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research article

Effects of economic recession and local weather on climate change attitudes

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What drives popular opinion on climate change? Recent failures to mobilize popular opinion in favour of the mitigation of greenhouse gas (GHG) emissions have been blamed on the unseasonably cool local weather and the unhealthy state of the economy. Using data from the European Union (EU), this article examines the effects of both annual temperature variations and economic growth rates on people's attitudes regarding the mitigation of GHG emissions. It is found that although the state of the economy has a significant effect on people's attitudes towards the mitigation of GHG emissions, variations in the annual temperature do not. Thus, while pessimism regarding policy changes during bad economic times appears justified, pessimism based on isolated spells of unseasonably cool weather does not.

Keywords: climate change; GHG emissions; public opinion; public perception

Quels sont les moteurs de l'opinion publique sur le changement climatique? Des échecs récents à mobiliser l'opinion publique en faveur de la réduction des émissions de gaz à effet de serre (GES) ont été imputés à des conditions locales de temps exceptionnellement frais et la mauvaise conjoncture économique. En utilisant des données de l'union européenne (UE), l'effet sur les attitudes du public à l'égard de l'atténuation des émissions de GES, attribuable aux variations annuelles de température et aux taux de croissance économique, est examiné. Il se trouve qu'alors que la conjoncture économique a une incidence significative sur les attitudes du public à l'égard de l'atténuation des émissions de GES, les variations annuelles de température n'en ont pas. Ainsi, alors que le pessimisme vis-à-vis des changements de politiques pendant les mauvaises périodes de l'économie semble être justifié, le pessimisme associé à des épisodes isolés de temps exceptionnellement frais ne l'est pas.

Mots clés : changement climatique; émissions de GES; opinion publique; perception du public

1. Introduction

What drives popular opinion on climate change? To explain recent failures to mobilize support for binding restrictions on greenhouse gas emissions, references in the popular press have appealed to two factors. The first cites instances of temporary but unseasonably cool local weather,[1] and the second the ongoing (since 2008) financial crises and economic recession. Such popular explanations diverge considerably from more detailed analyses of politics and negotiating dynamics, which tend to emphasize concrete differences in interests and strategies among key international actors such as the US Congress or the Chinese Communist Party (e.g. Grubb, 2010). It is therefore worth asking if there is in fact any empirical basis for these explanations in the popular press or if, on the contrary, they constitute another instance of analysis that 'needs to be rescued from pop commentators'.[2] What, in the end, drives public opinion in relation to climate change mitigation policies? This article attempts to provide answers to these questions by testing the effect of annual temperature variations and quarterly economic growth rates on public opinion regarding climate change.

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Using data from the European Union (EU), the importance of these two factors are assessed in so far as they are hypothesized by conventional wisdom to be among the determinants of people's attitudes towards climate change. First, in an overall (cross-nationally pooled) comparison of the data, it is found that fluctuations in both temperature and growth rates have a significant influence on attitudes: that is, after controlling for income differences, citizens in warmer and/or faster-growing countries tend *ceteris paribus* to be more worried about climate change than those in cooler and/or slower-growing countries. Second, analysis incorporating country-level fixed effects (i.e. of changes in opinion within individual countries) gives a different result: here, growth is significant but temperature is not. It thus appears that while year-to-year differences in summer temperatures do not have a significant effect on attitudes concerning the seriousness of climate change, short-term economic conditions, even within a single country, do.

Although based on a small sample of countries limited to within Europe, and relying on parsimonious model specifications, these results suggest that further research could well refute two widely held myths: that annual temperature differences have a significant effect on public attitudes towards climate change as a policy issue, and that concern about climate change in Europe is concentrated in the northern and western sections of the continent. In terms of the consequences for policy, the results suggest that conventional expectations of the prospects for change in climate policy should be revised. Although pessimism regarding policy change during bad economic times is justified, pessimism based on isolated spells of unseasonably cool weather is not. In other words, the findings refute the notion that annual temperature fluctuations affect attitudes on climate change.

