Adjusting for Measurement Error in the Analysis of Opinion Change[1]

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Abstract

This paper uses data on trait assessments and overall "thermometer" ratings of Ronald Reagan during the 1980 presidential campaign to illustrate the effect of measurement error on parameter estimates in panel studies of opinion change. In a model relating current opinions to prior opinions, party identification, television news and newspaper exposure, and age, education, and race, adjusting for measurement error significantly increases the estimated impact of exposure to television news and newspapers and significantly decreases the estimated impact of partisan predispositions. Adjusting for measurement error also makes pre-existing opinions look significantly more stable, suggesting that the new information absorbed via media exposure must be about three times as distinctive as has generally been supposed in order to account for observed patterns of opinion change.

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[1] This is a revised and abridged version of my article entitled "Messages Received: The Political Impact of Media Exposure," forthcoming in the *American Political Science Review* 87:2 (June 1993). Various versions of the research described here were presented at the 1991 Political Methodology Summer Conference, at the 1992 Meeting of the American Political Science Association, and at Princeton University, Carnegie Mellon University, and the University of Chicago. I am grateful for stimulating reactions on all these occasions, and especially to Christopher Achen, Charles Franklin, Shanto Iyengar, John E. Jackson, Simon Jackman, and John Zaller for specific suggestions incorporated in this revision.

Adjusting for Measurement Error in the Analysis of Opinion Change

Analysts of opinion dynamics typically ask two kinds of questions: First, how stable are opinions over time? And second, to the extent that opinions change, what produces those changes?

Thanks primarily to the efforts of Achen (1975; 1983), the effect of measurement error on inferences about opinion stability are now widely recognized. In particular, it is clear that the low levels of opinion stability in mass publics estimated by Converse (1964) and others are attributable in large part to the effects of measurement error in survey responses. Although the nature and significance of this "measurement error" is a matter of considerable -- and continuing -- theoretical debate (Feldman 1990; Zaller and Feldman 1992; Zaller 1992; Brady 1993), analysts of political attitudes and belief systems now at least know better than to mistake opinion responses in surveys for the real political opinions underlying those responses.

Somewhat surprisingly, the same level of methodological sophistication that has become commonplace in analyses of opinion stability is much less commonplace in analyses of opinion change. It is by no means unusual for analysts of opinion change to regress current opinions on prior opinions plus some other variables intended to capture potential causes of opinion change, making no allowance for error either in measured prior opinions or in the other measured variables associated with potential opinion change. Unfortunately, such an approach cannot, in general, lead to reliable inferences about the nature and causes of opinion change; nor does data analytic experience give us good reason to believe that the resulting biases are likely to be so minor that we can safely ignore them in practice.

This paper makes three related points about the impact of measurement error in individual-level analyses of opinion change, especially in models where prior opinions appear explicitly as explanatory variables. First, it says what should be obvious: that measurement error creates significant inferential problems not only in analyses of opinion stability, but also in analyses of opinion change. Second, it highlights the fact that the nature of the biases produced by measurement error is not predictable *a priori*. In particular, it is not always the case -- as analysts sometimes seem to assume, despite the explicit cautions of Achen (1983) -- that measurement error in explanatory variables produces attenuated parameter estimates in analyses of opinion change. In the example at hand, whereas the impact of media exposure on opinion change in a campaign setting is significantly underestimated by ordinary regression analysis, the impact of partisan predispositions is significantly *overestimated*.

Finally, by interpreting regression parameter estimates in the context of a simplified Bayesian model of opinion change, I illustrate an important *interaction* between the effect of measurement error on estimates of opinion stability and the effect of measurement error on estimates of opinion change. To the extent that we care -- as I argue we should care -- not only about measuring opinion change, but also about relating that change to the persuasive information or "messages" that produce it, naive inferences will be doubly bedeviled by the effects of measurement error. On the other hand, more careful attention to the effects of measurement error may significantly improve our understanding not only of *how much* opinions change, but of *why* they change.

1: A Model of Opinion Change

My aim in this section is to set out a model of opinion change that can be used to measure and interpret both the stability of opinions over time and the sources of opinion change. The model has three important characteristics:

• First, the model incorporates pre-existing opinions as explanatory variables, so that opinion change is observable more or less directly, albeit at the cost of requiring repeated measurements from a panel of survey respondents.

• Second, the incorporation of new information with pre-existing opinions is modeled by the assumption that respondents use new information to update their political opinions rationally in accordance with Bayes' Rule. Bayes' Rule may or may not be a realistic behavioral model, but it is certainly a useful accounting device -- in particular because it provides a systematic way to characterize both the relative weight of old and new information in respondents' current opinions and the nature and sources of the new information they have absorbed between any two opinion readings.

• Third, since measurements of pre-existing knowledge and attitudes in opinion surveys are usually quite imperfect, the model makes explicit distinctions between the underlying variables of theoretical interest and observable indicators of those variables.

The model represents individual i's opinion about some political stimulus j at time t as a Normal probability distribution with mean θ_{ijt} and variance $1/\pi_{ijt}$. (It may be helpful to think of θ_{ijt} as representing the "location" of the opinion and π_{ijt} as representing the certainty or "precision" of the opinion.) Given Bayesian updating, the relationship between this opinion at time t and the corresponding opinion at any previous time s is

$$\{1\} \qquad \theta_{ijt} = \theta_{ijs}\ \pi_{ijs}/(\pi_{ijs}+\omega_{ijt}) + \mu_{ijt}\ \omega_{ijt}/(\pi_{ijs}+\omega_{ijt})$$

$$\{2\} \qquad \pi_{ijt} = \pi_{ijs} + \omega_{ijt}$$

where μ_{ijt} and ω_{ijt} represent the mean (location) and precision, respectively, of a Normal probability distribution representing new information (a "message") received between time s and time t. The precision of the opinion at time t, π_{ijt}, is equal to the sum of the prior precision (π_{ijs}) and the message precision (ω_{ijt}); the location of the opinion at time t, θ_{ijt}, is a weighted average of the prior location (θ_{ijs}) and the message location (μ_{ijt}), each weighted by its precision.

