA officials had found no other defect, a statement that NHTSA says is incorrect.
November 25, 2009	Under a recall order covering Camry, Tundra, Avalon, Tacoma, Prius, and Lexus models, Toyota announces more measures aimed at preventing the floor mat from causing the accelerator to stick.
December 28, 2009	In New Jersey, an Avalon speeds out of control. The driver manages to drive the car to the dealer.
January 16, 2010	Toyota USA executive urges his colleagues to admit the company has mechanical problems with accelerator pedals.

January 21, 2010	Toyota announces recall of 2.3 million vehicles — including RAV4, Corolla, Camry, Avalon, Sequoia, Tundra, Matrix, Highlander, and the Pontiac Vibe — to fix a problem that could cause accelerator pedals to stick even without the presence of floor mats, though Toyota does not have a solution.
January 26, 2010	Toyota announces temporary suspension of sales in North America of eight models of vehicles including the Corolla and Camry as it works to fix problems.
January 27, 2010	Toyota widens the recall by 1.1 million vehicles.
January 27, 2010	Toyota expands the recalls to Europe and China, but has not determined the models and numbers of cars affected.
February 1, 2010	Toyota announces a repair to fix accelerator pedals by installing a steel reinforcement bar in the pedal assemblies of 2.3 million vehicles in the U.S. Toyota will provide replacement pedals to more than five million buyers whose cars were recalled over floor mats.
February 2, 2010	Toyota loses market share as sales fall while GM and Ford gain. Ford, GM, and Chrysler offer sales incentives to Toyota owners.
February 3, 2010	U.S. Transportation Secretary Ray LaHood warns Americans not to drive recalled cars, but later says this was a misstatement and advises drivers to take their vehicles to the dealer.
February 4, 2010	Toyota acknowledges a flaw in the Prius hybrid's antilock braking system, and safety regulators announce opening of an investigation.
February 5, 2010	Toyota President and CEO Akio Toyoda apologizes for the car recalls and promises to enhance quality control.
February 9, 2010	Toyota announces a worldwide recall of about 437,000 Prius and other hybrid vehicles to fix a problem in the braking system.
February 17, 2010	Toyota President and CEO Akio Toyoda announces steps to restore trust including installation of new brake override systems and faster disclosure of defects.
February 22, 2010	U.S. congressmen say that Toyota relied on a flawed study in dismissing the notion that computer issues could be a at fault for sticking accelerators, and that Toyota then made misleading statements.
February 25, 2010	Toyota President and CEO speaks at a U.S. House hearing, apologizes, and takes personal responsibility.
March 2, 2010	U.S. Transportation Secretary Ray LaHood says the Obama administration may recommend that automakers install brake override systems.
March 4, 2010	Federal safety regulators open investigation of cases of unintended acceleration in Toyotas that were already repaired.
April 5, 2010	U.S. Department of Transportation to seek \$16.4 million fine against Toyota.
April 13, 2010	Lexus quickly suspends sales of the 2010 Lexus GX 460 after <i>Consumer Reports</i> warns buyers of a dangerous handling problem.
May 18, 2010	Toyota pays a \$16.4 million fine to settle allegations by U.S. regulators that the company was too slow to recall cars with gas pedal problems.
May 21, 2010	Toyota recalls about 3,800 Lexus LS sedans in the U.S. to fix a problem with the steering system, after a similar recall in Japan.
July 2, 2010	Toyota recalls 270,000 Lexus GS, IS, and LS vehicles worldwide, including 138,000 in the U.S., to fix engine stalling problems.

July 5, 2010	Toyota recalls 270,000 Crown and Lexus models worldwide for valve springs with potential production issue.
July 29, 2010	Toyota recalls 412,000 Avalons and LX 470s in the U.S. for replacement of steering column components.
August 28, 2010	Toyota recalls approximately 1.13 million Corolla and Corolla Matrix cars Engine Control Modules (ECM) that may have been improperly manufactured.
February 8, 2011	In the U.S., NASA and NHTSA inquiry reveals that there were no electronic faults in Toyota cars that would have caused acceleration issues. Accelerator pedal entrapments still remain a problem.
February 22, 2011	Toyota recalls an additional 2.17 million vehicles for gas pedals that become trapped on floor hardware.
Sources: Owles and McDermon, Daniel, 2010 and MSNBC, 2010.	

