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U.S. public support for biofuels tax credits: Cost frames, local fuel prices, and the moderating influence of partisanship

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ABSTRACT

Researchers debate the viability of biofuels to address growing global energy demands and climate change. Understanding factors that maintain and build public support for government policies bolstering biofuels is critical. Using a nationally representative survey experiment, we examine the influence of competing cost arguments and spatial variation in ZIP-code level gasoline prices on Americans' support for federal tax credits to promote biofuels. We examine the influence of competing arguments about the cost implications of biofuels for consumers on support for federal tax credits, and whether such treatment effects are moderated by respondents' political partisanship and by variation in local fuel prices. Consistent with research on loss aversion, arguments that biofuels could increase costs for consumers were more influential than arguments touting economic benefits. However, arguments that biofuels could eventually decrease fuel costs for consumers were more influential among subjects who experienced high local gasoline prices. Finally, we found evidence of a significant partisan divide in policy preferences, and evidence that partisanship moderates the influence both of competing cost frames and of local fuel prices on support for federal biofuels tax credits. Our results add important nuance to understanding of how economic calculations affect public support for policies to support biofuels.

1. Introduction

Researchers continue to debate the extent to which biofuels can address the twin challenges of meeting increased energy demand, particularly for liquid transportation fuels, while also combatting climate change (Hill et al., 2006; Mathews, 2008; Lapan and Moschini, 2012; Farrell et al., 2006; Lynd, 2017; Huang et al., 2013). Globally, biofuel production has increased dramatically from a mere 316 million barrels per day in 2000 to 2.285 billion barrels per day in 2015 (U.S. Energy Information Administration (EIA), 2020). However, this significant growth is heavily reliant on government support, most importantly on direct subsidies to biofuel producers and fuel-blending mandates (Lapan and Moschini, 2012; Oliveira et al., 2017).

In the United States, the Energy Policy Act of 2005 established a number of direct governmental supports for the biofuel industry and mandated increased blending of biofuels with gasoline by 2012. The Energy Independence and Security Act of 2007 significantly expanded the renewable fuel standard, while also mandating that a growing share of the renewable fuel standard must come from cellulosic biofuel or feedstocks aside from corn by 2022 (Environmental Protection Agency (EPA), 2019). As a result, understanding the factors underlying public support and how it might change over time in response to changing economic conditions is of great importance for both producers and policymakers who support continued public investment in the sector.

Recent research has explored many factors that affect attitudes toward and understanding of biofuels generally, as well as support for government policies to encourage their production (Cacciatore et al., 2012a; Delshad et al., 2010; Baral, 2018). Employing an experiment embedded on a nationally representative online survey, this study builds on this literature to examine the extent to which American public support for federal government policies to bolster biofuel production is sensitive to fuel prices and to competing arguments about the effect of biofuels on fuel prices. The lack of robust time series data on public support for biofuels precludes analysis of how public support varies with fluctuations in aggregate fuel prices. To overcome this barrier, we exploit variation in local fuel prices and examine the relationship between local costs and support for a biofuel production tax credit. We also examine the influence of competing arguments about the potential long-term costs of expanded reliance on biofuels for consumers on support for federal tax credits, and whether these effects are moderated

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by local gasoline prices.

Finally, past research has found evidence of a significant partisan divide in attitudes toward biofuels (Cacciatore et al., 2012b; Delshad and Raymond, 2013), as well as evidence that partisanship moderates how Americans update their attitudes when presented with new arguments or information (Cacciatore et al., 2012a; Fung et al., 2014; Bolsen et al., 2014). As a result, this study also examines whether partisanship moderates the effect of both local fuel prices and our experimental cost treatments on support for a biofuel production tax credit.

2. Costs, context and support for biofuel tax credits

As global biofuel production has increased dramatically over the past two decades, an emerging literature has begun to explore the factors driving public attitudes toward biofuels in the United States (Bolsen et al., 2014; Bolsen and Cook, 2008; Wegener et al., 2014) and around the world (Savvanidou et al., 2010; Dragojlovic and Einsiedel, 2015). In the United States, aggregate-level opinion data paints somewhat contradictory pictures. Some polls and analyses show strong support for the expanded use of biofuels and federal tax incentives to support them (Bolsen and Cook, 2008; Wegener and Kelly, 2008). However, recent research by Delshad and Raymond found that both support for biofuels in general and for federal policies to stimulate them had decreased significantly by 2010 as media framing of biofuels had turned increasingly negative (Delshad et al., 2010). Other polls from the mid-2010s show rising public concern that biofuel production threatens food supplies, as well as concern that strengthened renewable fuel standards could increase fuel costs for consumers (Harris Poll, 2016).

Seeking insight into these divergent findings, an emerging literature examines the factors driving public support for biofuels at the individual-level. Researchers have identified a range of factors that influence support for biofuels in the United States, including subjects' level of policy-relevant knowledge (Cacciatore et al., 2012b), the frames employed by the media to discuss biofuel technology and policy (Delshad and Raymond, 2013), and even the very nomenclature used to describe biofuels (Cacciatore et al., 2012a). Overall, prior studies have consistently found that perceived economic costs and benefits are an important component of most Americans' calculus. For example, focus group data shows that supporters of biofuels tended to emphasize their economic promise, while opponents worried about their high costs (Delshad et al., 2010). More broadly, studies have shown that individuals' perceived risks and benefits greatly influence their willingness to support and use biofuels (Cacciatore et al., 2012a; Fung et al., 2014; Binder et al., 2012), with economic calculations playing an important role in assessments of both benefits and costs. More generally, research by Ansolabehere and Konisky shows the central importance that beliefs about cost play in shaping Americans energy policy preferences (Ansolabehere and Konisky, 2014). This study builds on this foundation by examining how American public opinion responds to arguments about the cost implications of expanded reliance on biofuels and how support correlates with spatial variation in local gasoline prices that influence the economic competitiveness of biofuels.

