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ELECTIONS HAVE CONSEQUENCES:
THE IMPACT OF POLITICAL AGENCY ON CLIMATE POLICY AND ASSET PRICES

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ABSTRACT

I study the origin and pricing of climate policy uncertainty. Using tools from natural language processing, I construct a novel dataset of timestamped climate policy announcements. Analyzing high-frequency returns around these announcements, I find a significant climate policy risk premium. This premium is larger when political constraints are more lax. To interpret these results, I build a model combining political economy and climate finance. In the model, climate policy uncertainty emerges endogenously because governments have private information about their future policies; this uncertainty generates a risk premium because climate policies affect cash flows and aggregate output. Political constraints affect the magnitude of the premium both by preventing implementation of extreme policies and altering the informativeness of policy communication.

CHAPTER 1

INTRODUCTION

Climate change promises to dramatically re-order economic activity (Nordhaus (2018)). More frequent extreme weather events have the potential to reduce firm profitability and depress aggregate output (Kelly et al. (2021)). Government policies may mitigate the worst effects of environmental damages, but they will certainly affect the regulatory environment in which firms operate. Asset prices should reflect not only the potential future physical destruction of climate change (Barnett et al. (2020)), but also the regulatory risk emanating from the government (Barnett (2020), Ilhan et al. (2020)).

There is no extant work that studies how political economy affects the joint determination of climate policy and asset prices. This study fills that gap in the literature. I show empirically that politics affects the pricing of climate policy uncertainty. To interpret my findings, I develop a model combining machinery from political economy and climate finance.

Policymakers' problem is inherently political. When implementing carbon taxes and other environmental policy instruments, policymakers pay large political costs (Furceri et al. (2021)). Political constraints will bound the scope and scale of government policy interventions designed to fight climate change. Regulatory risk in financial markets will crucially depend on equilibrium in the political system.

To study the impact of politics on climate finance, I construct a comprehensive dataset of White House policy announcements by scraping current and archived versions of `www.whitehouse.gov`. To the author's knowledge, this dataset has not previously been used in the finance literature. The White House press office and National Archives maintain comprehensive records of executive branch policy communication since 1993. Importantly, these records always contain the content, speaker and date of the announcements. Since 2001, the press office has also provided precise start and end timestamps.

The core empirical challenge in studying the impact of governmental policies on asset

prices is the endogeneity of government policy actions to economic and climatic conditions. The key difficulty is to separate the impact of government actions from these underlying states. Identification comes from the fact that we observe precise start and end times for this set of policy announcements. The core identifying assumption is that economic and climatic conditions do not change precisely at the same minute as these announcements are made.

To study changes in asset prices exactly around White House announcements, I merge this dataset with minute-level data from financial markets. I study the returns to zero-cost portfolios that take a long position in brown stocks and a short position in green stocks, which I call "brown-minus-green" portfolios. These portfolios are meant to capture climate policy risk.

To measure when policymakers discuss climate change specifically, I use techniques from natural language processing to decompose policymakers' speech into distinct topics. I leverage the strong factor structure implicit in political speech to precisely measure climate policy news.

I document five novel facts. First, I show that presidential announcements are associated with systematic declines in the VIX. These announcements are periods when a significant amount of information is revealed to market participants – policy uncertainty is resolved.

Second, there is a strong positive relationship between returns on brown-minus-green portfolios and the amount of climate policy news during a policy announcement. I find that when there is a substantial amount of climate policy news, the value of portfolios exposed to climate policy risk tend to appreciate.

Third, I show that the connection between climate policy news and expected returns is strongest under green parties. There is an asymmetry in the relationship between climate policy news and expected returns under pro-business and pro-environment parties respectively. Fourth, realized returns around climate announcements are highest when the president

making the announcement has near total control of the political system. These are periods when political constraints are lax, and presidents are most able to implement the policies they announce.

Fifth, there is a statistically significant relationship between the approval rating of the president making the announcement and the magnitude of the expected decline in the VIX. More popular policymakers make more informative policy announcements that result in larger declines in the VIX.

I interpret these and other results through the lens of a model combining political agency (Barro (1973), Ferejohn (1986)) with climate finance. Political agency emphasizes that voters delegate policymaking to elected officials. The government's problem is to implement its desired climate policies while remaining in office. Voters discipline the actions of the policymaker through elections. The relationship between elected officials and voters is that of an agent and principal.

I model elections as a signalling game. Policy announcements are signals meant to convince voters to re-elect the policymaker. The crux of the model is that investors understand the game being played between voters and the government. Investors use the information contained in policy announcements to forecast future output and cash flows.

The model clarifies the economics of the main empirical results. Climate policy uncertainty arises because investors are uncertain of the future policies of the government. This uncertainty generates a climate policy risk premium because government policies affect both investor utility and firm cash flows. There are excess returns around climate policy announcements because announcements are exactly when uncertainty is resolved and the climate policy risk premium is realized.

The model also explains why the relationship between climate policy news and returns differs across parties. Under green parties, brown stocks are particularly risky because they perform poorly when stringent environmental regulations are implemented. Under brown

parties pricing flips. Brown stocks are an excellent hedge against too lax environmental policy regimes.

The model endogenously generates time-variation in the magnitude of the announcement return. When governments are less constrained, they implement more extreme policies and also make more informative policy announcements. These two forces affect the magnitude of the climate policy risk premium and the extent to what it is realized over the course of policy announcements. When governments are politically constrained, the magnitude of the announcement return is smaller both because the climate policy risk premium decreases and because a smaller proportion is realized at the time of the announcement.

Politics affects asset prices (Kelly et al. (2016), Manela and Moreira (2017)). Policy-makers solve well-defined problems and their behavior is determined by the incentives and constraints they face. In this respect, governments are no different than mutual funds or banks. The same tools financial economists use to understand the problems of managers or bankers are also applicable to political decisions. Studying these problems can further our understanding of financial markets.

By jointly modeling asset prices and political decisions, financial economists can also contribute to political economy. Just as macro-finance leans on asset price data to test macro models, financial economists can leverage the high frequency nature of asset prices to evaluate otherwise untestable models of the political system. Such evidence from financial markets is relevant for policy. Academic economists have limited evidence as to what are politically feasible climate change policies (Morse et al. (2021)). By testing models of political decision making, financial economists can use asset market data to illuminate political feasibility.

CHAPTER 2

LITERATURE REVIEW

This paper relates to a large literature studying the economic effects of climate change. Influential early work in this field includes Mendelsohn et al. (1994), Nordhaus and Boyer (2000), Nordhaus (2007) and Nordhaus (2008). Much of this and subsequent research has analyzed the macroeconomic implications of climate change and optimal policy design. I use machinery from Golosov et al. (2014) to model the connection between production and carbon emissions.

A rapidly growing literature studies the impact of climate change on asset markets. Barnett et al. (2020) study the effect of uncertainty over far-off climate damages on asset prices today. Baldauf et al. (2020) and Alekseev et al. (2022) study the effects of beliefs about climate change on asset demand. Pastor et al. (2021, 2022) study the impact of investors' tastes for brown and green assets on returns. Kanzig (2022) studies the impact of carbon pricing on aggregate output, inequality and asset prices. For a comprehensive review of this space, see Kelly et al. (2021).

Climate finance classifies the risk associated with climate change into physical risk and transition risk. Physical risk is the direct risk to the capital stock from extreme weather events. Transition risk is the risk associated with a transition to a low carbon economy. Regulatory risk is one form of particularly salient transition risk. I contribute to this literature by studying how political constraints affect regulatory risk.

A few papers study the impact of uncertainty about regulatory policies meant to combat climate change on asset prices. Barnett (2020) investigates the incentives to exploit natural resources when assets may become stranded. Ilhan et al. (2020) find that there is larger tail risk for firms with greater levels of carbon emissions and that this risk decreased after the 2016 presidential election.

My paper also relates to papers in political economy studying political agency. Notable

contributions include Ferejohn (1986), Acemoglu et al. (2008), Barro (1973), Chari and Kehoe (Aug., 1990), Ales et al. (2014) and Yared (2010). These papers study the impact of agency frictions on government policies. Because voters delegate the ability to implement policies to elected representatives, there is an implicit agency problem between voters and elected officials. The threat of electoral removal serves to align the interests of politicians with the voters they represent. Strategic interaction between the principal and agent affects equilibrium government policies.

To the author's knowledge, Alesina and Cukierman (1990) is the only other paper studying the impact of political agency on the government's incentives to provision information. A larger number of papers, including Cukierman and Meltzer (1986), Stein (1989) and Stein and Sunderam (2018) study the monetary authority.

Furceri et al. (2021) finds that there is significant heterogeneity in the political costliness of climate change policies. These authors find that carbon taxes are associated with significant reductions in the support for governments that implement them.

There are a small number of theoretical papers at the intersection of political economy and asset pricing. Musto and Yılmaz (2003) studies the impact of access to a contingent claims market on voting decisions. In a series of papers, Pástor and Veronesi model the impact of government policies on asset prices: Pástor and Veronesi (2012, 2013 2016 and 2020). Pástor and Veronesi (2012, 2013) study theoretically the impact of policy uncertainty on asset markets.

One lens to view the model developed in this paper is that it microfounds the reduced form political cost of Pástor and Veronesi (2012, 2013). These authors model the cost of political decisions as drawn from a lognormal distribution. I microfound these political costs by explicitly modeling strategic interaction between voters and policymakers. The key deviation in this paper from these two papers is the explicit incorporation of agency frictions between voters and governments. In contemporaneous work, Hsu et al. (2022) enriches the

baseline model of Pástor and Veronesi (2012) by adding environmental costs, but does not endogenize this cost as I do.

This approach is also distinct from Pástor and Veronesi (2016, 2020). In these papers, the authors model political decisions as directly chosen by voters as opposed to implemented by elected representatives. These papers primarily study how objects from asset pricing affect political decisions; I study how the political system itself affects asset prices.

The empirical methods in this paper are closely related to Kelly et al. (2016) and Kanzig (2022). Kelly et al. (2016) studies variation in options prices around elections. Kanzig (2022) uses the surprise component in decisions by the European Union Emissions Trading System (EU ETS) to study the impact of carbon pricing on financial variables. The key identification problem is the endogeneity of governmental policies to economic and climate conditions. Like these papers, I leverage the high frequency nature of asset prices in order to identify the causal effect of governmental policies on asset prices. I contribute to this literature by identifying a new set of events that affect financial markets.

In contemporaneous work, Liu and Shaliastovich (2021) studies daily returns around State of the Union speeches, one kind of presidential policy announcement. They find large returns around these speeches, broadly consistent with the results of this paper. This paper studies a broader set of policy announcements using intraday data, relates the content of the speech itself and a broader set of political variables to returns and provides a model through which to interpret the empirical findings.

CHAPTER 3

DATA

I collect three types of data. The first are White House policy announcements. These documents contain the speaker, content, start and end-timestamps and title of announcements made by White House officials. I scrape this data from current and archived versions of the White House website. I describe the structure of this dataset and the steps involved in data collection in Section 3.1. To exploit the high-frequency nature of the announcements, I merge the dataset of policy announcements with trade and quote (TAQ) data. TAQ data records intraday quotes and trades for many different publicly traded securities. I provide more details about data coverage and the filters used in Section 3.2. Finally, I measure voter attitudes using micro-data from Gallup, described in Section 3.3

3.1 White House Policy Announcements

`www.whitehouse.gov` was established in 1994 by the Clinton administration. The website records information about the policies pursued and personnel employed in the executive branch. Among other information, the website records the transcripts of communication by the president and other White House officials.

These transcripts contain both the text of what was said and metadata about the content of the communication. The title of the transcript usually lists both the primary speaker and venue delineating, for example, between a press briefing and speech. The document itself lists the location of the communication and the start and end times, including the timezone. When there are multiple speakers, the speaker of each passage of text is recorded.

Extracts from one such document appear in Table B.1. This transcript, from President Biden's remarks at a climate summit held at the White House, is typical. The White House assigned title is the centered text at the top of the document. This information is recorded

as meta-data as opposed to within the document text itself.

The transcript text begins by declaring that the speech was delivered in the East Room of the White House on April 22, 2021. The subsequent and last lines record that the briefing began and ended at 10:50 A.M. and 10:56 A.M. Eastern time, respectively.

The body of the text records a single speaker – President Biden. Speakers from the administration are always identified, unless the document is marked "on background". I exclude such documents since the content is expressly not meant for dissemination at the time of the briefing.

The speech itself includes substantial information relevant to climate policy. In the final paragraph President Biden announces a new "Climate Finance Plan." In the preceding paragraphs, the president provides additional information about specific steps that the United States is taking to increase the supply of financing to firms that are making green investments.

The speechs' metadata has become increasingly organized over successive administrations. Since the Obama administration, communications by the president have been typically labeled "remarks," though sometimes presidential press conferences use other terminology. During the George W. Bush administration, live presidential statements are referred to as addresses, discussions, speeches or announcements. For the results presented below, I take a maximalist view of what constitutes a remark. This will necessarily include communication that does not have meaningful economic or political content.[1]

While there are no explicit rules governing the accuracy of content uploaded to the White House website, there are strong norms and outside pressure from news organizations that make providing inaccurate information unappealing from the perspective of the White House press office. This leads the White House to upload accurate transcripts, even when unflat-

1. The Clinton transcripts omit important information, including end timestamps. For this reason I do not use them in the analysis. For a discussion of the Clinton transcripts see Section D.2.2 in the appendix.

tering to the speaker.[2] The communications on which I focus are a matter of public record. In real-time, it is easy to monitor whether the press office is engaged in misrepresentation. After a president leaves office, an archived version of the White House website is maintained by the National Archives, where it can no longer be altered.

From the raw data of all White House Press Briefing documents, I construct the dataset after applying four filters. First, I require that all documents are a remark. The document must be a verbally delivered communication from a White House official in a public setting. I then filter out speakers who are not the president, which means removing White House cabinet officials, the first lady, vice-president and second lady. I remove non-presidential announcements because I want to capture high-profile announcements to which market participants pay attention to. It is less plausible that market participants closely monitor the speech of non-presidential speakers.

I then remove communications that do not include a valid time and timezone. I also remove the small number of communications delivered outside of the United States. These documents are usually marked as being delivered in "local" time. It is difficult to disambiguate what constitutes local time. For consistency, I remove all such documents. Finally, I require that the communication was delivered during trading hours. The result of these four filters is to select public speeches delivered by the president within trading hours.

I thus compiled a dataset that consists of 3650 remarks between 2001 and 2022, after filtering for public comments delivered by the president during trading hours. Four presidents are represented–George W. Bush (1936 speeches), Obama (1395 speeches), Trump (247 speeches) and Biden (72 speches). These numbers indicate that President Biden is only partially through his first term and Presidents Biden and Trump did not deliver public, prepared remarks with the same frequency as their predecessors. The number of briefings and effect of each filter by administration is broken down in Table B.2.

2. See this recent example where the White House uploaded a transcript that correctly recorded the President making a major gaffe.

By restricting to events during which a president made a public speech, it is extremely likely that market participants knew the timing of the event and the general subject because the White House Press Office publishes the president's daily schedule, typically the evening prior.