8. Appendix III: Media channels

Newspapers and online news			
Newspaper	Number of documents	Online edition of newspaper	Number of documents
Boston Globe	437	Boston Globe Online	287
		boston.com	1,044
Chicago Sun Times	--	suntimes.com	194
Chicago Tribune	822	Chicago Tribune Online	1,298
Dallas Morning News	608	Dallas Morning News Online	272
Denver Post	114	denverpost.com	815
Detroit Free Press	1,089	Detroit Free Press Online	1,728
Houston Chronicle	210	Houston Chronicle Online	1,916
		blog.chron.com	152
Indianapolis Star	38	www.indystar.com	709
Kansas City Star	932	KansasCity.com	878
Los Angeles Times	886	latimes.com	211
		Los Angeles Times Online	999
Milwaukee Journal Sentinel	258	www.jsonline.com	150
Minneapolis Star Tribune	58	startribune.com	1,232
New York Post	213	New York Post Online	32
New York Times	1,447	nytimes.com	1,666
Newsday	836	Newsday Online	182
Orange County Register	379	ocregister.com	478
Sacramento Bee	395	sacbee.com	141
		blogs.sacbee.com	265
San Diego Union-Tribune	358	www.signonsandiego.com	724
San Francisco Chronicle	265	San Francisco Chronicle Online	427
		feeds.sfgate.com	594
		mercurynews.com	1,579
San Jose Mercury News	709	siliconvalley.com	209
Seattle Times	315	seattletimes.com	1272
St. Louis Post-Dispatch	426	STLtoday.com	379
St. Paul Pioneer Press	496	TwinCities.com	403
St. Petersburg Times	567	www.tampabay.com	603
USA Today	563	USA Today Online	1,315
Washington Post	--	Washington Post Online	3,271

Blogs and forums

Blog	Number of documents	Forum	Number of documents
leftlanenews.com	3,141	toyotanation.com	36,897
thetruthaboutcars.com	1,214	gminsidenews.com	28,466
blogs.consumerreports.org	517	ttora.com	13,829
paultan.org	491	topix.com	12,111
autobloggreen.com	370	pirate4x4.com	7,338
autoblog.com	311	garagejournal.com	2,780
blogs.insideline.com	284	cleanmpg.com	2,734
thecarconnection.com	279	toyotatundraforum.com	1,930
green.autoblog.com	242	toyotaminis.com	1,141
autouncut.com	205	rcgroups.com	924
blogs.edmunds.com	129	politicalforum.com	918
blogs.wsj.com	80	webmaster-forums101.com	101
carscoop.blogspot.com	61		
1800starnet.com	50		
zhiyu4n.wordpress.com	39		
autoweek.com	21		
uk.autoblog.com	16		
autolineleads.com	11		
www.sportscarbloggers.com	5		
www.bmwmonitor.com	3		
search.live.com	2		
carphotoblog.com	1		
cleanmpg.com	1		

9. Appendix IV: Additional discussion of the limits of the media sample

Weaver and Bimber illustrate the extent of this gap in their study “comparing Google News to LexisNexis for finding stories in the New York Times, eight large-circulation U.S. newspapers, and all English-language news outlets in each database” (Weaver & Bimber, 2008, 517). The results show that “inter-database agreement between Google News and LexisNexis ranged from 29% to 83%” and that “LexisNexis missed half or more of stories appearing in major papers and in broad searches of English-language news because it is blind to wire stories” (Weaver & Bimber, 2008, 517).

Some notes of caution need to be added concerning the Weaver & Bimber results. First, Google News should be more complete than LexisNexis because LexisNexis only includes news outlets with which this aggregator has secured licensed agreements, while Google News indexes every online news source. Second, Google News does not return the same document count or content each time that a search is made. Therefore, Google News results can only be considered to be approximate with the accuracy of that approximation unknown. One possible source for variability in Google News results is that Google might use reader searches to influence the news content returned in the same way that Google selects other results for the user.

In contrast, news aggregators like Dialog actually search their databases following user commands so their results are very close to completely stable. However, aggregator databases can also change because news outlets can and have removed content, because content owners post stories late, or because of embargo periods.

Thus, as Weaver and Bimber note for newspaper stories, “content originating with wire services is typically stripped out of newspapers before stories are archived” in an electronic database. However, news outlets go further and have even removed content that they had originally posted to databases, especially stories with uncertain copyright privileges. Consequently, aggregator databases also cannot be considered to be invariant even though they are much more stable than Google News.

Furthermore, in *New York Times Co. v. Tasini*, 533 U.S. 483 (2001), the U.S. Supreme Court ruled that publications cannot license the works of freelance journalists to electronic databases without permission. Similarly, online editions of newspapers do not contain stories or columns to which they do not have clear copyright.