This model is obviously too general as it stands, since nothing in it is directly observable and everything varies both across individuals and over time. We might make some progress by introducing observable measures of subjective information corresponding to the unobserved variables π_{ijs} and π_{ijt}, but the resulting nonlinear model is difficult in practice to estimate. In view of this difficulty, a tempting alternative approach is to treat the ratio π_{ijs}/π_{ijt} as a constant parameter λ_{jt} for all i. This assumption implies that individuals vary in how much they know (or rather, in how much they think they know) at any given time, but that the amount of new (subjective) information acquired by any individual in a given time interval is proportional to the amount of (subjective) information she already possesses at the beginning of the interval.[2] Adopting this simplification gives

$$\theta_{ijt} = \theta_{ij*} \lambda_{jt} + \mu_{ijt} (1 - \lambda_{jt}) , \quad \{3\}$$

which represents each individual's opinion at time t (θ_{ijt}) as the same weighted average of prior opinions (θ_{ij*}) and new information (μ_{ijt}).

I assume that the relationships between the unobserved variables θ_{ijt} and μ_{ijt} and the observed data are of the forms

$$\theta_{ijt} = Y_{ijt} - \delta_{ijt} \quad \{4\}$$

and

$$\mu_{ijt} = (\mathbf{X}_{it} - \zeta_{it}) \alpha_{jt} + \epsilon_{ijt} \quad \{5\}$$

where Y_{ijt} is an opinion reading (including measurement error), $\mathbf{X}_{it}$ is a vector of observations (including measurement error) of exogenous characteristics related to the message individual i absorbs about stimulus s at time t, δ_{ijt} and ζ_{it} are random variables representing the measurement error in the observed data Y_{ijt} and $\mathbf{X}_{it}$, respectively, ϵ_{ijt} is a random variable representing additional components of the message μ_{ijt} absorbed by individual i, and α_{jt} is a vector of parameters to be estimated. Thus, the mean of the distribution representing opinion at time t is assumed to be measured directly but with error by the observed variable Y_{ijt}, whereas the mean of the distribution representing the new information received

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[2] It is worth noting that, if this assumption held exactly, the unconstrained nonlinear model in which π_{ij*} and π_{ijt} are separate variables with parameters to be estimated would be underidentified. Indeed, difficulties encountered in estimating the parameters of the unconstrained nonlinear model may be attributable to the approximate correctness of this simplifying assumption for relatively short-term processes of opinion change. The simplifying assumption would presumably be less adequate for long-term processes of opinion change, where prior certainty may be strongly related to age or experience (Achen forthcoming).

between time s and time t is assumed to be unobservable, but linearly related to a vector of exogenous characteristics which are in turn measured directly but with error by the observed variables $\mathbf{X}_{\mathbf{i}}$.

Substituting these relationships into {3} and rearranging gives

$$\{6\} \qquad Y_{ijt} = (Y_{ij*} - \delta_{ij*})\,\lambda_{jt} + (\mathbf{X}_{i} - \zeta_{i})\,\alpha_{jt}\,(1 - \lambda_{jt}) + \epsilon_{ijt}\,(1 - \lambda_{jt}) + \delta_{ijt}$$

$$= (Y_{ij*} - \delta_{ij*})\,\lambda_{jt} + (\mathbf{X}_{i} - \zeta_{i})\,\beta_{jt} + u_{ijt}\,.$$

This model takes the relatively simple form of an errors-in-variables regression model with dependent variable Y_{ijt}, explanatory variables Y_{ij*} (with associated parameter λ_{jt}) and $\mathbf{X}_{i}$ (with associated parameter vector $\beta_{jt} = \alpha_{jt}\,(1 - \lambda_{jt})$), and disturbance term $u_{ijt} = \epsilon_{ijt}\,(1 - \lambda_{jt}) + \delta_{ijt}$.[3]

2: Data

Election campaigns have provided the setting for several notable studies of opinion change, including the classic Columbia studies of the 1940 and 1948 presidential campaigns (Lazarsfeld et al. 1948; Berelson et al. 1954), the television-era panel studies of Patterson and McClure (1976) and Patterson (1980), and longitudinal ("rolling cross-section") analyses based upon the 1984 American National Election Study (Bartels 1988) and the 1988 Canadian National Election Study (Johnston et al. 1992).

The data employed here to estimate the parameters of the model set out in Section 1 are from an election-year panel survey conducted as part of the 1980 American National Election Study.[4] The data

[3] The most straightforward way to assure that this model is identified is to assume that all the stochastic terms (ζ_{i}, δ_{ij*}, δ_{ijt}, and ϵ_{ijt}) have mean zero and are uncorrelated with each other, and that we have consistent estimates of the measurement error variances $\sigma_{\zeta i}^2$, $\sigma_{\delta ij*}^2$, and $\sigma_{\delta ijt}^2$. These assumptions can be relaxed somewhat when the right sorts of additional data are available, as in the following empirical analysis.

[4] The data were originally collected by the Center for Political Studies of the Institute for Social Research, University of Michigan, under the direction of Warren E. Miller, and are available through the Inter-university Consortium for Political and Social Research. For a useful description and analysis,

consist of a variety of opinion readings at three time points for a national cross-section of 758 survey respondents (the survivors from a first-wave sample of 1008). The first wave of interviews was conducted in late January and February (before the first primary voting in New Hampshire), the second wave in June (between the end of the primary season and the national nominating conventions), and the third wave in September (during the first month of the general election campaign).

The key to dealing with the biases created by measurement errors in explanatory variables is to obtain estimates of the magnitudes of those measurement errors. Repeated measurement of the same opinion or behavior at three or more time points provides leverage for distinguishing between change in underlying "true" opinions and random measurement error. Here, the magnitudes of measurement errors are estimated using a variant of the Wiley and Wiley (1970) model.[5] The main assumptions underlying the model are that the measurement process produces constant error variance in each wave of the panel, and that measurement errors for the same respondent in different waves of the panel are uncorrelated.[6]

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see Markus (1982).

[5] The standard Wiley-Wiley measurement model is augmented here to make ("true") television news exposure in each wave of the panel a function of age, education, race, and party identification in addition to previous television news exposure, and ("true") newspaper exposure in each wave a function of age, education, race, and party identification in addition to previous newspaper exposure. In addition, disturbances for the television news exposure and newspaper exposure equations are allowed to be correlated (though the correlations turn out to be small: .03 in June and -.13 in September).