2.1. A "rational public" and cost-benefit calculations

Public opinion scholarship offers competing views of how Americans form their policy assessments and preferences. One branch of this literature presents a picture of a rational public in which many citizens acquire, directly or indirectly, information about a policy or the changing state of the world and update their preferences accordingly (Farrell et al., 2006; McCann et al., 1994). In many settings where the costs and benefits of policy options are explicit and tractable, scholars have argued that opinion formation is shaped by cost-benefit calculations. For example, an extensive literature on wartime opinion formation argues that support for war varies predictably with major conflict events and reliably declines as the costs of war rise (Burk, 1999). Similarly, research on economic voting shows that incumbents' political fortunes are closely tied to national economic performance (Kinder and Kiewiet, 1981).

Researchers and policymakers alike continue to debate the economic prognosis for biofuels, with some highlighting the potential for technological breakthroughs to make biofuels economically viable (Binod et al., 2019; Gebremariam and Marchetti, 2018) and others questioning whether biofuels can be economically competitive absent government support or climate change mitigation policies (Fiorese et al., 2013). This debate is frequently reflected in media coverage of the promise or pitfalls of biofuels. For example, in a content analysis of coverage of biofuels in the *New York Times* and *Washington Post*, Delshad and Raymond (Delshad and Raymond, 2013) show that these major papers of record employed economic cost and economic benefit frames with almost identical frequency from 2004 to 2008.

Because most Americans lack deep background knowledge on biofuels in general, let alone sophisticated understandings of their long-term economic costs and benefits, exposure to arguments about the economic consequences of increasing production may significantly shape public support. This leads to our first hypothesis:

H1. Exposure to arguments about the economic costs/benefits of increased production of biofuels will decrease/increase support for policies to incentivize biofuel production.

However, arguments about costs and benefits may not be equally influential. Decades of public opinion research on loss aversion has demonstrated that people are more sensitive to hypothetical losses when evaluating policy trade-offs than to potential gains (Kahneman and Tversky, 2018; Eckles and Schaffner, 2010). As a result, Americans might be more responsive to arguments warning about increased costs from greater reliance on biofuels than to arguments promising future economic benefits. This leads to our second hypothesis:

H2. Arguments about the economic costs of increased production of biofuels will be more influential on public support than arguments about the economic benefits.

Apart from any arguments about the costs and benefits of biofuels to which they may be exposed, most Americans will also have an easily accessible and salient consideration on which to draw when forming their opinions about biofuels: the price they currently pay at the pump for gasoline. For the foreseeable future, the cost of fossil fuels will continue to be an important determinant of whether biofuels are economically viable (Stephens et al., 2010; Gallagher, 2011). Even if the precise nature of these calculations is beyond most Americans, local fuel prices may provide a ready heuristic to many when judging whether increased investment in biofuels might benefit them personally. Recent research emphasizes the importance of local concerns in shaping both environmental (Wiest et al., 2015) and energy policy attitudes (Ansolabehere and Konisky, 2014). For example, Americans who live closer to coal-fired power plants and more directly experience their externalities are more supportive of government policies to promote renewable energy (Goldfarb et al., 2016). Similarly, residents of mill towns in Maine were more sensitive to the potential air pollution effects of forest-based refineries than were residents statewide (Marciano et al., 2014). By extension, local context, and particularly local fuel prices, may influence Americans' support for policies to promote alternate fuel sources. This logic leads to our third hypothesis:

H3. Higher local fuel prices should increase support for government policies to incentivize biofuel production.

Drawing on the logic of loss aversion, we previously hypothesized that arguments about the potential economic benefits of biofuels will be less influential with the public than arguments about their potential economic costs. However, the influence of arguments about economic costs and benefits may vary across Americans depending on their local context. Specifically, the efficacy of economic arguments may vary with local fuel prices. While loss aversion may limit the relative influence of

arguments that federal investment in biofuels will reduce costs for consumers in the aggregate, this prime may be more influential among Americans who pay higher than average prices at the pump. This leads to our fourth hypothesis:

H4. Arguments that increased production of biofuels will decrease fuel costs should be particularly influential among respondents who live in communities experiencing disproportionately high local fuel prices.

2.2. The moderating role of partisan heuristics

The literature on public support for biofuels has also shown that many Americans lack basic knowledge about biofuels and policies that promote them (Cacciatore et al., 2012b; Bolsen and Cook, 2008).[1] In such situations, another strand of public opinion scholarship argues that rather than searching out new information and engaging in complicated cost-benefit calculations, many Americans rely heavily on heuristics to inform their opinions and political preferences (Kinsey and Popkin, 1993), including on questions about emerging technologies (Scheufele, 2006). One of the most powerful heuristics shaping attitudes toward biofuels is political partisanship. Studies have consistently shown evidence of a sizeable partisan gap in support for public investment in biofuels, with Democrats being much more supportive, on average, than Republicans (Delshad and Raymond, 2013). Equally important, a number of studies have shown that partisanship can moderate the influence of new information (Cacciatore et al., 2012a), including information about costs and benefits specifically (Fung et al., 2014), on Americans' support for biofuels.

Partisanship may be both a simple heuristic that allows many Americans to form opinions when they lack relevant information, and/or may also serve as a perceptual screen through which Americans evaluate new information and decide whether to incorporate it into their opinions and judgements (Zaller, 1992; Bartels, 2002). In the context of energy and environmental policy, past research has found evidence that many Americans are less responsive to new information about fracking (Christenson et al., 2017), emergent technologies (Druckman and Bolsen, 2011), and climate change (Hart and Nisbet, 2012) that conflicts with their partisan priors.[2] The clear partisan divide in support for biofuels observed in past research thus generates the following pair of hypotheses:

H5. Because they conflict with partisan priors, arguments that increased production of biofuel will decrease costs will be less influential with Republicans than with Democrats or independents.

H6. Arguments that increased production of biofuel will increase costs for consumers will be less influential with Democrats than with Republicans or independents.

