# The relative importance of cultural and economic issues for the polarization of the U.S. electorate, 1972–2008

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**Abstract**

We develop a simple model in which voters care about both economic and "cultural" policy (non-economic issues such as abortion). Democrats and Republicans are ideologically differentiated and choose economic policy positions to maximize their respective probability of winning. Voters who are culturally and economically conservative or liberal strongly prefer one of the parties, while the boundary between the set of Democratic and Republican supporters is along a economically-conservative-socially-liberal to economically-liberal-socially-conservative line. The change of the slope of this line over time tells us about changes in the relative importance of cultural and economic issues for vote choice.

Using data from the American National Election Survey, we structurally estimate the model and show that the distribution of voter preferences in the American electorate remained relatively constant over the last 35 years. However, the importance of cultural factors relative to economic issues for the vote choice has increased significantly over the last generation. Also, policy preference intensity has increased substantially over the same time frame. These results are consistent with a view that parties have become much more internally homogeneous on cultural issues over the last generation, and that this is the factor that is driving polarization.

*Keywords:* Polarization, differentiated candidates, policy divergence, ideology.

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# 1 Introduction

One of the most fundamental problems in American politics today is the perceived increase in "polarization", both in Congress and among voters. Many political commentators diagnose a sharp and increasing partisan divide that splits the U.S. electorate. For example, the Economist writes that "the 50-50 nation appears to be made up of two big, separate voting blocks, with only a small number of swing voters in the middle",[1] and that "America is more bitterly divided than it has been for a generation".[2] Seemingly in contrast, political scientists have provided strong evidence that "there is little evidence that Americans' ideological or policy *positions* are more polarized today then they were two or three decades ago, although their *choices* often seem to be" (Fiorina, Abrams, and Pope 2006).

Another question that has received much attention is which factors explain the party choice of voters, and whether these factors have changed over time. In particular, there is the issue of whether "ideology" is increasingly inducing voters to vote "against their economic interests". In a popular bestseller, Thomas Frank (2005) asks "What's the matter with Kansas?": He argues that poor people in relatively poor states such as Kansas often vote for Republicans because of cultural issues such as abortion or gay marriage, while their economic interests would be more closely aligned with the Democratic party.

Of course, it is not clear a priori why economic issues "should" (both normatively and positively) be more important determinants of voting behavior. If a voter cares about both and prefers Democrats on economic issues and Republicans on cultural ones, or vice versa, then he faces a dilemma, and the most interesting question, both for political scientists and presumably for the candidates, is what affects this trade-off and how it has changed over time. We develop a simple formal model of vote choice with a two-dimensional policy choice and empirically analyze these questions for the U.S. electorate, using the National Election Survey.

We show that, indeed, cultural issues have become considerably more salient over time, relative to economic issues. Moreover, our model shows that this change is due to an increased distance between party positions. Indeed, we estimate that the difference between the Democrats' and the Republicans' cultural position has approximately quadrupled since the 1970s, whereas their economic distance has remained almost constant. While in the 1970s, economic issues were considerably more determinant for voting choice

[1] "On His High Horse," Economist, November 9, 2002: 25.

[2] "America's Angry Election," Economist, January 3, 2004.

than cultural issues, they are of roughly equal importance today. With the increased cultural differentiation between parties and the consequently changing fault line through the electorate, Republicans won culturally conservative and economically liberal supporters (the "Reagan Democrats"), while Democrats won culturally liberal and economically conservative supporters. However, we show that the size of the first group considerably outweighs the size of the second group, indicating that Republicans have benefited substantially from cultural polarization.

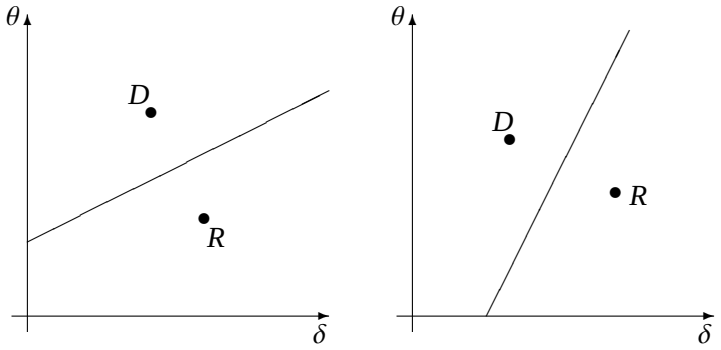
We also show that the fault line through the electorate has deepened. The average policy preference intensity among voters for one of the parties has increased substantially over time. While this effect has been diagnosed by pundits and political scientists alike, there is disagreement over what drives this "polarization", and in particular whether the voter preference distribution has become more partisan and less moderate, or whether there has just been increased "sorting" in the sense that today, liberals are more reliable as voters for Democrats, and conservatives for Republicans. Our model makes it possible to cleanly define and separate these effects. Over the whole time period, we estimate that about three quarters of the total increase in what we call "position predictiveness" come from sorting (which is driven by elite polarization), and one quarter comes from increased preference polarization in the electorate. However, the contribution of both effects varies considerably over time. While Ronald Reagan's conservative revolution lead to considerably increased sorting in the 1980s, it hardly changed the polarization of the electorate. In contrast, the further increase in position predictiveness during the Bush II era in the first decade of this century is driven by a roughly equal extent of elite polarization and voter polarization.

## 2 An intuitive description of our model and procedure

We develop a simple model in which voters care about economic and "cultural" policy (widely defined), as well as an idiosyncratic payoff from each candidate like in a probabilistic voting model. Democrats and Republicans are differentiated both ideologically and economically. Differentiation of economic platforms makes the Republican party (ceteris paribus, i.e., holding a voter's cultural position constant) more attractive for richer voters. Culturally conservative voters who also prefer a low level of spending support the Republican position on both issues, while culturally liberal voters who also prefer a high level of spending support the Democratic position on both issues. In contrast to these core supporters of each party, economically-conservative, but socially-liberal voters and economically-liberal, but socially-conservative voters are less

firm in their support, and the boundary line between the set of (likely) Democratic and Republican supporters goes through these regions of the type space.[3] The slope of this separating line depends on the size of the difference between party platforms in the economic and cultural dimension.

To see this, consider Figure 1, where $\delta$ measures the voter's cultural preference (values to the right are more "socially conservative") and $\theta$ measures the voter's preference for public goods (higher $\theta$-types want more public goods and are, therefore, "economically liberal"). The bold points denoted D and R indicate the two party platforms (i.e., the two voter types for whom the positions of the parties correspond to their ideal policy). If there are no or only small idiosyncratic personality preferences for the candidates among voters, then the separation line drawn perfectly separates the sets of Republican supporters below the line from the set of Democratic supporters above the line.




(a) Primarily economic voter separation (b) Primarily cultural voter separation

Figure 1: Voter separation lines

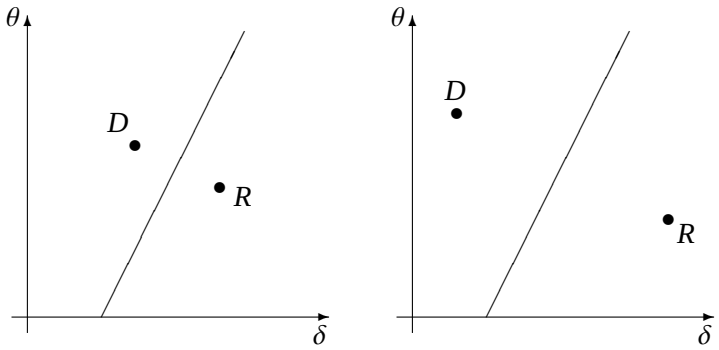
In the left panel of Figure 1, the platforms of the two candidates differ primarily along the economic dimension, while their cultural positions are fairly close. As a result, the separation line is fairly flat: Most Republicans have low values of $\theta$, while most Democrats have high values of $\theta$. In the intermediate range, cultural preferences do play a role, but the "marginal rate of substitution between economic and cultural issues" is low: Suppose we start from a voter who is just indifferent between the Democratic and Republican position. If this voter becomes more socially conservative (i.e., if $\delta$ increases by one unit), how much does $\theta$

[3]Voters in our model also receive an additional candidate-specific payoff, which may capture both a systematic component (say, how competent a candidate is) and an idiosyncratic component (e.g., how likable the voter finds each candidate). Because of the idiosyncratic component, the separation line in the economic-cultural space cannot be expected to separate the two voter sets exactly, but will only separate those who are more likely to prefer the Democrat from those who are more likely to prefer the Republican for policy reasons.

have to increase in order to keep this voter on the separating line, i.e. just stochastically indifferent between candidates? We call this marginal rate of substitution the *importance of cultural relative to economic issues*.

In the right panel, the importance of cultural relative to economic issues increases, that is, the dividing line becomes steeper. Note that the reason for the pivot of the separating line is the change of the Democratic and Republican position relative to the left panel – cultural differences between the candidates have become more pronounced, economic ones less so, and consequently, the polity has become more culturally divided.

Note that the slope of the dividing line depends solely on the difference between the candidates' economic and social positions. An increased importance of cultural relative to economic issues is not driven by "voters becoming more concerned with cultural issues and less concerned with economic issues." If the distribution of voter preferences changes, e.g. probability mass shifting from the middle of the distribution to more extreme positions, this is a completely separate effect that leaves the dividing line unchanged, but affects, for example, how many voters "cross-over" to the other party in a stochastic framework.




(a) Small policy differences (b) Large policy differences

Figure 2: Platform differences and voter intensities

Voters in our model also have idiosyncratic (non-policy) preferences for candidates. The intensity of their policy preference determines how likely these idiosyncratic preferences are to overturn a voter's policy preference. The locus of the separating line is the same in both panels of Figure 2. However, in the left panel, candidate positions are pretty close, and the importance of idiosyncratic non-policy preferences is high: While voters above the dividing line are more likely to vote Democrat, and those below the line are more likely to vote Republican, the transition between the two camps is rather gradual. In contrast, policy differences between candidates in the right panel are quite pronounced. While voters who are exactly located on the previous dividing line are still equally likely to prefer the Democrat and the Republican, those voters

who are located slightly off that line are now much more likely to prefer the candidate on their side of the dividing line to his opponent, as policy differences have become more important relative to idiosyncratic non-policy preferences. We can thus infer, from the extent to which the two voter blocs can be neatly divided by a line, how far apart the positions of the two candidates are.

Idiosyncratic candidate preferences are also important for the interpretation of which issues become "more important" or "more polarizing." If voters care only about social and economic policy, then there are two mutually exclusive developments over time: Either, cultural divisions become more pronounced and economic ones less so, or the other way around. Moreover, if the cultural dimension becomes more important (i.e., an increase in the slope of the dividing line), then we expect to see more sorting according to $\delta$; that is, more voters with high $\delta$, and fewer with low $\delta$, will be Republicans. In contrast, sorting on $\theta$ becomes less pronounced. If, however, voters care about a third issue or candidate characteristic such as likability (that we cannot measure directly), then two components can become more important, at the expense of the third one. For example, if party platforms diverge on both cultural and economic issues, then the importance of idiosyncratic preferences relative to both types of policy decreases, and voter sorting along both policy dimensions may increase.

We use data from the American National Election Survey (NES) to structurally estimate the model for U.S. Presidential elections. Specifically, we take all NES questions concerning the voters' preferences on either economic policy or cultural policy that have been asked without interruption during the 1972 to 2008 period. The results show that the fault line through the American electorate has turned as in Figure 1 and today reflects the divisions on cultural issues to a significantly stronger degree than a generation ago. Our model provides a consistent interpretation of these results, namely that parties have become much more internally homogeneous on cultural issues over the last generation, and this is what drives the increased importance of cultural issues relative to economic issues.

In addition, we show that position preferences are today significantly more predictive of vote choices, and our model allows us to analyze the sources of this effect. The larger part of it stems from increased sorting of voters as in the right panel of Figure 2, indicating that party platforms moved farther apart from each other, rather than just turn around some common center of gravity, and this leads to better sorting on both dimensions. We find that the policy preference intensity has increased considerably (over 50 percent) since 1976. While the dividing line in 2004 separates the two voting blocks in a pretty clean way, there were many more cross-over voters in the 1976 election.

In addition, there is some polarization of voter preferences; this effect is particularly strong in the last two elections. Interestingly, the polarization effect is difficult to see directly by just comparing the standard deviations of the marginal distribution of economic and cultural preferences, where there is little apparent change over the last 35 years. Instead, the correlation between social and economic conservatism or liberalism has increased substantially, and this increases the average voters' policy preference for their party.

Our model also generates interesting effects regarding the type of voters who, over time, switched their party allegiance. In a standard one-dimensional model, voter migration is limited to one direction: If, say, the Democratic candidate's valence increases relative to the last election, or if he becomes more moderate, while keeping everything about the Republican candidate constant, then some voter types who previously preferred the Republican will now vote for the Democrat. However, there will be no voters who preferred the Democrat before and now prefer the Republican.[4] In contrast, in our model, a pivot of the dividing line has the effect that socially-liberal and economically-conservative voters move to the Democratic party, while socially-conservative and economically-liberal voters move to the Republican party. The increasing importance of cultural issues has been electorally very beneficial for the Republican party. For example, in the 2004 election, there were about 13 percent of all voters who were more likely to vote Republican, but who would have been more likely to vote Democratic if the separating line had been the same as in the 1976 election. The complementary set of voters who were likely to vote Republican in the 1970s, but now are more likely to vote Democratic is considerably smaller (around 1-2 percent for the 2004 voter distribution).

## 3 Related literature

Our theoretical model uses the differentiated candidates framework developed by Krasa and Polborn (2009, 2010a, 2010b). In this type of model, candidates for political office are characterized by some unchangeable characteristics such their ability to transform tax revenue into public goods; given these characteristics, candidates choose a level of public good provision (and related taxes), and voters vote for their preferred

[4]To the extent that there are idiosyncratic preferences of voters for candidates, voters may migrate in both directions even in a model with a one-dimensional policy space. Such a voter migration against the trend is most likely to occur for voters who are moderates because their policy preferences are weak and can be more easily outweighed by idiosyncratic effects favoring one of the candidates. Note, however, that the reason why a voter has no strong policy preference – e.g., whether the voter is socially-liberal and economically-conservative, or socially-conservative and economically-liberal has no effect on the likelihood of a vote switch and its direction in a one-dimensional model.

candidate. The specific version closest to the present paper is Krasa and Polborn (2011), which introduces "ideology" as an unchangeable characteristic and analyzes how ideological differences between candidates affect their policy platforms.

Starting with the seminal papers of Poole and Rosenthal (1984) and Poole and Rosenthal (1985), there has been an extensive literature that studies the development of elite polarization, primarily by measuring the positions of members of Congress. This literature shows conclusively that the average Democrat and the average Republican in Congress have moved farther to the "left" and the "right", respectively, and consequently, the political parties appear more polarized today.