An example of a daily presidential schedule appears in Table B.3.[3] Such schedules are typically published the evening prior to the date in question. In this example, the schedule was likely published the night of April 21. I chose April 22, 2022 because the transcript in Table B.1 occurred on this date. The announcement in Table B.4 appears in Table B.3 indicating that it was included in the president's daily schedule. Both an approximate time and full title of the event are provided in the schedule. Market participants would have known that the president would be speaking at approximately 10:30 AM. From the title "The President delivers remarks and participates in the virtual Leaders Summit on Climate Session 2: Investing in Climate Solutions" market participants knew the subject of the speech would be climate policy – there is no ambiguity. From a hand audit of the articles included in the dataset, the schedule that contained both the title and time of remarks that survived the filters in Table B.2 is typical.

3.2 Trade and Quote (TAQ) Data

TAQ data contains intraday quotes and transactions for about 8,000 stocks listed on all US equity exchanges, including NYSE, AMEX and Nasdaq. I access this data through WRDS, aggregating the data to the minute level. For each minute, I calculate the low, high, open, and closing prices, and the trading volume, within that minute window for all trades.

To account for errors in TAQ, I impose standard filters on the correction indicator and sale condition variables in TAQ itself. I avoid well-known issues related to incorrect opening

3. These schedules are maintained at `https://factba.se/` from schedules published by the White House press briefing office.

prices in TAQ because the sample of events I use is restricted to events that occurred within trading hours. Finally, I treat dividends as paid after-hours.

The primary proxy I use for uncertainty is VIX futures ETFs, which hold VIX futures contracts. They ascend in value when the VIX is expected to increase. VIXY and VXX hold short-term VIX futures and they thus track the spot value of the VIX closely. VIXM and VXZ hold longer-dated maturity contracts and so track the VIX less closely. For all four series the end-of-day value is highly correlated with the spot value of the VIX. I do not use the VIX directly, since I do not have access to intraday values of the VIX.

I also use industry ETFs to calculate minute-level returns to industry portfolios, which are good proxies for industry portfolios because they are highly liquid. Some ETFs have been traded since the late 1990's. I construct portfolios that are exposed to climate policy risk, called a "brown minus green" (BMG) portfolio, by taking long positions in ETFs corresponding to brown industries and short positions in green industries.

For the baseline analysis, I construct the BMG portfolio by going long in one of three ETFs–Materials Select Sector SPDR Fund (XLB), SPDR S&P Metals & Mining (XME) and Energy Select Sector SPDR Fund (XLE). I use one of two portfolios for the short portfolio–Health Care Select SPDR Fund (XLV) and iShares Biotechnology ETF (IBB). In robustness checks, I use alternative short portolios including Consumer Staples Select SPR Fund (XLP) as well as other technology and consumer goods industry ETFs. I report the top ten constitutents for each of these ETFs in Table D.3.

I chose these portfolios based on two criteria–their exposure to climate and environmental regulation and their long lifespan. The short portfolios consist of companies in industries that have minimal exposure to climate policies. The health care, biotechnology and consumer staples industries are minimally exposed to environmental regulation.

Firms in XLB, XME and XLE are extremely highly exposed to environmental policy. Many, such as ATI Inc., Nucor Corporation, United States Steel Corporation, Aloca Corpo-

ration, Sherwin-Williams, Dow Inc. and Newmont Corporation have paid large settlements with the Department of Justice, Environmental Protection Agency and other environmental regulators.[4] In addition to paying direct fines, these companies are disproportionately in industries with significant carbon emissions. Consol Energy Inc is among the largest coal mining companies in the United States. Many of these companies engage in steel manufacturing, which is emissions-intensive. Other companies, such as Dow and Linde PLC, use or refine petrochemicals.

3.3 Gallup

To measure voter demand for climate policies and presidential approval, I use data from Gallup. The first series that I use is the Gallup Daily Tracker. Between 2008 and 2017, Gallup conducted daily polls of 1,000 U.S. adults, asking a variety of questions regarding political, economic and general well-being. On a typical day, approximately half of respondents were asked questions from the political track.

Between 2009 and 2017, Gallup asked respondents "Do you approve or disapprove of the way Barack Obama is handling his job as president?". Respondents had the choice of responding "Approve" or "Disapprove". A small number of respondents respond that they "Don't know" or refused to answer the question. For 2008 and 2017, Gallup does not report having asked respondents their approval of either Presidents Bush or Trump respectively.

The dataset provided by Gallup includes the response to this and other questions, a large number of demographic variables and sampling weights. Gallup includes sampling weights to account for "disproportionalities in probabilities of selection and response rate by sample

4. The following links record some fines and penalties for these companies. Many of these companies are repeat offenders and have other monetary settlements with the EPA. https://archive.epa.gov/epapages/newsroom_archive/newsreleases/681ddccde6228708852570d60070ff02.html, https://www.justice.gov/archive/opa/pr/2000/December/703enrd.htm, https://www.epa.gov/newsreleases/epa-settlement-steel-dynamics-inc-will-reduce-air-pollution-butler-indiana, and https://web.archive.org/web/20080227000345/http://www.fws.gov/midwest/grandcalumetriverndrda/documents/USX.pdf

frame". To construct the approval rating, I code "Approve" as 100 and "Disapprove" as zero. I drop the small number of respondents who do not choose one of these two options. I then take a weighted average, weighting by the Gallup supplied sample weights. Finally, to account for the relatively small sample of 500 respondents per day, I take a five-day rolling average. The series generated from this procedure is displayed in the top panel of Figure D.5.

Besides the Gallup tracker, Gallup also polls a large sample of US households each month as part of the "Gallup Poll Social Series" (GPSS). These surveys are conducted every month and organized around a particular topic. In March of each year the topic is energy and the environment. Each monthly survey, including the March survey, records the demographics of the respondents and asks a number of standard economic and political questions, including Presidential job approval. Each question in the survey is asked of approximately 500 respondents, which is the same number as the Michigan survey of consumers.

For the March survey specifically, Gallup asks respondents more specific questions about environmental and energy policy, including "Do you think [current President] will do/is doing a good job or poor job in handling each of the following issues as president" for "protecting the nation's environment" and "improving the nation's energy policies". The responses to these questions are extremely highly correlated both with each other and the respondent-level Presidential job approval.

Also in March, Gallup asks respondents several questions related to climate change, including the respondent's "view of the seriousness of global warming". Besides this, Gallup also asks questions about how knowledgable they are about climate change, when they expect the effects of climate change to occur and what their perceptions of what scientists say about climate change.

CHAPTER 4

MAIN EMPIRICAL FINDINGS

The primary empirical findings of the paper derive from an event study. I analyze high-frequency changes in asset prices around climate announcements. I first characterize climate speech by policymakers. Section 4.1 details this process. Section 4.2 describes the findings. A detailed discussion of how these results fit within the theoretical framework of the paper is given in Section 5.9.

4.1 Topic Modeling

To classify the content of the remarks themselves I train a topic model using Latent Dirichlet Allocation (LDA). LDA models the text of documents as generated from underlying abstract topics.

A topic is a probability distribution over words. A single topic could be characterized by high probabilities of using the words "McConnell," "Pelosi," "Capitol" and "chamber." A natural label for such a topic would be "Congress." Topic labels are a subjective choice of the researcher. Desirable topic models have topics that are interpretable, meaning that the words associated with a topic belong to a group understandable to a human reader.

To estimate the topic model, I take the original transcript set and split each document into a set of tokenized unigrams. Tokenizing is the process of breaking up a sentence into a set of individual words. I stem the words by removing suffixes. For example, the words "becoming" and "become" are each mapped to the single unigram "becom". I do this for the text of every document in the first column of Table B.2. The topic model is then trained on the entire set of documents.

A full list of topics, the manually assigned label and unigrams most associated with that topic appear in the appendix in Table D.1. The label is a subjective choice of the researcher.

For topics for which there is no obvious topic label, I leave the topic label blank.

Topic models are frequently uninterpretable to human readers. A high proportion of topics in this table are highly interpretable. The striking interpretability of topics from LDA applied to White House documents is likely due to an extremely strong factor inherent in political speech. Political speech often focuses on discrete and clearly delineated issues. This structure results in topics that are both machine and human-interpretable.

Two topics relate to energy policy and one to climate change specifically. Topic 115 captures language related to climate change. The five words that associate with this topic are "climat," "energi," "chang," "emiss" and "clean." The other topic relevant to energy policy is Topic 175, which has a large number of words related to oil and gas, the five most important of which are "energi," "oil," "price," "gas" and "fuel".

After estimating the topics, I infer the content of the individual transcripts by calculating the posterior probability that the words in the transcript were drawn from a particular topic. The posterior probability for document i and topic j is given by

$$\text{Posterior}_{i,j} = \frac{\mathbb{P}\left(\text{Words Drawn from Topic } j\right)}{\sum_{k \in K} \mathbb{P}\left(\text{Words Drawn from Topic } k\right)} \tag{4.1.1}$$

In practice, this posterior probability is high for documents that frequently use the words for a particular topic in Table D.1. For example, a document has a high posterior value for the climate change topic if it frequently uses words like "climate," "change," and "emissions".

To assess whether the procedure offers credible results, I list the ten documents with the most climate speech in Table B.4, ordered by descending values of the posterior. The second column is the article title, assigned by the White House Press Office. To be concrete, the posterior measure is calculated purely from the text of the document, not from the title. That the title of the document refers to climate validates that the topic model identifies speeches related to climate change correctly.

The second important feature of Table B.4 is that the filters in Table B.2, in conjunction

with the topic model, identify announcements that are both about climate change and that investors are almost certain to know are about climate change. There is no ambiguity that President Obama will discuss climate change at the U.N. Climate Change Summit. Further, the fact that there is a climate change summit at the United Nations is public knowledge broadcast well in advance. The other articles that load on the climate topic and survive the filters in Table D.1 nearly always have these two qualities: clearly about climate change and broadcast to market participants in advance. Additional summary statistics for climate scores appear in Table B.4.

As an additional check, I investigate which topics associate most strongly with negative returns to the VIX ETFs. Significant heterogeneity is evident in the content of the policy announcements, with some clearly unrelated to economic news. If negative returns to the VIX relate to the release of information relevant to market participants, and if the topic model captures the true content of these announcements, topics associated with the sharpest declines in the VIX ETFs should reflect news that is extremely important to markets.

The topic that best predicts declines in VXZ and VIXY is topic 123, the "Federal Emergency" topic. This topic is the second- and fourth-most negatively correlated topic with VIXM and VXZ, respectively. Topic 150, Coronavirus, is the second most negatively correlated topic for VXZ and VIXY, and it highly negatively correlates with the other ETFs. Other topics that associate most with large declines in the VIX futures ETFs are Topic 43 (Terrorism), Topic 154 (Budgets) and Topic 3 (Bill Passage). These all appear to proxy for topics that affect financial markets, and for which presidents are uniquely able to provision information

4.2 Event Study

The results from the event study are split into four parts. Section 4.2.1 shows that policy uncertainty is resolved during these announcements. Section 4.2.2 shows that there is a

climate policy risk premium. Section 4.2.3 shows supporting evidence that I identify a climate policy risk premium and Section 4.2.4 shows that the magnitude of the premium varies over time.

4.2.1 Resolution of Uncertainty and Behavior of VIX

To assess whether White House policy announcements associate with systematic movements in financial markets, I first plot returns to a trading strategy that invests in a VIX futures ETF or in cash. Ten minutes before a policy announcement, the strategy invests in the VIX futures ETF, and the strategy holds the ETF until ten minutes after the announcement, when it rotates back into cash.

I compare the strategy that holds VIX futures near policy announcements to several nearly identical strategies, which instead invest in the VIX ETF during a placebo period. The timing of these placebo periods is very similar to the time of the actual White House announcements by construction.

If there was a single remark between noon and 1 PM on Thursday, the baseline strategy would invest in VIX ETF at 11:50 AM, and at 1:10 PM it would sell the asset. At all other times on Thursday the strategy holds cash. I compare this to three different variants. The first two invest in the asset between 11:50 AM and 1:10 PM on Wednesday and Friday, instead of Thursday, and hold cash all other times throughout that day. The third invests in the asset on Thursday for the same duration, but it sells the asset one hour before. The asset is thus initially bought at 9:30 AM and sold at 10:50 AM. An illustration of this strategy appears in Figure A.1.

I plot log returns to each of these four strategies for four assets in Figure A.2. There is a pronounced decline in the expected future spot value of the VIX during these remarks, and there is no commensurate decline during any of the placebo dates.

The extremely tight event windows, large number of announcements and consistent visual

pattern make it implausible that the decline in the VIX that associates with policy announcements is driven by confounding events. Such events would have to occur consistently and exactly within a few minutes of the event.

It is also implausible that such announcements are scheduled explicitly in response to confounding events, at least within a tight window. The White House often explicitly addresses ongoing events, but the filters in Table B.2 restrict events to high-profile events, during which the president himself speaks. The president's schedule is published in advance, and high-profile speaking engagements take considerable effort to organize.

I formalize this analysis by estimating the following regression:

$$R_{i,t}^{\text{VIX}} = \beta \times \mathbb{I}\{\text{Announcement}_t\} + \nu_t \tag{4.2.1}$$

This regression is estimated on an unbalanced panel of VIX ETFs. Each VIX ETF is represented for its entire lifetime. The oldest two VIX ETFs began trading in January 2009 and the remaining two subsequently. All four ETFs are traded until 2022. I cluster at the minute level to account for cross-sectional correlation in returns.

Table B.5 presents estimates for this regression. The estimated coefficient β is negative and significant, indicating that the pattern of declines in the VIX observed in Figure A.2 is statistically significant. This same regression can be estimated for each VIX ETF individually. All four coefficients are negative and similar in magnitude, the coefficients for the oldest ETFs are statistically significant in these specifications.

In the appendix, I also estimate a matching estimator version of this regression in Table E.1:

$$R_t^{\text{VIX}} = \beta \times \mathbb{I}\{\text{Announcement}_t\} + \nu_{\text{pair}} \tag{4.2.2}$$

ν_{pair} is a fixed-effect for each day pair. Thus the regression compares across the actual announcement and the placebo date as a control. This is the regression counterpart of

Figure A.2.

The results for the VIX are reported in Table E.1. Comparing across any pair of same day, next day and prior day the briefing day is associated with a larger resolution of uncertainty, i.e. a more negative return to the VIX ETFs. These effects are large in magnitude. The returns to the VIX ETFs are approximately five to ten basis points lower in the event windows than during other periods.

Prior work has documented that proxies for policy uncertainty strongly comove with the VIX (Manela and Moreira (2017)). These results are strong evidence that Presidential policy announcements cause a decline in the VIX because policy uncertainty is resolved.

4.2.2 Climate Policy Risk Premium

I next study whether there is a systematic relationship between climate speech and returns. To do this, I estimate regressions of the form

$$R_t^{\text{BMG}} = \mathbb{I}\{\text{Remark}_t\} + \mathbb{I}\{\text{Remark}_t\} \times \text{Climate Speech}_t + \nu_t \tag{4.2.3}$$

R_t^{BMG} is the return on a long-short portfolio that goes long in brown stocks and short in green stocks (i.e. the BMG portfolio), described in Section 3.2. The unit of observation is a minute-level return. The remark indicator, $\mathbb{I}\{\text{Remark}_t\}$ takes the value one if there was a remark that minute or ten minutes before or after. All results are clustered at the level of the day.