[6] With three waves of panel data for a single variable, the basic Wiley-Wiley model is just identified, so it is impossible to test its goodness of fit. Here, the availability of additional data makes it possible to test the goodness of fit of the model, and in every case the fit is quite good. It is also possible to relax the conventional assumptions somewhat, for example, by allowing measurement error variances to differ across panel waves or by allowing measurement errors for different responses by the same respondent to be correlated. Having explored several modifications of this sort, I found none that produced more than marginal improvements in the statistical fit of the model, and none that appreciably changed the substantive results. For example, allowing measurement errors for thermometer ratings of Jimmy Carter and Ronald Reagan to be correlated produces an estimated format-induced correlation of .20, but the average difference in the eight estimated media exposure effects resulting from this generalization of the model is only 0.12. Additional examples of alternative model specifications--again, with no appreciable impact on the substantive results of the analysis--are reported in notes 12 and 18. These results are consistent with those reported by Feldman (1989, 33, 38), who applied the Wiley-Wiley model to a variety of items similar to those used here (party identification, issue positions, and candidate evaluations) using data from a five-wave panel, for which the model is overidentified. He concluded that "the simple measurement model fits very well."

The dependent variables in the analyses reported here include summary "thermometer" ratings of Ronald Reagan and perceptions of Reagan on a battery of nine separate traits: "power-hungry," "moral," "dishonest," "inspiring," "provide strong leadership," "weak," "develop good relations with other countries," "solve our economic problems," and "knowledgeable."[7] To facilitate comparison, all of the original responses are recoded to range from 0 to 100, with 0 denoting the most negative possible opinion and 100 denoting the most positive possible opinion. For each perception, I estimate the effects of prior opinions, partisan predispositions, and media exposure separately in each half of the election year panel (February to June and June to September). To guard against the possibility of estimating spurious partisan or media exposure effects, all of the analyses reported here include age, education, and race as additional exogenous control variables.

All of the analyses include separate parameter estimates for two distinct measures of media exposure. The only relevant item included in the three waves of the 1980 NES survey employed here focuses specifically upon exposure to television network news: "How often do you watch the national network news on early evening TV -- every evening, 3 or 4 times a week, once or twice a week, or less often?" However, in the first two waves of the 1980 NES survey, respondents were also asked: "Do you read a *daily* newspaper regularly?" This question was omitted in the third wave of the survey, but included again in a fourth (post-election) wave (albeit without the adverb), making it possible to exploit the availability of three-wave panel data for newspaper exposure as well as television news exposure.[8]

Partisan predisposition (measured by the traditional party identification item in the NES survey, recoded here to range from -1 for "strong Democrats" to +1 for "strong Republicans") is included as

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[7] For similar analyses of 27 additional opinion items, including parallel evaluations of Jimmy Carter, ratings of various aspects of Carter's job performance, perceptions of both candidates' issue positions, and respondents' own issue preferences, see Bartels (1993).

[8] Moreover, newspaper reading appears to be a sufficiently stable behavior to warrant using June exposure as a proxy for September exposure in the analysis that follows. The estimated effect of February newspaper exposure on June newspaper exposure (in an equation including age, education, race, and party identification as control variables, and adjusting for measurement error) is .927 (with a standard error of .052). The estimated effect of June newspaper exposure on post-election newspaper exposure in an equation including the same control variables, in spite of the slight change in question wording and some panel attrition, is .769 (with a standard error of .041).

an exogenous influence on the nature of the message μ_{ijt} received during each time period in order to allow for partisan "activation" and reinforcement effects (Berelson et al. 1954; Conover and Feldman 1989; Finkel 1990).[9]

Descriptive statistics for each of these variables in each wave of the panel, as well as measurement error estimates calculated from the modified Wiley-Wiley model, are presented in Table 1. The standard errors of measurement vary from about 12 points on the 100-point scale (for overall "thermometer" ratings) up to about 19 points (for assessments of Reagan as "power-hungry"). The corresponding measurement "reliabilities" suggest that about 25 percent of the observed variance in "thermometer" ratings -- and about 40 percent of the observed variance in the trait perceptions -- represents random noise. The measurement reliabilities for the explanatory variables are .75 for television news exposure, .78 for newspaper exposure, and .88 for party identification.

***** Table 1 *****

3: Parameter Estimates

Parameter estimates obtained by applying the model of opinion change proposed in Section 1 to the data described in Section 2 are presented in Tables 2 through 5 below.[10] Each of these tables presents a comparison of three sets of parameter estimates for a single explanatory variable: the first based upon ordinary least squares regression analysis taking no account of measurement error in the explanatory variables, the second based on errors-in-variables regression incorporating the measurement error estimates in Table 1, and the third based upon a factor analytic model in which individual trait

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[9] It would be desirable from a theoretical standpoint to allow for the possibility that party identification conditions the impact of media exposure (via selective perception) in addition to mattering in its own right. I am convinced on the basis of some exploratory analysis that partisanship and media exposure do interact significantly, but it is impossible to pursue that interaction rigorously here given the other complexities of the statistical model and the limitations of the available data.

[10] All of the parameter estimates reported in this paper were produced using the GLS routine in the EQS software package (Bentler 1989).

responses are treated as indicators of broader underlying trait dimensions.[11]

Table 2 shows the estimated effects of prior opinion produced by the ordinary least squares, errors-in-variables, and factor analytic models, respectively. A comparison of the ordinary least squares and errors-in-variables results demonstrates clearly that the ordinary least squares estimates are seriously biased by measurement error, understating the average stability of pre-existing opinions by about 50 percent in the case of candidate traits and by 30 percent in the case of overall thermometer ratings.

*** * * Table 2 * * ***

Tables 3 and 4 show similar comparisons for the estimated effects of television news and newspaper exposure. As with the effect of prior opinion, these effects are seriously underestimated in the ordinary least squares analysis, which takes no account of measurement error in the explanatory variables. The average magnitude of estimated television news exposure effects in the errors-in-variables analysis, which does adjust for the effects of measurement error, is 4.6 points on the 100-point scale for Reagan trait perceptions and 3.2 points for thermometer ratings -- from 30 to 50 percent larger than in the ordinary regression analysis. The estimated newspaper exposure effects are, on average, about half as large as those for television news; but they, too, are on the order of 50 percent larger in the errors-in-variables analysis than in the ordinary regression analysis.