Finally, partisanship could also moderate the influence of local context and variation in local gasoline prices on support for biofuels. Top-of-the-head models of opinion formation (Zaller, 1992) argue that citizens average across the range of salient considerations at the moment of the survey response. Partisans already possess at least one strong heuristic on which to draw when asked to evaluate their support for governmental policies to promote biofuels. Additional contextual information, such as local gasoline prices, may also be salient and affect partisans' opinions. However, this information should be more prominent and influential among Americans who lack strong partisan priors. This yields our final hypothesis:

H7. The effects of local gas prices on support for government policies that incentivize biofuel production will be strongest among independents who lack partisan priors.

3. Methods

3.1. Survey sample

To examine the influence of arguments about the economic costs and benefits of biofuels and spatial variation in local gasoline prices on support for governmental policies to incentivize biofuel production, as well as how the influence of these factors is moderated by political partisanship, we embedded an experiment on the 2014 Cooperative Congressional Election Study (CCES). This internet-based survey is administered by YouGov/Polimetrix and uses a two-stage sample matching methodology to produce nationally representative results from a large opt-in panel. For additional methodological details and validation information, see Ansolabehere and Rivers (Ansolabehere and Rivers, 2013). Our module was embedded on the post-election wave of the survey and administered to 889 subjects between November 5 and December 4, 2014.

3.2. Experimental design

Subjects were randomly assigned to one of three experimental conditions. All subjects received an initial prompt: "To reduce our dependence on fossil fuels and foreign oil, many scientists and policymakers suggest that the federal government should grant a tax credit to companies that produce biofuels. A new federal tax credit could spur the growth of renewable alternatives to gasoline." Subjects in the control group received no further information. Subjects in the first treatment group received an additional prompt describing the possible economic benefits of increased biofuel production for consumers: "Supporters of the credit argue that using more biofuels could ultimately decrease fuel costs for consumers." Subjects in the second treatment group instead received a prompt warning of the possible economic costs of increased reliance on biofuels for consumers: "Opponents of the credit argue that using more biofuels could ultimately increase fuel costs for consumers." All subjects were then asked the same question: "Would you support or oppose a new federal tax credit for companies that produce biofuels?"

3.3. Variable measures

The survey measured support for or opposition to a new biofuel tax credit on a four-point scale ranging from "strongly support" to "strongly oppose." A neutral option was omitted to guard against satisficing (Krosnick, 1991; Krosnick, 1999). The percentage of Americans supporting a policy is the most politically salient quantity that is most often emphasized in media report and policy debates. As a result, from this question we constructed a binary dependent variable coded 1 for subjects who strongly or somewhat supported a new biofuels tax credit and 0 for those who did not. A pair of indicator variables identify subjects exposed to the competing economic cost argument treatments.

To test our hypotheses about the influence of local fuel prices on support for federal investment in biofuels we created ZIP-code level measures of gasoline prices in fall 2014 and merged it with our survey data. The 2014 CCES is geocoded and provides each respondent's home ZIP code. This allow us to match each subject with highly localized gasoline price data. Yilmazkuday and Yilmazkuday (Yilmazkuday and Yilmazkuday, 2019) collected daily gas prices for 98,753 gas stations

[1] For example, Bolsen and Cook (Bolsen and Cook, 2008) conclude, "This situation has not changed much since 1994 when Farhar (Farhar, 1994) pointed out in a briefing to the Department of Energy: "almost no data were available on alternative fuels. Most people appear not to know much about them. No conclusions are possible on alternative fuels and policy." Similarly, in a representative survey of residents of Wisconsin, a major biofuels producing state, Cacciatore et al. found that the mean score on a nine-question, true/false knowledge battery was 5, only slightly higher than what would be expected from random guessing alone (Cacciatore et al., 2012a).

[2] For a discussion of whether this is evidence of directional motivated reasoning or of an accuracy motivated model, see (Druckman and McGrath, 2019).

around the country from September 8–14, 2014. Using this data, we constructed the mean gasoline price for all stations in each ZIP code in our survey sample during this period.[3] As shown in the top panel of Fig. 1, in the fall of 2014 there was significant spatial variation in the prices Americans paid at the pump. As shown in the bottom panel of Fig. 1, the median respondent in our survey paid roughly $3.50 per gallon. However, local gas prices varied significantly about that median from a low of just over $3.00 per gallon to a high of almost $4.25 per gallon.

To test our additional hypotheses that partisanship will moderate the influence of both our cost treatments and local fuel prices on support for a biofuel production tax credit, we also asked subjects to indicate their partisan affiliation on a seven-point scale. From this, we created a pair of indicator variables for subjects who identify as either Democrats or Republicans. Following standard practice in political science, we coded strong and weak identifiers, as well as those who leaned toward one party or the other, as partisans (Petrocik, 2009).

3.4. Analytical approach

We constructed a series of logistic regression models to test the influence of our competing cost treatments, local gas prices, individual partisan identification, and their interactions on support for a new federal biofuel tax credit while controlling for subjects' demographic characteristics. To test H1-H3, in the first logistic regression the main independent variables of interest are the indicator variables for the two competing costs treatments and our measure of ZIP-code level gasoline prices. To test H4, the second logistic regression also includes the interaction of both cost treatments with local gasoline prices. To test H5 and H6, the third logistic regression instead includes the interaction of both cost treatment variables with the two partisan indicator variables identifying Democratic and Republican respondents. Finally, to test H7 the fourth logistic regression includes the interaction of local gasoline prices with the two partisan indicator variables.

4. Results

Table 1 presents the results from all four logistic regressions. In the first logistic regression, the coefficients on the two experimental treatments are in the expected directions. However, only the coefficient for the treatment exposing subjects to the argument that biofuels could increase costs for consumers is statistically significant ($p = 0.054$). Fig. 2 illustrates the substantive size of the treatment effects using first differences holding all other variables constant at their mean or median. In the control group, the median respondent had a predicted probability of supporting a new federal biofuel tax credit of approximately .72. In the increase costs treatment, the predicted probability of supporting a new tax credit drops by 8% to 0.64. By contrast, the predicted probability of supporting the tax credit is slightly higher in the decrease costs treatment than in the control group; however, the two are statistically indistinguishable. These results are partially consistent with H1 and strongly consistent with H2. Survey subjects were more responsive to arguments that an increased reliance on biofuels might increase their fuel costs than to arguments that it could potentially decrease costs for consumers, all else being equal.