ν_t is a date fixed-effect, which I include because there could be latent economic or climatic states that both affect the expected return to BMG and correlate with the timing of climate remarks. For example, investor tastes for green assets might have increased over time, increasing the expected return to the BMG portfolio. This increase in investor taste is plausibly correlated with the amount of climate policy speech. Fixed effects de-mean the

expected return across a day and ensure that the estimated coefficients are not contaminated by changing investor tastes or other underlying states.

The Climate Speech$_t$ variable is the posterior value calculated from the topic model, and it takes values between zero and one. The posterior is high if there is significant use of words such as "climate" or "emissions" in the text of the announcement. This variable is near zero for the majority of articles, indicating that there is typically little discussion of climate.

I use posterior value instead of an indicator for two reasons. First, this limits subjectivity. To label something a climate policy announcement based on the posterior would require defining a precise threshold for which an announcement is or is not a climate policy announcement. Second, this would remove significant variation. Even speeches for which the main purpose of the remark is not climate policy might include information relevant to investors.

Estimates from this regression appear in Table B.6. There is a strong, statistically significant relationship between climate speech and the return to the brown minus green portfolio during announcement periods. There is also a strong relationship between the average minute-level return on the BMG portfolio and the amount of climate speech over the course of the announcement.

The regression results imply that the minute-level return to the BMG portfolio over the course of a policy announcement that was purely climate news (i.e. the variable Climate Speech takes the value one) would be between two and three basis points per-minute higher than an announcement that had no climate speech. This number comes with an important caveat– the maximum value that this variable takes is approximately 0.25. Appropriately scaling by the average value of the posterior, announcements that have the most climate news have a BMG return approximately 0.33 basis points per minute higher relative to the remainder of the day.

Two possible economic interpretations of this positive statistical relationship are possible.

The first is that there is unanticipated good news for brown firms during remarks with a significant amount of climate content. Alternatively, investors are compensated for holding stocks exposed to regulatory policy when climate news is released to the market–that is, there is a climate policy risk premium.

The weight of evidence supports a risk premium explanation, due to filters applied in Table B.2 and the kinds of remarks that the topic model identifies as having substantial climate content in Table B.4. These are pre-scheduled remarks that market participants know ex-ante will have substantial discussion of climate policy. There are also a large number of articles with substantial climate content, approximately 140. Were this relationship driven by unexpected cash flow news, market participants would have had to have been systematically surprised many times over. This hypothesis seems less plausible than a risk premium.

4.2.3 Good News vs. Risk Premium

I conduct two further tests to rule out that this statistical relation is driven by positive cash flow news as opposed to a risk premium.

In Table B.7, I estimate the same regression as in Table B.6, except that I restrict the set of announcements that are counted as a "remark." To isolate announcements that market participants understand will have climate or environmental news, I use only announcements that have explicit environmental content in their titles. I require that a title includes one of the following substrings: "climate," "paris agreement," "clean energy," "clean fleet," "clear skies," "ocean," "energy," "environment," "efficien," "renewable," "conservation" or "build back better".

Subsetting the sample this way makes it even more implausible that communication about climate policy was a surprise to market participants. The announcements that survive these filters were explicitly about environmental policy, and it is implausible that market participants would have been surprised by significant climate content. This test clarifies

exactly what the alternative story must be if this relationship is not driven by a risk premium. Investors know that these announcements will have explicit climate content ex ante. In spite of this foreknowledge, the content of the announcement must be systematically surprising many times over.

Comparing the estimates in Tables B.6 and B.7 provides additional evidence that this statistical relationship in returns is attributable to a risk premium. Despite the many fewer explicitly environmental announcements and consequent decrease in power, all six coefficients of interest are significant. Each coefficient has also increased in magnitude, indicating that climate speech is associated with higher returns when it comes during speeches that are explicitly about environmental policy.

I conduct several robustness checks to corroborate this statistical relationship. In Table E.4, I estimate the same regression as in Table B.6, but I use alternative portfolios. I also use a technology sector ETF (XLK), consumer discretionary ETF (XLY) and consumer durables ETF (XLP) as the short portfolios. The interaction term remains significant in most of these regressions, and the magnitude of the coefficient remains stable. In Table E.5 I estimate regressions using where the dependent variable is an indicator for whether the amount of climate speech in a given remark is above a threshold. In Table E.6, I replicate the baseline result using topic models with varying numbers of topics. In Table E.7 I use alternative clustering.

As further evidence against the good cash flow news story, I estimate the same regressions, except that instead of a climate topic, I use an energy topic:

$$R_t^{\text{BMG}} = \mathbb{I}\{\text{Remark}_t\} + \mathbb{I}\{\text{Remark}_t\} \times \text{Energy Speech}_t + \nu_t \tag{4.2.4}$$

The "Energy Speech$_t$" variable is the posterior score for Topic 175 in Table D.1. The five most important words for this topic are "energi," "oil," "price," "gas," and "fuel". *This is a placebo test.* These announcements consist of discussion of policies that will likely affect

firms exposed to climate regulation. However, a close reading of the articles that load on this topic indicate that announcements with high energy posterior scores almost never include explicit discussions of regulatory actions to address climate change and almost never address climate change itself explicitly.

The results from this placebo test are listed in Table B.8. There is no positive relationship between the energy topic and the return to the brown minus green portfolio. None of the interaction terms are significant and many are negative. Further, they are uniformly smaller in magnitude than the estimates from Table B.6. I interpret the evidence from this placebo test as supporting evidence that the pattern of returns in Table B.6 is due to a risk premium as opposed to news.

4.2.4 Time Variation in Climate Policy Risk Premium

I document in Table B.9 that there is significant time variation in the relationship between returns and climate speech. First, the relationship between climate speech and returns is driven by climate announcements under Democratic presidents. When the dataset is subset into Democratic and Republican presidents, the estimated coefficients behave sharply differently. On the sample of announcements for Democratic presidents, the coefficient always retains significance and the estimated value is stable, relative to the coefficient estimated on the full sample. Under Republican presidents, the point estimate varies widely and is never significant.

The behavior of the estimated coefficient on the interaction term seems largely driven by most climate announcements being made under Democratic presidents. Republican presidents seldom make climate announcements and thus the coefficient is imprecisely estimated.

In Table B.10, I show that the relationship between returns and climate speech are considerably higher during periods where there is unified government. I define unified government as periods during which the same party controls the Presidency and has outright majorities

in both the Senate and House of Representatives.[1] Periods of single party control of both Congress and the Presidency are periods where governments are most able to implement their desired policies.

The first two columns of Table B.10 estimate the regression separately based on whether the unified control indicator is true or false. The estimates for both regressions are positive and significant. However, the estimate when the unified control indicator is true is more than three times larger in magnitude than the estimate from the regression when the indicator is false. This difference corresponds to approximately six basis points per minute, which is large and economically meaningful.

1. A majority in the Senate is defined as when a party has at least 51 seats, not 50. I show in the appendix that the result holds when the definition is expanded to include ties.

CHAPTER 5

MODEL

To understand the economics behind the empirical results reported in Section 4, I jointly model asset prices and the determinants of political decision making. A key feature of climate policy is the political costliness of policy actions (Furceri et al. (2021)). I micro-found the political costs that policymakers face by enriching a production-based asset pricing model with voting. The model delivers insight in three dimensions.

Why do investors face climate policy uncertainty? Investors face climate policy uncertainty because they are uncertain over the government's future policy actions. These actions are a function of the government's type. The government's type is private information, known only to the government. Because they face an electoral constraint, governments sometimes have strong incentives to conceal their type. Climate policy uncertainty originates and lingers because of political considerations.

What is the connection between climate policy uncertainty and returns? The government's type is important information for investors because they can use it to forecast future policy actions. High types may enact drastic policies to abate climate change in the future, low types may not take any environmental regulatory action at all. Investors are concerned about future policy actions because of regulation's impact on future output and cash flows.

Why does the relationship between climate policy uncertainty and returns vary over time? Two forces endogenously generate time-variation in the relationship between climate policy uncertainty and returns.

First, the climate policy risk premium is positive under green parties and negative under brown. Under green parties, stock returns negatively covary with marginal utility. The covariance is positive for brown parties. This leads to a positive climate policy risk premium under green parties and negative one under brown.

Second, the degree to which governments are capable of implementing their preferred

policies affects the magnitude of the climate policy risk premium. When political constraints are more binding, governments are less able to implement extreme policies. This force decreases the quantity of risk and the overall magnitude of the climate policy risk premium consequently declines.

Sections 5.1 through 5.6 provide the technical details of preferences, technology and equilibrium. Sections 5.7 and 5.8 derive implications for asset prices and discuss the mapping from model to empirics. Section 5.9 contains a discussion of the links between theory and empirics. Readers primarily interested in understanding the model's relation to the empirical findings can skip to this section. Finally, Sections 5.10 and 5.11 conclude with a discussion of modeling assumptions.

5.1 Production

The production block is extremely similar to a two-period version of Golosov et al. (2014). A representative final good producer combines energy (E_t) and capital (K) using a Cobb-Douglas production technology to produce a final good (Y_t):

$$Y_t = E_t^{\lambda} K^{1-\lambda} \tag{5.1.1}$$

Energy is an intermediate good produced by a competitive energy-producing sector. The j^{th} energy-producing firm in the sector combines brown ($B_{t,j}$) and green ($G_{t,j}$) inputs also using a Cobb-Douglas aggregator with output elasticities α and $1-\alpha$:

$$E_{t,j} = B_{t,j}^{\alpha} G_{t,j}^{1-\alpha} \tag{5.1.2}$$

Total emissions ($\mathcal{E}_t$) generated in production depend on the total amount of brown energy

(B_t) used in energy generation:

$$\mathcal{E}_t = (1 - g_t) B_t \text{ where } B_t = \sum_j B_{t,j} \tag{5.1.3}$$

The key object of interest is the government policy, g_t. This policy affects the cost and greenness of energy generation. Higher g_t results in cleaner but more expensive energy. In equilibrium, this results in a trade-off between aggregate output and total emissions, summarized by the following two equations:

$$Y_t = \hat{\alpha} (1 - g_t) K \text{ and } \mathcal{E}_t = \bar{\alpha} (1 - g_t)^2 K \text{ where } \hat{\alpha}, \bar{\alpha} > 0 \tag{5.1.4}$$

These equations are derived in Section C of the appendix.[1] g_t closer to one results in better environmental quality, measured by lower emissions, but also depresses aggregate output. The value of g_1 is unimportant, so I set $g_1 = 0$ for convenience.

The object of the production block of this economy is to micro-found the connection between environmental regulation, consumption and aggregate emissions. The model endogenously produces a critical trade-off: stringent environmental regulation results in higher environmental quality but depresses aggregate consumption. The elections block of the economy takes this trade-off as given and characterizes the equilibrium determination of g_t.

5.2 Households

Households are heterogeneous, the i^{th} household's problem is to maximize expected utility (Equation (5.2.1)) by both choosing a consumption plan state-by-state (s) and voting subject

1. Section C provides additional information about how g_t enters into the energy firm's problem and how the cost of energy generation affects aggregate production.

to the intertemporal budget constraint Equation (C.3.2).

$$\max_{vote_i, \{C_{i,s}\}} \log\left(C_{i,1} - \theta_G \mathcal{E}_1\right) + \mathbb{E}_1\left[\beta \log\left(C_{i,2} - \theta_i \mathcal{E}_2\right)\right] \tag{5.2.1}$$

Household preferences are defined over consumption ($C_{i,t}$) and carbon emissions ($\mathcal{E}_t$).

The relative weight given to the disutility of carbon emissions is household specific and determined by θ_i. There is a continuum of households with θ_i uniformly distributed according to $\mathcal{U}\left(\underline{\mathcal{H}}, \overline{\mathcal{H}}\right)$. I assume that θ_i is sufficiently small such that the non-negativity of the argument to the log term is not violated. The rate at which households discount over time is governed by β. Markets are complete and households can trade Arrow-Debreu securities with price q_s.

Production is related to aggregate consumption through market clearing:[2]

$$\int_i C_{i,s} di = Y_s \tag{5.2.2}$$

Households' voting decision takes into account that the government in office sets g_t. The regulatory policy matters for utility because it affects emissions directly and also aggregate output, which equates to aggregate household consumption through market clearing.

5.3 Government

At time 1, there is an incumbent government. Like households, governments have preferences over consumption and emissions. The incumbent government's disutility of emissions is denoted θ_G, which represents the government's type. The incumbent government's time-1 problem is

$$\max_{\{g_2, \hat{g}_2\}} \log\left(\bar{C}_1 - \theta_G \mathcal{E}_1\right) + \mathbb{E}_1\left[\beta \log\left(\bar{C}_2 - \theta_G \mathcal{E}_2 - l\left(g_2, \hat{g}_2\right)\right)\right] \tag{5.3.1}$$

2. I use the notation $\int di$ to indicate the integral across agents using the relevant density over i. When necessary for clarity I explicitly list the density.

$\bar{C}_t$ is an equal-weighted cross-sectional average of household consumption. The functional form of the government's preferences is nearly identical to that of households, except that it is defined over average consumption and that the term $l(g_2, \hat{g}_2)$ enters into the government's objective. The incumbent government both chooses the g_2 it will implement if re-elected and makes a policy announcement, $\hat{g}_2$. Households observe the policy announcement, not the policy.

The incumbent government's choosen policy, g_2, is only implemented if the incumbent government is re-elected. If the incumbent is not re-elected, then the policy is set by a challenger government. In this case, consumption, emissions and, implicitly, the incumbent's utility are then determined by the challenger's policy.

$l(g_2, \hat{g}_2)$ captures the non-pecuniary cost to the incumbent government if the policy it implements, g_2, differs from the policy announcement it makes in the first period, $\hat{g}_2$. This cost can only be non-zero if the incumbent is re-elected. If the incumbent is not re-elected then it does not implement g_2. Only when the incumbent remains in office in the second period can the incumbent both announce a policy and deviate from it.

I impose that $l(g_2, \hat{g}_2)$ is a convex function to capture that larger differences between the announcement and implemented policies are increasingly costly. For tractability, I consider the special quadratic form:

$$l(g_2, \hat{g}_2) = \begin{cases} \frac{\mathcal{C}}{2}(g_2 - \hat{g}_2)^2 & \text{If government in office in periods 1 \& 2} \\ 0 & \text{Otherwise} \end{cases} \tag{5.3.2}$$

The magnitude of this cost depends on $\mathcal{C}$.

The government is not a social planner. The government's problem is characterized by three assumptions: *non-benevolence*, *asymmetric information* and *lack of full commitment*. These assumptions are standard in work that models agency frictions between elected rep-

resentatives and voters in the macro-political economy literature.[3] The key deviation from my model and other work in climate finance is this agency friction and that the government is subject to removal from office through elections.