Whether there is a corresponding polarization of the electorate is less clear. Many political pundits argue that cultural issues have become increasingly important since the 1990s to explain voters' behavior. In the popular bestseller "What's the matter with Kansas?", Thomas Frank (2005) argues that many voters in the American heartland, in particular "angry white males" vote increasingly against their economic interest, i.e., for the Republican party. Consistent with this interpretation, a core strategy of the Republican party in the 2004 elections was to put referendums on gay marriage on the ballot in several states. Such a strategy makes sense from the party's point of view if the referendum makes participation in the election more attractive for voters who care a lot about these issues, and if these additional voters are likely to vote for Republicans.

Supporting the argument that there has been substantial polarization in the United States, Abramowitz and Saunders (2008) provide some evidence that Democratic and Republican voters (and, in particular, party members who actively engage in campaign activities) have become more polarized in the sense that their positions on an ideological spectrum have become more liberal for Democrats and more conservative for Republicans. They also show that the correlation between liberal-conservative self-identification and party identification has increased from about 0.32 in 1972 to about 0.58 in 2004, indicating an increased importance of ideological issues for vote choice. Finally, they argue that there is a stark contrast between religious and non-religious voters in the 2004 elections, and that church attendance and belonging to an evangelical church is considerably stronger correlated with vote choice in the 2004 election than family income.

On the other side of this argument are a number of political scientists who provide evidence for several claims that seemingly conflict with the value voters argument. First, there is convincing evidence that the political preferences of the American electorate on a number of policy issues are substantially the same that they were a generation ago (Fiorina, Abrams, and Pope (2006), Bartels (2006), Levendusky (2009)).

There does not appear to be a radicalization in the sense that voters have moved from moderate positions to more extreme ones (DiMaggio, Evans, and Bryson (1996), Baker (2005)). We also find that average economic and cultural preferences, as well as their standard deviation change very little over time, but we show that the increasing correlation between cultural and economic conservatism still results in somewhat higher polarization, especially most recently.

Fiorina and Abrams (2008) report the seven-point scale measure of ideology from the NES for 1972 and 2004 and argue that the number of voters who think of themselves as moderate is virtually unchanged (even though there are substantially more conservative and extremely conservative voters). Yet, when comparing these social constructs over such a long time, it is unclear whether "liberal", "moderate" and "conservative" mean the same to voters in 2004 as they meant in 1972. For example, TV personality and former Republican Congressman Joe Scarborough said the following (on Hardball with Chris Matthews, February 15, 2011):

> Well Chris it's fascinating [...] I went on Hardball all the time in '95, '96, '97 and I was saying the same thing then that I'm saying now. I don't think, if you just want to talk about where the Republican Party is economically, I don't think they're conservative enough. [...] It used to be that that position would make me more conservative than establishment Republicans in Washington, DC. But I guess since I don't run around talking about where the President was born, and because I say that he's a Christian, [...] I guess by 2011 standards that makes me a liberal. I don't get it.[5]

While we certainly do not want to argue that Joe Scarborough specifically has become a liberal or moderate (yet), the larger point is certainly valid: Attitudes to particular questions that made an individual reasonably classified as "liberal" or "conservative" some decades ago may today lead to a different classification, and a different voting behavior. The main objective of our paper is to analyze how this reclassification has played out over the last 35 years with respect to economic and cultural positions.

A second stylized fact that political scientists have found consistently over time is that a voter's income matters for his vote choice (see Gelman, Shor, Bafumi, and Park (2008); chapter 3 of McCarty, Poole, and Rosenthal (2006)). Indeed, we find the same result in the sense that, throughout our observation period, a higher income ceteris paribus makes a voter more likely to vote Republican. Thus, income still influences voting behavior. Yet, we find that the extent of the trade-off between income (and, more generally, economic-

[5] See transcript at `http://www.mrc.org/biasalert/2011/20110216113803.aspx`

policy preferences) on the one hand and cultural-ideological preferences on the other hand, has changed substantially from the 1970s to today.

The most closely related paper is Ansolabehere, Rodden, and Snyder (2006) (henceforth ARS) who construct a "moral issues scale" and an "economic issues scale" using 1977 to 2004 data from the NES and the General Social Survey. Their main objective is to find whether moral issues are more or less important for the vote choice than economic issues. They find that economic issues are at least twice as important as moral issues, but that the importance of moral issues for vote choice has increased from close to zero in the 1970s and 80s to a nontrivial size in the latest elections.[6]

There are three main differences between ARS and our paper. First, our empirical analysis is based on a theoretical model, which facilitates a more precise interpretation of results: Certain effects in our model such as an increased preference intensity and an increased importance of cultural issues have a clear cause: Party platforms have become more polarized (and, predominantly, on cultural issues). Second, we statistically estimate parameters of our theoretical model. This approach provides us with not just point estimates, but also confidence intervals for the variables of interest, which enables us to state that cultural issues have become more important relative to economic ones *in a statistically significant way*.

Third, our non-economic variable of interest is defined somewhat more broadly than ARS's "moral issues scale". This distinction may explain why some of our quantitative results differ substantially from theirs. For one, our broader cultural conservatism measure is a significant determinant of voting for Republicans throughout our observation period, while ARS's "moral issues" have an almost negligible impact up to the 1992 elections. In our estimation, the relevance of cultural issues jumped upwards with Reagan's election in 1980, and has generally kept on rising since then. Moreover, in our estimation, cultural factors are at least as important as economic factors for the determination of voting behavior at the end of our observation period, while ARS emphasize the preponderance of economic factors over moral ones.

[6] ARS report the difference between the probability that a respondent who is on the 75th percentile and on the 25th percentile of the moral issues scale votes Republican. In the 1980 election, this difference was $-2$ percentage point (indicating that respondents classified as moral conservatives by their scale were more likely to vote for Carter than social liberals), and the average effect in the 1984, 1988 and 1992 was +3 percentage points. After that, the effect grows to around 20 percentage points.

# 4 Model

Two candidates, labeled $D$ and $R$, are endowed with a (cultural) ideological position $\delta_D, \delta_R \in [0,1]$. Candidates also differ in their ability to transform tax revenues into public goods. Candidates choose a policy $g$ that we interpret as the level of public goods supply that they promise to provide if elected. A candidate's cost function is denoted by $c_P(g) = B_P + C_P g$, where $B_P$ is the fixed cost and $C_P$ is the marginal cost of providing a level $g$ of public goods. Specifically, we assume that candidate $R$ has a cost advantage in providing lower levels of $g$, whereas candidate $D$ has an advantage in providing higher levels of $g$. Formally, we have

**Assumption 1** *Assume that $B_D > B_R$ and $C_D < C_R$.*

Candidates are office motivated, that is, they choose policy $g$ in order to maximize their probability of winning the election.

A voter is characterized by his cultural ideology $\delta \in [0,1]$; a parameter $\theta \in [0,1]$ that determines his preferences for public goods, and a parameter $\xi_P \in \mathbb{R}$ that measures the impact of the personal charisma of the candidate $P = D, R$ on the voter. Specifically, a voter's utility from candidate $P$ is given by

$$u(P,g) = \theta v(g) - c_P(g) - (\delta - \delta_P)^2 + \xi_P. \tag{1}$$

Note that $v(\cdot)$ is an increasing and strictly concave function that is the same for all voters. Since a voter's gross utility from public goods is $\theta \cdot v(g)$, high $\theta$-types receive a higher payoff from public goods and thus, their preferred public good provision level, taking into account the cost of provision, is higher than for low $\theta$ types.[7] We assume that $\theta$ is distributed according to a continuous cdf $F_\theta(\cdot)$.

Let $\xi = \xi_R - \xi_D$. We assume that $\xi$ is independent of $\theta$ and $\delta$, and that both $\xi$ and $\delta$ have a discrete distribution (for simplicity of exposition). We denote by $\pi_\Xi(\xi)$ and $\pi_\Delta(\delta)$ the probabilities of realizations $\delta$ and $\xi$, respectively.

[7] We could generalize the utility function to $u(P,g) = \theta v(g) - c_P(g) - s(\delta - \delta_P)^2 + \xi_P$, where $s > 0$. The case $s = 1$ corresponds to (1), and higher $s$ means that voters put more emphasis on cultural issues. By setting $\chi = \sqrt{s}(\delta - \bar{\delta}) + \bar{\delta}$, for arbitrary $\bar{\delta}$ we can write the new utility function as $u(P,g) = \theta v(g) - c_P(g) - (\chi - \chi_P)^2 + \xi_P$, which is exactly the same form (1) (just with $\chi$ replacing $\delta$). Thus, our assumption that the parameter multiplying the ideological loss $(\delta - \delta_P)^2$ is one is without loss of generality.

# 5 Equilibrium Policies

A voter with ideology $\delta$ is indifferent between the two candidates if and only if

$$\theta v(g_D) - c_D(g_D) - (\delta - \delta_D)^2 + \xi_D = \theta v(g_R) - c_R(g_R) - (\delta - \delta_R)^2 + \xi_R,$$

which implies

$$-2\delta(\delta_R - \delta_D) + (v(g_D) - v(g_R))\theta = c_D(g_D) - c_R(g_R) - (\delta_R^2 - \delta_D^2) + \xi. \tag{2}$$

For any given value of $\xi$, if $v(g_D) = v(g_R)$, the line of these indifferent or *cutoff voters* in a $(\delta, \theta)$-space is vertical. Intuitively, if Democrat and Republican provide the same amount of public goods, then only the voters' ideological preferences ($\delta$) matter for their voting choice, while the voters economic preference ($\theta$) is immaterial. If, instead, $v(g_D) \neq v(g_R)$, the cutoff value for $\theta$ is given by

$$\theta(\delta, \xi, g_D, g_R) = \frac{2\delta(\delta_R - \delta_D) + c_D(g_D) - c_R(g_R) - (\delta_R^2 - \delta_D^2) + \xi}{v(g_D) - v(g_R)}. \tag{3}$$

It follows immediately that (3) is a straight line in the $\delta$-$\theta$ space, and it has a positive slope if $v(g_D) > v(g_R)$. Intuitively, if the Democrat provides more public goods than the Republican, then a voter is indifferent between the candidates either if he is socially relatively liberal, but wants lower spending on public goods (i.e., low $\delta$ and low $\theta$), or if he is socially conservative, but likes substantial government spending on public goods (i.e., high $\delta$ and high $\theta$). Voter $(\delta, \theta, \xi)$ strictly prefers candidate $R$ if $\theta < \theta(\delta, \xi, g_D, g_R)$. Thus, the Republican vote share is given by

$$V_R = \sum_{\xi \in \Xi} \sum_{\delta \in \Delta} F_\theta(\theta(\delta, \xi, g_D, g_R))\pi_\Delta(\delta)\pi_\Xi(\xi) \tag{4}$$

As a consequence, candidate $D$ minimizes (4) while candidate $R$ maximizes it.

The first order condition for candidate $D$ is given by

$$\sum_{\xi \in \Xi} \sum_{\delta \in \Delta} f_\theta(\theta(\delta, \xi, g_D, g_R))[c_D - v'(g_D)\theta(\delta, \xi, g_D, g_R)]\pi_\Delta(\delta)\pi_\Xi(\xi) = 0. \tag{5}$$

The first order condition for candidate $R$ is given by

$$\sum_{\xi \in \Xi} \sum_{\delta \in \Delta} f_\theta(\theta(\delta, \xi, g_D, g_R))[v'(g_R)\theta(\delta, \xi, g_D, g_R) - c_R]\pi_\Delta(\delta)\pi_\Xi(\xi) = 0. \tag{6}$$

The following Theorem 1 provides Inada-like conditions for a solution of (5) and (6) to exist, and conditions that guarantee that this solution is at least a local Nash equilibrium. Moreover, such an equilibrium is characterized by the Democrat offering more public goods than the Republican.

**Theorem 1** *1. Let $g_D$, $g_R$ be solutions to the vote share maximization problem. Then $v'(g_R)c_D = v'(g_D)c_R$, which implies that Candidate D's spending level exceeds that of candidate R, i.e., $g_D > g_R$.*

2. *Suppose that $v'(0) = \infty$ and $v'(\infty) = 0$. Then there exist policies $g_D$, $g_R$ that satisfy the first order conditions* (5) *and* (6).

3. *If the derivatives of the density $f'_\theta$ are sufficiently close to 0 (e.g., if the distribution of $\theta$ is close to uniform) then any solution to the first order conditions is a local optimum for the vote share maximization problem.*

All proofs are in the Appendix. Theorem 1 provides the theoretical basis for our empirical model. First, it provides a framework in which economic policy differentiation arises in equilibrium. Since parties are also differentiated with respect to their cultural ideology, this implies that both factors influence voter choice. For any given voter ideology, higher types of $\theta$ are more likely to vote for the Democrat (who provides more public goods, at a cost of a higher tax rate), and for any given economic preference type $\theta$, higher $\delta$-types are more likely to vote for the Republican.[8]

# 6 Estimating the Model

Define

$$k = \frac{2(\delta_R - \delta_D)}{v(g_D) - v(g_R)}, \quad a = \frac{c_D(g_D) - c_R(g_R) - (\delta_R^2 - \delta_D^2) + \bar{\xi}}{v(g_D) - v(g_R)}. \tag{7}$$

where $\bar{\xi} = E[\xi]$. Define

$$\varepsilon = \frac{\xi - \bar{\xi}}{v(g_D) - v(g_R)} \tag{8}$$

We assume that $\varepsilon$ is normally distributed with standard deviation $\sigma$ (given the normalization in (8), the mean of $\varepsilon$ is 0). Equations (3), (7) and (8) imply that a citizen votes Republican if and only if

$$\theta - k\delta - a - \varepsilon < 0. \tag{9}$$

Let $X_i$, $i = 1, \ldots, n$ and $Y_i$, $i = 1, \ldots, m$ be random variables that describe the answers to survey questions on cultural and economic issues, respectively. From these data, we construct an index of cultural and economic

[8] Schnidman and Schofield (2011) present an alternative model of non-convergence of party positions in a two-dimensional policy space. Their main driving force is the presence of policy-motivated party activists who support the candidates conditional on their policy choices.

preferences. Specifically, we assume that $\delta = \sum_{i=1}^{n} \lambda_i X_i$ and $\theta = \sum_{i=1}^{m} \mu_i Y_i$, where, of course, the $\lambda_i$ and $\mu_i$ are parameters to be estimated.