Finally, the first logistic regression offers only modest support for H3. The coefficient for local gas prices is positive; however, it fails to reach conventional thresholds of statistical significance. The results for many of the control variables largely accord with past research. Democrats were significantly more supportive of a new biofuels tax credit than were independents or Republicans. The coefficient for Republicans is negative, indicating that they are less likely to support the tax credit than independents, all else being equal; however, it fails to reach conventional levels of statistical significance. Women were more supportive, on average, of government support for biofuels than were men. And finally, older Americans were less likely to support a biofuels tax credit than were younger Americans.

4.1. The interactive effect of cost treatments and local gas prices

The second logistic regression model includes a pair of interaction variables to test H4 that subjects' exposure to local gas prices may moderate the influence of the cost treatments on support for a new biofuel tax credit. Because interaction coefficients are difficult to interpret in raw form, Fig. 3 illustrates the effect of each treatment on the likelihood of the median subject supporting a biofuels tax credit as local gas prices in her community increase. When local gasoline prices are low, there is no significant difference in the probability of the median subject supporting the proposed tax credit. However, as gas prices increase, the predicted probability of the median subject in the decrease costs treatment backing the tax credit begins to rise, while the probability of the median subject in the increase costs treatment slowly falls. When local gasoline prices reach $3.50 per gallon, the gap in predicted likelihood of supporting the tax credit across the two experimental groups becomes statistically significant. And at the highest level of local gas prices in our data, subjects in the decrease costs treatment are approximately 20% more likely to support a biofuels tax credit than subjects in the increase costs treatment.

4.2. Partisan moderation of cost treatment effects

The third logistic regression tests H5 and H6 that partisanship will moderate the effect of the competing cost treatments on support for a biofuels tax credit. Fig. 4 illustrates the effect of each treatment on the preferences of the median member of each partisan subgroup (i.e holding all other demographic variables at their median values). The interaction results are broadly consistent with H5. Although the decrease costs treatment did not produce significantly different levels of support from that observed in the control among any partisan group, the simulations in Fig. 4 show that this treatment affected Republicans differently from Democrats or independents. In the control group, the median Republican and independent were almost equally likely to support the biofuels tax credit. However, in the decrease costs treatment group, the median independent is significantly more likely to support the tax credit than the median Republican — a gap of more than 15%. Thus, this treatment resonated more with Democrats and independents than it did with Republicans.

By contrast, the model finds no support for H6. The increase costs treatment moderately decreased support for a biofuels tax credit among all three partisan groups and to roughly the same degree.

4.3. Partisan moderation of the effect of local gas prices

Finally, the last logistic regression in Table 1 includes a new pair of interaction variables to test whether partisanship moderated the influence of local gas prices on support for a biofuels tax credit. Fig. 5 illustrates the effect of increasing gas prices on the predicted probability of the median Democrat, Republican, and independent supporting the tax credit (i.e. holding all other demographic factors constant at their median value). Strongly consistent with H7, Fig. 5 shows that the estimated effects of gas prices are strongest for political independents who lack partisan priors. When local gas prices are low, the median

[3] This procedure allowed us to construct precise ZIP-code level gasoline price measures for more than 90% of the subjects in our sample. In the rare cases where the data (Yilmazkuday and Yilmazkuday, 2019) did not include a gas station for a subject's home ZIP code, we then identified all ZIP codes within a specified radius (5, 10, 15, or 20 miles) of its centroid and used the mean gas price in those ZIP codes as our measure of local gas prices. For only 3 subjects in our sample did we have to use gas price data from ZIP codes more than 10 miles from the home ZIP code centroid.