The incumbent's type, θ_G, has no direct connection to the preferences of households – it is drawn by nature from one of two type distributions:

$$\theta_G \sim \mathcal{U}\left(\underline{\mathcal{G}}, \overline{\mathcal{G}}\right) \text{ or } \theta_G \sim \mathcal{U}\left(\underline{\mathcal{B}}, \overline{\mathcal{B}}\right) \text{ where } \overline{\mathcal{B}} < \frac{\overline{\mathcal{H}} - \underline{\mathcal{H}}}{2} < \underline{\mathcal{G}} \tag{5.3.3}$$

$\mathcal{G}$ stands for Green and $\mathcal{B}$ for Brown, which represent pro-environment and pro-business parties, respectively. The support of these type distributions is exogenous. That the government's policy choice is a function of its own preferences and not that of households is non-benevolence. By assumption, the challenger's type θ_C is drawn from the type distribution opposite that of the incumbent.

The government's type is known to itself, but not to households. There is an information asymmetry between households and the elected officials who are vying to represent them. Households do know the type distribution from which the government's type is drawn and the parameters of the type distribution.

That governments cannot commit to implementing a particular policy once in office represents lack of full commitment. Since there is a cost associated with misreporting, the government has a limited ability to commit.

The non-pecuniary cost is analogous to an adjustment cost. I interpret policy announcements as a technology incumbents use to partially commit to instituting particular policies. When governments make announcements they hire lawyers and begin drafting laws and regulations. They cannot fully commit to implementing these policies, because they can always revise their policies at a later date. However, doing so is costly. They must re-write what they have already implemented. This frequently entails costly interaction with the legal

3. See Acemoglu et al. (2008), Ales et al. (2014) or Yared (2010), for instance.

system.

The challenger does not signal. The inability for governments that are out-of-power to credibly commit to policy aims is one of the fundamental asymmetries between incumbents and challengers. The fact that incumbent governments can commit in this way is a form of incumbency advantage. Consequently, the challenger's problem can be written as

$$\max_{\{g_2\}} \log\left(\bar{C}_1 - \theta_C \mathcal{E}_1\right) + \mathbb{E}_1\left[\beta \log\left(\bar{C}_2 - \theta_C \mathcal{E}_2\right)\right] \tag{5.3.4}$$

Because the challenger does not signal the term $l\left(g_2, \hat{g}_2\right)$ does not appear. To economize on notation, I write that the challenger chooses g_2. However, this g_2 is only implemented if the challenger is elected, otherwise the incumbent chooses g_2. If the incumbent sets the policy, then the challenger's payoff is determined by the incumbent's choice.

While households cannot set the policy directly, they can vote for or against the incumbent government. Elections are the mechanism by which households prevent governments from implementing policies that a government prefers at the expense of voters. Households condition their vote on the policy announcement they observe.

5.4 Contingent Claims Market

At the start of period one, a contingent claims market opens and agents trade. Agents seek to insure themselves against risk by buying or selling contingent claims that pay out in a single state k, the price of which I denote as P_k. Each state corresponds to a different realization of g_t. There is heterogeneity across agents and so there will be gains from trade.

Lemma 1 (Contingent Claims)**.** *The i^{th} agent will trade in the contingent claims market until*

$$\frac{P_j}{P_k} = \frac{\beta^{t_j - 1}/\tilde{C}_{i,j}}{\beta^{t_k - 1}/\tilde{C}_{i,k}} \text{ where } \tilde{C}_{i,j} = C_{i,j} - \theta_i \mathcal{E}_j \tag{5.4.1}$$

that is, until the ratio of marginal utilities are equated with the ratio of the prices of the

contingent claims state-by-state.

Agents are heterogeneous, but we can price assets using the SDF of a particular agent: the agent with the average disutility of emissions across households $\overline{\theta}$ who, state-by-state, consumes the cross-sectional average of consumption, $\overline{C}_t$.

Proposition 1 (Stochastic Discount Factor)**.** *The agent with disutility of emissions $\overline{\theta}$ who consumes $\overline{C}_t$, with utility given by*

$$U_{M,t} = \sum_{t' \geq t} \beta^{t'-t} \log\left(\bar{C}_t - \bar{\theta}\mathcal{E}_t\right) \tag{5.4.2}$$

has a stochastic discount factor given by

$$M_{t,t'} = \beta^{t'-t} \frac{\bar{C}_t - \bar{\theta}\mathcal{E}_t}{\bar{C}_{t'} - \bar{\theta}\mathcal{E}_{t'}} \tag{5.4.3}$$

This is a valid SDF.[4]

I subscript this agent's utility with M and refer to this agent as agent M or just M in susbsequent discussion. M denotes that this agent has the mean value of θ_i across households.

Lemma 2 (Uniform Valuation)**.** *Every household's relative valuation across any two pairs of states is the same as that of agent M.*

For each household, the relative valuations across state pairs will be equalized and the ratio of marginal utilities will equate with the ratio of state prices. This result will simplify the analysis of voting considerably. Musto and Yilmaz (2003) were the first to show that access to complete markets transforms voting decisions when the election results in redistribution across agents.

4. "Valid" means that any security's price is given by the expected value of the discounted (by the SDF) future payoff (Kim and Korajczyk (2018)).

5.5 Voting

At the beginning of period two an election is held. After observing the policy announcement, voters choose between the incumbent government and the challenger. As with the incumbent, the type of the challenger, θ_C, is unknown. By assumption, the type distribution from which challenger's type is drawn is the opposite of that of the incumbent. This mimics that nominees from different parties compete in general elections

If the challenger is elected at the beginning of period two, the challenger will set the policy. The challenger government has no way to commit to setting a particular policy before being elected and so will simply implement its preferred policy.

This structure approximates that of the actual political system. Voters vote for candidates with incomplete knowledge about their policy positions. The exact policy preferences of individual candidates are not known with certainty. In the model and in actuality, households must parse statements that candidates make to infer their preferences. Voters' information set at the time of the election consists of the announced policy, the type distribution of the challenger and incumbent governments and each type of government's equilibrium strategy.

Voters are sincere. They have no ability to commit ex-ante to a voting strategy and so vote for the incumbent if their expected utility is higher under the incumbent than the challenger:[5]

$$\mathbb{E}_t\left[U_{i,t}\left(g_2\right) \mid \text{Incumbent Sets Policy}, \hat{g}_2\right] \geq \mathbb{E}_t\left[U_{i,t}\left(g_2\right) \mid \text{Challenger Sets Policy}\right] \quad (5.5.1)$$

5.6 Equilibrium

To find an equilibrium in elections, I start by characterizing the optimal unconstrained policy of the government, which I subsequently refer to as the "dictatorial solution" as this is the

5. See Section 5.10 for a discussion of why sincerity is justified.

policy the government would implement in the absence of electoral constraints.

Proposition 2 (Dictatorial Solution)**.** *The dictatorial solution to the government's problem, denoted* $g^{\star}(\theta_G)$ *is given by*

$$1 - g^{\star}(\theta_G) = \frac{1}{2}\frac{\hat{\alpha}}{\bar{\alpha}}\frac{1}{\theta_G} \tag{5.6.1}$$

This proposition characterizes the *unconstrained* maximizer of the government. Each type of government will prefer a different prevailing policy, g_2. Those with higher θ_G will prefer a greener policy g_2. The left-hand panel of Figure A.4 graphs the optimal policy of the government as a function of θ_G. Governments with higher θ_G have higher disutility of emissions and are more willing to trade-off lower consumption for decreased emissions. As the disutility of emissions increases the optimal policy increases as well, i.e. it becomes more green.

Because governments are subject to electoral discipline, they are not necessarily free to implement the dictatorial solution. The key is to characterize what policies governments implement given that they are subject to removal from office through elections.

The election is a signaling game in which the government is the sender and the voters are the receiver. The timing of the signaling game is given in Figure A.3. Equilibrium is a Perfect Bayesian Equilibrium (PBE) in which the actions of both the government and voters are sequentially rational and beliefs are derived from Bayes' rule whenever possible. Equilibrium is characterized by first conjecturing the strategy of voters and then solving for the strategy of the incumbent government and voter beliefs. Proposition 7 verifies that these strategies and beliefs constitute a PBE.

The first step is to characterize the actions of voters. Because voters trade in the contingent claims market at the start of period one, the ratio of marginal utilities across states is equalized for every pair of households. Relative valuations for each voter will be the same and the voting decision identical for each agent. To characterize the outcome of the election, we need only characterize the decision of M, that is the voter with $\theta_i = \bar{\theta}$ who consumes

$C_{i,t} = \overline{C}_t$ state-by-state.

Proposition 3. *The choice of the voter with $\theta_i = \bar{\theta}$ who consumes $C_{i,t} = \bar{C}_t$ will win the election.*

Instead of considering the equilibrium decision of each voter separately, we only need to consider the decision of agent M. I refer to agent M as the "median voter", as the decision of this agent is decisive.

I guess that the median voter employs a threshold voting rule, the incumbent is re-elected if the policy announcement lies in an interval $\left[\underline{g}, \overline{g}\right]$. The bounds define a closed interval because the preferences of households are bliss-point preferences. They prefer policies that are close to their own, either a little browner or a little greener. The economic content of the guess is that the incumbent is re-elected if the announced policy is sufficiently close to the preferred policy of the median voter.

These bounds are endogenously determined by Equation (5.5.1), which becomes:

$$\mathbb{E}_t\left[U_{M,t}\left(g_2\right) \mid \hat{g}_2 = \underline{g}, \text{Incumbent Sets Policy}\right] = \mathbb{E}_t\left[U_{M,t}\left(g_2\right) \mid \text{Challenger Sets Policy}\right] \tag{5.6.2}$$

$$\mathbb{E}_t\left[U_{M,t}\left(g_2\right) \mid \hat{g}_2 = \overline{g}, \text{Incumbent Sets Policy}\right] = \mathbb{E}_t\left[U_{M,t}\left(g_2\right) \mid \text{Challenger Sets Policy}\right] \tag{5.6.3}$$

The left-hand side of the indifference condition depends on the incumbent government's strategy exactly when the incumbent reports $\hat{g}_2 \in \left\{\underline{g}, \overline{g}\right\}$. Voters understand that the incumbent will not implement the policy it announces when $\hat{g}_2 \in \left\{\underline{g}, \overline{g}\right\}$. Voters will re-elect the incumbent only if they are at least as well off voting for the incumbent that misreports as under the challenger government. Equilibrium is when voters are exactly indifferent between these two alternatives.

If the government's unconstrained policy choice, $g^{\star}\left(\theta_G\right)$, lies within $[\underline{g}, \overline{g}]$, the government can do no better than implementing that policy and truthfully reporting that they have done

so. When a government's preferred policy is close enough to that of the median voter, then governments have no incentive to misreport. If the government's preferred policy is outside the bounds $\left[\underline{g}, \overline{g}\right]$, then there are incentives to misreport the implemented policy.

I numerically solve for and plot the equilibrium bounds in Figure D.2 in the appendix.

Proposition 4 (Government's Strategy)**.** *Denote the unconstrained maximizer of the government as $g^{\star}$ and the constrained policy choice as $g^{\star\star}$. An equilibrium strategy that satisfies sequential rationality for the incumbent government under the conjectured equilibrium is given by*

$$g^{\star\star}\left(\theta_G\right), \hat{g} = \begin{cases} g^{\star}\left(\theta_G\right), g^{\star}\left(\theta_G\right) & \textit{If } g^{\star}\left(\theta_G\right) \in \left[\underline{g}, \bar{g}\right] \\ f\left(\theta_G, \overline{g}\right), \overline{g} & \textit{If } g^{\star}\left(\theta_G\right) > \overline{g} \\ f\left(\theta_G, \underline{g}\right), \underline{g} & \textit{If } g^{\star}\left(\theta_G\right) < \underline{g} \end{cases} \tag{5.6.4}$$

where

$$1 - f\left(\theta, s\right) = \frac{\mathcal{C}\left(1 - s\right) + \hat{\alpha}K}{\mathcal{C} + 2\theta\bar{\alpha}K} \tag{5.6.5}$$

The incumbent's strategy can be understood through a limiting argument. When $\mathcal{C} \to \infty$, the government simply implements $g_2 = s$. The cost of misreporting is too high so governments simply report truthfully. Conversely, as $\mathcal{C} \to 0$ the government's policy collapses to the government's dictatorial solution. The cost of misreporting is infintesimal so the government simply implements its preferred policy in the second period.

This policy rule is illustrated on the right-hand panel of Figure A.4. Three lines are shown. The unconstrained optimal policy of the incumbent is shown as a light gray line – it is the same as the blue line on the left-hand panel. The blue line is the policy that the incumbent implements, the dashed yellow line the policy announcement. The median voter's thresholds are $\underline{g} = -0.2$ and $\overline{g} = 0.3$. When the optimal policy of the government lies within $\underline{g}$ and $\overline{g}$, the government implements their optimal policy and truthfully reports $\hat{g}_2 = g_2$.

The median voter re-elects the incumbent because their utility under g_2 is higher than their expected utility under the challenger.

When the optimal policy of the incumbent lies outside of these thresholds, the government misreports their policy and implements a policy intermediate between the policy they prefer and the policy they report. These dynamics can be seen on the left- and right-hand regions of Figure A.4. The implemented policy is not the same as the policy announcement. The dashed line corresponding to the policy announcement is flat for all types

$$\left\{\theta_G \mid g^\star\left(\theta_G\right) \notin \left[\underline{g}, \bar{g}\right]\right\} \tag{5.6.6}$$

These types misreport and issue a policy announcement exactly at one of the thresholds $\{\underline{g}, \overline{g}\}$.

The difference between the grey and blue line illustrates the gain to the median voter from decreasing $\overline{g}$ and increasing $\underline{g}$. Relatively extreme types of the incumbent government alter the policy they implement. These types shade away from their own preferred policy and towards the preferred policy of the median voter so that they are re-elected.

The upper-right panel of Figure A.4 also illustrates how policy uncertainty arises endogenously. It is driven by the partial-pooling equilibrium. Even after the policy announcement is made, investors will be unsure of the true policy if the incumbent government reports $\hat{g}_2 \in \left\{\underline{g}, \overline{g}\right\}$. When there is misreporting, households will be unsure of the implemented policy and, consequently, future cashflows of the final-good producer. Equilibrium policy uncertainty will depend on the mass of government types that misreport and their policy rules conditional on misreporting.

Proposition 5. *Under the threshold voting rule, the type that is indifferent between misreporting and truthfully reporting $\hat{g}_2 = \bar{g}$ and $\hat{g}_2 = \underline{g}$, denoted $\theta^H\left(\bar{g}\right)$ and $\theta^L\left(\underline{g}\right)$ respectively,*

is given by

$$\theta^H(\overline{g}) = \frac{1}{2}\frac{\hat{\alpha}/\bar{\alpha}}{1-\overline{g}} \text{ and } \theta^L(\underline{g}) = \frac{1}{2}\frac{\hat{\alpha}/\bar{\alpha}}{1-\underline{g}} \tag{5.6.7}$$

$\theta^H(\overline{g})$ is an increasing function of $\bar{g}$. As the $\overline{g}$ increases, the type that is indifferent between misreporting and truthfully truth-telling increases as well. In the limit as $\overline{g}$ goes to one all types tell the truth. $\theta^L(\underline{g})$ has the same functional form, but crucially depends on the lower bound $\underline{g}$. The logic for the lower bound is reversed. As $\underline{g}$ decreases more types engage in truth-telling.