We normalize $X_i$ and $Y_i$ such that (i) the lowest and highest realizations for each question are 0 and 1; (ii) high values on $X_i$ and $Y_i$ increase the estimated value of $\delta$ and $\theta$, respectively (i.e., we code answers such that all $\lambda_i$ and $\mu_i$ are non-negative). We can do (ii) without loss of generality by redefining a new variable $\hat{X}_i = 1 - X_i$ (or $\hat{Y}_i = 1 - Y_i$) if the corresponding coefficient $\lambda_i$ (or $\mu_i$) in a regression using the original answers $X_i$ or $Y_i$ is negative. Finally, we normalize $\sum_{i=1}^{n} \lambda_i = 1$ and $\sum_{i=1}^{m} \mu_i = 1$ so that $\theta, \delta \in [0, 1]$, as required by the model, and to keep the distribution of $\theta$ and $\delta$ comparable over time. This normalization is without loss of generality because multiplying all variables in (9) by the same constant will not change whether (9) is satisfied.[9]

Let $\Phi(\cdot)$ be the cdf of a normal distribution with mean 0 and standard deviation 1. Then (9) implies that the probability that a person votes Republican is

$$\Phi\left(\frac{1}{\sigma}\left[k\sum_{i=1}^{n}\lambda_i X_i - \sum_{i=1}^{m}\mu_i Y_i + a\right]\right). \tag{10}$$

In order to determine $k$, $a$, $\sigma$, $\lambda_i$, $i = 1, \ldots, n$, and $\mu_i$, $i = 1, \ldots, m$, we first estimate the model in which the probability of voting Republican is given by

$$\Phi\left(\left[\sum_{i=1}^{n}\tilde{\lambda}_i \tilde{X}_i - \sum_{i=1}^{m}\tilde{\mu}_i \tilde{Y}_i + \tilde{a}\right]\right), \tag{11}$$

where there are no restrictions on the $\tilde{\lambda}_i$, and $\tilde{\mu}_i$, i.e., they could be negative or greater than 1. $\tilde{X}_i$ and $\tilde{Y}_i$ are the responses to the survey questions, solely normalized to be between 0 and 1, but absent the additional requirement that higher realizations of the response to each question increase $\delta$ and $\theta$.

Note that (11) corresponds to a standard probit model, which can be estimated by maximizing the log-likelihood function. We now characterize the relationship between the parameters in the modified model in (11) with those in (10).

**Theorem 2** *Let $\tilde{\lambda}_i$, $i = 1, \ldots, n$, $\tilde{\mu}_i$, $i = 1, \ldots, m$, and $\tilde{a}$ be parameters of the modified model in* (11)*. Then the parameters of the original model* (10) *are determined as follows:*

[9] In the estimation, multiplying all variables in (9) by the same constant leaves the parameter estimate for $k$ unchanged and multiplies the estimate of the standard deviation of $\varepsilon$ accordingly.

1. *The weight of cultural issue i in the cultural preference index is given by*

$$\lambda_i = \frac{|\tilde{\lambda}_i|}{\sum_{i=1}^{n} |\tilde{\lambda}_i|} \tag{12}$$

2. *The weight of economic issue i in the economic preference index is given by*

$$\mu_i = \frac{|\tilde{\mu}_i|}{\sum_{i=1}^{m} |\tilde{\mu}_i|} \tag{13}$$

3. *The standard deviation of the individual preference shock $\varepsilon$ is given by*

$$\sigma = \frac{1}{\sum_{i=1}^{m} |\tilde{\mu}_i|} \tag{14}$$

4. *The slope of the separating line in the $(\delta, \theta)$ space is*

$$k = \frac{\sum_{i=1}^{n} |\tilde{\lambda}_i|}{\sum_{i=1}^{m} |\tilde{\mu}_i|} \tag{15}$$

5. *The vertical intercept of the separating line in the $(\delta, \theta)$ space is*

$$a = \frac{\tilde{a} - \sum_{i=1}^{m} \min\{\tilde{\mu}_i, 0\} + \sum_{i=1}^{n} \min\{\tilde{\lambda}_i, 0\}}{\sum_{i=1}^{m} |\tilde{\mu}_i|}. \tag{16}$$

6. *$\delta$ and $\theta$ are given by*

$$\delta = \frac{\sum_{i=1}^{m} \left[\tilde{\lambda}_i \tilde{X}_i - \min\{\tilde{\lambda}_i, 0\}\right]}{\sum_{i=1}^{m} |\tilde{\lambda}_i|}, \qquad \theta = \frac{\sum_{i=1}^{n} \left[\tilde{\mu}_i \tilde{Y}_i - \min\{\tilde{\mu}_i, 0\}\right]}{\sum_{i=1}^{n} |\tilde{\mu}_i|}. \tag{17}$$

When we compare different years, we may fix the way how questions $X_i$ and $Y_i$ translate into types $(\delta, \theta)$ does not change. That is, we estimate the parameters $\lambda$ and $\mu$ for a "base period" (usually several years). We then apply these parameter values to different years; that is, we use the $\lambda$ and $\mu$ of the base period to calculate the preference type of each voter in the new year, and then only estimate the remaining parameters $k$, $a$, and $\sigma$. In this reduced model, the probability of voting Republican is given by

$$\Phi\left(\frac{1}{\sigma}\left[k\delta_i - \theta_i + a\right]\right). \tag{18}$$

We can estimate this model by first estimating

$$\Phi\left(\beta_\delta \delta_i - \beta_\theta \theta_i + \beta_a\right), \tag{19}$$

and then using the identities

$$\sigma = \frac{1}{\beta_\theta}, \quad k = \frac{\beta_\delta}{\beta_\theta}, \quad a = \frac{\beta_a}{\beta_\theta}. \tag{20}$$

Intuitively speaking, different base years give slightly different results because what is economically and culturally "conservative" (i.e., leaning towards the Republican position) may change over time. Different approaches have both advantages and disadvantages. Pooling all years gives us the largest data set and compares all years against a common benchmark. In contrast, focusing on a rather late base year has the advantage of measuring people's preferences in a way that is more consistent with what is considered economically and culturally liberal or conservative *today* as opposed to an average over the last generation. We will also show that our main results are not sensitive with respect to the choice of the base period.

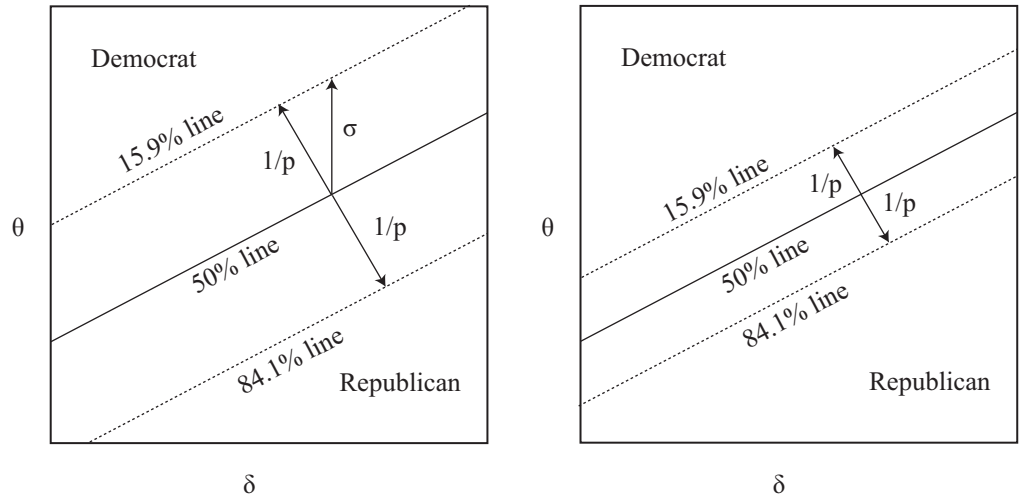



Figure 3: Preference Intensity $p$

Next, we want to draw conclusions about voters' preference intensity for the two candidates. In order to represent candidates graphically, we display $\delta$ on the horizontal, $\theta$ on the vertical axis, and take account of $\xi$ by graphing lines in the $\delta$-$\theta$ space along which the probability of voting for a candidate is constant.[10] For example, the solid line in Figure 3, represents voters who are evenly split in their support for the two

[10]Other studies often have these axes reversed (see, e.g. Brady (2011). We believe that graphing the cultural issues (pure position issues in the terminology of Stokes (1963)) on the horizontal axis and the economic issues (which may contain a number of valence issues) on the vertical axis is more natural. However, the main advantage of our axis arrangement is that confidence intervals for the slope parameter are convex when cultural issues matter little relative to economic ones. If, instead, the arrangement of the axes is reversed, then the point estimate for the slope of the separating line might be positive and very high, but it would not be excluded (in the sense of a confidence interval) that the slope parameter is instead negative (with a very high absolute value). Finally, an interpretative advantage of our arrangement of axes is that an increase of the slope parameter corresponds to an increased relative importance of cultural issues.

candidates. That is, if $\xi < \bar{\xi}$ (or equivalently if $\varepsilon > 0$) then voter $(\delta, \theta, \xi)$ votes for the Democrat, while if $\xi > \bar{\xi}$, the person votes Republican.

Lines parallel to the 50 percent separating line are again isoprobability lines on which all types have the same probability of voting Republican. In Figure 3, we have drawn two such lines that correspond to probability levels $\Phi(-1) \approx 0.159$ and $\Phi(1) \approx 0.841$ (that is, they are one standard deviation away from zero for a standard normal distribution). We define the preference intensity $p$ to be the inverse of the distance between the solid 50% line, and the $\Phi(1)$-line.

Simple geometry shows that $p = (1/\sigma)\sqrt{1+k^2}$. Next, note that (8) implies that the standard deviation of $\xi$ is given by $\sigma(\xi) = (v(g_D) - v(g_R))\sigma$. This, and (7) implies

$$p = \frac{\sqrt{[v(g_D) - v(g_R)]^2 + 4(\delta_R - \delta_D)^2}}{\sigma(\xi)}. \tag{21}$$

Thus, if the standard deviation of $\xi$ does not change between observations, then an increase in the preference intensity is caused by an increase in the difference between the candidates' positions on cultural and economic positions. If the preference intensity increases, there are fewer swing voters, i.e., a voter type whose $(\theta, \delta)$ is above the 50% line is more likely to vote for the Democrat, while a voter below the line is more likely to vote Republican.

Substituting $v(g_D) - v(g_R)$ in (21) by using (7) we get

$$p = \frac{2(\delta_R - \delta_D)\sqrt{1 + \frac{1}{k^2}}}{\sigma(\xi)}. \tag{22}$$

If we take the standard deviation on both sides of (8) we get

$$\sigma = \frac{\sigma(\xi)}{v(g_D) - v(g_R)} \tag{23}$$

Thus, if $k$ increases, it follows that the preference intensity $p$ can only increase if the difference between the candidates' cultural positions increases. Similarly, if $k$ increases, (23) implies that the difference in the candidates' economic position increases as well.

Finally, it is useful to discuss the impact of data limitations on our results. Suppose that the true model for year $t$ has the same structure as the one that we estimate, but has $\delta$ and $\theta$ influenced by more issues than we can have data for: $\delta = \sum_{i=1}^{N} \lambda_i X_i$ and $\theta = \sum_{i=1}^{M} \mu_i Y_i$, where $N > n$ and $M > m$ (i.e., we have data only on the first $n$ and $m$ issues, respectively, but the true model is determined by all $N$ and $M$ issues). This

problem may arise particularly acutely because we have to restrict ourselves to questions that were asked in the NES in every year from 1972 to 2008. Clearly, missing some issues on the cultural dimension will lead to an underestimate of the importance of cultural issues relative to economic issues, and vice versa. Moreover, missing questions implies that we will ascribe more variation to the idiosyncratic shock $\varepsilon$ than justified in the true model. Thus, the absolute values of $k$ (and also $p$) should not be over-interpreted in the sense that $k < 1$ ($k > 1$) as implies that "cultural issues are less (more) important than economic issues." The value of $k$ depends, among other things, on which questions we use for our measurement of economic and cultural preferences and therefore, how well measured preferences reflect "true" preferences on economic and cultural issues. If, for example, we measure cultural preferences much better than economic ones, then $k$ is higher than it would be if we measured economic preferences in a better way. However, the interpretation of *the development of k and p over time* is not systematically affected by this problem as long as the true issue weights (of the included and omitted issues) do not change systematically over time.

Which type of systematic change of the issue weights of included and omitted variables over time can we expect? Presumably, the committee deciding on which questions to ask in the NES has some notion of the importance of different issues that guides their decision – when a new issue becomes sufficiently important in political discourse, a new question will be included, and if the importance of an existing issue falls below some threshold, its usage will be discontinued. However, since continuity of questions is a very important feature for many studies, the importance threshold for inclusion is presumably higher than the threshold for exclusion. Thus, if a question remains in the NES for the whole period between 1972 and 2008, the NES committee must have felt in 1972 that its importance warranted inclusion, and its importance remained sufficiently high over the entire period to prevent exclusion. Issues that became important within this time period, but were not yet sufficiently important to be included in 1972 are not in our data set so that we would expect that the sum of the true normalized weights of the questions included in our analysis may have been higher in 1972 than in 2008.[11] If this is the case, then our estimate of the preference intensity $p$ is biased downward late in our sample period (relative to the estimate in early years), as too much variation is attributed to idiosyncratic shocks rather than unmeasured variations in a voter's position. Fortunately, $p$ increases significantly even without taking into account this bias, which strengthens our results.

[11] For example, a respondent's attitude towards gay people is now probably a good predictor of social conservatism, but in the 1970s, the NES did not contain any questions on this complex. Similarly, we would suspect that a question about the respondent's confidence in scientific results (say, in evolution or global warming) would be more informative about a respondent's social conservatism today than it was 40 years ago.

# 7 Concepts and Data

Our fundamental question about the relative importance of cultural and economic factors for voting choices require a definition of what we mean by economic and cultural. We think of *economic policies* as those policies that affect net personal income or consumption of public goods directly for a significant number of people. For example, this policy area would contain the level of taxation and of public good provision, legislation affecting the power of unions in wage bargaining, and general business regulation affecting profits and capital incomes.

In contrast, what we think of as *cultural policies* is somewhat more amorphous. In our view, policies in this area have to do with the government regulating or influencing behavior, and most people care about these policies even if they are not personally affected one way or the other. For example, most heterosexual voters have a view on gay marriage, even though the legality of gay marriage does not affect their effective personal choice set (i.e., marrying someone from the opposite gender, or not marrying) at all. Clearly, those policies labeled "moral issues" by Ansolabehere, Rodden, and Snyder (2006) fall into this category. However, there are other policy issues that do, too, but are not "moral issues" in a narrow sense. For example, people differ widely in whether they see the U.S. as a force for good in the world that should impose its policy preferences on other countries, often by using military means.[12] Related to this specific example is the whole complex of patriotism/jingoism which is also broached by Frank (2004) as an important cultural wedge issue.

We use data from the post-election survey of the American National Election Survey for Presidential election years during the time period from 1972 to 2008.[13] We considered all questions that were continuously available between 1972 and 2008 and could be identified as either cultural or economic, and eliminated those questions that were not statistically significant in the probit model discussed below. As a result, we use the following questions in order to determine the cultural ideology index $\delta$ of a voter: Questions VCF0837 (1980 and before) and VCF0838 (1984 and after) about whether abortion should be always legal, mostly legal, mostly illegal or always illegal; Question VCF0834 about the role of women, with answers ranging

[12] Of course, one could expand the definition of the "moral" category to cover these cases. It is not immediately obvious why the legality of abortion for U.S. residents is a "moral" issue, but the consequences of U.S. military occupation in foreign countries (whether killing children as collateral damage in drone strikes, or enabling girls to go to school) are not a "moral" issue.