2. Theoretical framework

The rest of this article is built on the assumption that voters' positions on energy and environmental policy issues reflect the perceived trade-off between two components that determine net expected utility: the short-run sacrifice in income and consumption imposed by the presumed costs of regulation, and the long-run gains in utility that would be produced by more stringent measures to conserve and protect natural resources.[3] This model of citizen decision-making makes no assumptions or judgements about the accuracy or quality of the information upon which voters base their decisions. It could well be that voters mistrust their sources of information (Malka et al., 2009; Ricci et al., 2010), or that their decisions are being made on the basis of heuristics that sometimes lead to error or bias (Tversky and Kahneman, 1974; see also Leiserowitz, 2006: 48). Acknowledging these possibilities, however, does not mean that voters completely disregard objective costs and benefits (Sunstein, 2007: 549). Indeed, one of the goals of the present article is to shed light on the information that actually engages and influences voter opinion on the issue of climate change. Working within an expected-utility model allows one to theorize coherently about the component concerns that are most relevant to the formation of citizen attitudes.

Two specific questions are asked: first, how do voters incorporate factors relating to short-run economic conditions, as measured by quarterly growth in gross domestic product (GDP), into their opinions on climate change? Second, how do citizens detect and experience possible changes in the weather as indicators of trends in climate change? In theory, the former should have an impact on the relative weightings of the short-term income component of policy decision-making, while the latter could affect assessments on the probability and seriousness of long-term threats to welfare from global climate change.

Much has been written concerning the role of socio-economic conditions in the formation of attitudes towards environmental issues. However, with the notable exception of Scruggs (2010),[4] little

attention has been given in the literature to the effect of short-run fluctuations in economic growth on public opinion regarding climate change. This contrasts with the widely studied effects of income and affluence generally, which are hypothesized to either produce adherence to 'postmaterialist values' among citizens of wealthier societies,[5] or else otherwise generate the 'environmental Kuznets curve' proposed by economists whereby environmental outcomes first deteriorate and then improve as a country undergoes economic development and increases its income levels.[6] Nonetheless, the overall logic here is that higher-income countries 'have less direct need to worry about economic issues and, therefore, can be more concerned about other issues like the environment' (Freymeyer and Johnson, 2010: 186).

Similarly, few scholars have inquired into the effects on popular opinion of objectively measurable changes in weather conditions. Zahran et al. (2006) provide an exception by examining local variations in the USA, while others consider the role of self-reported perceptions of changing weather (Palutikof et al., 2004, figure 6, cited in Lorenzoni and Pidgeon, 2006; Krosnick et al., 2006).[7] Further work on cross-national effects on public opinion from short-term fluctuations in average summer temperatures is warranted. Such a relationship has been prominent in informal analysis, but no empirical studies have (to the author's knowledge) tried to establish whether effects on opinion might indeed result from objectively fluctuating weather conditions over time and across countries.

Although isolated examples of real temperature fluctuations in the short run are of course poor indicators of long-term climate trends, it is reasonable to hypothesize that they have a significant effect on public opinion. This is because they represent information that is directly experienced by the public, and which may therefore have a disproportionate effect on decision-making as a result of the 'availability heuristic' that has been documented in the literature on behavioural economics. In other words, it is possible that anecdotal evidence of individuals expressing greater concern for climate change after a particularly warm August is representative of a larger phenomenon, a cognitive tendency whereby a person assesses a risk probability according to 'the ease with which instances or occurrences can be brought to mind' (Tversky and Kahneman, 1974: 1127). Typical examples of this situation occur when a person estimates, for example, the divorce rate in a community or the risk of a heart attack in middle age, by recalling familiar cases that have occurred among acquaintances (Tversky and Kahneman, 1973: 208, 1974: 1127). Another example of this kind of reasoning is based on the relatively easier recall of events that are more recent in time, as when 'the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road'.[8]

3. Hypotheses and data

The aim of this article is to test two hypotheses concerning causes of change in attitudinal evaluations of the seriousness of climate change. The first hypothesis is that voters are influenced by the availability of temperature conditions occurring prior to the time of the survey. It is, for example, commonly assumed that concern over climate change will increase after an exceptionally warm summer. The testable hypothesis here therefore is that an increase in summer temperatures will subsequently produce an increase in concern over climate change. This temperature hypothesis is tested while controlling for another widely hypothesized effect, namely that of affluence or wealth as represented in national income measures of per capita GDP.

