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Public climate change agreement and GHG emissions in the US

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ABSTRACT

Scientists have a broad consensus on climate change. Yet, this consensus has not passed to the public opinion in the United States (US). A significant percentage of the US population does not agree that climate change is happening, or that it can cause harm to people. We call this a public climate change agreement gap. In this paper, we estimate the quantitative effect of increasing public climate change agreement on greenhouse gas (GHG) emissions in the US. We find a significant relationship between higher public agreement and lower subsequent GHG emissions. Then, we estimate the welfare impact of closing the public climate change agreement gap. We find that closing this gap can result in welfare gains up to \$4.75 trillion through the expected decreases in GHG emissions.

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1. Introduction

Scientists have a broad consensus on climate change (Cook et al. 2013). However, public opinion in the US is far from reaching such a consensus. According to Leiserowitz et al. (2023), the percentage of Americans who agree that climate change is happening was 72% in 2021. Further, and perhaps more importantly for policy support, between 40% and 50% of Americans do not think that climate change will harm people in the present or the near future. This indicates a significant gap in the public agreement on climate change in the US. In this paper, we aim to answer the following question: what is the quantitative effect of increasing public climate change agreement (PCCA) in the US on GHG emissions?

Studies (e.g. Adger 2003; Herrnstadt and Muehlegger 2014) show that PCCA affects individual and collective behaviour like energy consumption behaviour and voting behaviour for example. In addition, while households may not have direct control on firms' emissions, there are channels through which increased PCCA can lead to lower emissions by firms. For example, increased PCCA usually puts pressure on policymakers to impose stricter emissions standards. This, in turn, forces firms to decrease their emissions. In other words, PCCA plays an important role in shaping the socio-political

context of climate change policymaking and can result in decreased emissions by changing both households' and firms' behaviour.

The important role of PCCA has motivated a growing body of research to study the reasons behind the lack of public agreement on climate change in the US. Boykoff and Boykoff (2007), Sampei and Aoyagi-Usui (2009), Schmidt et al. (2013), Shapiro (2016) and Brüggemann and Engesser (2017) are examples of such studies. These studies highlight the roles of special interest groups in promoting climate change scepticism and denial. However, to the best of our knowledge, existing literature does not quantify the impact of PCCA on GHG emissions. This paper aims to fill this gap. Quantifying the effect of increasing PCCA on GHG emissions can further highlight the importance of public opinion in supporting or deterring policies that tackle climate change. It can also be used to quantify welfare benefits of increasing PCCA.

Using the two-stage least squares (2SLS) method, we find that increasing PCCA is significantly related to decreasing subsequent GHG emissions per capita. A percentage point increase in PCCA is expected to reduce per capita GHG emissions by 24.35% the following year. This relationship is robust across various specifications. Further, we quantify the welfare impact of increasing PCCA in the US. We find that increasing PCCA to 100% (closing the PCCA gap) can lead to welfare gains up to \$4.75 trillion.

The rest of the paper is organised as follows: [Section 2](#) discusses the data used in our study. [Section 3](#) presents the regression model, estimation method and benchmark results. [Section 4](#) presents robustness checks. [Section 5](#) presents calculation of the welfare impact. A conclusion is provided in [Section 6](#).

2. Data

2.1. PCCA

As a measure of PCCA in the US, we use the reported responses from the 'Climate Change in the American Mind' surveys (Leiserowitz et al. 2023). These surveys ask samples of Americans about their agreement or disagreement on climate change. Data are available since 2008 at the state level and since 2014 at the county level. We use data at the county level which yields a bigger sample and richer variations.

Survey questions include whether climate change is happening (the 'happening' question), whether climate change is expected to harm people in the present or near future (the 'timing' question), and other climate-change-related questions. The most recent survey that we use is from December 2022 and is a joint effort between the Yale Program on Climate Change Communication and the George Mason University Center for Climate Change Communication (Leiserowitz et al. 2023).

[Table 1](#) shows the percentage of surveyed people answering yes to the 'happening' and 'timing' questions in different years for the US as a whole. As shown in [Table 1](#), a significant PCCA gap exists. For example, as of 2021, 41% of surveyed Americans do

Table 1. PCCA in the US.

	2016	2021
Climate change is happening	69%	72%
Climate change will harm people	49%	59%

not agree that climate change will harm people in the present or near future. As mentioned, the goal of this paper is to quantify the effect of decreasing this gap on GHG emissions in the US.