Voters are Bayesian. Their beliefs follow immediately from Bayes' rule, the government's policy rule $g^{\star\star}(\theta_G)$ and the incumbent's type distribution.

Proposition 6 (Voter Beliefs)**.** *For actions on the equilibrium path, voter beliefs* (μ) *are given by*

$$\mu(\theta_G \mid \hat{g}_2) = \begin{cases} (g^{\star})^{-1}(\hat{g}_2) & \text{If } \hat{g}_2 \in (\underline{g}, \overline{g}) \\ \mathcal{U}\left(\underline{\theta}_G, \theta^L(\underline{g})\right) & \text{If } \hat{g}_2 = \underline{g} \\ \mathcal{U}\left(\theta^H(\overline{g}), \overline{\theta}_G,\right) & \text{If } \hat{g}_2 = \overline{g} \end{cases} \quad \text{and } \mu(\theta_C) = \mathcal{U}\left(\underline{\theta}_C, \overline{\theta}_C\right) \tag{5.6.8}$$

are derived from Bayes' rule.

Equation (5.6.8) illustrate how voters understand that governments misreport and know exactly which types of the incumbent do so. Beliefs off the equilibrium path are given by Equation (D.0.17) in the appendix and satisfy the intuitive criterion.

Equations (5.6.2), (5.6.3) and (5.6.4) crystallize equilibrium in the signaling game. The outside option of voters is to vote for the challenger, who will set the policy according to their own preferences. For any $g_2 \in (\underline{g}, \overline{g})$, the median voter knows with certainty the policy that will be implemented and does strictly better by re-electing the incumbent than electing the challenger.

When governments misreport the policy, voters know that the policy is being misreported.

Further, they know the strategy that governments employ conditional on misreporting the policy. The bounds of the threshold voting rule will adjust until voters are indifferent between keeping the misreporting incumbent or electing the challenger.

Because the challenger is drawn from the type distribution opposite that of the incumbent government, the incumbent government can always do better by either truth telling or misreporting than intentionally losing. The strategy in Equation (5.6.4) strictly dominates making a policy announcement that results in the challenger setting the policy. Thus, in equilibrium, the incumbent is always re-elected. In practice, incumbents are not always re-elected. However, empirically incumbent politicians are re-elected more frequently than not.

Proposition 7 (PBE)**.** *The incumbent government's strategy given by equation 5.6.4, the median voter's threshold voting rule with thresholds determined by the equations D.0.15 and D.0.16 and voter beliefs given in equations 5.6.8 are a PBE.*

There are two more important features of the equilibrium. First, there is an asymmetry in the threshold equilibrium for green and brown parties. For any nondegenerate threshold equilibrium, the types closest to the median voter will report truthfully. These types are the brownest green types and the greenest brown types. This can be seen implicitly in Figure A.5. The left-hand panel graphs the policy rule of the brown government and the right-hand panel the policy rule of the green government. The brown types with the highest θ_G report truthfully as do the green types with the lowest θ_G. This is formalized by the following lemma:

Lemma 3. *If $\overline{g} \neq \underline{g}$, then $\underline{g} = g^{\star}(\underline{\mathcal{G}})$ for the green party and $\overline{g} = g^{\star}\left(\overline{\mathcal{B}}\right)$ for the brown party.*

The key economic intuition behind this lemma is that the threshold equilibrium disciplines the policy choice of extreme types. The types with θ_G close to that of the incumbent

implement their desired policies. It is only those types with extreme types of θ_G relative to that of $\overline{\theta}$ that are forced to misreport. The equilibrium effect of the threshold equilibrium is to compress the set of potential implemented policies towards the optimal policy of $\overline{\theta}$. For brown parties this means the average policy becomes greener and for green parties the average policy becomes browner.

The second important feature is that the the equilibrium bounds also depend on the expected utility under the challenger. This dependence can be seen from Equation (5.6.3). The higher the expected utility under the challenger, the higher the expected utility must be for the median voter on observing a policy announcement exactly at the bounds of the threshold voting rule.

Result 1. *The difference between the optimal policy of the median voter and the implemented policy of the incumbent, for every type θ_G, is weakly decreasing in $\mathbb{E}\left[U_{M,2} \mid \textit{Challenger sets Policy}\right]$.*

The utility of the median voter under the challenger is the median voter's outside option. If the median voter's outside option is better, then the distance between $\overline{g}$ and $\underline{g}$ will shrink. The utility of the median voter, conditional on observing $\hat{g}_2$ exactly at the threshold must be higher to equate with the expected utility under the challenger.

The two panels of Figure A.5 illustrate this. Given an increase in the expected utility under the challenger, the distance between $\underline{g}$ and $\overline{g}$ shrinks and a greater mass of types reports a policy exactly on the new thresholds.

$\mathbb{E}\left[U_{M,2} \mid \text{Challenger}\right]$ is a measure of the political constraindness of the incumbent government. A better outside option for voters will result in $\underline{g}$ and $\overline{g}$ being set more aggressively. In expectation, the incumbent government will be forced to deviate more from its preferred policy towards that of the median voter's preferred policy so that the indifference condition is satisfied.

These two results emphasize that voters are able to influence the policy implemented by

the government. However, there is a second aspect of equilibrium: misreporting induced by electoral discipline. As the bounds shift inwards in Figure A.5, a progressively larger mass of the type distribution misreports the implemented policy. Misreporting induced by political constraints is is the downside of electoral discipline.

5.7 Policy Uncertainty

Policy uncertainty refers to the posterior variance of households over the government's type. I denote this posterior variance at time t as $\mathbb{V}_t(\theta_G)$. To discuss the evolution of this object around the policy announcement, denote $t+$ as the instant after the policy announcement and $t-$ as the instance before.

Result 2. *The magnitude of the expected resolution of uncertainty over the incumbent's type*

$$\mathbb{E}\left[\mathbb{V}_{t+}(\theta_G) - \mathbb{V}_{t-}(\theta_G)\right] \tag{5.7.1}$$

is weakly decreasing in $\mathbb{E}\left[U_{M,2} \mid \textit{Challenger Sets Policy}\right]$. *This quantity is always non-positive and is strictly negative if* $\overline{g} \neq \underline{g}$.

While voters are able to discipline the incumbent, incumbents respond to electoral constraints by misreporting. As electoral discipline becomes more severe, the expected uncertainty after seeing the policy announcement increases as incumbents distort the policy announcement to a greater extent. This can be seen in the second panel of Figure A.5. When $\underline{g}$ and $\overline{g}$ more inwards, the mass of types that misreport increases. The equilibrium effect of this shift is a higher posterior variance on seeing $\hat{g}_2 \in \left\{\underline{g}, \overline{g}\right\}$. The shaded portions of the x-axis illustrate the mass of the type distribution that previously truthfully reported and now mis-report the policy they implement. In expectation, this results in higher posterior variance over θ_G post-announcement.

Policy uncertainty arises endogenously in this model, it is a consequence of the partial-pooling equilibrium. In the absence of political constraints, all uncertainty would be resolved at the time of the announcement as the government would truthfully report its type.

The equilibrium effect of the increase in the number of types that pool can be seen in Figure A.6. The solid line corresponds to the expected decline in the posterior variance of θ_G as a function of the expected utility of the median voter under the challenger. As this quantity increases, more types pool. As more types pool there is less information revealed at the time of the announcement.

Figure A.6 also illustrates why uncertainty over θ_G affects asset prices: there is a tight connection between uncertainty over θ_G and uncertainty over the implemented policy in the final period. As investors are more uncertain over θ_G, so to are they more uncertain over g_2. g_2 affects both aggregate output and firm cashflows. Thus uncertainty over g_2 is reflected in asset prices.

5.8 Asset Prices

Politics affects asset prices because regulatory actions of the government will determine the consumption process of households, aggregate emissions and the profitability of individual firms. By Equation (5.2.2) we know that aggregate consumption will equal aggregate output. Marginal utility depends on both aggregate consumption and aggregate emissions, thus through Equations (5.1.4) and (5.4.3) asset prices will depend on the equilibrium policy g_t. Investors care about politics because the endogenous determination of g_t depends on equilibrium in elections.

To understand the behavior of asset prices both in aggregate and the cross-section, I consider pricing two separate claims. The first is a claim to the wealth portfolio Y_t. The second is the price of a claim to the profits of a small firm. This small firm has the same maximization problem as the representative firm, except that the production technology

differs:

$$Y_{t,j} = E_{t,j}^{\lambda_j} K_j^{1-\lambda_j} \tag{5.8.1}$$

This is the same functional form as the representative firm, except that the Cobb-Douglas exponents are allowed to vary. Firms with $\lambda_j > \lambda$ use more energy in production than does the representative firm, I call these firms "brown firms". Conversely, those with $\lambda_j < \lambda$ are called "green firms".

The problem of the small firm is given by

$$D_{t,j} = \max_{E_{t,j}} E_{t,j}^{\lambda_j} K_j^{1-\lambda_j} - P_{t,E} E_{t,j} \tag{5.8.2}$$

$D_{t,j}$ is the firm's profits and paid to the equity holder as a dividend. This is exactly identical to the problem of the representative firm, except that the production technology differs.

Lemma 4 (Small Firm Profits)**.** *The equilibrium profits of the small-firm are given by*

$$D_{t,j} = \hat{\alpha}_j \left(1 - g_t\right)^{\frac{\alpha\lambda_j}{1-\lambda_j}} K_j \text{ where } \hat{\alpha}_j > 0 \tag{5.8.3}$$

This expression illustrates the connection between the dividend process and the production technology of the firm. The dividend process of firms with larger λ_j will depend more on the realization of g_t. Exactly because the production process of brown firms is energy-intense, the cash flows of an equity claim are extremely exposed to the realization of the policy. The return to the aggregate claim is the same as the return to a small firm with $\lambda_j = \lambda$ and $\alpha_j = \alpha$.

Proposition 8. *The period-1 SDF can be written as*

$$M_{1,2} = \beta \frac{\hat{\alpha} - \bar{\theta}\bar{\alpha}}{\hat{\alpha}\left(1 - g_2\right) - \bar{\alpha}\bar{\theta}\left(1 - g_2\right)^2} \tag{5.8.4}$$

These preferences are bliss point preferences over g_t. The level of utility is highest when g_t takes the preferred policy of the agent. As g_t moves in either direction away from the preferred policy the level of utility declines. The level of utility is the solid line displayed in Figure A.7. This is the yellow dashed line labeled $g^\star\left(\bar{\theta}\right)$ is the preferred policy of the median voter. The solid and dashed lines are the level of utility and marginal utility of the median voter respectively.

Marginal utility is inversely related to the level of utility. As you move to the left or right of the figure marginal utility increases. This is because marginal utility depends on effective consumption $\tilde{C}_{i,t} = C_{i,t} - \theta_i \mathcal{E}_t$. Moving to the right of the figure g_t increases and consumption declines. This force drives down effective consumption and raises marginal utility. As you move to the left, consumption increases but this force is dominated by the increase in $\mathcal{E}_t$ which also results in a decline in effective consumption. In both cases marginal utility increases.

Figure A.7 clarifies what are "the bad states of the world" for investors. Bad states are when an extreme policy is implemented, far from the optimal policy of the agent with $\bar{\theta}$. These states depend on *both* the consumption and emissions process. Investors view a stock as risky and demand a high expected return when there is a possibility that an extreme g_2 is implemented, i.e. effective consumption is low, and the payout of the stock is concurrently depressed.

Figure A.7 shows that there are two kinds of bad states, one in either direction. The first is that the policy moves too far to the right and is "too green". When the policy is too green both aggregate output and emissions are low. These states will occur under the green party. To illustrate this, the green shaded areas is the region of policies that could be implemented by a green government. As you go farther into the green area the level of utility declines by more and marginal utility continues to increase. Conversely, the brown region is where both consumption and emissions are high. The brown region is the range of g_t that could

be implemented by the brown party. In this region as well there is a decrease in the level of utility and an increase in marginal utility.

The model is built to speak to announcement returns, which is the main object of interest in the empirical section. The announcement return is the capital gain or loss exactly at the time $\hat{g}_2$ is revealed – which is meant to map a presidential remark. To understand the behavior of announcement returns, it is important to first understand the holding period return over both periods.

Proposition 9 (Expected Returns)**.** *Expected returns are given by*

$$\mathbb{E}\left[R_1^i\right] - R_1^f = -R_1^f \, Cov\left(\beta \frac{\hat{\alpha} - \bar{\theta}\bar{\alpha}}{\hat{\alpha}\left(1 - g_2\right) - \bar{\alpha}\bar{\theta}\left(1 - g_2\right)^2}, R_1^i\right) \tag{5.8.5}$$

Expected returns depend on the covariance of the return with the SDF. In general, this covariance is non-zero, leading to a climate policy risk premium. This can be seen in Figure A.8, which plots the expected excess holding period return.

Result 3. *There is a non-zero climate policy risk premium. This premium is partially realized immediately before and after policy announcements. Because brown stocks are more exposed to climate policy, there is a non-zero expected announcement return to brown-minus-green portfolios.*

Figure A.8 separately plots the expected excess announcement returns for relatively green and brown firms. Brown firms are those with $\lambda_j > \lambda$, meaning they use more energy in production than the representative firm.

Firms that use no energy in the production process ($\lambda_j = 0$) are completely unaffected by the realization of g_t. Thus the cashflows of these firms are uncorrelated with the realization of the policy and the return is exactly the risk-free rate. Conversely, as λ_j increases the correlation between the payout and marginal utilities, increasing the risk premium of the

asset. This can be seen in the upper-left panel of Figure A.8. As λ_j increases the risk premium of the asset increases.

Implicitly, Figure A.8 plots the expected return to a brown-minus-green portfolio over the course of announcement. This quantity can be read off the figure by examining the difference between the expected excess announcement return for brown and green stocks. This quantity is also non-zero and has the same sign as the overall risk premium and expected excess announcement return.

What can be also seen from Figure A.8 is that the risk premium is not constant. There are two dimensions of heterogeneity.

Result 4. *The climate policy risk premium and expected announcement return to a brown-minus-green portfolio are both positive under green parties and negative under brown parties.*

Under green parties, the risk is that g_t will be very high, i.e. far to the right of Figure A.7. This extreme realization of g_t will depress marginal utility. The payout of the equity claim also depends on the realization of g_t through Equation (5.8.3). When g_t is high cashflows will also be depressed. Under green parties, equity payouts and marginal utilities are negatively correlated. This leads to a large, positive risk premium. This effect is more pronounced for brown stocks.

This dynamic is reversed under the brown party. Marginal utilities are high for extremely low realizations of g_t under the brown party. However, when g_t is particularly low is exactly when cashflows are high. Thus, the sign of the covariance in Equation (5.8.5) flips. Intuitively, these are periods in which output and cashflows are high, but the environment is destroyed. Stocks are a good hedge against these states, which is why there is a negative risk premium. Brown stocks are particularly good hedges against states in which the environment is bad, so the risk premium is particularly negative for these stocks.