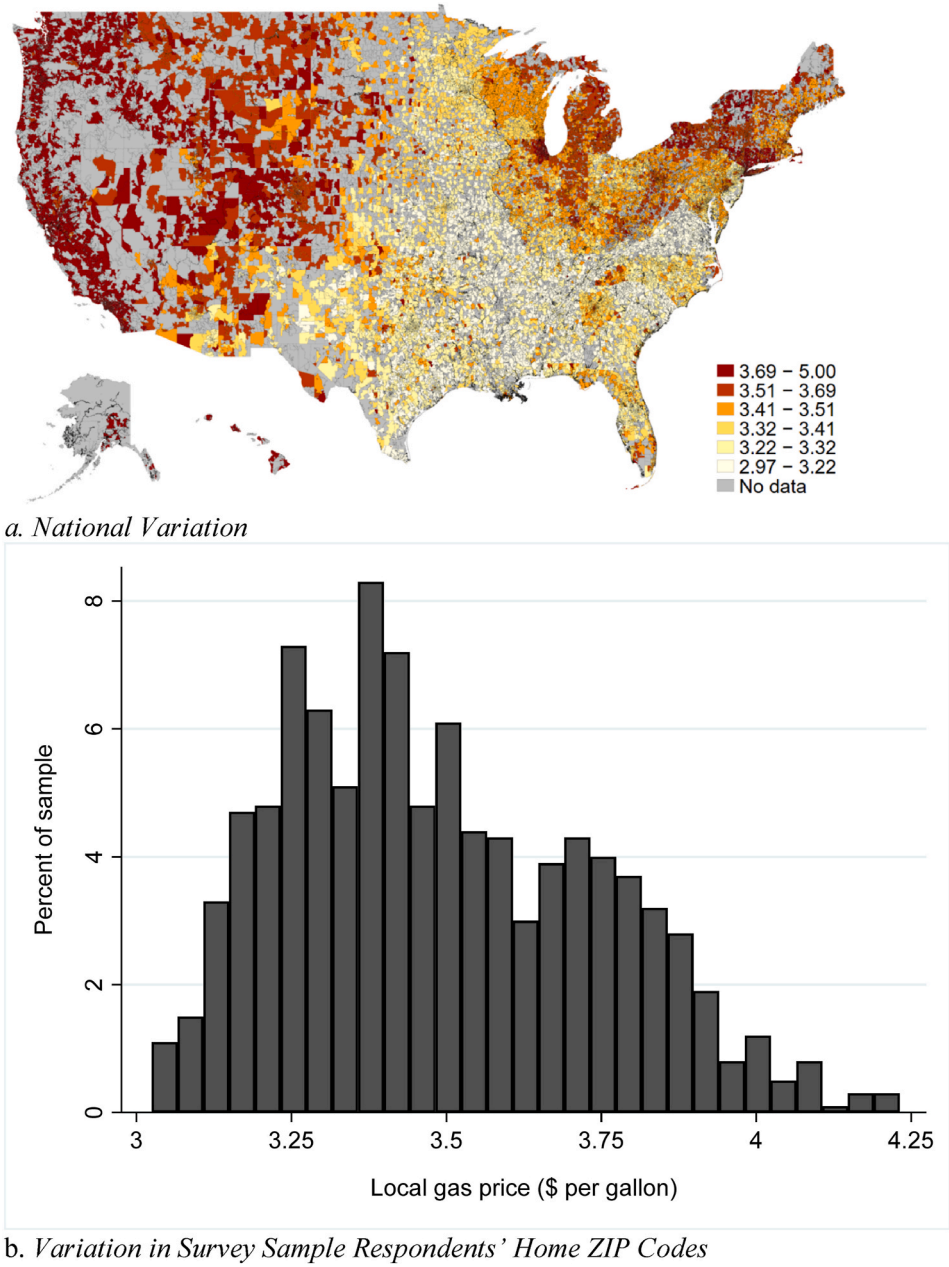

Fig. 1. Variation in Local Gasoline Prices by ZIP Code (September 2014) *Figure produced using data from Yilmazkuday and Yilmazkuday (2019).*

independent has a predicted probability of supporting a biofuels tax credit that is more than 20% lower than the median Democrat and statistically indistinguishable from that of the median Republican. As local gas prices increase, the predicted probability of supporting the tax credit increases for all three partisan subgroups, but it increases most sharply for independents. When local gas prices reach $3.60 per gallon, independents are significantly more likely to back the tax credit than are Republicans, all else equal. And once local gas prices reach $3.95 per gallon the predicted probability of the median independent supporting the tax credit has increased to the point that it has become statistically indistinguishable from that of the median Democrat.

5. Discussion

Our results add important nuance to past research examining how public perceptions of the economic costs and benefits of biofuels influence support for government policies essential to continued growth in their production. Consistent with past experimental research that has examined the influence of economic cost and benefit primes on attitudes toward biofuels (Fung et al., 2014), exposing subjects to competing arguments about the cost implications for consumers of greater reliance on biofuels affected support for federal policies to promote biofuels. However, the effect of these primes was asymmetric; arguments that a greater reliance on biofuels could increase costs for consumers were more influential than arguments that biofuels could potentially lower consumer costs. This greater sensitivity in the aggregate to cost primes is consistent with literatures on loss aversion.

Apart from examining how public support responded to experimental primes, our analysis also leveraged the significant spatial variation in gasoline prices across the country to examine whether public support for government policies to promote biofuel production is sensitive to fuel prices in subjects' home ZIP-codes. In the aggregate, we found little evidence that lower gasoline prices sapped support for federal investment in biofuels or that higher fuel prices make Americans

Table 1
Factors influencing support for biofuel production tax credit.

	(1)	(2)	(3)	(4)
Decrease costs treatment	0.083	-2.185	0.402	0.090
	(0.193)	(2.796)	(0.402)	(0.193)
Increase costs treatment	-0.357*	1.512	-0.339	-0.350*
	(0.185)	(2.553)	(0.402)	(0.186)
Decrease costs x Local gas price		0.657		
		(0.805)		
Increase costs x Local gas price		-0.536		
		(0.730)		
Decrease costs x Democrat			-0.101	
			(0.516)	
Decrease costs x Republican			-0.700	
			(0.504)	
Increase costs x Democrat			0.010	
			(0.499)	
Increase costs x Republican			-0.055	
			(0.498)	
Local gas price x Democrat				-0.834
				(0.834)
Local gas price x Republican				-0.681
				(0.840)
Democrat	0.849***	0.849***	0.885**	3.747
	(0.210)	(0.211)	(0.353)	(2.904)
Republican	-0.309	-0.301	-0.064	2.056
	(0.212)	(0.213)	(0.348)	(2.924)
Male	-0.495***	-0.493***	-0.499***	-0.494***
	(0.158)	(0.158)	(0.159)	(0.158)
Education	-0.001	-0.003	-0.000	-0.004
	(0.055)	(0.055)	(0.055)	(0.055)
Age	-0.030***	-0.030***	-0.030***	-0.031***
	(0.006)	(0.006)	(0.006)	(0.006)
White	0.275	0.266	0.246	0.272
	(0.194)	(0.195)	(0.196)	(0.195)
Local gasoline price	0.429	0.452	0.405	1.022
	(0.312)	(0.529)	(0.313)	(0.673)
Constant	0.708	0.627	0.705	-1.323
	(1.147)	(1.882)	(1.180)	(2.336)
Observations	885	885	885	885

Note: Models are logistic regressions. Standard errors in parentheses. All significance tests are two-tailed.
***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

increasingly willing to support federal tax credits for biofuel production. However, our results do suggest that local gas prices may significantly affect how responsive Americans are to arguments about the cost implications of a greater reliance on biofuels. Among subjects living in ZIP-codes with disproportionately low gasoline prices, the increase and decrease costs treatments had no effects on support for a biofuels tax credit. However, our results suggest that as gasoline prices increase Americans become more sensitive to competing arguments about the potential influence of increased biofuel production on consumer fuel prices. Examining how the influence of other types of arguments and frames concerning biofuels vary with local context is an important ground for future research.