*** * * Tables 3 and 4 * * ***

Media effects of the magnitude reported in Tables 3 and 4 are especially impressive when we bear in mind that even "full exposure" to network television news represents, at most, a few hours of relevant coverage of each candidate spread over the entire campaign year. Robinson and Sheehan's (1983: 149) content analysis of the news media during the 1980 campaign suggests that a faithful viewer of the CBS

[11] The parameter estimates for age, education, and race in the opinion change equations are omitted due to space constraints, but are available from the author.

Evening News from January through October was exposed to a total of about fifteen and a half hours of presidential campaign coverage, of which about ten hours were devoted to the "horse race" and about five and a half hours were devoted to "candidate information" and "policy issues." Even with some allowance for the effects of other sources of information that are likely to be correlated with exposure to television network news -- most notably, debates and other public affairs broadcasts and advertising -- the tendency of television viewers to make distinctive inferences about the candidates' personal traits, performance, and issue positions on the basis of relatively modest amounts of coverage is striking.

Finally, Table 5 shows a similar comparison of estimated effects of party identification. Here, in contrast to the cases of prior opinions and media exposure, the ordinary least squares estimates significantly *overstate* the impact of partisan predispositions on opinion change during the campaign period, by an average of 50 percent in the case of trait perceptions and 36 percent in the case of thermometer ratings. Although the errors-in-variables estimates of the impact of party identification are quite substantial, they suggest that "partisan activation" is markedly less pervasive than naive analysis would suggest. This example underlines the danger of supposing that measurement error necessarily biases ordinary least squares estimates toward zero, making them "conservative" estimates of the corresponding true effects; except in the simple bivariate case, the direction of biases produced by measurement error is unpredictable *a priori*.

*** * * Table 5 * * ***

The statistical fit of the models that are the basis for the errors-in-variables parameter estimates in Tables 2 through 5 -- including prior opinions, television news and newspaper exposure, party identification, and demographic controls -- is generally quite good. The average standard error of estimation on the common 100-point scale is 10.8, and the Bentler (1989, 114-117) Comparative Fit Index for each of the ten errors-in-variables regressions is 1.000. Nevertheless, many of the individual errors-in-variables parameter estimates in Tables 2 through 5 are quite imprecise; more than half of the estimated media exposure effects are smaller than their standard errors, since the standard errors themselves average between two and four points on the 100-point scale. However, it would be rash to conclude from the prevalence of statistically "insignificant" parameter estimates that there really are no substantively significant media exposure effects to be found. This point is clear from further analysis of the candidate trait variables, where the availability of several measures of essentially similar traits can be exploited to refine the parameter estimates. For example, treating "power-hungry," "moral," and "dishonest" explicitly as aspects of a general *character* dimension makes it possible to analyze the dynamics of opinions concerning Reagan's character somewhat more precisely than with the specific responses taken separately. The same is true for a *leadership* dimension made up of the "inspiring," "strong leader," and "weak" traits, and for a *competence* dimension consisting of the "develop good relations," "solve economic problems," and "knowledgeable" traits.

The last columns of Tables 2 through 5 present the results of covariance structure analyses for these three image dimensions. In each case, the parameter estimates for prior opinion, television news exposure, newspaper exposure, or party identification in June and September, respectively, are shown under the heading "Factor Analytic Model," with the estimated "Factor Loadings" relating the image dimensions and their observable indicators (normalized to have an average absolute value of 1.0) shown to the right.[12] The standard errors of the parameter estimates for media exposure and party identification are, on average, about 30 percent smaller in the factor analytic models than in the corresponding errors-in-variables models. The results of this more refined analysis suggest even more clearly than the results of the errors-in-variables analysis that in several -- though by no means all -- cases, media exposure significantly conditioned the dynamics of opinion change in the 1980 presidential campaign.

3: Messages Received

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[12] These more elaborate dimensional models appear to fit the data well; the average value of the Bentler Comparative Fit Index for the three separate models is .998, and the average standard error of estimation for the six distinct opinion regressions is 9.0 on the 100-point scale (as compared to 10.8 for the 18 corresponding errors-in-variables regressions for separate trait perceptions).

The results presented in Tables 3 through 5 demonstrate that attention to measurement error is sufficient by itself to produce some significant revision in the apparent effects of media exposure and party identification. But the implications of the analysis presented here for our understanding of the dynamics of opinion change are considerably greater than the comparisons in Tables 3 through 5 alone suggest. A more significant, but also more subtle, revision in our understanding of the impact of both the media and partisan predispositions is necessitated by the comparison in Table 2, which indicates that allowing for the effects of measurement error produces a picture of much more stable political opinions over time.

The comparison between ordinary least squares and errors-in-variables results presented in Table 2 is represented somewhat differently in the first column of Table 6, which compares the ordinary least squares and errors-in-variables estimates of the fraction of total information apparently gained during the campaign season (after the first wave of NES interviews in February) for each of the ten Reagan evaluations included in the analysis. Since total information is, by definition, the sum of pre-existing information and campaign information, the increased weight of pre-existing information once we take account of measurement error necessarily produces a corresponding decrease in the relative weight of campaign information. The ordinary least squares estimates suggest that, on average, more than 80 percent of the total information respondents had at the time of the third NES interview in September had been gained since the first interview in February. The implication of these estimates is that campaign impressions dominate electoral politics, at least at the presidential level. By contrast, the errors-in-variables estimates suggest that, on average, only a little more than one third of the total information respondents had in September had been gained since February. By these estimates, most of what people believed about both Carter and Reagan in the midst of the general election campaign was already fixed months earlier, before the public phase of the campaign had even begun.

*** * * Table 6 * * ***

The difference between these two sets of estimates is of profound significance for any general understanding of the electoral process. In terms of the Bayesian model proposed in Section 1, new information must compete with a much greater mass of prior information than has generally been supposed, and thus must itself be much more distinctive than has generally been supposed in order to produce the changes in opinion actually observed. Perhaps counterintuitively, evidence that pre-existing opinions are very stable therefore suggests, albeit indirectly, that the political information absorbed from the mass media during a presidential campaign must be very distinctive.