Result 5. *The magnitudes of the climate policy risk premium and expected return to brown-minus-green portfolios are both decreasing in* $\mathbb{E}\left[U_{M,2} \mid \textit{Challenger}\right]$.

The x-axis of Figure A.8 is the expected utility under the challenger. This also affects the expected holding period return because of the force seen in A.5. As this quantity decreases, the range of possible realizations of g_2 increases. This introduces more volatility both into discount rates and into cashflows. This force increases the magnitude of the overall risk premium.

The lower panel of Figure A.8 shows the expected announcement return to holding the stock at the instant before and after the announcement is made. The risk premium is due to investor uncertainty about the government's type. As the announcement is made some uncertainty is resolved and part of the risk premium is realized. As with the risk premium, the model predicts that the expected announcement return is positive under green parties and negative under brown parties.

The expected announcement return is also decreasing in the expected utility under the challenger. This is due to two forces. The first is the decrease in the overall risk premium described above. There is a second force, which is the one seen in Figure A.6. As the expected utility under the challenger increases, less information is revealed at the time of the announcement. As announcements become less informative, there is smaller expected decline in political uncertainty and less of the premium is realized which results in a consequent decreased in the expected announcement return.

In Figure D.3 I plot the gross risk-free rate under the green and brown party as a function of the expected utility under the challenger. Similar dynamics can be seen in this plot. The risk-free rate is particularly low when the expected utility under the challenger is low and thus political constraints are lax. In this case, the probability of extreme policies being set is highest and investors are most willing to pay to insure themselves.

5.9 Connection of Model Implications to Main Empirical Findings

To understand the connection between the model and empirical results presented in Section 4, I formulate four testable hypotheses from the model's predictions. These hypotheses relate to the price and dynamics of political uncertainty over the course of policy announcements.

HYPOTHESIS 1: *on average, policy uncertainty declines during policy announcements.*

HYPOTHESIS 2: *there is a climate policy risk premium that is realized during climate policy announcements.*

HYPOTHESIS 3: *the expected announcement return to a brown-minus-green portfolio is positive under green parties and negative under brown parties.*

HYPOTHESIS 4: *the magnitude of the expected announcement return to a brown-minus-green portfolio is larger when political constraints are more lax.*

Each of these hypotheses is motivated by the theoretical findings in Sections 5.7 and 5.8. For each of these hypotheses, I compare the return around policy announcements in the data to the behavior of asset prices in the instants before and after the policy announcement $\hat{g}_2$ is made in the signalling game.

5.9.1 Hypothesis 1

Hypothesis 1 follows from Result 2. On average, policy uncertainty declines over the course of policy announcements because policy announcements are signals. These signals contain information about the future policies the government will implement. Investors use these signals to forecast future cashflows and aggregate output. The statement is "on average", because there is an edge case where policy announcements contain no information and thus there is no decline in uncertainty.

I test this hypothesis in Figure A.2, Table E.1 and Table B.5. The empirical test is to analyze whether a proxy for investor uncertainty, the VIX, declines in very small windows around policy announcements. To operationalize this test I use VIX Futures ETFs, which

are highly correlated with the VIX itself.

I find both strong visual and statistical evidence for this prediction. Figure A.2 plots the returns to a strategy holding VIX futures ETFs during announcements and placebo periods. The VIX futures ETFs decline substantially during the policy announcements. There is no strong visual pattern during the placebo periods. Tables E.1 and B.5 provide additional statistical evidence for this hypothesis.

5.9.2 Hypothesis 2

Hypothesis 2 states that there is a climate policy risk premium. This hypothesis follows from Result 3. Climate policy uncertainty generates a climate policy risk premium because investors are uncertain over the government's future actions – these actions affect both aggregate output and firm cashflows. This climate policy risk premium is realized during policy announcements because information is released to market participants precisely at these times.

To test this hypothesis I examine abnormal returns around policy announcements. If this hypothesis is correct, there should be non-zero abnormal returns to each stock and non-zero returns to a brown-minus-green portfolio exactly over the duration of these announcements.

Tables B.6 is direct evidence in support of this hypothesis. This table shows that climate policy news is associated with systematic non-zero returns to a brown-minus-green portfolio. When there is more climate policy news, the magnitude of the return to the brown-minus-green portfolio is larger. Through the lens of the model, this relationship holds in the data because as more climate policy news is released to market participants a bigger portion of the climate policy risk premium is realized.

5.9.3 Hypothesis 3

Hypothesis 3 follows from Result 4. This result says that the expected announcement return to a brown-minus-green portfolio is positive under green parties and negative under brown parties. The sign of the expected announcement return flips because of asymmetric variation in marginal utilities under green versus brown parties. Under green parties stocks are risky, they do poorly exactly when green parties implement extreme policies and marginal utilities are high. The opposite is true under brown parties – stocks are a hedge under brown parties.

I find mixed evidence in Table B.9 in support of Hypothesis 3. When estimating the relationship between returns on separate samples for brown and green governments, only the estimates from the green government subsample are both positive and statistically significant. This is consistent with the model's prediction that the climate policy risk premium is positive under green governments. When estimated on the brown party subsample the estimates are insignificant. The sign and magnitude of the coefficient varies across specifications. Thus, I cannot reject the model's prediction that the climate policy risk premium is negative under brown governments.

5.9.4 Hypothesis 4

Hypothesis 4 stats the magnitude of the expected return to the brown-minus-green portfolio is larger when political constraints are more lax. When political constraints do not bind, governments both implement more extreme policies and make more informative policy announcements. The first force increases the overall magnitude of the risk premium, the second increases the proportion of the risk premium realized at the time of the announcement.

In the data, I proxy for political constraints by using an indicator for whether or not the party of the president making the announcement has outright majorities in both Congress and the Senate. I do not explicitly model Congress. Instead, the measure of the political constraint in the model is the expected utility under the challenger government. However,

who controls Congress is itself endogenous to the expected utility of voters under either party. Periods when the same party controls both the Presidency and Congress are exactly when utility is high under that party relative to the alternative.

Table B.10 provides evidence for Hypothesis 4. I demonstrate that the expected announcement return to the brown-minus-green portfolio is considerably higher when the same party has near total control of the political system.

5.10 Discussion of Assumptions

I assume that voters are sincere. Voters vote for the candidate that gives them the highest expected utility upon assuming office. In principle, voters might employ non-sincere strategies. One such strategy would be to vote for the incumbent only if the incumbent announced a policy $\hat{g}_2 = \tilde{g}$. I do not give voters the ability to commit to such a strategy because the voting decision is non-verifiable. Governments have the ability to commit because ex-post their actions can be verified. If they deviate from their announced actions they are subject to a cost only because this deviation can be observed.

Conversely, voting decisions are unobserved. There is no way to verify ex-post how voters vote as they are atomistic. Further, it is illegal to directly monitor voting behavior. It is also impossible for a group of voters to delegate their voting power to a union that would then be able to vote in a verifiable manner. Votes must be cast in person and it is illegal for a union representative to accompany voters in the voting booth.

5.11 Climate Damages

Limiting the model to two periods necessarily omits important dynamics associated with climate change. Many of climate change's effects on financial markets are through far-off environmental damages and uncertainty about the magnitude of these effects on firm output.

This model has both a short horizon and makes no attempt to model climate damages. Further different from much of the climate change literature, the main climate variable of interest is the flow value of emissions as opposed to the stock of total emissions.

This is a model of regulatory risk, not physical risk. To speak to physical risk would require seriously modeling long-run risk induced by the damage function. In turn this would require Epstein-Zin preferences. The dynamics in this model come from heterogeneity across voters and between voters and the government. Epstein-Zin preferences do not aggregate and are not suited to studying either heterogeneity or voting, these preferences would make it impossible to find analytic solutions to the signaling game.

CHAPTER 6

ADDITIONAL EMPIRICAL TESTS

Proposition 2 implies that there should be a larger decrease in policy uncertainty over the course of an announcement when the expected utility under the challenger is lower.

Table B.12 provides evidence for this prediction. In the model, the measure of the political constraint is the expected utility under the challenger. I proxy for this in the data by using the approval rating of the incumbent government. This variable captures the degree to which voters approve of an incumbent relative to alternative governments. When the expected utility of voters under the challenger is high, they are likely to express substantial disapproval of the incumbent government. My proxy for investor uncertainty are the four VIX ETFs.

The evidence in Table B.12 is consistent with larger declines in uncertainty after the announcements of popular governments. The value of the VIX declines by more when the approval rating of the policymaker making the announcement is higher. For three of the four specifications the estimated coefficients on the interaction between the announcement and approval rating is significant. It is insignificant for a fourth, but this appears largely driven by a shorter time-series. The magnitude of this fourth specification is negative and has a point estimate similar in magnitude to that of the other specifications.

The model is silent as to the effect of shocking $\bar{\theta}$, because $\bar{\theta}$ affects not only the disutility of emissions, but also risk aversion. However, I separately test whether expressed voter environmentalism matters for the amount of environmental speech provisioned by the government, I regress the amount of climate speech for the i^{th} announcement on whether there was a Democratic President in office at the time of the announcement, the demand for environmentalism from Gallup and an interaction term. The demand for environmentalism is calculated as the share of respondents who report to Gallup that they worry "a great deal" about the impact of global warming.

The results from this regressions are displayed in Table B.11. There is a statistically significant positive relationship between voter environmentalism and the amount of climate speech provisioned by governments. While not a direct test of the model, this does provide some suggestive evidence that policy speech itself is responsive to voter preferences.

CHAPTER 7

CONCLUSION

Government policymaking to combat climate change affects asset prices. Government actions crucially depend on political incentives and constraints. This paper is the first to provide theory and empirics at the intersection of political economy and climate finance.

I construct a novel dataset of timestamped policy announcements and detect discussion of climate policy using techniques from natural language processing. I identify a statistically significant climate policy risk premium by empirically analyzing returns in the minutes around climate policy announcements. I further show that political variables affect the magnitude of this announcement return.

I combine machinery from political economy into an off-the-shelf model of climate finance. I explain my results by appealing to an agency friction implicit in the relationship between voters and their elected representatives. My model microfounds the political costs that governments pay when implementing climate policies and endogenously generates both climate political uncertainty and a climate policy risk premium.

I establish that government actions matter for asset prices. Like any other economic agent, governments solve well-defined problems. Governments' constraints and objectives will matter for the policies they implement and the impact of these policies on financial markets. Theory combining political economy and climate finance can guide empirical analysis of the relationship between government actions and asset prices.

Researchers empirically studying the impact of political economy on asset pricing are the beneficiaries of recent advances in natural language processing. These advances have made available reams of new data that finance researchers can exploit to understand the connections between politics and asset prices. Finance academics are uniquely capable of empirically studying political decision making because we can exploit high-frequency variation in asset prices in conjunction with text.

Much research remains to be done to understand the impact of politics on financial markets. Combining theory with these new methods can further our understanding of the many political risks that investors face and the impact of these risks on financial markets.

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APPENDIX A

FIGURES

Figure A.1
VIX ETF Trading Strategy

This figure graphically illustrates a trading trading strategy that invests alternatively in a VIX Futures ETF or in cash during actual announcements or over the course of a placebo date. The returns to this strategy in displayed in Figure A.2.

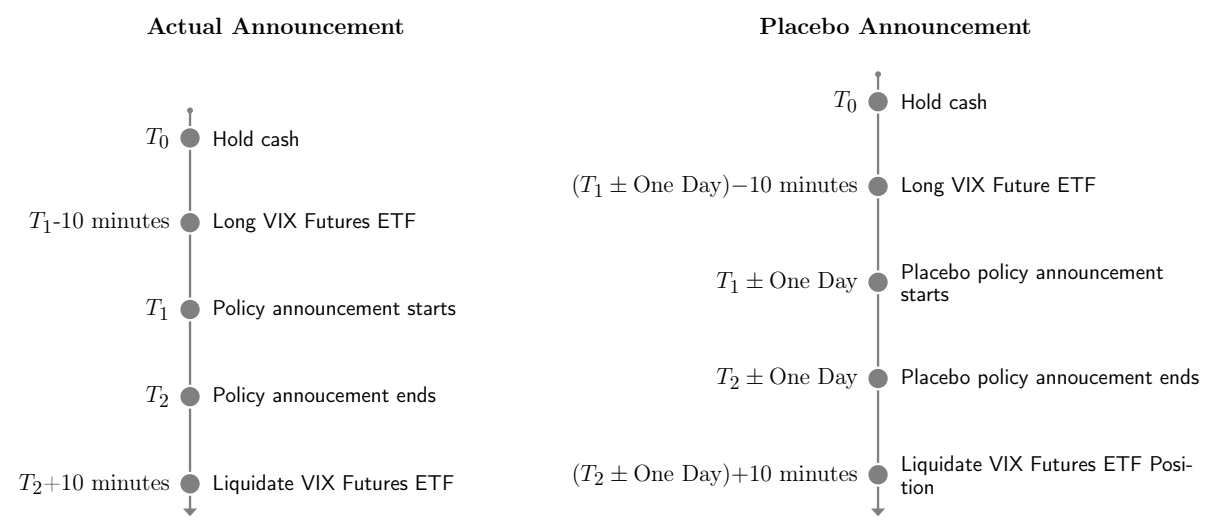


Figure A.2
VIX Futures ETF Announcement Return Series

This figure shows the returns to holding ProShares VIX Mid-Term Futures ETF (VIXM), iPath Series B S&P 500 VIX Mid-Term Futures ETN (VXZ), ProShares VIX Short-Term Futures ETF (VIXY) and iPath Series B S&P 500 VIX Short-Term Futures ETN (VXX) using three different trading strategies. The first trading strategy holds the ETF ten minutes before to ten minutes after Presidential remarks. The second holds the ETF on the same time window but the prior day and the third the same time window the following day. The y-axis is the cumulative log return.