[13] Because we want to compare elections over time, we have chosen this set of questions that address the cultural and economic policy preferences of voters such that the questions we include must have been asked in all NES presidential election years since 1972. This is the reason for why we start our analysis in 1972, as moving to the 1960s would have meant losing a substantial number of questions.

from “Women and men should have an equal role” to “Women’s place is in the home”; Question VCF0206, about the respondent’s attitude towards blacks (“thermometer scale” from 0 to 100); Question VCF0830, about affirmative action and the government’s responsibility to help minorities, with answers ranging from “Government should help minority groups/blacks” to “Minority groups/ blacks should help themselves”; Question VCF0213 about the respondent’s attitude towards the U.S. military (“thermometer scale” from 0 to 100); Question VCF0130 about church attendance, which we use as a dummy with 1 for respondents who go to church weekly or almost every week.

In order to determine the economic preferences of a voter, we use the following questions: Question VCF0809 on the role of the government in the economy, with answers ranging from “Government should see to job and good standard of living” to “Government should let each person get ahead on his own”; Question VCF0210 about the respondent’s attitude towards unions (“thermometer scale” from 0 to 100) ; Question VCF0209 about the respondent’s attitude towards “big business” (“thermometer scale” from 0 to 100) ; Question VCF0114 about family income. Here, respondents are put into 5 groups according to how their income compares with the percentiles of the U.S. income distribution.

Some questions we include ask about the individual’s preferences on certain policy issues and their affinity to certain groups, which we interpret as proxies for policy issues. For example, we believe that the attitude towards unions and big business should be a good proxy for right-to-work legislation or business regulation in general. We interpret the question about aid to minorities as primarily about affirmative action and hence more cultural than economic. With respect to the patriotism/chauvinism complex, there is unfortunately no directly usable question about nationalism; but since chauvinism (i.e., extreme nationalism characterized especially by a belligerent foreign policy) requires power projection by means of armed forces, the attitude towards the military is a useful proxy measure.

We do not include any demographic measures (such as gender, race, age, geographic characteristics) because we believe it is more useful to take the individual’s preferences on policy issues as a measure of their ideological position. It is certainly true that a voter’s demographic characteristics influence his preferred positions. For example, women have on average a more liberal position on abortion rights than men, so if one did not know a voter’s preferences on abortion, including information on the voter’s gender might well be a useful proxy for preferred positions. However, since the NES has information on policy preferences, we prefer to use this information directly. The idea is that, controlling for the respondent’s opinion about abortion and the role of women, the respondent’s gender does not provide much additional

information about the voter's preferences.[14]

Note that we do not include any measure of partisan affiliation or self-placement on a one-dimensional liberal-to-conservative scale. Including such a measure would defy the purpose of our analysis. As mentioned in the introduction, we want to know which policy-preferences (on both the economic and the cultural dimension) translate into a preference for the candidate of one of the parties. Regressing individuals' vote choices for Democrats or Republicans on whether the individuals feel attached to either party is not very helpful. Similarly, the liberal-conservative scale is not helpful because it collapses the two dimensions of our interest into one: For example, if a voter claims to be moderate, is that because he is a social liberal but a fiscal conservative, or a social conservative but a fiscal liberal, or a moderate in both dimensions? Changes of party positions over time affect these groups very differently, and thus, we prefer to measure economic and cultural positions directly by taking as input the individuals' positions on actual economic and cultural policy issues, rather than their own assessment on whether their positions make them "liberal" or "conservative" relative to their fellow countrymen.

Finally, we have some reservations about the data quality in 2008 because the NES sample appears non-representative: Obama voters outnumber McCain voters 2-to-1 in the post-election sample, while the actual election result was 52.9% for Obama versus 45.7% for McCain. This is by far the largest difference between the NES post-election sample and the actual election result during the time interval that we consider. While we report results for 2008, some additional caution in the interpretation of the results for this particular year appears appropriate.

# 8 Empirical Results

## 8.1 Probit regression for $\delta$ and $\theta$

The first two columns in Table 1 report the values of $\tilde{\lambda}$ and $\tilde{\mu}$ for the base period equal to all years pooled and the last five presidential elections pooled (i.e., 1992-2008, the second half of our time period). Below the point estimates for each parameter, we report the corresponding 95 percent confidence interval.

[14] In fact, we have run our regression including a number of demographic controls, and with a few exceptions, they have turned out to be small and often insignificant. Also, dummies for the major religious groups (Protestants, Catholics) turned out to be very close to zero and statistically insignificant.

| | base: all years | base: 1992–2008 | $(\lambda,\mu)_{all}$ | $(\lambda,\mu)_{1992-2008}$ |
|---|---|---|---|---|
| military (thermometer) | 1.174<br>[0.995,1.354] | 1.125<br>[0.948,1.302] | 0.329<br>[0.284,0.373] | 0.320<br>[0.276,0.364] |
| affirmative action (high answers<br>= against affirmative action) | 0.516<br>[0.386,0.646] | 0.439<br>[0.313,0.566] | 0.145<br>[0.107,0.184] | 0.125<br>[0.088,0.163] |
| black (thermometer) | -1.086<br>[-1.275,-0.896] | -1.056<br>[-1.242,-0.869] | 0.304<br>[0.259,0.348] | 0.301<br>[0.256,0.344] |
| role of women (high answers<br>= women's place is in the house) | 0.174<br>[0.057,0.291] | 0.283<br>[0.169,0.396] | 0.049<br>[0.012,0.084] | 0.080<br>[0.044,0.116] |
| abortion (high answers<br>= should be legal) | -0.526<br>[-0.631,-0.421] | -0.528<br>[-0.631,-0.425] | 0.147<br>[0.116,0.180] | 0.150<br>[0.119,0.183] |
| attends church | 0.094<br>[0.025,0.164] | 0.081<br>[0.013,0.150] | 0.026<br>[0.006,0.046] | 0.023<br>[0.004,0.043] |
| income | -0.630<br>[-0.756,-0.505] | -0.629<br>[-0.753,-0.506] | 0.137<br>[0.110,0.164] | 0.142<br>[0.115,0.168] |
| big business (thermometer) | -1.254<br>[-1.424,-1.083] | -1.239<br>[-1.407,-1.072] | 0.272<br>[0.241,0.302] | 0.279<br>[0.247,0.309] |
| union (thermometer) | 1.707<br>[1.553,1.862] | 1.600<br>[1.449,1.751] | 0.371<br>[0.342,0.402] | 0.360<br>[0.330,0.392] |
| government standard of living<br>(high answer = no gov. welfare) | -1.009<br>[-1.134,-0.884] | -0.976<br>[-1.098,-0.853] | 0.219<br>[0.192,0.247] | 0.220<br>[0.192,0.248] |

Table 1: Probit regression results; 95 percent confidence interval

The first two columns of Table 1 show the expected effects of political positions on voting behavior. Remember that our model is normalized in a way that a high value of the cultural index $\delta$ and a low value of the preference for public goods, $\theta$, increases an individual's likelihood of voting Republican. Consequently, Table 1 indicates that a person is more culturally conservative (i.e., high $\delta$) if he likes the military; is against special government support for minorities; feels "less warm" towards blacks, believes that caring for the family is better for women than working outside the home; believes that abortion should be illegal; and attends church weekly or almost every week. A person is more economically conservative (i.e., low $\theta$) if his income is high; likes big business; dislikes unions; and is against the idea that government should provide guaranteed jobs and a standard of living for everyone.

The third and fourth column report the implied values for the $\lambda_i$ and $\mu_i$. Remember that these are normalized so that they are positive and sum to 1, respectively, so that the values can be interpreted as the

relative weight of different issues in determining whether a person is culturally or economically conservative, respectively. Also, since answers are normalized such that they go from 0 to 1, the value of $\lambda_i$ is the effect on the point value of $\delta$ that arises when a respondent changes from the most liberal answer in question $i$ to the most conservative one.

Overall, the importance of different issues for the determination of the cultural and economic scores are remarkably stable when comparing the whole period (1972-2008) to just the elections since 1992. Since it effectively does not matter for our results whether we define conservatism with respect to the full time period or just the second half, we choose to report only results based on the 1992 to 2008 conservatism index in the following.[15]

Having established that the determining factors for economic and cultural conservatism did not change much over time, we now analyze how much the distribution of voter ideal points on these two dimensions changed over time. Note that these are two logically independent concepts – the preference distribution may change significantly even if the determining factors of conservatism remain constant. Table 2 reports the average values of $\delta$ and $\theta$ for all years between 1972 and 2008, as well as the corresponding standard deviations for both voters and non-voters.[16]

| year | av. $\delta$ | std $\delta$ | av. $\theta$ | std $\theta$ | corr. |
|---|---|---|---|---|---|
| 1972 | 0.501 | 0.141 | 0.491 | 0.144 | -0.268 |
| 1976 | 0.508 | 0.132 | 0.454 | 0.148 | -0.185 |
| 1980 | 0.500 | 0.124 | 0.482 | 0.146 | -0.261 |
| 1984 | 0.479 | 0.133 | 0.490 | 0.147 | -0.242 |
| 1988 | 0.503 | 0.125 | 0.472 | 0.153 | -0.240 |
| 1992 | 0.482 | 0.135 | 0.477 | 0.146 | -0.318 |
| 1996 | 0.519 | 0.125 | 0.467 | 0.143 | -0.309 |
| 2000 | 0.518 | 0.124 | 0.477 | 0.143 | -0.311 |
| 2004 | 0.501 | 0.134 | 0.494 | 0.154 | -0.407 |
| 2008 | 0.496 | 0.135 | 0.524 | 0.162 | -0.456 |

(a) Voters

| year | av. $\delta$ | std $\delta$ | av. $\theta$ | std $\theta$ | corr. |
|---|---|---|---|---|---|
| 1972 | 0.522 | 0.143 | 0.513 | 0.148 | -0.193 |
| 1976 | 0.496 | 0.128 | 0.496 | 0.136 | -0.151 |
| 1980 | 0.483 | 0.132 | 0.528 | 0.154 | -0.170 |
| 1984 | 0.492 | 0.125 | 0.529 | 0.126 | -0.030 |
| 1988 | 0.502 | 0.126 | 0.524 | 0.141 | -0.112 |
| 1992 | 0.502 | 0.114 | 0.525 | 0.143 | -0.171 |
| 1996 | 0.488 | 0.120 | 0.528 | 0.129 | -0.205 |
| 2000 | 0.494 | 0.141 | 0.518 | 0.146 | -0.093 |
| 2004 | 0.512 | 0.131 | 0.533 | 0.148 | -0.271 |
| 2008 | 0.504 | 0.123 | 0.535 | 0.137 | -0.184 |

(b) Nonvoters

Table 2: Cultural and economic indices: Average and standard deviation

The average $\delta$ and $\theta$ move around in a relatively unsystematic way over time. Looking at the development of the standard deviations, it is also quite apparent that there is no clear time trend. The distribution

[15] The results based on the 1972-2008 conservatism index are available from the authors upon request.

[16] As indicated above, $\delta$ and $\theta$ are calculated with respect to $(\lambda, \mu)_{1992-2008}$.

of economic or cultural issue preferences certainly does not become a lot more polarized over time, as this would require a substantial increase in the standard deviations. This confirms the results of DiMaggio, Evans, and Bryson (1996), Fiorina, Abrams, and Pope (2006) and Fiorina and Abrams (2008) who all find that overall issue preferences of American voters have remained mostly stable over time.

Table 2 reports the ideological distribution of voters and nonvoters in the corresponding years. The correlation between economic and cultural conservatism among voters (the left table) has increased from a low of $-0.185$ in 1976 to $-0.407$ and $-0.456$ in 2004 and 2008, respectively. Since high values of $\delta$ and low values of $\theta$ correspond to cultural and economic conservatism, this means that the two types of conservatism are today more closely related among voters, although that correlation is far from perfect. While it is often claimed that voting behavior of members of Congress has become essentially one-dimensional in recent years, it will be quite clear from the figures in the next subsection that such a claim cannot be made for the American electorate at-large.

The right part of Table 2 reports the ideological distribution of nonvoters in the corresponding years. Nonvoters tend to be on average more liberal than voters, both economically and culturally. Moreover, with the exception of cultural preferences in 2000, the standard deviation of preferences is smaller among nonvoters. These results are consistent with expectations about nonvoters based on theoretical models with endogenous participation choices: If (some) liberals face substantially higher costs of voting, for example, because of poor organization and therefore longer voting lines in inner cities, they are more likely to abstain. It is also interesting that, among non-voters, the correlation between the two types of conservatism is weaker and does not follow a clear trend over time.

### 8.2 Relative importance of cultural and economic issues

We now turn to the central focus of our analysis. First, how did the relative importance of cultural and economic issues for the determination of individuals' voting behavior change from 1972 to 2008? And second, is there "polarization" with respect to policy? That is, have political positions become more important for the determination of voting behavior relative to idiosyncratic candidate-specific preferences?

Figure 4 displays the values of $\delta$ and $\theta$ for all voters, together with the voter's choice (red for Republican, blue for Democrat). The left panel is for the 1976 election, the right one for the 2004 election. In both panels, we have drawn the 50 percent separating line, i.e., voters on this line have an implied probability of voting

Republican or Democrat that is exactly $1/2$. Voters below and to the right of the separating line are more likely to vote Republican, while voters above and to the left of the line are more likely to vote Democrat.

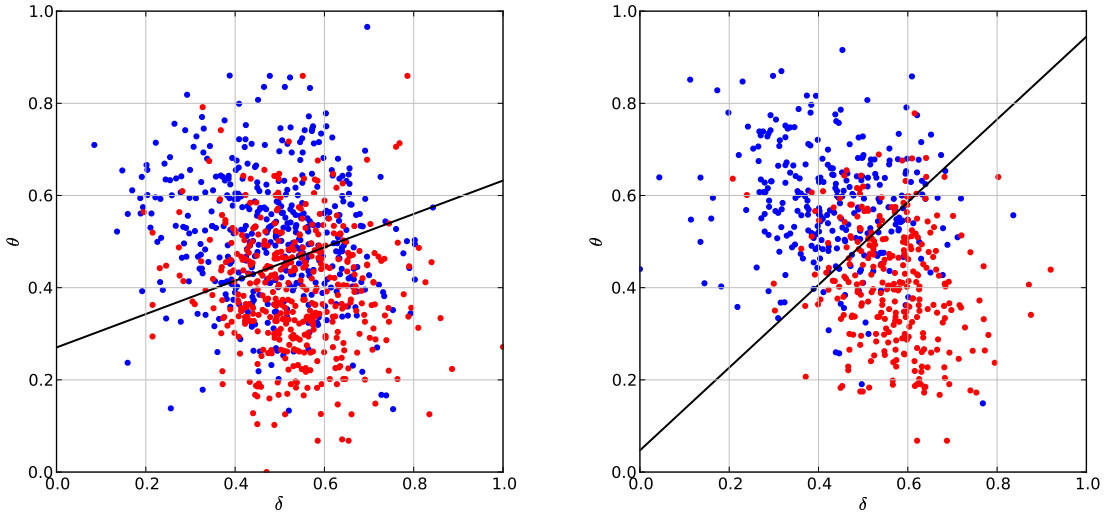



Figure 4: Voter preferences and vote choices in the 1976 (left) and 2004 (right) U.S. Presidential elections

Note that the separation of voter blocks is much cleaner in 2004 than in 1976. Moreover, the separation in 1976 is primarily along economic issues (with high $\theta$ types mostly voting for Carter, and low $\theta$ types mostly voting for Ford). In contrast, in 2004, the separating line is considerably steeper and thus, to a higher degree along cultural lines, with social liberals primarily voting for Kerry, social conservatives for Bush.