Previous studies have focused on income levels as an explanatory variable for environmental policy outcomes.[9] In the present study, income levels are included as a control variable. In addition to the effects of temperature and income, however, a second hypothesis is tested concerning short-run changes in economic conditions at the level of the economic growth that occurs during

the precise quarter or 3-month period during which a survey is undertaken. This second growth hypothesis is that, *ceteris paribus*, periods of economic growth will tend to correspond with increased concern for climate change, while quarters of economic recession will conversely correspond with decreased concern.

These short-run effects are testable, because there are data from Europe that monitor changes in opinion, growth and average temperatures on a monthly or quarterly basis for recent years. The source of the opinion data is the special series on climate change conducted at the request of the European Commission's Directorate General for Communication over 2008 and 2009, consisting of three separate surveys (or 'waves') during this period (Commission of the EC, 2008, 2009a, 2009b). Surveys were conducted in each EU member country with national sample sizes ranging from around 500 for smaller states (e.g. Malta) to over 1,500 for Germany, comprising a total of over 26,000 interviews across the EU for each wave.[10] From these surveys a dependent variable is used: the percentage of respondents in a country who are considered to be 'very worried' about climate change, defined as those who rated their concern about climate change somewhere between 7 and 10 on a 10-point scale. Figures for economic growth are also available for the quarter when each survey was taken, which are drawn from publications by Eurostat and the Economist Intelligence Unit. Finally, average (mean) monthly temperatures for the August preceding each survey, in 2007, 2008 and 2009, respectively, are available in the monthly summary publications prepared by the United States National Oceanic and Atmospheric Administration (US NOAA, 2007–2009) in cooperation with the World Meteorological Organization.

4. Results

The analysis of cross-national public opinion data can be performed in two ways, by comparing either all observations together in a single pool, or the changes over time for each country in isolation. Table 1 takes the former approach, whereas Table 2 adopts the latter. Table 1 shows the results from analysing all of the data in a single pool across all countries and time periods.

TABLE 1 Pooled data

Dependent variable: percentage of respondents 'very worried' about climate change	(1) All countries, robust ordinary least-squares regression (OLS)	(2) All countries plus EU-15 variable, robust ordinary least-squares regression (OLS)
C	36.15029 (5.23)***	30.63097 (4.4)***
Previous August mean temperature	1.565695 (5.99)***	1.713264 (6.39)***
Quarterly economic growth	0.713075 (3.83)***	0.623697 (3.4)***
GDP per capita	0.00052 (2.18)**	0.0013779 (3.62)***
EU-15 (accession prior to 1995)		−7.95141 (−2.37)**
No. of obs.	68	68
R^2	0.5483	0.581
F-statistic	32.45	26.47

Note: Robust *t*-statistics are in parentheses.
*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

TABLE 2 Panel data

Dependent variable: percentage of respondents 'very worried' about climate change	(3) Within-country fixed effects, robust OLS	(4) Within-country fixed effects, robust OLS, income omitted
Q1 C	85.9182 (5.05)***	85.89882 (5.96)***
Previous August mean temperature	−0.4238877 (−0.57)	−0.632404 (−0.90)
Quarterly economic growth	1.054181 (5.10)***	0.9983675 (7.75)***
GDP per capita	−0.00051 (−0.80)	
No. of obs.	68	72
No. of groups (by country)[a]	25	26
Avg. no. of obs. per group	2.7	2.8
R^2		
Within-country	0.6144	0.6180
Between-countries	0.0173	0.0010
Overall	0.1632	0.1120
F-statistic	23.42	31.53

Q2 *Note:* Robust *t*-statistics are in parentheses.
*Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.
[a]These groups correspond to the members of the EU-27 for which data are available. The main exception is Luxembourg, while Slovakia is a partial exception.

In model (1) the dependent 'concern' variable is regressed on the three independent variables described in Section 3. Here both of the variables of interest, temperature and quarterly growth, are highly significant at a 99% level of confidence. The income control variable at 95% is also significant, a level of confidence that is only slightly lower. This high degree of significance is obtained in the study despite the small number of observations, and is therefore subject to the caveat that the findings apply only to Europe during 2008 and 2009, when and where the data are available, and may merely be the result of coincidental correlation at this time and place. In addition to their significance, the direction of the coefficients for these independent variables is also consistent with theoretical predictions: warmer Augusts, faster growth and higher levels of income are all associated with higher levels of concern relating to climate change. Finally, the explanatory power of this simple model is quite considerable: the R^2 statistic for this specification is 0.5483, indicating that the use of these three independent variables can already explain more than half of the observed variation in the national level of concern over climate change.