I use the term "distinctiveness" to refer to the difference in new information attributable to media exposure. This implication of the data is elaborated in the remaining columns of Table 6, which present estimates of the distinctiveness of the messages received from television news, newspapers, and partisan predispositions, respectively, during the 1980 campaign. For example, each entry in the second column of the table is an estimate of the difference between the message received by a regular viewer of the network news and a non-viewer between February and September. In the notation of the model presented in Section 1, these are estimates of the α_{jt} parameters for the effect of television news exposure on the location of the received message μ_{ijt} in equation {5}. The estimates are constructed by dividing the estimated β_{jt} parameters associated with television news exposure in equation {6} by the complement of the estimated λ_{jt} parameters representing the persistence of prior opinion.[13]

The individual estimates vary a great deal, and most are in any case quite imprecise; but the average difference in the messages received by regular television news viewers and non-viewers over this seven-month period is on the order of fifteen points on the 100-point scale. The corresponding average difference for regular newspaper readers and non-readers is about half as large, while the average

[13] For each model, Table 6 reports the estimated distinctiveness of media and partisan messages cumulated over both waves of the NES panel. Message distinctiveness is defined as the ratio

$$(\beta_{j2}\,\lambda_{j3} + \beta_{j3}) \,/\, (1 - \lambda_{j2}\,\lambda_{j3}),$$

and the estimates in Table 6 are calculated by substituting for β_{j2}, λ_{j2}, β_{j3}, and λ_{j3} in this ratio the corresponding parameter estimates from Tables 2 through 5. Parallel calculations for each wave separately are impossible in two cases because the estimated lag parameters λ_{jt} equal the theoretical maximum value of 1.00 (so that the estimated denominators of the ratio $\beta_{jt} \,/\, (1 - \lambda_{jt})$ are zero), and uninformative in a few other cases because the estimated denominators are close to zero.

difference attributable to partisan predispositions is about 25 points on the 100-point scale.[14]

The standard errors of these "distinctive message" estimates are impossible to calculate directly, since the estimates themselves are based on ratios of correlated parameter estimates from Tables 2 through 5. However, a good sense of the sampling variability of the estimates can be built up empirically by repeated sampling from the original correlated distributions. Figures 1 and 2 display the estimated sampling distributions of television news and newspaper message distinctiveness, respectively, constructed in this way for the case of Reagan thermometer ratings in the June wave of the 1980 NES panel.[15]

*** * * Figures 1 and 2 * * ***

For purposes of comparison, Figures 1 and 2 also display the estimated sampling distributions of message distinctiveness based upon the ordinary least squares estimates of the same media exposure effects. The specific example nicely illustrates the general tendency for ordinary least squares to underestimate the distinctiveness of the messages received by respondents regularly exposed to the mass media during the 1980 campaign. It was clear from Tables 2 through 5 that ordinary least squares significantly underestimates both the impact of media exposure and the stability of preexisting opinions.

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[14] Here, as elsewhere, it may be worth noting that the effects of party identification, though large for individual identifiers, are much smaller for the population as a whole, simply because effects on Republicans and opposite effects on Democrats tend to cancel out. Even if every strong partisan absorbed new information about 25 points more favorable toward her own candidate than the new information absorbed by "pure" independents, as the results in Table 6 suggest, the corresponding average *aggregate* impact of this partisan reinforcement would have been only two or three points on the 100-point scale, given the distribution of party identification in 1980. By contrast, the average aggregate impact of television news exposure on the messages received by the population as a whole is on the order of six points, and the average aggregate impact of newspaper exposure is on the order of three points on the 100-point scale.

[15] Although there is no straightforward way to derive the distribution of $\beta_{jt} / (1 - \lambda_{jt})$ analytically from the distributions of the corresponding β_{jt} and λ_{jt}, an estimated sampling distribution for $\beta_{jt} / (1 - \lambda_{jt})$ can be built up empirically by repeated sampling from correlated Normal distributions based upon the parameter estimates from Tables 2 through 5 and their variances and covariances. The distributions shown in Figures 1 through 3 are based on samples of 10,000 pseudo-observations each, and were constructed by Simon Jackman.

The estimated message distinctiveness compounds these two underestimates, producing results that fall short by 57 percent in this case, and by about 70 percent on average. Thus, the messages conveyed by the media in the 1980 presidential campaign were about three times as distinctive as they appear from simple regression analysis.

4: Conclusions

Attention to the effects of measurement error significantly alters the apparent impact of media exposure and partisan predispositions on opinion change in a presidential campaign setting. Nevertheless, to the extent that analysts focus upon observable opinion change over relatively short periods of time, the apparent effects of media exposure will often be modest in magnitude even when adjusted for the effects of measurement error. That fact has less to do with any impotence of the media than with the strength of pre-existing opinions in a typical presidential campaign. By the logic of rational (Bayesian) opinion change, even very distinctive campaign information will have modest effects when combined with strongly held prior opinions.

The explanatory variables used to account for opinion change during the campaign are not directly implicated in the formation of these prior opinions. But then, there is no way that they could be, given the nature of the available data.[16] A panel spanning eight months is far from a snapshot, but it is too truncated a moving picture to capture completely the dynamics of opinions and perceptions that were already well-developed at the beginning of this eight month period. In the absence of any direct access to the process of opinion formation prior to the campaign season, the most natural supposition is that it was governed by some of the same factors demonstrably related to opinion change during the campaign period. However, the apparent stability of political opinions in a presidential campaign setting suggests that more direct and convincing demonstrations of the causes of opinion change will require data collections spanning considerably longer time periods.

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[16] For example, there are many cases in which February values of the variables examined here are significantly related to media exposure; but the difficulties involved in making causal inferences from such cross-sectional relationships are daunting.

The logic of Bayesian opinion change pursued here also suggests that any explanatory variable is most likely to be consequential (in the sense of producing large observable opinion changes) when prior opinions are weak -- most notably, for "new" candidates or issues. For this reason, simply as a matter of efficiency, analysts of opinion dynamics would do well to focus upon "new" or "uncrystallized" opinions, even if they are atypical or intrinsically less significant than opinions that are better established and more firmly held.