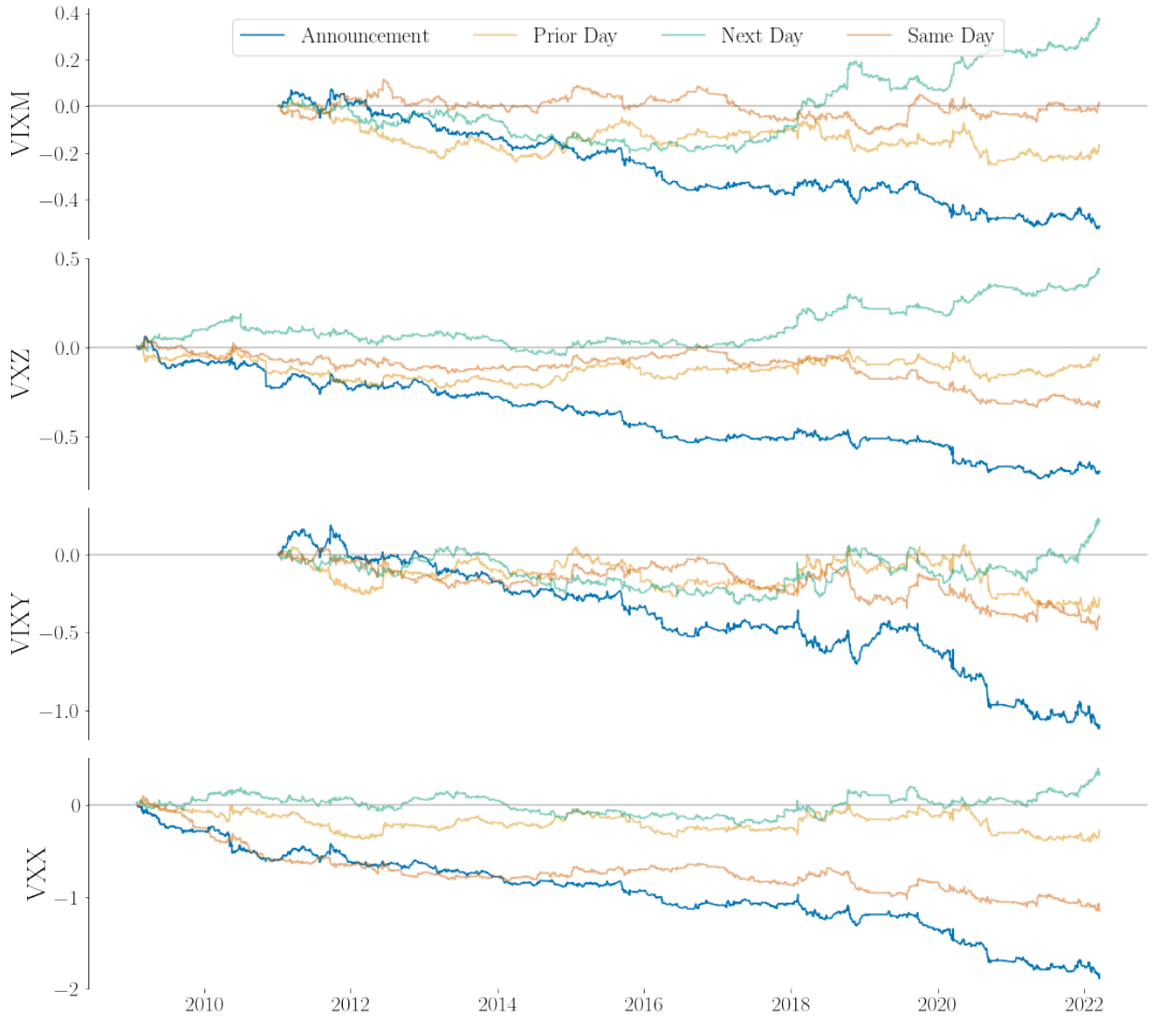


Figure A.3
Timing of Signaling Game

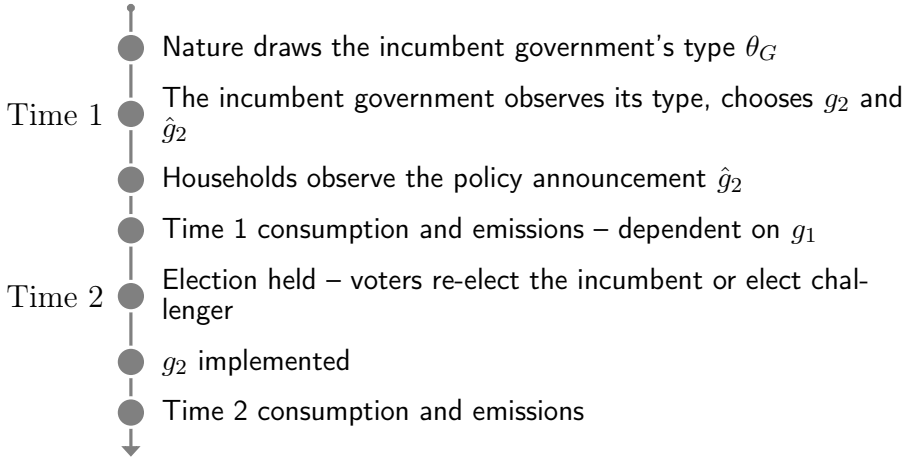


Figure A.4
Government's Policy Rule

This figure shows the preferred policy and implemented policy of the government. The left-hand panel shows the optimal policy as a function of the government's type. This is the same as the optimal policy of a household with disutility of emissions $\theta_i = \theta_G$. The second panel shows the equilibrium strategy of the government given $\underline{g} = 0.85$ and $\overline{g} = 0.95$. The solid blue line is the implemented policy and the dashed yellow line is the reported policy. The dashed blue line is the optimal policy, it is identical to the solid blue line in the left-hand panel.

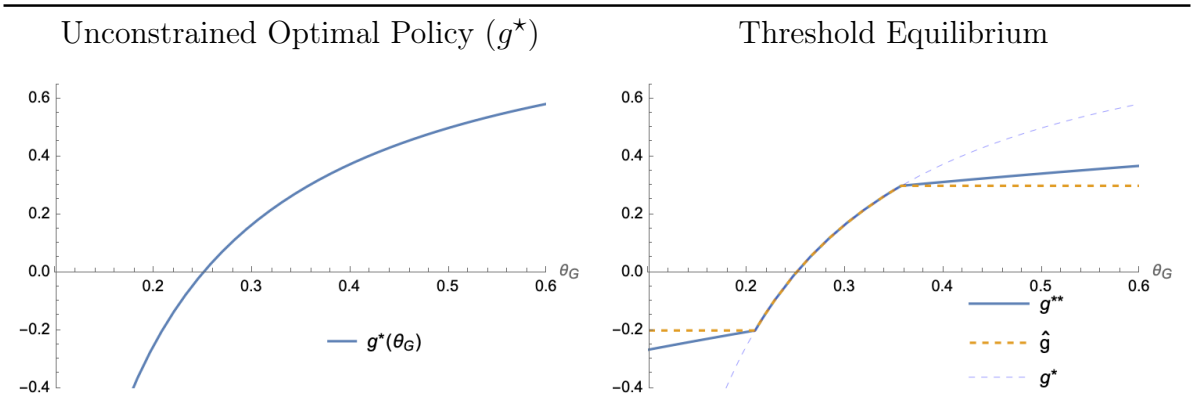


Figure A.5
Comparative Statics

The left-hand panel shows the change in equilibrium given an increase in the disutility of emissions of the median voter, θ_M. $\underline{g}$ and $\overline{g}$ both rise. The strategy of the incumbent, conditional on the incumbent's type, shifts from the blue line to the dashed yellow line. The right-hand panel shows the change in equilibrium after the median voter's expected utility under the challenger increases. The distance between $\overline{g}$ and $\underline{g}$ shrinks and the incumbent's strategy shifts from the blue line to the dashed yellow line. The shaded region on the x-axis are the types that are induced to mis-report and previously reported truthfully.

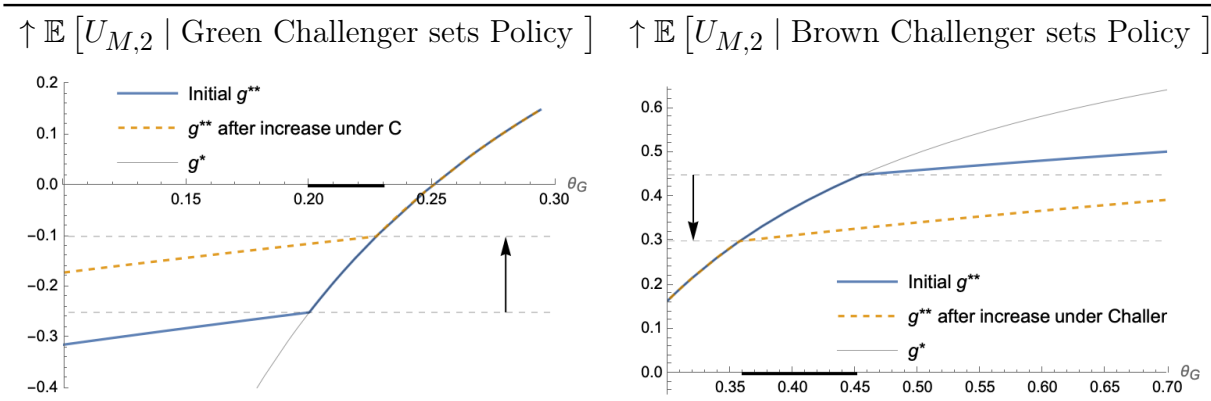


Figure A.6
Dynamics of Political Uncertainty

This figure displays the expected decline in the posterior variance over θ_G and g_2 at the time of the policy announcement. The left-hand side y-axis scale is for the variance of θ_G and the right for the variance of g_2. The x-axis is the utility of the median voter under the challenger.

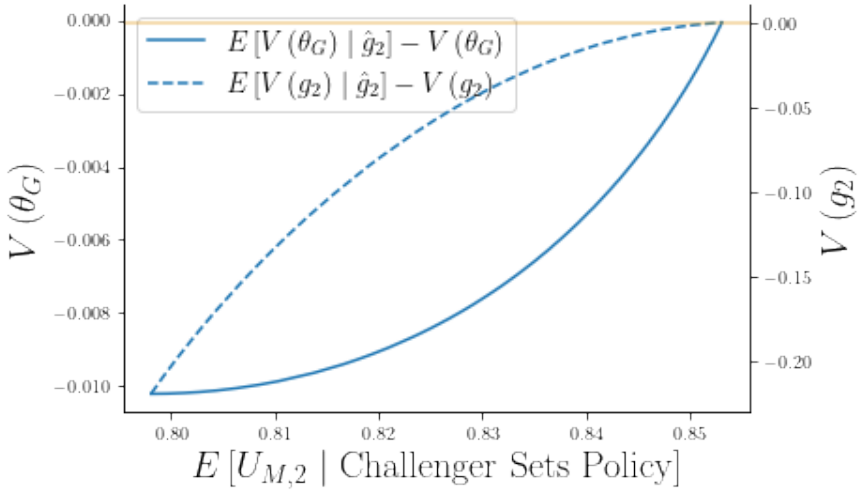


Figure A.7
Utility and Marginal Utility

This figure displays the expected decline in the posterior variance over θ_G and g_2 at the time of the policy announcement. The left-hand side y-axis scale is for the variance of θ_G and the right for the variance of g_2. The x-axis is the utility of the median voter under the challenger.

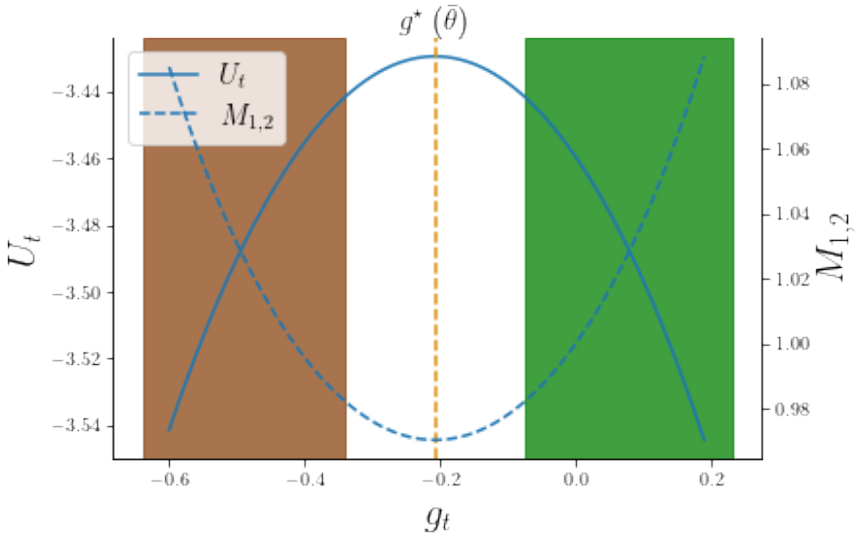
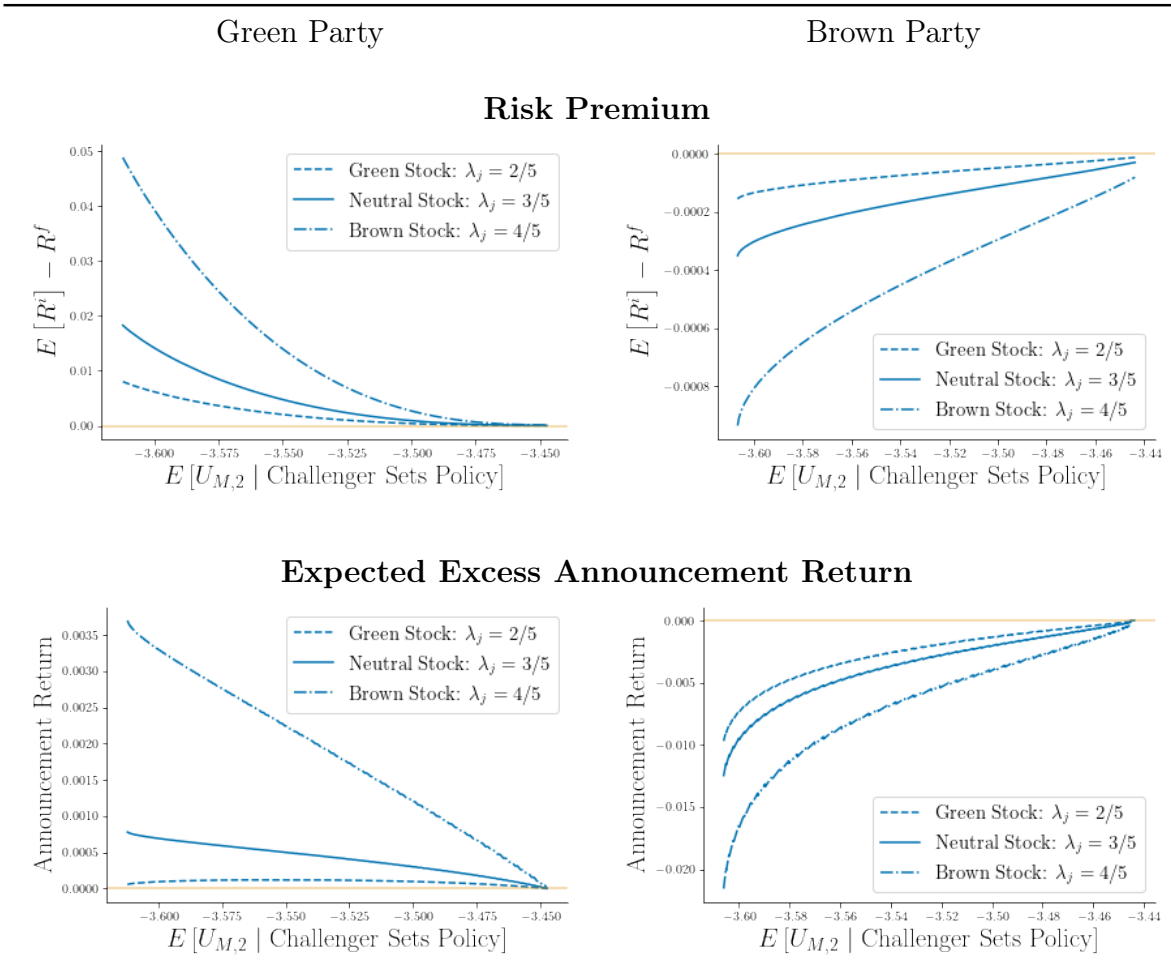


Figure A.8
Expected Returns

This figure shows risk premia and the expected announcement returns. The top panel shows the risk premium, defined as the expected holding period return from time-one to the end of time-two net of the risk-free rate. The bottom panel shows the expected holding period return over the announcement. The left-hand panel shows these quantities for the green party and the right for the brown party. In all cases the x-axis is the expected utility of the median voter under the challenger government.