Model (2) builds upon the basic framework by adding an independent variable relating to differences in political institutions among European countries.[11] A dummy variable is therefore added here to distinguish between the more established democracies of the 15 EU member states that constituted the EU prior to 1995 and the addition of Cyprus, Malta and the 10 Eastern European states that were formerly members of the socialist bloc. The results for this specification are similar to those of model (1).

First, it is observed that the EU-15 dummy variable is significant at a 95% level of confidence, while the other variables retain similar levels of significance and magnitudes of influence. The one partial exception to this pattern pertains to per capita GDP: with the addition of the political

variable, the effect of income on environmental concern increases in both significance and magnitude. This result suggests that income effects in model (1) were partially obscured by differences among EU member states that are more precisely rooted in differences in political institutions. By adding the political dummy variable, the income effect is revealed more unequivocally.

Second, it is interesting to observe that, controlling for all other variables (and most importantly, controlling for income), membership in the 'old Europe' of the West is associated with decreased concern over climate change. In the real world, this cannot be observed because the newer accession countries also tend to be poorer than the EU-15, which would account for levels of concern that are generally no greater, and often weaker, than in the West. However, the inference to be drawn is that a newer EU-27 member state with higher levels of income would tend to have the greatest levels of concern over climate change.

This finding thus makes a prediction that is by no means trivial: it suggests that as incomes in the East increase and converge with those in the West, these Eastern states may become among the most concerned countries regarding climate change, and possibly therefore also among the strongest supporters of stricter regulations and policies. This could be due to a generally heightened sensitivity to environmental degradation in the East as a result of the experience of environmental neglect during the period of Communist Party rule.[12] Given this recent history, citizens in the East may have especially good reason to be vigilant and concerned about government policies as they relate to the natural environment.

Another set of results in presented in Table 2. These results are produced after incorporating country fixed effects. This form of analysis is essentially equivalent to the specification of an independent variable for each country, in order to account for unspecified differences unique to each country, in addition to the temperature, growth and income variables that have been explicitly specified. The results in Table 2 show notable differences when one adopts this mode of analysis. For example, we can see from the R^2 statistics that while our specified independent variables can generally explain over 60% of the variation within a given country, they cannot account for much of the variation between countries (the explanation of which is accordingly the task of the unspecified fixed effects).

The purpose of this analysis is to understand the effects of temperature and economic conditions within a given country. The results here are both suggestive and distinctive when compared with the cross-national analysis above. In model (3), the same specified independent variables are listed as in model (1). (We do not include the model (2) EU-15 dummy variable because differences in political institutions are already accounted for within the country effects.)

The results of model (3) are most notable for the loss of significance regarding two of the independent variables. Neither mean August temperature nor per capita income are significant in this fixed-effects model. For the case of the control variable for income effects, an obvious interpretation of its insignificance lies in possible collinearity with both the country fixed effects and the growth variable, especially because the incremental changes in GDP within a given country are likely to be comparatively minor over the 2-year period under analysis. It is therefore appropriate to drop the income variable when analysing an alternative fixed-effects model, as is done in model (4).

In model (4), note first the better *F*-statistic compared to model (3); this suggests a better fit for the data. It is apparent that the significance of the remaining independent variables is nonetheless the same as in model (3): quarterly growth is significant but temperature is not. The implications of this interesting result are discussed further in the next section.

5. Discussion

In the results for the within-country analysis presented in Table 2, the lack of significance of temperature is robust across specifications with or without an income variable. This is not due to a lack of variation in the temperature data themselves: year-to-year temperatures fluctuated within every country, and the mean within-country variance in temperatures is a sizable 1.01 °C. The results therefore suggest that observable variations in local annual temperature exist but do not actually affect attitudes on climate change. In terms of theoretical models of voter decision-making, these results support the notion that national-level changes in European attitudes regarding climate change are consistent with assumptions of rationality, because they are in fact unaffected by recent experience of short-term fluctuations in average summer temperatures.