Figure 5 displays the development of $k$, defined in (7). Given the values of $\delta_i$ and $\theta_i$ for each voter in each year, we estimate the model given in equation (19), and use (20) to determine $k$ and $\sigma$.

After the initial decrease in $k$ from 1972 to 1976, the relative importance of cultural issues starts to increase to reach high points in 2000 and 2008. The confidence intervals given in Figure 5 clearly indicate that, while election-to-election changes are often not statistically significant, the longer term trend definitely is statistically significant (we will discuss statistical significance in more detail below).

What do these values of $k$ mean? Consider an individual voter who is on the separating line and thus just stochastically indifferent between Democrats and Republicans in the 1976 elections: From our perspective as outside observers who only know his policy preferences, but not his idiosyncratic preference $\varepsilon$, he has a 50% probability of voting Republican. Suppose now that we consider a second voter who is one standard deviation more culturally conservative (i.e., someone whose $\delta$ is 0.132 points higher than the first voter).

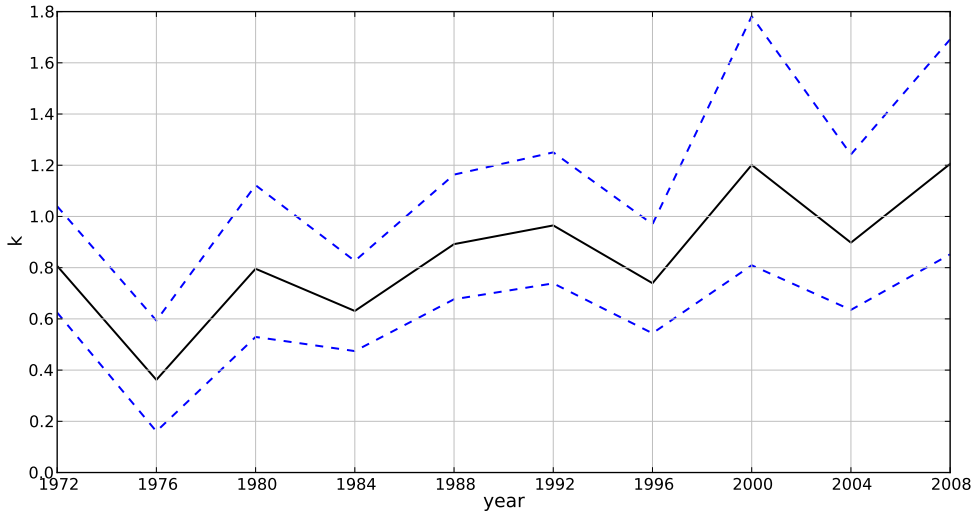



Figure 5: The development of $k$ from 1972 to 2008

How much more economically liberal than the first voter would this second voter have to be in order for his probability to vote Republican to remain at 50%? Given that $k$ in 1976 is about 0.362, the answer is that an increase of $\theta$ by $0.132 \times 0.362 \approx 0.048$ points (i.e., about 32% of one standard deviation of $\theta$) is sufficient to compensate for the higher cultural conservatism of the second voter.

Now consider the same exercise in 2000. An increase in $\delta$ by one standard deviation (0.124 points) now requires an increase of $\theta$ equal to $0.124 \times 1.201 \approx 0.149$ in $\theta$ to keep the probability of voting Republican unaffected, and such an increase equals about 104% of one standard deviation of $\theta$. Thus, the importance of cultural preferences relative to economic preferences for the vote choice has more than trippled between 1976 and 2000.

This result is *not* a consequence of voters directly putting more weight on cultural issues in 2000 than in 1976; changes in the distribution of preferences are independent of these changes in $k$, and, as argued above, preferences did not actually change all that much. Instead, in our model, the much larger relative weight on social-cultural issues is a consequence of *elite polarization*. In the context of our model framework, these results imply that the distance between the cultural positions of Democrats and Republicans has increased since the 1970s, relative to the distance between their economic positions.

Table 3 provides 95% confidence intervals for the estimated model parameters $k$, $a$, $\sigma$. Considering the development of $k$ shows that the general increase in $k$ is statistically significant. The value of $k$ in 2000

| year | $k$ | conf $k$ | $a$ | conf $a$ | $\sigma$ | conf $\sigma$ | $p$ | conf $p$ |
|---|---|---|---|---|---|---|---|---|
| 1972 | 0.807 | [0.625,1.040] | 0.198 | [0.093,0.283] | 0.229 | [0.194,0.272] | 5.620 | [4.951,6.437] |
| 1976 | 0.362 | [0.161,0.593] | 0.270 | [0.152,0.374] | 0.260 | [0.216,0.317] | 4.086 | [3.452,4.874] |
| 1980 | 0.796 | [0.529,1.122] | 0.133 | [-0.025,0.259] | 0.212 | [0.174,0.262] | 6.023 | [5.143,7.184] |
| 1984 | 0.631 | [0.474,0.826] | 0.245 | [0.157,0.317] | 0.193 | [0.164,0.227] | 6.136 | [5.389,7.087] |
| 1988 | 0.892 | [0.677,1.163] | 0.052 | [-0.084,0.160] | 0.226 | [0.190,0.273] | 5.917 | [5.158,6.853] |
| 1992 | 0.965 | [0.739,1.250] | -0.062 | [-0.211,0.056] | 0.229 | [0.192,0.274] | 6.057 | [5.280,7.015] |
| 1996 | 0.739 | [0.544,0.970] | 0.041 | [-0.082,0.148] | 0.180 | [0.150,0.216] | 6.909 | [5.992,8.171] |
| 2000 | 1.201 | [0.809,1.782] | -0.194 | [-0.508,0.018] | 0.235 | [0.181,0.313] | 6.654 | [5.591,8.120] |
| 2004 | 0.898 | [0.635,1.242] | 0.047 | [-0.127,0.180] | 0.181 | [0.144,0.226] | 7.408 | [6.245,9.065] |
| 2008 | 1.205 | [0.852,1.692] | -0.204 | [-0.472,-0.009] | 0.216 | [0.170,0.274] | 7.260 | [6.290,8.626] |

Table 3: Estimates of model parameters $k$, $a$, $\sigma$ and $p$ with 95% (bootstrap) confidence intervals (Base: 1992-2008)

and 2004 is significantly higher than the value of $k$ in each of the elections from 1972 to 1984. Thus, the long-term increase in $k$ is certainly not spurious. In contrast, changes from one election to the next are only in some cases significant.

The value of $a$ determines the position of the separating line, with higher values being favorable for Republicans. One can view this term as resulting from a pure valence shock that makes all voters more or less likely to vote Republican, for example because of the state of the economy (by (7), $a$ depends on the average value of $\xi$ among voters). However, interpreting $a$ in isolation is usually difficult because both $a$ and $k$ together determine the position of the separating line. For a rough estimate, one can consider the $\theta$-value on the separating line at the average value of $\delta$. In a good year for the Democratic candidate, this value is low, and vice versa (because the Democrat receives most votes from people located above the separating line). This indicates, for example, that 1976 was a much better year for Democrats than both 1972 and 1980. We will discuss the last value given in Table 3, $p$, further below in more detail.

We return now to consider the temporal development of $k$, and to argue that the development of the values over the different elections is qualitatively plausible. Our first comparison is with some result of Roemer (1998). The NES asks each respondent to list his view of the three most important issues in this year's election. Roemer coded these issues as "economic issues," "values issues," or "other issues," and defined the *salience of values* as the number of values issued mentioned divided by the number of economic issues mentioned in the answer to this question. Since $k$ increases over time, we would also expect that

Roemer's salience measure increases. In fact this is the case: For the five presidential elections included in his analysis, salience is strictly increasing from 1976 to 1988, and drops to the 1984 level in 1992. This said, the two measures do not measure the same concepts. For example, we suspect that a mention of 'unemployment' may well have been coded as an 'economic issue' by Roemer, but if the mention occurs during a recession, it may simply be a sign of the incumbent's low economic competence in the voter's view (i.e., affecting *a*), rather than a sign that economic positions become more important for the voter's choice.

We now turn to a qualitative–historical discussion of the development of *k*. The *k* for 1972, the election, between Nixon and McGovern is relatively high. This election was primarily about the Vietnam war and related social issues (such as amnesty for draft dodgers or the policy toward illegal drugs), while economic differences played a smaller role. For example, the Wikipedia article on the 1972 presidential election states:[17]

> On April 25, 1972, George McGovern won the Massachusetts primary and journalist Bob Novak phoned Democratic politicians around the country, who agreed with his assessment that blue-collar workers voting for McGovern did not understand what he really stood for. On April 27, 1972 Novak reported in a column that an unnamed Democratic senator had said of McGovern: "The people don't know McGovern is for amnesty, abortion and legalization of pot. Once middle America –Catholic middle America, in particular – finds this out, he's dead." The label stuck and McGovern became known as the candidate of "amnesty, abortion and acid."

In contrast, the *k* for 1976 is the lowest in the whole period under consideration. The Wikipedia article[18] mentions the aftermath of Watergate as a fundamental theme (in our parlance, this topic is probably better classified as a idiosyncratic valence effect than as a cultural issue). The only economic campaign issue mentioned is that Ford unsuccessfully asked Congress to end the 1950s-era price controls on natural gas, and the only cultural issue mentioned is that Carter pledged to end desegregation busing (a fairly conservative position for a Democratic candidate). Other issues mentioned are squarely in the idiosyncratic category.[19] Carter, an evangelical Christian, did very well in states that have a high share of conservatives (winning almost all states of the former Confederacy). Clearly, this doesn't imply that Carter was the more

[17] http://en.wikipedia.org/wiki/United_States_presidential_election,_1972, accessed 3-21-2011.

[18] http://en.wikipedia.org/wiki/United_States_presidential_election,_1976, accessed 3-21-2011.

[19] Carter blundered by admitting that he "lusted in my heart for women" other than his wife; and Ford blundered by stating that "there is no Soviet domination of Eastern Europe and there never will be under a Ford administration".

conservative candidate (the positive slope of the separating line in Figure 4 actually demonstrates that more conservative voters were more likely to vote Republican), but it means that Carter cannot have done too badly with conservative voters in the 1976 election.

From 1976 to 1992, $k$ increases substantially. Without going into details in every election, it is generally accepted that the election of 1980 was a key turning point in American politics. "Reagan's success as a conservative would initiate a realigning of the parties, as liberal Republicans and conservative Democrats would either leave politics or change party affiliations through the 1980s and 1990s to leave the parties much more ideologically polarized."[20]

This, in fact, is our interpretation of ideological polarization in presidential elections: Suppose that, in cultural issues, the most important political power of the president is his ability to nominate justices for the Supreme Court (issues like abortion or gay marriage are primarily decided by judges rather than the legislative or executive branch of government in this country). Suppose furthermore that the President will generally pick a member of his own party, but without necessarily being able to fine-tune the ideological position of the nominee. If the cultural positions represented are fairly heterogeneous within each party, and the distribution of Democrats is fairly similar to that of Republicans, then voters do not perceive a large cultural difference between parties, and they do not weigh this issue heavily when deciding whom to vote for, even if they care a lot about cultural issues. In contrast, if most Democrats are clearly pro-choice and most Republicans are clearly pro-life, voters will take this into account much more when deciding whether to vote for the Democrat or the Republican in the presidential election.[21]

What about the substantial decrease of $k$ in 1996? The Wikipedia description of the main campaign issues in this race between Bill Clinton and Bob Dole states that

> With respect to the issues, Dole promised a 15% across-the-board reduction in income tax rates and made former Congressman and supply side advocate Jack Kemp his running mate. Bill Clinton framed the narrative against Dole early, painting him as a mere clone of unpopular House Speaker Newt Gingrich, warning America that Bob Dole would work in concert with

[20] http://en.wikipedia.org/wiki/United_States_presidential_election,_1980, accessed 3-21-2011.

[21] For example, Republican Gerald Ford nominated John Paul Stevens for the U.S. Supreme court, who was confirmed by the Senate with a 98-0 vote. Stevens eventually developed into the leader of the liberal wing on the Court. However, it probably was not Ford's intention to choose a particularly liberal justice. His short-list apparently also included Robert Bork and Antonin Scalia, and thus the full ideological span of the Republican party in the 1970s. In contrast, nomination shortlists in the years after 2000 probably displayed a much larger degree of ideological homogeneity.

the Republican Congress to slash popular social programs, like Medicare and Social Security, dubbed by Clinton as ”Dole-Gingrich”. Bob Dole’s tax-cut plan found itself under attack from the White House, who said it would ”blow a hole in the deficit” which had been cut nearly in half during his opponent’s term.

In contrast, there is no mention of any campaign issue that can be classified as cultural. This does not necessarily mean that voters did not perceive cultural differences between the candidates (because, of course, the general differentiation of the parties along cultural lines proceeded throughout the nineties), but in general, Bob Dole did not qualify as a conservative culture warrior. Also, Dole’s running mate Jack Kemp is described in Wikipedia as having “sometimes sounded like a liberal Democrat: he supported affirmative action and rights for illegal immigrants” (though he opposed abortion).