Finally, consistent with past research we found evidence of a sizeable partisan gap in support for biofuels (Cacciatore et al., 2012b; Delshad and Raymond, 2013), with Democrats being significantly more supportive of government efforts to promote them than Republicans or independents. Equally if not more important, our results add additional insight into the ways in which partisan heuristics moderate the influence of both experimental economic primes and contextual factors on support for federal policies to promote biofuels (Fung et al., 2014). Republicans responded very differently to arguments about the potential economic benefits of increased reliance on biofuels.

Partisanship also moderates the influence of objective contextual factors, in this case local fuel prices, on support for government investment in biofuels. Among Democrats and Republicans, support for a new biofuel production tax credit increased only modestly, if at all, as ZIP code-level gasoline prices increased. The median Democrat remained about 20% more likely to support a biofuels tax credit than the median Republican across the full range of local gasoline prices. However, among independents who lack partisan priors, local contextual information is much more influential. For the median independent, a two standard deviation increase in local gasoline prices increases the predicted probability of supporting a biofuel tax credit by more than 10%. This suggests that contextual factors, including fuel prices, do indeed influence attitudes toward biofuels and support for government policies to promote them. However, given the strength of partisan heuristics in shaping opinion on many issues related to energy and environmental policy, these factors are most influential on the preferences of political independents.

5.1. Limitations

Our study provides important insight into how both experimental economic primes and contextual information, specifically variation in local gasoline prices, influenced public support for government investment in biofuels. However, the study has several limitations that could be addressed in future research.

While local fuel prices varied considerably across the country in fall 2014 affording us considerable leverage on the question of how variation in fuel prices affects public support for a biofuel tax credit, this was a period of relatively high gas prices. By contrast, the national average price per gallon in January 2020 was lower than even the lowest ZIP-code level gas price in our 2014 sample (Bureau of Labour Statistics, 2018). This complicates extrapolating from our results to how public support for biofuels may differ in today's climate of extremely low gas prices. Moreover, it is unclear whether and how support for greater federal investment in biofuels will vary with spatial variation in local gas prices in today's lower range. Examining the relationships between support for biofuels and local fuel prices across a wider range of gasoline prices is an important area for future research.

A second limitation of our study stems from the experimental treatments themselves. The experimental primes concerning the cost implications for consumers of an increased reliance on biofuels were simple by design. They do not engage debates over the relative economic viability of first, second, and third generation biofuels (Saladini et al., 2016). Rather, they were intentionally short on specifics and designed solely to focus on how the effects of simple cost arguments are moderated by local fuel prices and partisanship. The experiment did not examine the effect of simultaneous competitive frames on public support (Chong and Druckman, 2007; Nisbet et al., 2013), nor did it consider source effects in who is making the various economic arguments. Future research expanding the scope of experimental analysis along each of these dimensions would enrich our understanding of how information about the economic costs and benefits of biofuels influence support for government policies to bolster their production.

Finally, competing types of frames also surely matter and do so to varying degrees (Fung et al., 2014; Dragojlovic and Einsiedel, 2015; Raymond and Delshad, 2016). To provide some context given most Americans' lack of knowledge of biofuels (Baral, 2018), the opening prompt received by all subjects across experimental groups provided a pro-biofuel frame. It informed subjects that many scientists and policymakers support a biofuels tax credit to reduce America's dependence on fossil fuels and foreign oil. This may have blunted the effect of the economic benefits treatment as it merely reinforces another positive frame. Moreover, it heightens the power of the increase costs treatment as this effect was observed even after subjects had received information on two potential benefits of increased employment of biofuels. More generally, this speaks to the potential for future research to examine the relative influence of competing frames assessing different aspects of biofuel production, and how those effects are moderated by partisan

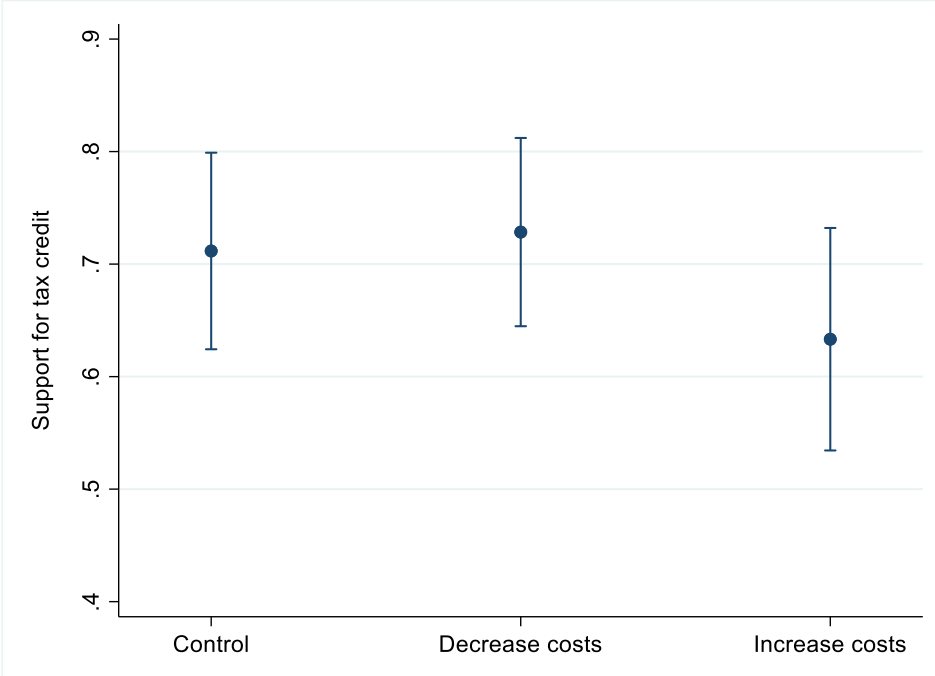

Fig. 2. Support for biofuel production tax credit across treatments.
Note: Each dot plots the predicted probability of supporting the biofuel tax credit in each experimental condition holding all other factors constant at their means or medians. I-bars present 95% confidence intervals around point predictions.