2.2. Temperature anomalies

We aim to quantify the effect of exogenous variations in PCCA on GHG emissions. The intricacy of the underlying mechanisms complicates the estimation. For example, emitting firms may simultaneously lobby policymakers against policies aimed to decrease GHG emissions and try to promote climate change scepticism through the media. The result could be higher GHG emissions and lower PCCA. For this reason, our strategy is to use instrumental variables for PCCA. In particular, we use temperature anomalies. Temperature anomaly is defined as the difference between the current 12-month average temperature and the long-term average or expected temperature. Data on temperature anomalies at the county level in the US are obtained from Climate at a Glance System.

The literature highlights the relationship between temperature anomalies and PCCA. For example, according to Donner and McDaniels (2013), there is a strong relationship between previous year's temperature anomaly and perceiving that climate change is happening. Similarly, Myers et al. (2013) point out that public perception of temperature anomalies affects public opinion regarding climate change. Another example is Hamilton and Stampone (2013) reporting stronger effects of anomalies closer in time. Whitmarsh (2009) relates this relationship to mixing up the concepts of weather and climate by the public. In other words, people tend to judge the validity of climate change based on temperature anomalies. This means that temperature anomalies are correlated with PCCA.

It is possible that current temperature anomalies affect current GHG emissions. Consequently, we use lagged temperature anomalies as IVs to identify the impact of lagged PCCA on current GHG emissions per capita. Using lags helps ensure that changes in PCCA and the subsequent effect on GHG emissions exclude the potential direct effect of current temperature anomalies on current GHG emissions.

2.3. GHG emissions

The emissions data used in the study are firm emissions. In particular, the data are on GHG emissions of firms classified as 'direct emitters'. Through the Greenhouse Gas Reporting Program, firms classified as direct emitters must report their GHG emissions to the US Environmental Protection Agency. The data are available at the county level. We sum emissions of all direct emitters registered in each county, and then we divide total emissions by the county's population size to get GHG emissions per capita for each county. The measure is in terms of annual metric tons of CO₂ equivalent commonly used in literature.

2.4. Median household income

Of the main factors contributing to GHG emissions are the level of economic activity, level of education and the types of employment in each county. These factors are reflected

in the level of income. For this reason, we use the median household income level in each county as a control variable in our regression models. We obtained data from the US Census Bureau, Poverty estimates.

3. Regression model and estimation results

We use a panel data sample with 7,132 observations. As of preparing this study, data on emissions are available until 2021. Data on PCCA at the county level start in 2014. Therefore, we use data on emissions in 2015, 2017, 2019 and 2021, while we use data on PCCA in 2014, 2016, 2018 and 2020. Counties with direct emitters included in the sample are 1,783. Equation (1) presents our regression model:

$$GHG_{it} = \gamma PCCA_{it-1} + \beta X_{it} + \alpha_i + \lambda_t + u_{it} \quad (1)$$

The dependent variable, GHG_{it} , is the log of GHG emissions per capita at county i in time t . $PCCA_{it-1}$ is the public climate change agreement at county i in the previous period, $t-1$. As a measure of PCCA, we use the percentage of people who responded yes to the ‘timing’ question. As a robustness check, we repeat the estimation using the percentage of people who responded yes to the ‘happening’ question. X_{it} is the log of the median level of household income at county i in time t . We also include county fixed effects, α_i , and time fixed effects, λ_t . Finally, u_{it} is an error term.

As mentioned, we use lags of temperature anomalies to instrument for PCCA in order to alleviate the potential endogeneity. We use the two-stage least square (2SLS) method. Equation (2) presents the first stage, where the endogenous variable, lagged PCCA, is projected on lagged temperature anomalies ($Temp_{it-1}$, $Temp_{it-2}$, $Temp_{it-3}$) and other exogenous variables. The ‘1’ subscript is to denote the first stage. Equation (3) is the second stage. At this stage, we use projected PCCA, $\widehat{PCCA}$, from the first stage. The ‘2’ subscript is to denote the second stage.

$$PCCA_{it-1} = \mu_1 Temp_{it-1} + \delta_1 Temp_{it-2} + \theta_1 Temp_{it-3} + \beta_1 X_{it} + \alpha_{1i} + \lambda_{1t} + u_{1it} \quad (2)$$

$$GHG_{it} = \gamma_2 \widehat{PCCA}_{it-1} + \beta_2 X_{it} + \alpha_{2i} + \lambda_{2t} + u_{2it} \quad (3)$$

Table 2 presents the results. The first-stage relationship between temperature anomalies and PCCA is statistically significant. Furthermore, lagged PCCA is significantly related to

Table 2. Benchmark estimation results.