## 8.3 Voter Migration

The largest increase of $k$ occurred in the 1980 and the 2000 Presidential elections. As a result, economically liberal but cultural conservative voters left the Democratic party and supported the Republican candidates. The size of this voter migration can be seen in figure 6

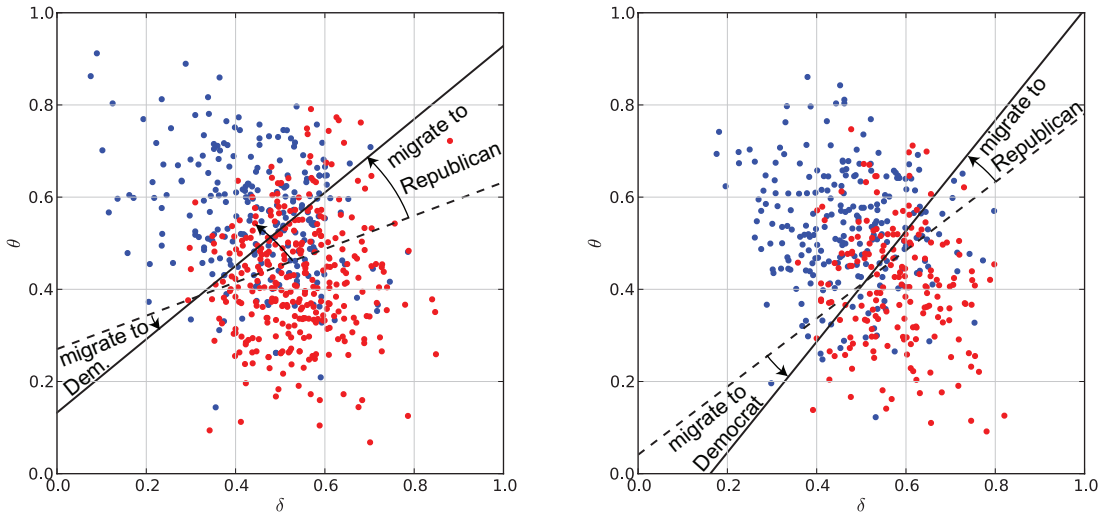



Figure 6: “Reagan Democrats” in the 1980 (left) and the 2000 (right) U.S. Presidential elections

The left panel of figure 6 shows the distribution of voter types in the 1980 election between Reagan and

Carter. The dashed line is the separating line from the 1976 election, and the solid line is the actual one for 1980. The area between the dashed and solid lines shows the extend of voter migration from one party to the other. 18.6 percent of the population shifted their allegiance to the Republicans, i.e., unlike in 1976 they had a higher than 50 percent probability of voting Republican in 1980. These voters have a high $\theta$, for example because of lower income or union membership, but they are culturally conservative and found Reagan's cultural conservatism appealing. In exchange, for these "Reagan Democrats", some fiscally-conservative but socially liberal voters migrated to the Democrats. However, only 0.2% of the population were in this regions, resulting in a net-gain for Reagan. Since then, $k$ has been above the 1980 level except for small dips in 1984 and 1996, which are not significant according to Table 3. In other words, the "Reagan Democrats" were lost to the Republicans in 1980 and never returned to the Democrats. Fiscally conservative but socially liberal voters gained by the Democrats did not make up for the loss.

The graph for the 2000 elections provides a very similar message. The dashed line represents the 1996 election. Bush was able to attract more fiscally liberal but culturally conservative voters than either Dole or Reagan. This gain corresponds to 6.0 percent of the population. Like Reagan, Bush lost some fiscally conservative but socially liberal voters, but those constituted only 1.2 percent of the population. Thus, Gore would have won easily, if he had been able to hold on to some of the cultural conservative voters that had still supported Clinton against Dole.

### 8.4 Platform Differentiation

We can use the model to identify changes in the distance between the candidates' platforms. In particular, (23) and (7) imply

$$\delta_D - \delta_R = \frac{\sigma(\xi)k}{2\sigma}, \text{ and } v(g_D) - v(g_R) = \frac{\sigma(\xi)}{\sigma} \tag{24}$$

If we assume that the standard deviation of $\xi$ did not change,[22] we can identify both the cultural and economic difference in the candidates' platforms, if we normalize the policy difference $v(g_D) - v(g_R)$ in a base year to, for example, 100. We have chosen 1976 as the base year for both series, because it is the lowest point for both. Figure 7 displays the development of the difference between the candidates' cultural and economic positions implied by the model.

[22] We do not need to make an assumption with respect to the mean of the $\xi_i$, so that a candidate can have a higher valence that all people appreciate, as long as the additional idiosyncratic shock has a constant distribution.

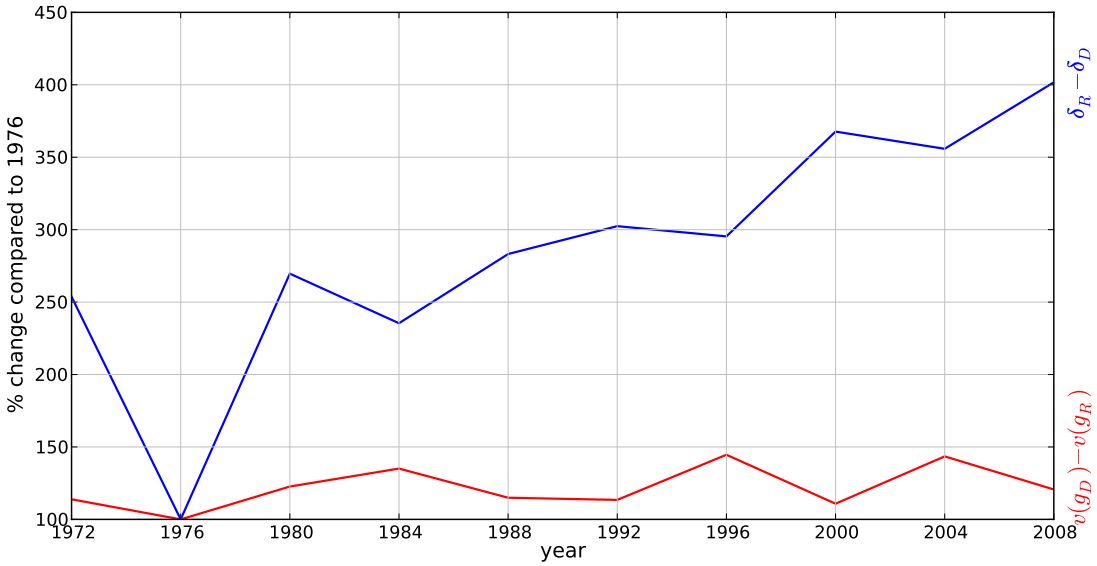



Figure 7: The polarization of candidates from 1972 to 2008

The data show that the difference between the two parties' cultural positions, $\delta_R - \delta_D$ is more than three times as large after 1992 than it was in 1976. For economic positions, the change in the distance between positions is much smaller (the maximum change is to an index value of less than 150 in 1996).[23]

It is useful to contrast our model and its implications about the polarization of candidate platforms in presidential elections with Poole and Rosenthal's DW-nominate score that measures polarization in Congress. The DW-nominate score is based on legislators' actual votes in Congress. Party polarization is commonly operationalized by considering the difference between the average Democratic and the average Republican score. Poole and Rosenthal's method cannot be applied to compare the positions of presidential candidates because very rarely, both candidates serve in Congress during the same time period and thus voting on the same laws (Obama vs. McCain was the only exception to this in the recent past, and clearly, a single data point does not tell us anything about the development of polarization over time).

In contrast, our method is based on comparing the behavior of voters, and thus on their understanding of what the differences between candidates are. Crucially, our data have a measure of the voters' preferred positions, as well as their vote choices. This allows us to reconstruct the importance of economic and cultural

[23]Note that the impact of changes in $\delta_R - \delta_D$ versus changes of $v(g_D) - v(g_R)$ cannot be compared against each other, because $\delta_R$ and $\delta_D$ enter with a square in the utility function, and the utility impact also depends on the individual voter's $\delta$ and $\theta$.

positions for vote choices and, assuming that the variance of the idiosyncratic preference shocks is fixed, it allows us to reconstruct a measure of the distance between policy platforms on both the cultural and the economic dimension.

## 8.5 Preference Intensity

Another measure that our model provides is the development of the preference intensity $p$ over time. Remember that the preference intensity $p$ is defined as the inverse of the distance between the 50 percent separation line, and the line that is one standard deviation away and thus contains all types whose probability of voting Republican is 84.1 percent (also, the distance to the 15.9 percent line). Effectively, $p$ measures the distance between different "isoprobability lines", that is, lines that run parallel to the 50 percent separation line and have the property that all types on the line have the same probability of voting Republican (say, 30%, 40%, 60%, 70% etc.).[24] If these lines are far apart from the 50 percent separation line, then most voters lie between, say, the 30 percent line and the 70 percent line and are "moderates" in the sense that their vote choice is not predetermined by their political preferences, but also depends on their idiosyncratic personal preference for the specific candidates. If, in contrast, the isoprobability lines are close together (i.e., the inverse of their distance from each other is high), then there are fewer moderates.

Figure 8 shows the development of the policy preference intensity $p$ from 1972 to 2008. Overall, there is a clear increase in $p$, from a low of about 4.1 to a value around 7.4. The increasing trend reflects the increase of $k$ and the decrease of $\sigma$ over the same time period. Table 3 shows that this increase is statistically significant; for example, the value of $p$ in 2004 and 2008 is significantly higher than the value of $p$ in any election before 1996.

## 8.6 Polarization and Sorting of the Electorate

Up to this point we have investigated "elite polarization," i.e., increasing differences and changes in the policy position of the presidential candidates. Bigger difference in candidate platforms lead to an increased sorting of voters, i.e., social and fiscal conservatives become more likely to voter Republican, while social

[24] There is noting special about focusing on the one standard normal standard deviation line. If we were to take any other value, say the 70% line, the absolute values of $p$ would evidently be different, but the percentage change between different years would be exactly the same as for the values reported in Table 8.

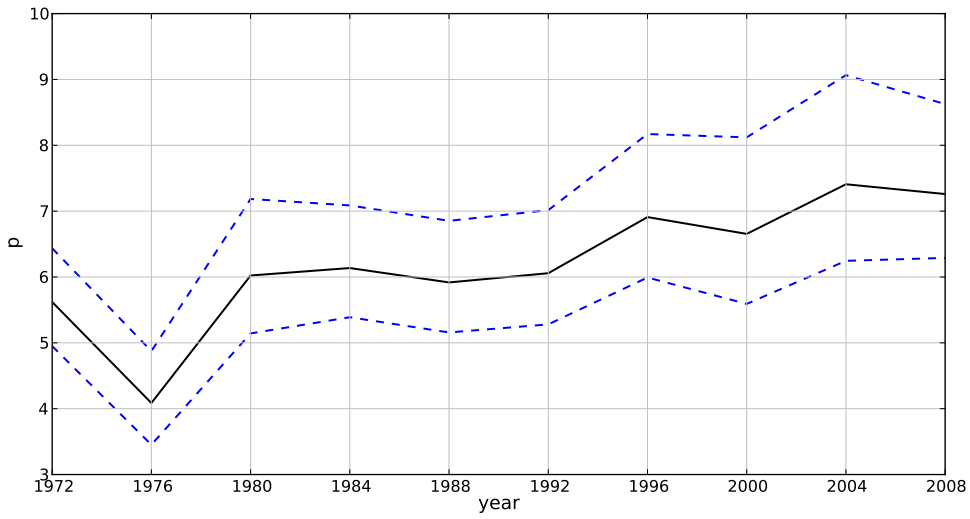



Figure 8: The development of $p$ from 1972 to 2008

and fiscal liberals have an increased probability of voting Democratic. As explained in Levendusky (2009) sorting is different from polarization. To use his example, suppose there are three types, liberals, conservatives and moderates. Suppose that in year $A$ half of the liberals vote Republican and half of the conservatives vote Democratic, while in year $B$ all liberals vote Democratic and all conservative vote Republican. Then the electorate is more sorted in year $B$ than in year $A$, however, polarization has not changed since the number of voters of each type remained the same. In contrast, suppose that in year $B$ there are more conservatives and liberals, and less moderates than in year $A$. Then the electorate is more polarized in year $B$ than in year $A$. The objective of this section is to separately measure changes in sorting and polarization.

To do this, we introduce the measure of *position predictiveness*, $\Psi$. Suppose that we are asked to predict the voting behavior of a large group of voters in a tight election. If we did not have any information about these voters, we could not do better than flipping a coin (or predict "Democrat" for every voter), and this will give us a 50 percent "success quota." Using information about the preferred political positions of a voter will enable us to make better predictions: We will predict that a voter votes Republican (Democrat) whenever his position is below (above) the separating line, and the probability of being correct for voter $i$ with this prediction is simply $\Phi\left(\frac{1}{\sigma_t}[k_t\delta_i - \theta_i + a_t]\right)$, where $(k_t, a_t, \sigma_t)$ denote the parameters for a separating line for year $t$.

Note that a problem could arise in lopsided elections. For example suppose that 70 percent of voters

vote for the Republican candidate in an election because that candidate has a large expected valence $\bar{\xi}$. Then even a completely uninformed guesser could achieve a 70 percent success quota (by guessing that each voter votes Republican). To avoid this problem, we adjust the valence such that the election would have ended in a tie. More formally, we find a new intercept $a_t'$ such that $\Phi\left(\frac{1}{\sigma_t}[k_t\delta_i - \theta_i + a_t']\right) = 0.5$.

We measure the quality of information about political positions by how much the success quota of our forecasting system lies above the success quota of a pure coin flip, given by

$$\Psi_t = 2\frac{\sum_{i=1}^{I}\left|\Phi\left(\frac{1}{\sigma_t}[k_t\delta_i - \theta_i + a_t']\right) - 0.5\right| w_i}{\sum_{i=1}^{I} w_i}, \tag{25}$$

where $w_i$ is the sample weight of voter $i$. Note that $\left|\Phi\left(\frac{1}{\sigma_t}[k_t\delta_i - \theta_i + a_t']\right) - 0.5\right|$ is the increase in the success probability relative to a pure coin flip, and the factor 2 in front normalizes the expression such that it lies between 0 and 1.[25]

If $\Psi = 1$, society is extremely divided along ideological lines: Every conservative votes Republican, and every liberal votes Democratic. Since the voters' preferred policy positions are presumably relatively constant, this means that most voters would know which party they will vote for before they know who are the actual candidates of each party – they are not going to give the other party's candidate a chance to convince them to switch parties in this election, so they are not "swing voters." In contrast, if $\Psi = 0$, knowledge of a voter's a-priori ideology does not help to predict voting behavior – all voters are ex-ante open to both candidates.

Both increased sorting and increased polarization increase $\Psi$: Given the same set of voters, a decrease in $\sigma_t$ brought about by a starker contrast between the candidates' positions leads to more sorting (i.e., the values of $\Phi(\cdot)$ are farther apart from 0.5, for every voter). Alternatively, position predictiveness can increase for constant candidate positions (constant $\sigma_t$) if voters' ideal positions move away from the dividing line, so that $[k_t\delta_i - \theta_i + a_t']$ increases.

To isolate the effect of polarization, we fix the separating line $(k_t, a_t, \sigma_t)$ for base years $t = 1976$ (left part of Figure 9) and $t = 2004$ (right). We choose these years as base years because they are the most different in the sample; nevertheless, as Figures 9 and 10 indicate, the graphs are only vertically shifted but otherwise very similar.

[25] That is, $\Psi$ measures the increase in the success quota over a pure coin flip relative to the success quota of a pure coin flip. For example, if knowledge of political preferences allows to correctly forecast 70 percent of voters, then this is $(0.7 - 0.5)/0.5 = 40\%$ better than a pure coin flip.

Note that the value at 1976 in the left panel is the actual value of $\Psi$ in the 1976 election, while the value at time $t \neq 1976$ is the value of $\Psi$ that would arise for the time $t$ electorate, given fixed 1976 policies. The right panel displays the same information taking as base the 2004 policies. Since we know from the last section that the 2004 candidates' policies were considerably more distinct from each other than in 1976, we expect that the values of $\Psi$ in the right panel are considerably higher than in the left panel, and this expectation is borne out by the data.