This point is illustrated in Figure 3, which compares the estimated sampling distribution of television news "message distinctiveness" for Reagan thermometer ratings in June 1980 (reproduced from Figure 1) with the corresponding sampling distribution of message distinctiveness for September. The central tendencies of the two distributions suggest that the distinctive messages received from network television news were not wildly different for the two parts of the campaign; the medians for the two sampling distributions are 15.7 and 9.9, respectively. However, the sampling distribution for September is so diffuse that it provides little useful information about the real distinctiveness of the message received from television news during this part of the campaign. (More than thirty percent of the mass of the sampling distribution actually falls outside the range of values represented in Figure 3.) The main cause of this diffuseness is the significantly greater stability of prior opinions about Reagan in September than in June. As a result, the estimated impact of television exposure, which had a t-ratio of 1.8 in June, had a t-ratio of 0.4 by September -- not because there was no impact to be measured, but because the stability of pre-existing opinion by September reduced that impact to a level below the threshold of precision of the available data. Attempting to study opinion change in settings with very stable prior opinions is a social scientist's equivalent of attempting to count galaxies through the wrong end of a telescope.

*** * * Figure 3 * * ***

Finally, the analysis presented here highlights the political significance of distinctive, consistent messages presented over relatively long periods of time. Many of the media exposure effects evident in the 1980 presidential campaign were not, ultimately, consequential in the final election outcome, either because positive effects in one period canceled out negative effects in another period (as with the effects of television news exposure on perceptions of Carter's competence and job performance) or because similar effects of roughly equal magnitude for both candidates canceled each other out. Consistent, distinctive media messages favoring one side or the other in a political controversy are, by contrast, likely to produce sizable opinion changes over time (Zaller 1992).

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<u>**Table 1**</u>
Descriptive Statistics and Measurement Error Estimates

All variables except Network News Exposure (0 to 1), Newspaper Exposure (0 to 1), and Party Identification (-1 to 1) recoded to vary between 0 and 100. N=758.

	Mean (Std Dev)			$\hat{\sigma}_\delta$
	February	**June**	**September**	
Network News Exposure	.708 (.317)	.662 (.316)	.644 (.315)	.158
Newspaper Exposure	.621 (.485)	.600 (.490)	.623 (.476)	.227
Party Identification	-.124 (.657)	-.099 (.676)	-.116 (.678)	.231
Power-hungry	48.9 (28.2)	49.1 (28.0)	53.2 (30.4)	18.8
Moral	62.6 (22.2)	63.7 (21.8)	61.5 (23.1)	14.6
Dishonest	27.5 (23.7)	26.5 (22.7)	25.6 (24.0)	15.2
Inspiring	45.9 (25.7)	48.1 (25.8)	44.8 (27.6)	13.5
Strong Leader	52.5 (23.9)	55.5 (24.5)	51.7 (27.3)	16.3
Weak	31.6 (23.2)	28.8 (21.7)	28.6 (24.7)	18.0
Develop Good Relations	49.0 (23.3)	51.2 (22.9)	46.3 (26.0)	15.7
Solve Economic Problems	46.3 (22.5)	49.4 (22.5)	44.2 (24.2)	14.4
Knowledgeable	61.0 (21.8)	59.3 (22.9)	58.5 (26.0)	14.3
Thermometer Rating	52.5 (23.6)	58.4 (23.3)	56.2 (25.0)	11.7

Table 2

Comparison of OLS and Errors-in-Variables Parameter Estimates for Prior Opinion

June parameter estimates in first row, September parameter estimates in second row. Asymptotic standard errors of parameter estimates in parentheses. N=758.

	Ordinary Least Squares	**Errors-in-Variables Model**	**Factor Analytic Model**	**Factor Loadings**
Power-hungry	.431 (.033)	.812 (.089)		-1.151
	.473 (.034)	.951 (.088)		(.038)
Moral	.401 (.032)	.768 (.092)	.774 (.064)	.951
	.419 (.034)	.848 (.091)	.872 (.065)	(.030)
Dishonest	.319 (.033)	.577 (.082)		-.899
	.410 (.035)	.829 (.118)		(.029)
Inspiring	.472 (.031)	.668 (.063)		1.245
	.540 (.034)	.772 (.072)		(.031)
Strong Leader	.405 (.033)	.809 (.098)	.709 (.057)	1.127
	.498 (.036)	1.000 (.013)	.859 (.066)	(.025)
Weak	.238 (.033)	.667 (.127)		-.628
	.244 (.041)	1.000 (.007)		(.032)
Develop Good Relations	.392 (.032)	.780 (.099)		1.118
	.392 (.038)	.863 (.102)		(.025)
Solve Economic Problems	.365 (.033)	.654 (.083)	.764 (.078)	1.065
	.445 (.035)	.826 (.100)	.817 (.078)	(.027)
Knowledgeable	.359 (.036)	.661 (.110)		.825
	.486 (.037)	.818 (.112)		(.031)
Thermometer Rating	.488 (.030)	.667 (.051)	—	—
	.607 (.032)	.887 (.067)	—	

Table 3

Comparison of OLS and Errors-in-Variables Parameter Estimates for Television News Exposure

June parameter estimates in first row, September parameter estimates in second row. Asymptotic standard errors of parameter estimates in parentheses. N=758.