Stage 1	
% Temp. Anomaly 1	0.133***
% Temp. Anomaly 2	−0.085***
% Temp. Anomaly 3	0.156***
Stage 2	
PCCA	−0.279**
Log (Median Income)	1.351**
County Fixed Effects	Yes
Time Fixed Effects	Yes

*Significant at 90%, **Significant at 95%, ***Significant at 99% confidence level.

Table 3. Results using 'happening' as a PCCA measure.

Stage 1	
% Temp. Anomaly 1	0.168***
% Temp. Anomaly 2	0.044**
% Temp. Anomaly 3	0.046*
Stage 2	
PCCA	−0.118*
Log (Median Income)	0.521
County Fixed Effects	Yes
Time Fixed Effects	Yes

Note: *Significant at 90%, **Significant at 95%, ***Significant at 99% confidence level.

GHG emissions. A percentage point increase in PCCA is expected to cause a 24.35% decrease in GHG emissions per capita next year. This is our main result.

4. Robustness

4.1. 'Timing' vs. 'Happening'

As a robustness check, we repeat the estimation using the percentage of people who responded yes to the 'happening' question to measure PCCA. As shown in Table 3, PCCA remains significantly related to GHG emissions per capita. Using this measure, a percentage point increase in PCCA is expected to cause an 11.13% decrease in GHG emissions per capita next year. This is not surprising, since simply believing that climate change is happening does not provide the same motivation to act as believing that climate change can cause harm now or in the near future.

4.2. Current temperature anomalies

As an additional robustness check, we add current temperature anomalies as an additional explanatory variable to the model. This is to capture the potential direct effect of temperature anomalies on GHG emissions. Also, it controls for potential effect of lagged anomalies on current anomalies (auto-correlation). Table 4 shows that

Table 4. Estimation results with current temperature anomaly.

Stage 1	
% Temp. Anomaly 1	0.198***
% Temp. Anomaly 2	−0.135***
% Temp. Anomaly 3	0.179***
Stage 2	
PCCA	−0.245**
Log (Median Income)	1.234**
Current Temp. Anomaly	−0.016
County Fixed Effects	Yes
Time Fixed Effects	Yes

*Significant at 90%, **Significant at 95%, ***Significant at 99% confidence level.

the main conclusion holds. PCCA is significantly related to emissions. A percentage point increase in PCCA is expected to cause a 21.73% decrease in GHG emissions per capita next year. In this estimation, we use the ‘timing’ question as a measure for PCCA.

5. Welfare impact

In this section, we quantify the economic significance of the existing PCCA gap. Different studies provide estimates to monetise the consequences of climate change by estimating the ‘social cost of carbon’ (SCC), since CO₂ is the main GHG emission. Nordhaus (2017) estimates SCC for the US to be 4.78\$/t CO₂. Pindyck (2019) estimates an average SCC of 200\$/t CO₂. We use these estimates as lower and upper bounds in the below estimation.

The total GHG emission reported by direct emitters in the sample is 2.38 billion units of metric tons of CO₂ equivalent in 2021. The US population size in 2021 is around 332 million. This means that GHG emissions per capita is approximately 7.16 in 2021. Using the estimated coefficient from Table 2, a percentage point increase in PCCA is expected to decrease subsequent GHG emissions per capita by 24.35%. This means a decrease from 7.16 to 5.42, which decreases total GHG emissions by about 578 million units. Using estimates of SCC, the estimated welfare benefits of increasing PCCA by one percentage point are therefore between \$2.76 billion and \$115.74 billion.

Further, increasing the percentage of people who answer yes to the ‘timing’ question to 100% (closing the PCCA gap) requires a 41-percentage point increase. This means that closing the PCCA gap in the US can result in welfare benefits between \$113.42 billion and \$4.75 trillion. Using the ‘happening’ question to measure PCCA yields lower estimates of the welfare gains. In addition, such increases in PCCA are not marginal increases, so these welfare gain estimates are to be taken with caution.

6. Conclusion

While there is a broad consensus among scientists about climate change, there is a lack of such consensus among the US public opinion. This may be contributing to deterring the efforts to reduce GHG emissions in the US. In this paper, we estimate the effect of increasing the public climate change agreement on GHG emissions per capita in the US.

We instrument for lagged PCCA using lagged temperature anomalies. Lagged anomalies are correlated to PCCA and have no direct effect on current GHG emissions. We find that a percentage point increase in PCCA is expected to lower subsequent GHG emissions per capita by 24.35%.

Through the expected reductions in GHG emissions, higher PCCA can lead to welfare gains. Using our results and estimates for the ‘social cost of carbon’, we find that increasing PCCA by a percentage point can result in up to \$115.74 billion welfare gains. Closing the PCCA gap can result in up to \$4.75 trillion welfare gains.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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