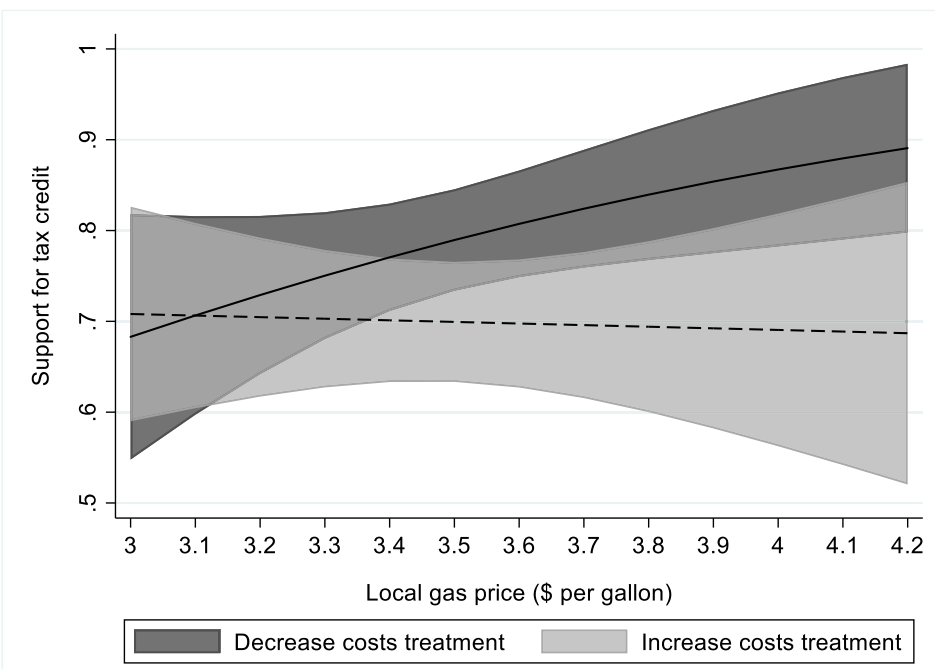

Fig. 3. Moderation of treatment effects by local gas prices.
Note: Shaded regions present 95% confidence intervals around point predictions.

attachments and local context.

6. Conclusions and policy implications

According to the Bureau of Labor Statistics, gasoline prices in the United States have declined significantly in recent years from a peak of almost $4.00 per gallon in May of 2011 to less than $2.50 per gallon in February of 2020 (Bureau of Labour Statistics, 2018). The Covid-19 global pandemic threatens to plunge the world economy into a steep recession of unknown duration with significant implications for fossil fuel prices. How might a prolonged slump in gas prices affect public support for government investment in alternative fuels? With the caveat discussed previously concerning the limited range of local gas prices in our sample, from the perspective of proponents of government policies

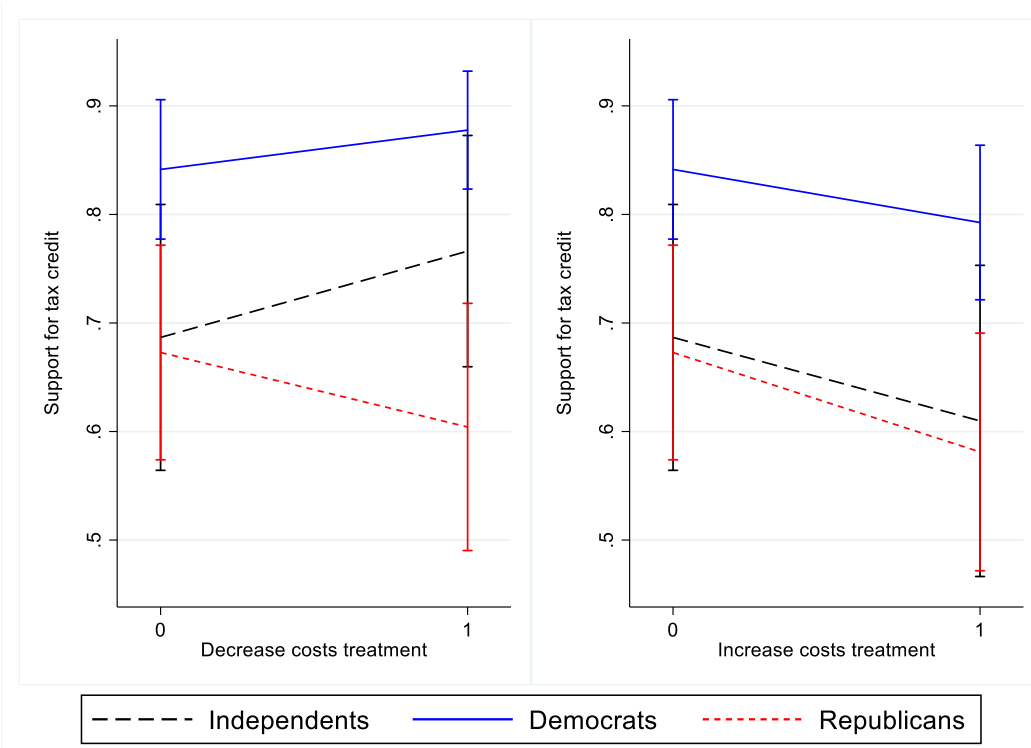

Fig. 4. Partisan moderation of treatment effects.
Note: I-bars present 95% confidence intervals around point predictions.