Some notes of caution regarding these conclusions are required. For example, it is possible that different temperature measures could have varying effects: Zahran et al. (2006) found robust local effects on US opinion regarding climate change when using a temperature trend variable based on the number of instances in a year when daily average temperatures exceeded the multi-year average temperature over the 1948–2005 period. Consequently, further research should examine whether the public respond differently to temperature trends that vary in their definition or measurement; for example, responses may vary according to the period of time over which an average temperature is being taken, or to the baseline period against which the period under study is being compared.

Zahran et al. (2006) also attempted to estimate the effects of local vulnerability to climate change from the potential flooding associated with low-lying coastal communities, and found that survey respondents living within one mile of the nearest coastline at a negative elevation were in fact less (not more) likely to support government climate initiatives. In general, more data on similar aspects of local vulnerability would be useful for future analysis. Most importantly, further study into possible interactions between long-run climate risks and the short-run economic vulnerabilities (as discussed in the present analysis) are needed. In this way, greater understanding may be achieved regarding findings such as those on the perceived risks from sea-level changes and the puzzle posed by the observed pattern of apparent indifference to climate change on the part of those whose properties are at greatest risk of being flooded.

Finally, a caveat is necessary regarding the variability of the results for Table 2 and the estimation of their levels of significance: it has been noted that cross-sectional panel analysis can produce inflated *t*-statistics (in parentheses in the tables) that understate parameter variability (Beck and Katz, 1995). Although it is not possible to correct for such potential underestimation directly, given the available data, we have applied ordinary least-squares regressions with robust standard errors in order to minimize problems with overconfidence.[13] Furthermore, even though the absolute levels of significance for the independent variables may be inexact, it is nonetheless safe to conclude that the variable representing economic growth is in any event relatively more significant than the average temperature parameter.

6. Conclusion

Evidence has been presented showing the relatively higher salience of economic growth (in comparison to that of local temperature fluctuations) in terms of its influence on seasonal and year-to-year shifts in opinion concerning the seriousness of climate change in Europe. This result derives from two key findings. First, it appears that the effects arising from changes in mean August temperatures differ depending on whether it is the determinants of opinion across or within countries that are analysed. Across Europe as a whole, August temperatures do appear to have an effect on opinion. Thus, an

EU citizen experiencing warmer temperatures in August does indeed, *ceteris paribus*, tend to express greater concern about climate change than a fellow European enjoying a relatively cooler one. Within a single EU member state, however, the effect is very different. In this setting there is no evidence that short-term changes in temperature have any influence on opinion. In short, August temperatures that are warmer or cooler from 1 year to another, fixed at a given location, do not appear to affect public opinion on climate change.

Changes in quarterly GDP growth rates, on the other hand, do appear to have an effect on attitudes about climate change at both the European and national levels. This suggests that short-term economic conditions affect citizen's assessments of the relative seriousness of climate change as a potential threat to their well-being. Pessimism concerning the prospects of new climate regulations winning broad public support during an economic recession is therefore well-founded in fact. The observed behaviour is compatible with models that assume that voters behave as if they are actively calculating the expected utility of various courses of action, and are thereby incorporating information on short-run economic patterns to the extent that such changes affect projected income and utility levels for the future. Moreover, there is evidence that successful interventions to influence public opinion on climate change in the past have been based, at least in part, on recognizing the primary importance of economic interests for voters: van den Hove et al. (2002), for example, have recorded how such considerations were incorporated into the Global Climate Coalition's (GCC) strategy to undermine support for ratification of the Kyoto Protocol in the USA.[14] Such episodes, with their apparently effective deployment of economic concerns, underline how important it is for policymakers to understand the role that economic insecurity can play in voters' minds.