	Ordinary Least Squares	Errors-in-Variables Model	Factor Analytic Model	Factor Loadings
Power-hungry	-1.01 (3.02) -1.03 (3.21)	3.40 (4.16) -2.37 (4.72)		-1.151 (.038)
Moral	2.40 (2.33) 2.18 (2.43)	1.56 (3.26) -1.94 (3.61)	-0.23 (2.49) 0.86 (2.69)	.951 (.030)
Dishonest	-3.87 (2.55) -6.29 (2.65)	-2.45 (3.48) -3.70 (3.92)		-.899 (.029)
Inspiring	-1.53 (2.66) -3.04 (2.83)	-1.28 (3.54) -8.44 (3.93)		1.245 (.031)
Strong Leader	1.43 (2.61) -4.10 (2.87)	1.50 (3.66) -8.33 (4.30)	0.39 (2.49) -7.78 (2.83)	1.127 (.025)
Weak	-1.10 (2.51) 3.68 (2.96)	-0.39 (3.65) 8.82 (4.77)		-.628 (.032)
Develop Good Relations	4.13 (2.41) -5.31 (2.80)	5.96 (3.39) -10.65 (4.18)		1.118 (.025)
Solve Economic Problems	0.47 (2.42) -5.51 (2.53)	0.56 (3.25) -9.58 (3.63)	4.07 (2.47) -9.93 (2.94)	1.065 (.027)
Knowledgeable	3.92 (2.60) -2.76 (2.87)	3.78 (3.53) -8.66 (4.09)		.825 (.031)
Thermometer Rating	3.43 (2.25) 1.41 (2.36)	5.21 (2.96) 1.23 (3.29)	— —	—

Table 4

Comparison of OLS and Errors-in-Variables Parameter Estimates for Newspaper Exposure

June parameter estimates in first row, September parameter estimates in second row. Asymptotic standard errors of parameter estimates in parentheses. N=758.

	Ordinary Least Squares	Errors-in-Variables Model	Factor Analytic Model	Factor Loadings
Power-hungry	0.15 (1.92) -0.49 (2.00)	-0.45 (2.58) -0.69 (2.78)		-1.151 (.038)
Moral	-0.05 (1.48) 3.27 (1.51)	0.38 (1.98) 5.11 (2.07)	0.50 (1.51) 3.57 (1.54)	.951 (.030)
Dishonest	-1.00 (1.61) -3.54 (1.64)	-0.60 (2.08) -4.11 (2.23)		-.899 (.029)
Inspiring	-1.61 (1.69) 0.08 (1.76)	-0.72 (2.16) 1.07 (2.27)		1.245 (.031)
Strong Leader	0.02 (1.66) -1.01 (1.78)	1.37 (2.25) -1.29 (2.48)	0.73 (1.50) 0.06 (1.61)	1.127 (.025)
Weak	0.06 (1.59) -4.49 (1.84)	0.25 (2.17) -5.31 (2.75)		-.628 (.032)
Develop Good Relations	-0.91 (1.53) -0.35 (1.74)	-0.48 (2.07) -0.08 (2.39)		1.118 (.025)
Solve Economic Problems	2.86 (1.54) -0.98 (1.58)	5.43 (2.03) -1.89 (2.12)	1.76 (1.54) -0.40 (1.68)	1.065 (.027)
Knowledgeable	0.59 (1.65) 2.18 (1.78)	1.36 (2.16) 1.80 (2.32)		.825 (.031)
Thermometer Rating	1.63 (1.43) 0.40 (1.47)	2.99 (1.82) 0.29 (1.91)	— —	—

Table 5
Comparison of OLS and Errors-in-Variables Parameter Estimates for Party Identification

June parameter estimates in first row, September parameter estimates in second row. Asymptotic standard errors of parameter estimates in parentheses. N=758.

	Ordinary Least Squares	Errors-in-Variables Model	Factor Analytic Model	Factor Loadings
Power-hungry	-5.81 (1.40) -10.75 (1.46)	-3.75 (1.78) -6.95 (1.98)		-1.151 (.038)
Moral	3.06 (1.07) 6.43 (1.10)	1.43 (1.36) 4.91 (1.41)	1.95 (1.05) 5.56 (1.08)	.951 (.030)
Dishonest	-2.84 (1.17) -5.62 (1.19)	-1.94 (1.38) -4.40 (1.52)		-.899 (.029)
Inspiring	6.45 (1.23) 6.72 (1.31)	6.57 (1.42) 4.47 (1.65)		1.245 (.031)
Strong Leader	7.42 (1.21) 7.53 (1.33)	5.31 (1.64) 2.39 (1.58)	5.09 (1.00) 3.32 (1.18)	1.127 (.025)
Weak	-4.12 (1.15) -6.67 (1.34)	-2.88 (1.49) -2.96 (1.75)		-.628 (.032)
Develop Good Relations	7.61 (1.12) 10.96 (1.31)	5.79 (1.52) 6.27 (1.95)		1.118 (.025)
Solve Economic Problems	8.08 (1.13) 8.00 (1.19)	6.90 (1.46) 4.38 (1.85)	5.06 (1.15) 5.36 (1.39)	1.065 (.027)
Knowledgeable	3.73 (1.20) 5.64 (1.30)	2.46 (1.52) 4.36 (1.65)		.825 (.031)
Thermometer Rating	8.27 (1.07) 5.85 (1.14)	7.82 (1.28) 2.59 (1.59)	--- ---	---

Table 6
Campaign Information and Distinctive Campaign Messages

Calculations for February through September based upon errors-in-variables parameter estimates in Tables 2 through 5. Esimates in italics based upon ordinary least squares estimates.

	Campaign Information / Total Information	Distinctive Television News Message	Distinctive Newspaper Message	Distinctive Partisan Message
Power-hungry	.228 *.796*	+3.8 *-1.9*	-4.9 *-0.5*	-46.2 *-17.0*
Moral	.349 *.832*	-1.8 *+3.8*	+15.6 *+3.9*	+17.6 *+9.3*
Dishonest	.522 *.869*	-11.0 *-9.1*	-8.8 *-4.5*	-11.5 *-7.8*
Inspiring	.484 *.745*	-19.5 *-5.2*	+1.0 *-1.1*	+19.7 *+13.7*
Strong Leader	.191 *.798*	-35.7 *-4.2*	+0.4 *-1.3*	+40.2 *+14.1*
Weak	.333 *.942*	+25.3 *+3.6*	-15.2 *-4.8*	-17.5 *-8.1*
Develop Good Relations	.327 *.846*	-16.8 *-4.4*	-1.5 *-0.8*	+34.4 *+16.5*
Solve Economic Problems	.460 *.838*	-19.8 *-6.3*	+5.6 *+0.3*	+21.9 *+13.8*
Knowledgeable	.460 *.826*	-12.1 *-1.0*	+6.3 *+3.0*	+13.9 *+9.0*
Thermometer Rating	.408 *.704*	+14.4 *+5.0*	+7.2 *+2.0*	+23.3 *+15.4*