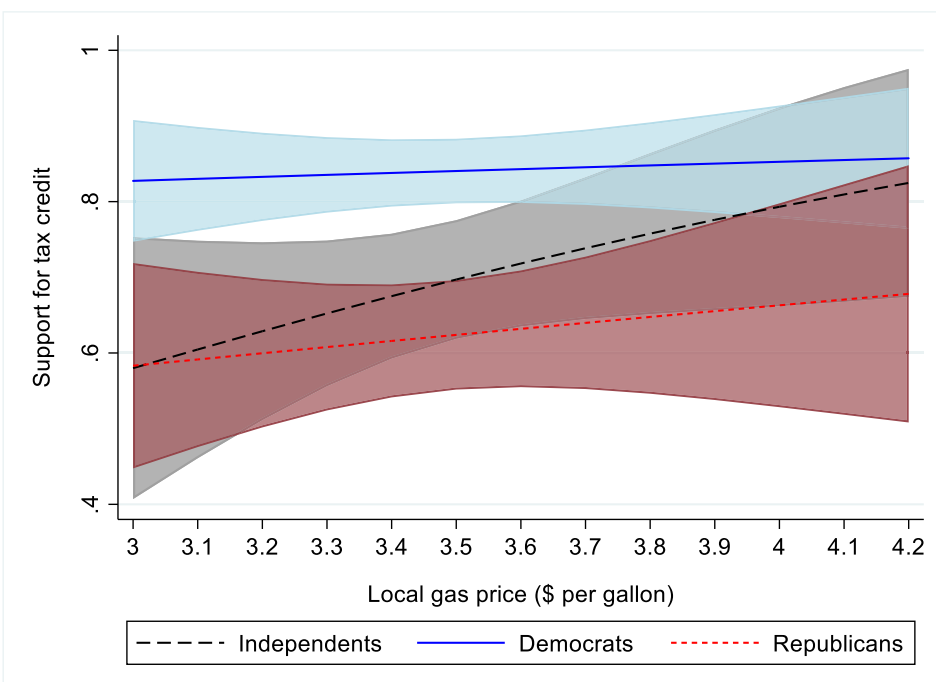

Fig. 5. Partisan moderation of effect of local gas prices.
Note: Shaded regions present 95% confidence intervals around point predictions.

to promote biofuel production our results suggest reason for optimism. Local gas prices only significantly affected political independents' support for the biofuel tax credit. And even at the lowest of ZIP-code-level gas prices in our sample, strong majorities of Democrats, Republicans, and independents continued to support government investment in biofuels. This evidence is consistent with studies showing consumers' willingness to pay extra for biofuels (Savvanidou et al., 2010; Lanzini et al., 2016).

Low gasoline prices may also blunt the effect of arguments about the cost implications of biofuels for consumers, both positive and negative.

In our experiment, we observed significant gaps in support across our increase and decrease costs treatments – but only among subjects from ZIP-codes with higher than average gas prices.

In the contemporary context, advocates of greater federal investment in biofuels might strategically focus more squarely on non-economic arguments for a stronger public commitment for biofuels. Arguments based on the environmental or national security benefits of greater investment in biofuels might be more influential (Raymond and Delshad, 2016).

Finally, while our results suggest that public support for government investment in biofuels is not as polarized along partisan lines as other aspects of public opinion on energy and environmental policy, such as fracking (Christenson et al., 2017) or climate change (Dunlap et al., 2016), Democrats are significantly more supportive of such policies than independents or Republicans. Moreover, partisanship moderates the influence of both experimental frames and real-world local context on public policy preferences. Scientists, interest groups, and policymakers seeking to influence the public discourse on biofuels policy should thus target their outreach efforts in ways that appeal most directly to the concerns of specific partisan subgroups of the mass public.

While Xue et al. conclude that Republicans may be more receptive to messages that focus on short-term economic benefits of energy policies (Xu et al., 2015), the present work suggests that short-term benefits, at least in terms of gasoline prices, will not be effective arguments for this partisan subgroup. Rather than relying on unidimensional frames, it may be advantageous to employ a dual process motivational model (Crawford et al., 2013), whereby messages intended for diverse audiences play to both Republican's partisan values (e.g. national security and the economy) and to Democrats' core values, (e.g. the environment and social justice), allowing the audience to "choose" their preferred reason to support such a policy while ignoring the other. Once could envision using the U.S. military's biofuel program as a singular example with dual process motivation. The U.S. Navy's "Great Green Fleet" is a case in point example of the government's intent to reduce its dependence on foreign fuel (thereby reducing military threats) under the guise of building green infrastructure for biofuels in a so-called "militarized greenwashing" (Bigger and Neimark, 2017). To ensure the effectiveness of any of these arguments, we must guard against rational inattention, or information overload, by privileging the strongest, most salient arguments to each subgroup. Such targeted message framing, as discussed recently by Farrow et al., is more likely to increase message efficacy, especially when used in combination with strategies that leverage injunctive feedback and advantageously created descriptive norms (Farrow et al., 2018). In the context of the present study, this might mean highlighting the current use of bio-based fuels in aviation (the 2018 FAA target was set at one billion gallons per year of "drop-in" sustainable alternative jet fuels (Sustainable Alternative J, 2020)) as prominent descriptive feedback that emphasizes the desirability and feasibility of this renewable fuel use. Finally, the fragmented nature of the U.S. political system may be exacerbating public resistance towards biofuel adoption by engendering systemic bias towards potential renewable energy solutions through deepening distrust of political elites and advocacy coalitions (Ocelík et al., 2019). As such, widespread public support for biofuels may require political elites to form stronger coalitions with coordinated message strategies to enact the widespread sociotechnical changes necessary for a biofuel-powered future.

Data availability

All data files and statistical code to produce the tables and figures reported in the manuscript are available at the Harvard Dataverse:https://doi.org/10.7910/DVN/KDZ60Y.

CRediT authorship contribution statement

Jillian L. Goldfarb: Conceptualization, Data curation, Formal analysis, Writing - review & editing. **Douglas L. Kriner:** Data curation, Formal analysis, Conceptualization, Writing - original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2020.112098.

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