Finally, in terms of specific policy implications, the validity of conventional wisdom can be questioned when it come to the fear of 'irrational' voters whose attitudes are swayed by short-term fluctuations in the weather. Citizens appear to understand that the experience of a singularly warm summer has little relevance to broader climate trends. Accordingly, year-to-year changes in August temperatures within a given country have little impact on opinions regarding climate change – just as rational observers would hope to be the case. To enhance the robustness of such findings, further research is required. Additional scrutiny is merited regarding, for example, regions outside Europe and average mean monthly temperatures at various times of the year. In addition, greater quantities of data are needed to establish the true extent of within-country effects over the long term, because the available data presently only cover three periods, at most, for each country in the sample.

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Notes

1. For example, it has been argued that this occurred in much of the northern hemisphere during the months leading up to the 15th Conference of the Parties (COP 15) in Copenhagen, December 2009 (e.g. *The Economist*, 18 March 2009). **Q3**

2. The call for scholarly rescue (in the context of discussing globalization) is from Drezner (1991: 78).
3. See Congleton (1992) for a detailed model of the formation of preferences concerning pollution regulations, and see Shum (2009) for an extension that explicitly models a role for public opinion within such a rational-choice framework.
4. Sandvik's (2008) cross-national study of overall wealth effects on climate opinion also includes an explanatory variable for economic growth over a longer 4-year period (2000–2004), which is found to be insignificant in a static single-period context.
5. See, for example, Inglehart (1990, 1995, 1997).
6. See, for example, Bagliani et al. (2008), Barrett and Graddy (2000), Baumol and Oates (1988), Bimonte (2002), Caviglia-Harris et al. (2009), Cole et al. (1997), Dasgupta et al. (2002), Dinda (2004), Grossman and Krueger (1995), Khanna and Plassmann (2004), Palmer (1997), Panayotou (1997), Selden and Song (1994) and Stern and Common (2001).
7. Self-reported perceptions, however, could reflect a subjective inclination to believe that the climate is changing, rather than showing that a change in preferences in response to new information has occurred.
8. See Tversky and Kahneman (1974: 1127). See also Weber (2006: 107), who similarly concludes from her experimental studies of risk perceptions of climate change that 'people's evaluation of risky options under repeated sampling seem to follow classical reinforcement learning models where initial impressions are continuously updated in a way that gives recent events more weight than distant events'.
9. See Congleton (1992) on environmental policy outcomes generally. See also Sandvik (2008), who adopts this approach to explain concern over climate change specifically.
10. Further details on collection procedures are provided in the 'Technical Specifications' sections in EC (2008, 2009a, 2009b); for example, 'The basic sample design applied in all states is a multi-stage, random (probability) one. In each country, a number of sampling points was drawn with probability proportional to population size (for a total coverage of the country) and to population density'.
11. Recent research suggests that openness and liberalization in political institutions can have a positive effect on environmental policy performance, even in cases of transboundary pollution problems (Congleton, 1992; Murdoch and Sandler, 1997; Murdoch et al., 1997; Midlarsky, 1998; Neumayer, 2002; Fredriksson et al., 2005; Farzin and Bond, 2006). Another related branch of studies has devoted attention to the effect of variation within democratic systems on domestic environmental performance (Crepaz, 1995; Jahn, 1998; Lijphart, 1999; Scruggs, 1999, 2001, 2003; Fredriksson and Millimet, 2004a, 2004b; Wälti, 2004; Esty and Porter, 2005; Tonn, 2007; Poloni-Staudinger, 2008).
12. As Jancar-Webster (1998) and Waller (1998) note, neglect of ecological problems gave impetus to reform movements leading up to 1989 by mobilizing dissent in the wake of incidents such as the nuclear accident at Chernobyl and the proposal to dam the Danube at Nagymaros.
13. As Beck and Katz (1995: 634) observe: 'It is well known that even though OLS estimates of TSCS [time-series cross-section] model parameters may not be optimal, they often perform well in practical research situations'. This dilemma is also acknowledged here. See also Beck et al. (1993).
14. This is illustrated by the following passage from their interview (van den Hove et al., 2002: 6–7) with the industry group's former chairman: '[W]e only had one public relations campaign, prior to Kyoto. It cost $12 million. The GCC participated, but did not have the money to finance it alone. This campaign was very effective. The reason why, is that fairness is very important to the American people. And the Treaty, by not being global, is not fair. Another important thing is the economic impacts on them. This campaign did galvanise public opinion and helped the passing of the [Byrd–Hagel] Senate resolution'.

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