Figure 1: Estimated Distinctiveness of Television News Message for Reagan Thermometer Ratings, June 1980

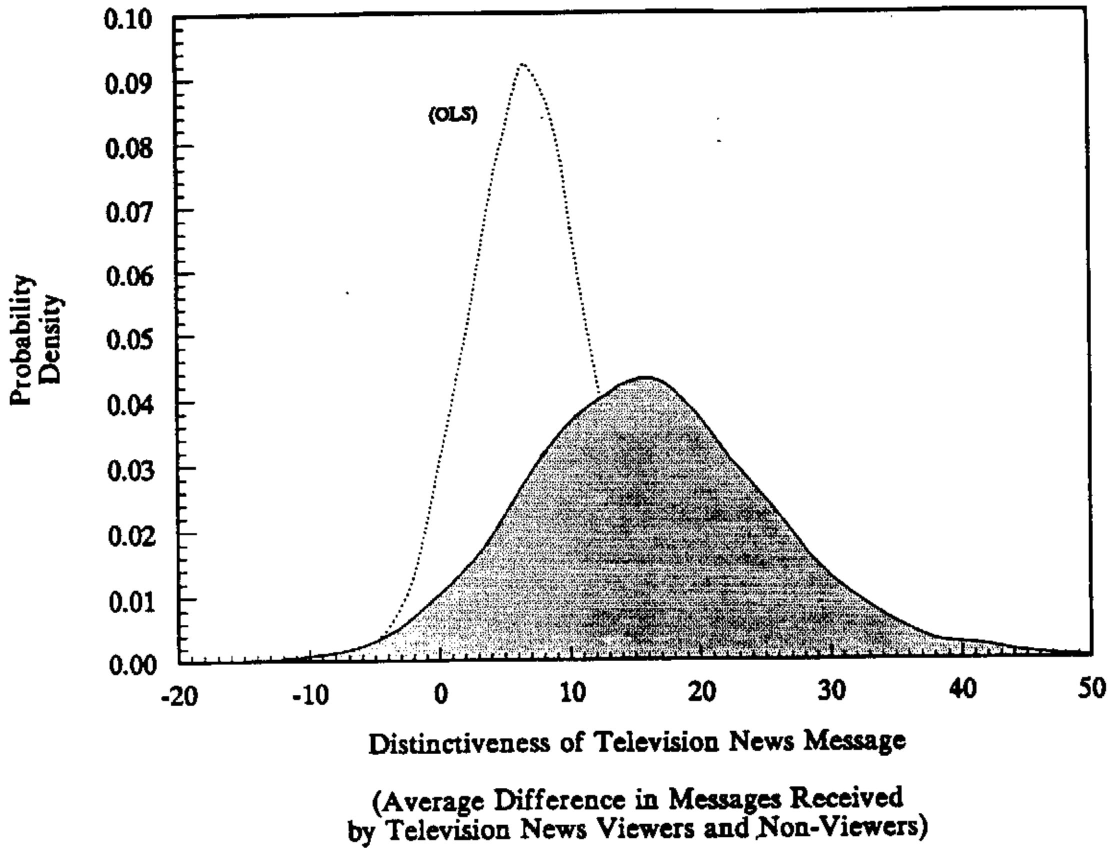

Figure 2: Estimated Distinctiveness of Newspaper Message for Reagan Thermometer Ratings, June 1980

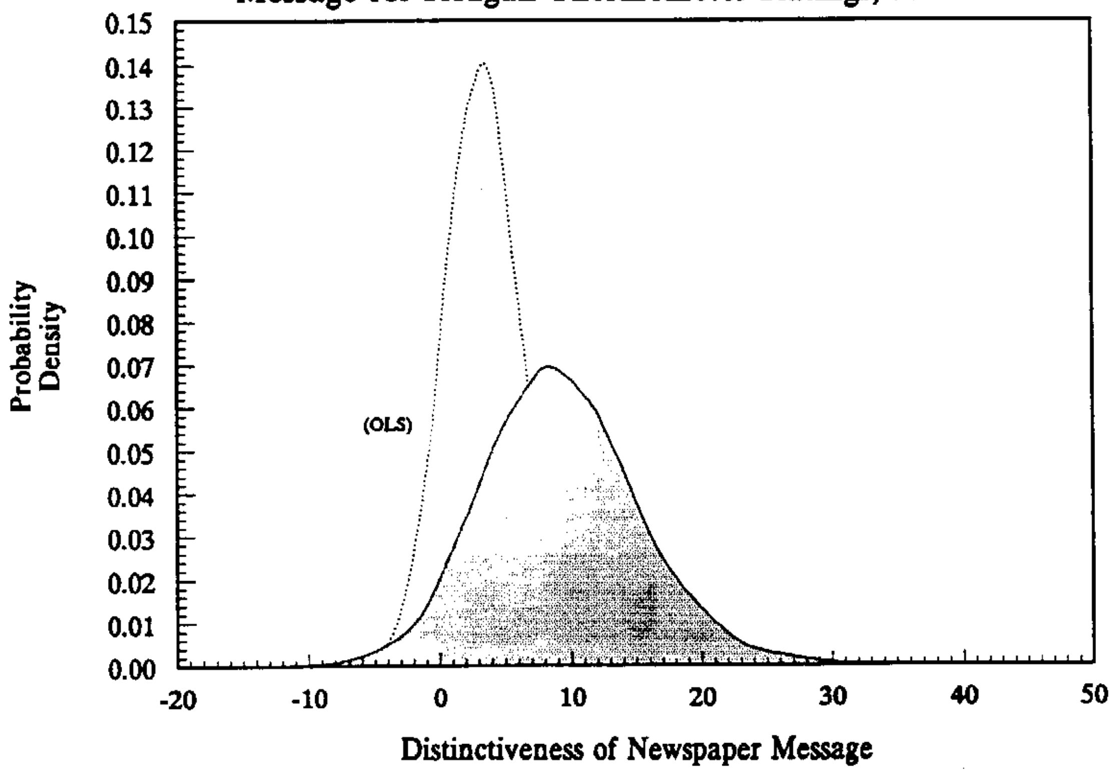

Figure 3: Estimated Distinctiveness of Television News Message for Reagan Thermometer Ratings, June and September 1980