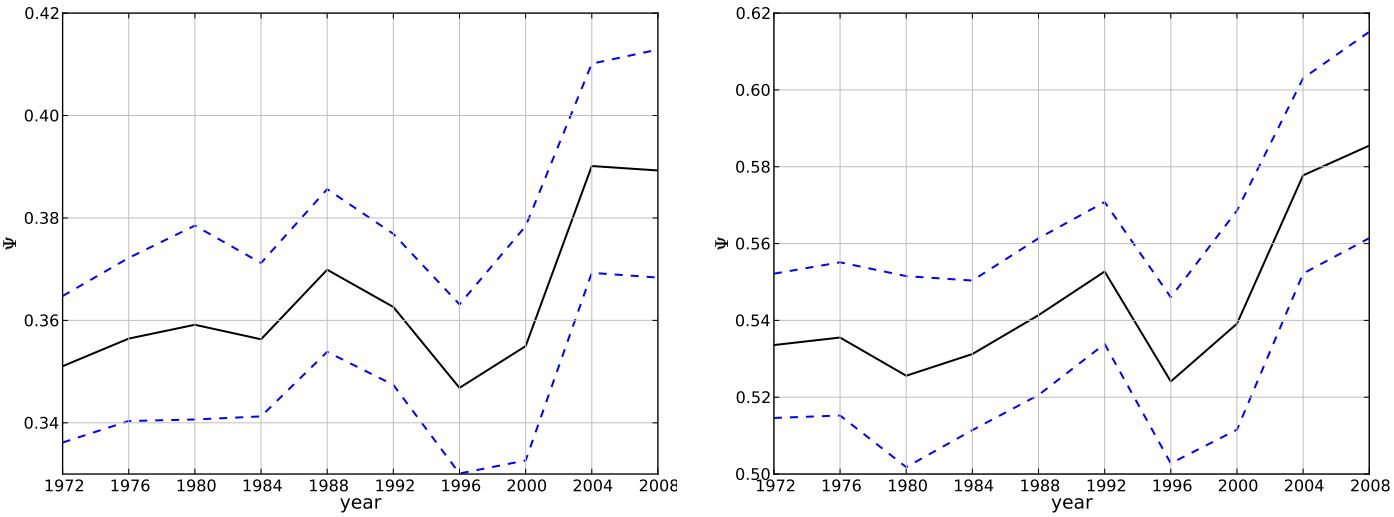



Figure 9: Polarization measured by $\Psi$ for fixed 1976 (left) and 2004 (right) platforms

Overall, voter polarization appears more or less flat throughout the time period, with a notable decrease in 1996 and a slightly higher value in the last decade. In particular, the values of $\Psi$ in 2004 and 2008 are significantly higher than in all years before 2000, indicating that there has been some polarization of the electorate in this decade. However, the size of the polarization effect it is relatively small, with an increase of the point estimate of $\Psi$ by about 0.03 over the average value of $\Psi$ from 1972 to 2000. Since the total increase of predictiveness from 1976 to 2004 is about 0.22, this suggests that the bulk of this increase is caused by increased voter sorting rather than by polarization.

To isolate the effect of sorting, we fix the electorate $\{(\delta_i, \theta_i)|i = 1, \ldots, I\}$ from a base year. We then take the separating line $(k_t, a_t', \sigma_t)$ for any year $t$ to compute $\Psi_t$ to measure the pure sorting effect. The result for base years 1976 and 2004 (with 95% confidence intervals) is shown in Figure 10. Both panels show a significant and substantial increase in sorting over time.

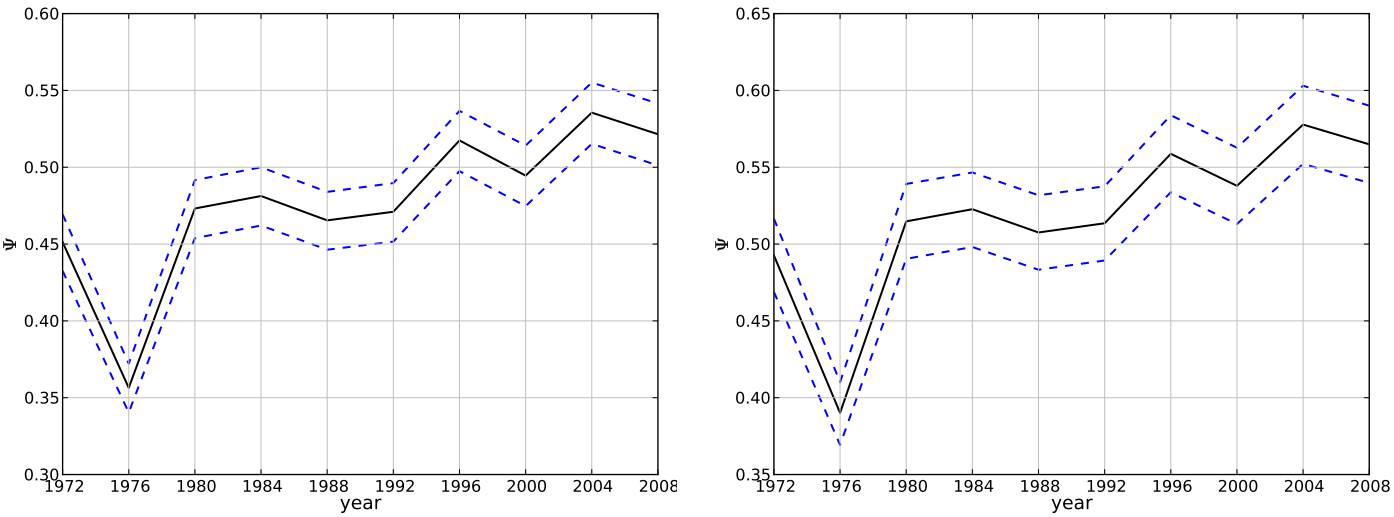



Figure 10: Sorting measured by $\Psi$ with base electorate1976 (left) and 2004 (right)

It is interesting to consider some key years in which polarization and/or sorting changed significantly. The predictiveness of political positions is lowest in 1976. Both in 1972 and in 1980, sorting is significantly higher, while there is no significant change in the polarization of the American electorate. The Nixon vs. McGovern and the Reagan vs. Carter race offered the U.S. electorate a much starker choice than the Ford vs. Carter race in 1976.

In contrast, consider the change that took place between the 2000 and 2004 elections, where both sorting and polarization increase significantly, and by roughly the same amount. In fact, this is the only year in which the polarization jumps up significantly, and it remains at roughly this level in 2008, which increases our confidence that this jump in the electorate's polarization is real and permanent. While Reagan's elections in the 1980s marked the beginning of the overall trend of increased predictiveness of political ideology for vote choices, this is an instance of pure elite polarization that did not result in significant change of the polarization of the electorate itself. In contrast, the current high point of predictiveness in the first decade of this century is a hybrid result of even stronger elite polarization (resulting in even more sorting), but now in conjunction with increased polarization in the U.S. electorate itself. In a nutshell, the elite polarization that started a generation ago has finally caught up with the electorate.

What was the cause of the significant change between 2000 and 2004? Notwithstanding the recognition from today's point of view that a Gore presidency would likely have been very different from the Bush pres-

idency, many journalists and voters at the time actually perceived very limited policy differences between Bush and Gore. Political talk shows featured discussions among political pundits about which candidate voters would rather have a beer with, and which outfit Al Gore should wear to emphasize his alpha male credentials. However, after the 2000 election, a series of very controversial events such as the Florida recount and the decision to go to war in Iraq take place, and we see a sharp increase in the overall $\Psi$ in 2004 (from 0.50 to 0.58; the second largest increase in $\Psi$, after the 1980 increase). As already mentioned in the introduction, some quotes from the popular press about the 2004 election state that "America is more bitterly divided than it has been for a generation" and that "the 50-50 nation appears to be made up of two big, separate voting blocks, with only a small number of swing voters in the middle." Our results provide some evidence that this is actually true.[26]

# 9 Robustness

## 9.1 Results driven by realignment of Southern Whites?

One of the secular changes in the U.S. political landscape is the partisan realignment of in the former confederate states. After the Civil War and Reconstruction periods, most Southern whites felt an animosity against the Republican party, and in the 1930s, Roosevelt managed to include Southern whites in his New Deal coalition. As a consequence, the Deep South remained one of the most Democratic regions of the country for the next generation. Thus, during this time, both parties had culturally conservative wings. Following the civil rights legislation of the 1960s, a large block of social conservatives (white, southern evangelicals) migrated to Republican party. This partisan realignment of the South proceeds throughout the

[26]Some external evidence for the comparison between the 2000 and 2004 elections is available in the Gallup polls taken before the election which ask respondents the degree to which they support a candidate (as cited by Bernhardt, Krasa, and Polborn (2008)). For the 2004 elections the polls reveal stronger preferences than in the previous three presidential elections: for the 2004 elections, 71% of voters indicated a strong preference for their candidate versus 64% for the 2000 elections (This number is an average of the three polls that asked this question, weighted by number of respondents.) Given that partisans are likely to support their candidate strongly in any election, these numbers indicate that significantly more voters with policy preferences that would previously have been considered "moderate" had strong preferences in the 2004 elections. Also, stronger preference intensities by moderates correspond to a smaller percentage of undecided voters. The exit polls of the 2000 and 2004 elections support this claim. In 2004, only 11% of voters were undecided until the last week, while the corresponding number for 2000 was 18%. Similarly, the corresponding percentages for being undecided a month before the elections were 22% in 2004 and 31% in 2000.

period we consider in our paper. The reader may therefore wonder whether it could be the case that our empirical results pick up this realignment of voters, rather than a change in the position of parties.

The most consistent interpretation of the Southern counter-hypothesis is that, during the 1970s, some voters with cultural conservative and economically liberal positions (i.e., the Southern whites from the argument) may have preferred the position of the Republican candidate for policy reasons, but had a strong non-policy dislike against voting Republican and therefore voted for the Democrat. In other words, voters in the south would have a lower average valence $\bar{\xi}$ for Republican candidates than voters in the north. This could have unpredictable consequence on the estimation of $k$ if we pool southerners with northerners.

To check whether systematic valence differences could have affected our results, we repeat our analysis for three subsets of voters: those who live in the South, Southern Whites specifically, and voters who live in the North (i.e., anywhere outside the South). Table 4 provides the resulting $k$ for these three sets, as well as (for comparison) for the country as a whole.

| year | $k_{US}$ | conf $k_{US}$ | $k_S$ | conf $k_S$ | $k_{S,W}$ | conf $k_{S,W}$ | $k_N$ | conf $k_N$ |
|---|---|---|---|---|---|---|---|---|
| 1972 | 0.807 | [0.625,1.040] | 1.265 | [0.720,2.281] | 1.575 | [0.698,5.040] | 0.718 | [0.516,0.964] |
| 1976 | 0.362 | [0.161,0.593] | 0.285 | [-0.169,0.865] | 0.298 | [-0.291,1.217] | 0.410 | [0.182,0.667] |
| 1980 | 0.796 | [0.529,1.122] | 0.688 | [0.208,1.354] | 0.475 | [0.038,1.078] | 0.844 | [0.545,1.240] |
| 1984 | 0.631 | [0.474,0.826] | 0.492 | [0.136,0.980] | 0.372 | [-0.031,0.999] | 0.663 | [0.492,0.868] |
| 1988 | 0.892 | [0.677,1.163] | 1.536 | [0.917,2.676] | 1.142 | [0.555,2.289] | 0.782 | [0.554,1.059] |
| 1992 | 0.965 | [0.739,1.250] | 0.853 | [0.470,1.422] | 0.969 | [0.472,1.811] | 1.024 | [0.759,1.373] |
| 1996 | 0.739 | [0.544,0.970] | 0.573 | [0.298,0.921] | 0.655 | [0.284,1.221] | 0.834 | [0.579,1.183] |
| 2000 | 1.201 | [0.809,1.782] | 0.922 | [0.435,1.677] | 1.169 | [0.404,2.724] | 1.323 | [0.788,2.204] |
| 2004 | 0.898 | [0.635,1.242] | 0.897 | [0.431,1.755] | 0.945 | [0.282,2.616] | 0.899 | [0.613,1.298] |
| 2008 | 1.205 | [0.852,1.692] | 0.996 | [0.598,1.597] | 1.632 | [0.712,5.340] | 1.290 | [0.780,2.117] |

Table 4: Estimates of $k$ for the entire United States ($k_{US}$), for the South only ($k_S$), for Southern Whites only ($k_{S,W}$) and for all Northern voters ($k_N$), with 95% (bootstrap) confidence intervals.

Note that, because of the smaller numbers of respondents in each subset, confidence intervals are substantially wider for the value of $k$ in subsets than for the corresponding $k$ for the entire United States. For all years, there is no $k$ for any subset of voters that is significantly different from the $k$ for the whole United States.[27]

[27]For a meaningful "significant difference", it should be true that the point value of $k_{US}$ is outside the confidence interval for the subset (and not the other way around). The reason is that, the smaller the subsets become, the more volatile the point estimate for

Next, note that the results for $k$ for the entire US are virtually identical with those for the North (i.e., entire US minus the former confederate states), and hence systematic differences of Southern voters cannot have affected the main conclusions of the paper. In addition note that the increase of $k$ starting with 1976 is also present in the two subsample for the south, indicating that the results for South alone are consistent with those for the rest of US, although the small sample size results in large confidence intervals which makes it difficult to draw any firm conclusions.

In summary, Southerners (in particular, Southern Whites) vote more Republican than the rest of the country, but they do so because they have political preferences that differ from the rest of the country, and not because they trade off their positions on cultural and economic issues in a way that differs from how voters in the rest of the country trade off positions on these issues. Further, our results remain valid if we drop the South from the data. This provides strong support for our interpretation that the increase in $k$ is caused by changes in party platforms rather than the alternative Southern realignment hypothesis.

### 9.2 Direct measurement of candidate positions

In our model, candidate positions on economic and cultural issues are inferred indirectly by measuring the response of voters whose ideal positions we can measure directly. In principle, it would be interesting to compare how our indirect measure of candidate positions compares with a direct assessment of these positions by voters, even though data availability is a major problem. The NES contains only a limited number of questions that ask respondents for their assessment of the candidates' positions, so that we cannot calculate candidates' positions in the $(\delta, \theta)$ space by plugging their voter-assessed positions on every issue into the economic and cultural index formulas. The only questions that have sufficient data for the time period that we are considering are the following. VCF9083 and VCF9091 ask about the the democratic and republican candidate's position on "role of women"; VCF9084 and VCF9091 ask about the position on giving "aid to blacks"; and VCF9087 and VCF9095 ask about the governments role in guaranteeing jobs. These questions correspond to VCF0834, VCF0830, and VCF0809 which ask respondents for their own position on these issues, and which we use to determine $\delta$ and $\theta$.

the parameter on that subset, and the wider the confidence interval. If we were to look whether the point estimate on the subset falls outside the US-confidence interval, this would happen more and more often the smaller the subset is, even if the true $k$ is the same throughout all sets. Looking instead whether the point estimate of the parameter for the U.S. as a whole falls outside the confidence intervals of the subsets avoids this problem.

To estimate candidates' positions on the three different policy issues in different years, we proceed as follows. In order to control for respondents' characteristics we estimate a regression that contains the difference in the two candidates' positions on a particular policy issue (as reported by the respondent) as dependent variable, and the respondent's $\delta$, $\theta$, $\delta^2$, $\theta^2$, and year dummies as explanatory variables. The year dummies are the variables of interest here, as they measure the average perceived difference in a given year, while the other variables control for respondent ideological characteristics. It turns out that centrists tend to report the smallest difference between candidates, while the candidate difference that extreme partisans report is larger.[28]

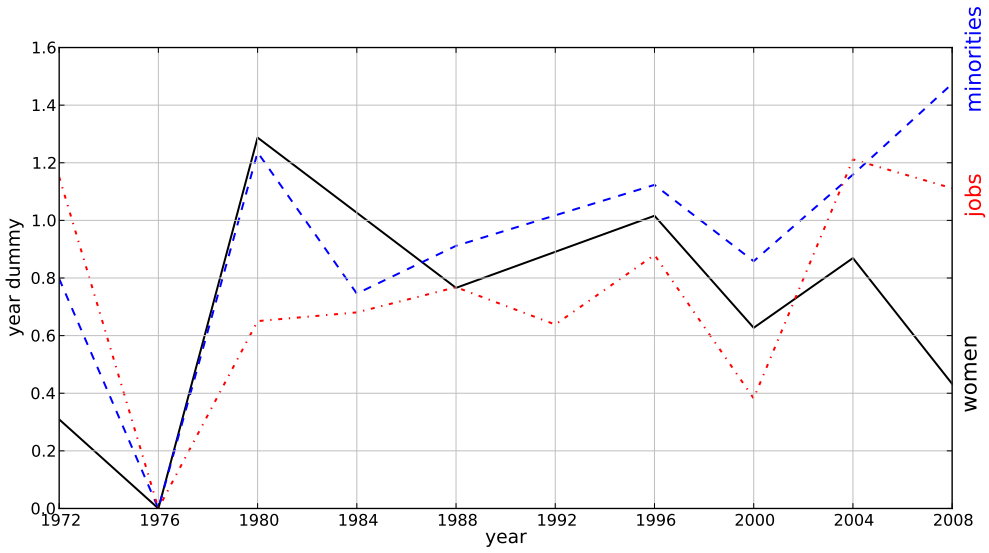



Figure 11: Difference in Candidate Positions on Different Issues

Figure 11 graphs the change in the difference between candidate position as captured by the coefficient of the year dummy, with 1976 as the base year, just like in Figure 7. (Note that the year dummies measure *differences relative to 1976*, so the value in 1976 is zero by definition.) The curves provide a picture that is at least qualitatively similar to the results derived in our basic model. Just like in Figure 7, perceived differences between the candidates decrease between 1972 and 1976 and then start to increase.

Before concluding, we should also point out that there may be an interpretative problem with measuring

[28] For question on on the role of women, the estimate difference in candidate positions is given by $-11.7\delta + 9.4\delta^2 - 3.9\theta + 5.5\theta^2$ plus the year dummies; for aid to minorities, the expression is $-12.9\delta + 11.1\delta^2 - 10.4\theta + 9.7\theta^2$; and for the jobs question we get $-7.6\delta + 5.6\delta^2 - 14.5\theta + 13.6\theta^2$. The minimum values $(\delta, \theta)$ for these three expression are $(0.62, 0.35)$, $(0.58, 0.53)$, and $(0.68, 0.53)$.

perceived candidate differences by using the respondent answers. For example, consider a policy area that consists of two binary issues A and B. Both candidates have adopted position 0 on issue A, while on issue B, the Democrat has position 0 and the Republican has position 1. Among voters, preferred positions on these issues are highly positively correlated – there are many $(0,0)$ and $(1,1)$ types, and few $(0,1)$ or $(1,0)$ types. Assume that the NES only asks for voters' preferred positions on issue A, and for their assessment of candidate positions. If voters know the candidates' positions and answer truthfully, they will report no difference between the candidates. Nevertheless, an *individual voter's* preferred position is informative about his candidate preference because it provides information about the contentious (but unmeasured) issue B. For example, consider the question on the "role of women" where 1 indicates that "women and men should have an equal role," and 7 that "women's place is in the home." It is safe to say that this issue was not a salient wedge issue in any of the recent elections, and that a fair assessment *of the literal question* should place both Democratic and Republican candidates close to the left end of the scale (few candidates would say anything close to wanting to send women "to the home"). In contrast, an individual respondent's position on this question is likely to be strongly correlated with positions on more salient social issues that are policy relevant, and therefore is more predictive of his vote choice.

## 10 Conclusion

In this paper, we have developed a theoretical model in which voters care about both economic and "cultural" policy positions, and tested the model empirically. Our particular focus was on the voters' trade-off between cultural and economic positions. Using data from the American National Election Survey, we show that the importance of cultural factors relative to economic issues for the vote choice has increased significantly over the last generation. As a consequence, the fault line through the American electorate has turned and reflects much more the divisions on cultural issues than a generation ago, although economic issues are still important. We show that the change of this fault line was generated by increasing divergence of party platforms that has been more pronounced for cultural than for economic issues. We show that the Republican party gained substantial support by their increased emphasis on cultural issues (i.e., they gained a lot more socially-conservative and economically-liberal voters than they lost socially-liberal and economically-conservative voters). These results are consistent with the observations by Stan Greenberg who coined the term "Reagan Democrats" for the culturally conservative voters of Macomb County, Michigan, just north

of Detroit (largely white, unionized auto-workers); and by Journalist Thomas Frank who writes about the development of party preferences in the state of Kansas.

As a consequence of the divergence of policy platforms (or "elite polarization") preference intensities and sorting of voters has increased, i.e., a voter's position on cultural and economic questions has become a much better predictor of voting behavior. While the political elites have become more polarized, there is no evidence of increased polarization of the electorate between 1972 and 2000, but this may have finally changed. We find a small but statistically significant increase in polarization for 2004 and 2008. The fact that until very recently, elite polarization had not discernible impact on voter preferences is consistent with the result of political scientists such as Mo Fiorina and Larry Bartels who have demonstrated that neither average preferences nor the dispersion of preferences in the U.S. electorate have changed dramatically. They also show that voting choices continue to be strongly influenced by a voter's economic position, which is consistent with our results.

Thus, our paper shows that the views of Greenberg or Frank on the one hand, and Fiorina and Bartels on the other, are not in conflict, as it has often been interpreted, but that they are logically consistent and we find evidence supporting both claims. This is the fundamental contribution of our model.

# Appendix

**Proof of Theorem 1.** Multiplying (5) by $v'(g_R)$ and (6) by $v'(g_D)$ and add them together we get

$$\sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f_\theta(\theta(\delta,\xi,g_D,g_R))[v'(g_R)c_D - v'(g_D)c_R]\pi_\Delta(\delta)\pi_\Xi(\xi) = 0. \tag{26}$$

Note that (26) is equivalent to

$$[v'(g_R)c_D - v'(g_D)c_R]\sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f_\theta(\theta(\delta,\xi,g_D,g_R))\pi_\Delta(\delta)\pi_\Xi(\xi) = 0.$$

Since $f_\theta$, $\pi_\Delta$ and $\pi_\Xi$ are non-negative and strictly positive for some realizations, it follows that

$$v'(g_R)c_D = v'(g_D)c_R. \tag{27}$$

Finally, note that (27), $c_R > c_D$ and $v'' < 0$ imply $g_D > g_R$.

(27) implies that $g_R$ is a differentiable function of $g_D$. We next prove that

$$\sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f_\theta(\theta(\delta,\xi,g_D,g_R(g_D)))[c_D - v'(g_D)\theta(\delta,\xi,g_D,g_R(g_D))]\pi_\Delta(\delta)\pi_\Xi(\xi) = 0 \tag{28}$$

has a solution. Recall that $v'(0) = \infty$. Further, $\theta \notin [0,1]$ then $f_\theta(\theta) = 0$. Thus, the left-hand side of (28) becomes less or equal to zero as $g_D \downarrow 0$. Next, suppose that $g_D \to \infty$. By assumption $v'(\infty) = 0$. Thus, since $f_\theta(\theta) = 0$ for $\theta > 1$, it follows that the left-hand side of (28) is greater or equal to zero for a sufficiently large $g_D$. As a consequence, continuity implies that (28) has a solution.

The second derivatives at a solution of the first order conditions are given by

$$\begin{aligned}\sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f'_\delta(\theta(\delta,\xi,g_D,g_R))[c_D - v'(g_D)\theta(\delta,\xi,g_D,g_R)]^2\pi_\Delta(\delta)\pi_\Xi(\xi)\\ - \sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f_\theta(\theta(\delta,\xi,g_D,g_R))v''(g_D)\theta(\delta,\xi,g_D,g_R)\pi_\Delta(\delta)\pi_\Xi(\xi),\end{aligned} \tag{29}$$

for candidate $D$, and for candidate $R$,

$$\begin{aligned}\sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f'_\delta(\theta(\delta,\xi,g_D,g_R))[c_R - v'(g_R)\theta(\delta,\xi,g_D,g_R)]^2\pi_\Delta(\delta)\pi_\Xi(\xi)\\ + \sum_{\xi\in\Xi}\sum_{\delta\in\Delta} f_\theta(\theta(\delta,\xi,g_D,g_R))v''(g_R)\theta(\delta,\xi,g_D,g_R)\pi_\Delta(\delta)\pi_\Xi(\xi).\end{aligned} \tag{30}$$

In order to have a minimum, (29) must be positive, while (30) must negative in order for candidate $R$ to maximize vote share. Since $v'' < 0$, both second order conditions are satisfied as long as $f'_\theta$ is sufficiently small. For example, they would automatically be satisfied for a uniform distribution. ■

**Proof of Theorem 2.** Let $N_\Lambda$ be the set of all $i$ with $\tilde{\lambda}_i < 0$. Then let $X_i = 1 - \tilde{X}_i$ if $i \in N_\Lambda$, and $X_i = \tilde{X}_i$, otherwise.

Similarly, let $N_M$ be the set of all $i$ with $\tilde{\mu}_i < 0$. Then let $Y_i = 1 - \tilde{Y}_i$ if $i \in N_M$, and $Y_i = \tilde{Y}_i$, otherwise.

Note that $\tilde{\lambda}_i \tilde{X}_i = -\tilde{\lambda}_i(1 - \tilde{X}_i) + \tilde{\lambda}_i$. Thus, for $i \in N_\Lambda$ we get $\tilde{\lambda}_i \tilde{X}_i = (\lambda X_i - \lambda_i) \sum_{i=1}^n |\tilde{\lambda}_i|$. For $i \notin N_\Lambda$ the definition of $\lambda_i$ implies $\tilde{\lambda}_i \tilde{X}_i = \lambda_i X_i \sum_{i=1}^n |\tilde{\lambda}_i|$. Thus,

$$\sum_{i=1}^n \tilde{\lambda}_i \tilde{X}_i = \left[\sum_{i=1}^n \lambda_i X_i - \sum_{i \in N_\Lambda} \lambda_i\right] \sum_{i=1}^n |\tilde{\lambda}_i| = \left[\sum_{i=1}^n \lambda_i X_i - \sum_{i \in N_\Lambda} \lambda_i\right] \frac{k}{\sigma}. \tag{31}$$

Similarly, it follows that

$$\sum_{i=1}^m \tilde{\mu}_i \tilde{Y}_i = \left[\sum_{i=1}^n \mu_i Y_i - \sum_{i \in N_M} \mu_i\right] \sum_{i=1}^m |\tilde{\mu}_i| = \left[\sum_{i=1}^n \mu_i Y_i - \sum_{i \in N_M} \mu_i\right] \frac{1}{\sigma}. \tag{32}$$

Further, the definition of $\lambda_i$ and $\mu_i$ in (12) and (13) imply

$$\lambda_i = -\frac{\min\{\tilde{\lambda}_i, 0\}}{\sum_{i=1}^m |\tilde{\lambda}_i|}, \text{ for } i \in N_\Lambda, \quad \mu_i = -\frac{\min\{\tilde{\mu}_i, 0\}}{\sum_{i=1}^m |\tilde{\mu}_i|}, \text{ for } i \in N_M. \tag{33}$$

Thus, applying (15), (14), and (33) to (16) implies

$$\begin{aligned} \tilde{a}\sigma + \sum_{i \in N_M} \mu_i - k \sum_{i \in N_\Lambda} \lambda_i &= \frac{\tilde{a}}{\sum_{i=1}^m |\tilde{\mu}_i|} - \frac{\sum_{i=1}^n \min\{\tilde{\mu}_i, 0\}}{\sum_{i=1}^m |\tilde{\mu}_i|} + k \frac{\sum_{i=1}^n \min\{\tilde{\lambda}_i, 0\}}{\sum_{i=1}^m |\tilde{\lambda}_i|} \\ &= \frac{\tilde{a} - \sum_{i=1}^n \min\{\tilde{\mu}_i, 0\} + \sum_{i=1}^n \min\{\tilde{\lambda}_i, 0\}}{\sum_{i=1}^m |\tilde{\mu}_i|} = a \end{aligned} \tag{34}$$

Equations (16), (31), and (34) therefore imply

$$\begin{aligned} \Phi\left(\left[\sum_{i=1}^n \tilde{\lambda}_i \tilde{X}_i - \sum_{i=1}^m \tilde{\mu}_i \tilde{Y}_i + \tilde{a}\right]\right) &= \Phi\left(\frac{1}{\sigma}\left[k \sum_{i=1}^n \lambda_i X_i - \sum_{i=1}^m \mu_i Y_i - k \sum_{i \in N_\Lambda} \lambda_i + \sum_{i \in N_M} \mu_i + \tilde{a}\sigma\right]\right) \\ &= \Phi\left(\frac{1}{\sigma}\left[k \sum_{i=1}^n \lambda_i X_i - \sum_{i=1}^m \mu_i Y_i + a\right]\right). \end{aligned} \tag{35}$$

Finally, we prove equation (17) that relates $\delta$ and $\theta$ to the parameters of the modified model.

Recall that $\delta = \sum_{i=1}^n \lambda_i X_i$. The first equality in equation (31) and (33) therefore imply

$$\delta = \frac{\sum_{i=1}^n \tilde{\lambda}_i \tilde{X}_i}{\sum_{i=1}^n |\tilde{\lambda}_i|} + \sum_{i \in N_\Lambda} \lambda_i = \frac{\sum_{i=1}^n \tilde{\lambda}_i \tilde{X}_i - \sum_{i \in N_\Lambda} \min\{\tilde{\lambda}_i, 0\}}{\sum_{i=1}^n |\tilde{\lambda}_i|} = \frac{\sum_{i=1}^m \left[\tilde{\lambda}_i \tilde{X}_i - \min\{\tilde{\lambda}_i, 0\}\right]}{\sum_{i=1}^m |\tilde{\lambda}_i|}.$$

■

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