APPENDIX B

TABLES

Table B.1
Example Transcript Excerpts

This table reports excerpts from a single transcript, President Biden's remarks during the second session of the "Virtual Leaders Summit on Climate". The structure of this transcript is typical. It declares the location, start and end time of the speech. Besides this, it also lists the speaker and content for each passage of text.

Remarks by President Biden at the Virtual Leaders Summit on Climate Session 2: Investing in Climate Solutions

April 22, 2021
East Room

10:50 A.M. EDT

THE PRESIDENT: Well, hello again, everyone...

You know, our shared goal of mobilizing $100 billion per year in developing countries is critical for achieving that. You know, it's an investment that's going to pay significant dividends for all of us. And to help meet that goal, the United States will double its 2024 — by 2024, our annual public climate financing development to developing countries. Compare that to what we were providing during the second half of the Obama-Biden administration.

At the same time, we intend to triple our public financing for climate application in developing countries by 2024, recognizing the dividends that pays in reducing the costs of disasters and conflicts are avoided.

You know, our Development Finance Corporation is committing to net-zero emissions through its investment portfolio by 2040 and to increase climate-focused investments to 33 percent of all new investments beginning in 2023, the earliest of any country.

In addition, today we are issuing America's first-ever International Climate Fi-Finance Plan. This plan represents our vision for financing the gloma- the global climate response in a coordinated way. It lays out specific steps that federal agencies of the United States will take to increase both the quality and quantity of climate financing...

10:56 A.M. EDT

Table B.2
Document Counts

This table reports the document counts after several steps of dataset construction. Reading from left to right, the first step filters on whether the document is a remark. The second filters out invalid speakers, such as the first lady or vice-president. The third restricts to articles that have valid timestamps and the final to those that are within a trading day. Totals across all four administrations are provided in the bottom row.

	Full Sample	Only Remarks	Valid Speaker	Timestamped	In Trading Day
Biden	417	137	104	104	72
Bush	4157	2705	2524	2508	1936
Obama	3899	2637	2145	2137	1395
Trump	815	508	380	378	247
	9288	5987	5153	5127	3650

Table B.3
Presidential Daily Schedule – April 22, 2021

This table shows an example Presidential daily schedule, taken from April 22, 2021. These schedules are typically published the evening before the scheduled day.

Time	Description
8:00 AM	The President and The Vice President deliver remarks and The President participates in the virtual Leaders Summit on Climate Session 1: Raising our Climate Ambition
10:00 AM	The President receives the President's Daily Brief
10:30 AM	The President participates in the virtual Leaders Summit on Climate Session 2: Investing in Climate Solutions
12:00 PM	The President has lunch with the Vice President
3:45 PM	The President and the Vice President receive a COVID-19 briefing

Table B.4
Climate Articles

This table shows ten articles with the highest climate change topic posterior score among the set of articles that meet the four criteria in Table B.2.

Date	Article Title
2001-06-11	President Bush Discusses Global Climate Change
2014-09-23	Remarks President UN Climate Change Summit
2009-09-22	Remarks President UN Secretary General Ban Ki Moons Climate Change Summit
2002-02-14	President Announces Clear Skies
2021-04-23	Remarks By President Biden At The Virtual Leaders Summit On Climate Session 5 The Economic Opportunities Of Climate Action
2008-04-16	President Bush Discusses Climate Change
2013-06-25	Remarks President Climate Change
2016-10-05	Remarks President Paris Agreement
2015-08-03	Remarks President Announcing Clean Power Plan
2021-04-22	Remarks By President Biden At The Virtual Leaders Summit On Climate Session 2 Investing In Climate Solutions

Table B.5
VIX Panel Regressions

This table reports results from a regression using an unbalanced panel. I estimate a regression of the minute-by-minute level return to one of four VIX Futures ETFs. The independent variable is an indicator that takes the value one if a briefing was held that minute. All results are clustered at the minute to account for cross-sectional correlation in return across VIX ETFs.

Dependent Variable:	VIX ETF Return
Model:	(1)
Variables	
Announcement	-0.0789**
	(-2.045)
Fixed-effects	
Date	Yes
Fit statistics	
Observations	4,892,186
R^2	0.00178
Within R^2	1.57×10^{-6}

Clustered (Datetime) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.6
Brown minus Green Returns

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Climate Speech$_t$ is the topic model posterior measure of climate speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: basic materials (XLB), mining (XME), energy (XLE), health care (XLV) and biotechnology (IBB).

Dependent Variables:	XLB - XLV	XLB - IBB	XLM - XLV	XLM - IBB	XLE - XLV	XLE - IBB
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Remark	-0.0275	-0.0191	0.0275	0.0227	-0.0098	-0.0014
	(-1.562)	(-0.9521)	(0.8526)	(0.6982)	(-0.5063)	(-0.0633)
Climate Speech × Remark	3.167***	3.129**	3.626***	3.675**	2.208*	2.170
	(2.693)	(2.388)	(2.702)	(2.436)	(1.696)	(1.525)
Fixed-effects						
Date	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	1,848,643	1,848,636	1,574,501	1,574,501	1,848,645	1,848,636
R^2	0.00160	0.00151	0.00228	0.00210	0.00170	0.00159
Within R^2	3.16×10^{-6}	1.98×10^{-6}	2.56×10^{-6}	2.2×10^{-6}	1.1×10^{-6}	7.96×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.7
Brown minus Green Returns – Climate Announcements

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Climate Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Climate Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2 and includes one of the following phrases in the title: "climate", "paris agreement", "clean energy", "clean fleet", "clear skies", "ocean", "energy", "environment", "efficien", "renewable", "conservation" or "build back better". Climate Speech$_t$ is the topic model posterior measure of climate speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: basic materials (XLB), mining (XME), energy (XLE), health care (XLV) and biotechnology (IBB).

Dependent Variables:	XLB - XLV	XLB - IBB	XLM - XLV	XLM - IBB	XLE - XLV	XLE - IBB
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Climate Announcement	-0.3032*	-0.2833*	-0.2307	-0.2040	-0.2395	-0.2197
	(-1.796)	(-1.689)	(-0.6781)	(-0.5799)	(-1.493)	(-1.233)
Climate Speech × Climate Announ.	5.077***	5.227***	4.679**	4.786*	3.122*	3.271*
	(2.886)	(3.027)	(2.007)	(1.942)	(1.728)	(1.811)
Fixed-effects						
Date	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	1,848,643	1,848,636	1,574,501	1,574,501	1,848,645	1,848,636
R^2	0.00160	0.00151	0.00228	0.00210	0.00170	0.00159
Within R^2	4.3×10^{-6}	3.11×10^{-6}	1.68×10^{-6}	1.6×10^{-6}	1.48×10^{-6}	1.12×10^{-6}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.8
Placebo Regressions with Energy Speech Score

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Energy Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Energy Speech$_t$ is the topic model posterior measure of energy speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: basic materials (XLB), mining (XME), energy (XLE), health care (XLV) and biotechnology (IBB).

Dependent Variables:	XLB - XLV	XLB - IBB	XLM - XLV	XLM - IBB	XLE - XLV	XLE - IBB
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Remark	-0.0124	-0.0099	0.0355	0.0244	-0.0023	0.0001
	(-0.6922)	(-0.4845)	(1.101)	(0.7491)	(-0.1200)	(0.0056)
Energy Speech × Remark	-0.8335	-0.0440	0.5478	1.491	-0.1681	0.6215
	(-1.024)	(-0.0547)	(0.4034)	(1.030)	(-0.2542)	(0.7956)
Fixed-effects						
Date	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	1,848,643	1,848,636	1,574,501	1,574,501	1,848,645	1,848,636
R^2	0.00159	0.00151	0.00228	0.00210	0.00169	0.00159
Within R^2	1.08×10^{-6}	7.88×10^{-8}	7.86×10^{-7}	1.18×10^{-6}	3.41×10^{-8}	2.51×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.9
Subsample Regressions

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a subsample of a minute-by-minute panel of returns. The two subsamples are first by the party of the President making the announcement. The second is by whether the President's party had outright majorities in both Congress and the Senate at the time the announcement was made. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Energy Speech$_t$ is the topic model posterior measure of energy speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: basic materials (XLB), mining (XME), energy (XLE), health care (XLV) and biotechnology (IBB).

Portfolio	XLB - XLV			XLE - XLV			XME - XLV		
Party	Both	D	R	Both	D	R	Both	D	R
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Remark	-0.0275	-0.0241	-0.0302	-0.0098	0.0014	-0.0158	0.0275	0.0256	0.0304
	(-1.562)	(-1.071)	(-1.177)	(-0.5063)	(0.0552)	(-0.5636)	(0.8526)	(0.6659)	(0.5738)
Climate Speech × Remark	3.167***	3.076**	3.497	2.208*	2.652*	-0.0972	3.626***	3.868***	2.542
	(2.693)	(2.480)	(1.034)	(1.696)	(1.816)	(-0.0464)	(2.702)	(2.727)	(0.7104)
Fixed-effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics									
Observations	1,848,643	927,452	921,191	1,848,645	927,452	921,193	1,574,501	927,452	647,049
R^2	0.00160	0.00209	0.00134	0.00170	0.00175	0.00166	0.00228	0.00241	0.00217
Within R^2	3.16×10^{-6}	6.38×10^{-6}	1.51×10^{-6}	1.1×10^{-6}	3.54×10^{-6}	2×10^{-7}	2.56×10^{-6}	4.65×10^{-6}	7.9×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.10
Climate Speech – Majorities in House and Senate

This table shows estimates from a specification with a triple interaction. The dependent variable is the returns to a brown minus green (BMG) portfolio constructed various ways. The indepdent variables are a remark indicator, an indicator for whether the remark was made when the President making it had absolute majorities in both the House and Senate and the posterior measure of the amount of climate speech contained in the remark.

Dependent Variables:	XLB - XLV	XLB - IBB	XLM - XLV	XLM - IBB	XLE - XLV	XLE - IBB
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Remark	-0.0298	-0.0308	0.0297	0.0288	0.0146	0.0136
	(-1.312)	(-1.127)	(0.7260)	(0.6985)	(0.5392)	(0.4173)
Remark × Climate Speech	1.918**	1.909*	2.597*	2.588*	1.148	1.139
	(2.129)	(1.695)	(1.926)	(1.661)	(0.9862)	(0.8501)
Remark × Majority	-0.0018	0.0182	-0.0121	-0.0238	-0.0572	-0.0372
	(-0.0517)	(0.4541)	(-0.1858)	(-0.3585)	(-1.476)	(-0.8318)
Remark × Climate Speech × Majority	8.392***	8.464***	6.971*	7.283*	6.381**	6.453*
	(4.293)	(3.908)	(1.704)	(1.659)	(2.035)	(1.951)
Fixed-effects						
Date	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	1,848,643	1,848,636	1,574,501	1,574,501	1,848,645	1,848,636
R^2	0.00160	0.00151	0.00228	0.00210	0.00170	0.00159
Within R^2	5.74×10^{-6}	3.99×10^{-6}	3.44×10^{-6}	3.06×10^{-6}	2.67×10^{-6}	1.78×10^{-6}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.11
Climate Speech Regressions

This table shows results from regressions where the dependent variable is the topic model implied posterior measure of climate speech. The independent variables are indicators for whether or not a Democratic president was in office and measures from Gallup surveys for voter concern about climate change. I estimate versions of this model with and without fixed-effects.

Dependent Variable:	Climate Speech
Variables	
Voter Environmentalism	0.0155***
	(3.328)
Democratic President × Voter Environmentalism	0.0186**
	(2.402)
Cluster	Year
Fixed-effects	
President	Yes
Fit statistics	
Observations	11,635
R^2	0.01304
Within R^2	0.00422

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.12
Resolution of Uncertainty

This table shows results from regressions where the dependent variable is the minute-level returns to a VIX ETF. The independent variables are indicators for whether or not a Democratic president was in office and measures from Gallup surveys of voter approval.

Dependent Variables:	VIXM	VXX	VXZ	VIXY
Model:	(1)	(2)	(3)	(4)
Variables				
Climate Announcement	3.035**	4.507***	1.286	5.719**
	(2.259)	(2.719)	(1.216)	(2.355)
Climate Announcement × Approval Rating	-6.672**	-10.42***	-3.198	-12.94**
	(-2.399)	(-3.217)	(-1.502)	(-2.556)
Fixed-effects				
Date	Yes	Yes	Yes	Yes
Fit statistics				
Observations	1,122,559	1,312,196	1,312,196	1,122,559
R^2	0.00177	0.00239	0.00170	0.00255
Within R^2	2.11×10^{-6}	1.19×10^{-5}	4.12×10^{-6}	4.93×10^{-6}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table B.13
Parameters

This table reports the parameter values used in the numerical solutions. The results displayed in Figures A.4 and A.5 are calculated under this parameterization.

Parameter:	λ	α	P_G	P_B	K_t	C	β	$\bar{\theta}$	$\underline{\mathcal{G}}$	$\overline{\mathcal{G}}$	$\underline{\mathcal{B}}$	$\overline{\mathcal{B}}$
Value:	$\frac{3}{5}$	$\frac{2}{3}$	1	1	1	1	0.99	0.2	0.225	0.45	0.12	0.18

APPENDIX C

PRODUCTION MICROFOUNDATION

C.1 Energy Producing Sector

Energy producing firms operate in a competitive sector. These firms sell energy E_t to final good producers at an endogenous price $P_{t,E}$. They produce energy by combining green (G_t) and brown (B_t) inputs at cost P_G and P_B respectively.

The j^{th} energy firm's problem is to maximize profits, taking as given the price of energy:

$$\Pi_j = \max_{\{B_s, G_s\}} \mathbb{E}_t \left[\sum_{s \geq t} q_s \left(P_{s,E} \left((1 - g_s) B_s \right)^{\alpha} G_s^{1-\alpha} - P_B B_s - P_G G_s \right) \right] \tag{C.1.1}$$

The energy firms sells energy at an endogenous price, $P_{t,E}$, and its profits are the proceeds from selling energy net of the cost of raw materials. The efficiency of the energy firms is also affected by a prevailing policy g_t. A higher g_t will result in less energy generation per unit of inputs used. This relationship depends on the share of brown inputs used by the energy firm. The higher the share of brown inputs, the greater the decrease in energy generation for increased g_t.

Proposition 10 (Price of Energy)**.** *The price of energy is increasing in g_t according to the expression*

$$P_{t,E} = (1 - g_t)^{-\alpha} \alpha^{\star} \text{ where } \alpha^{\star} \equiv \frac{(1-\alpha)^{\alpha-1}}{\alpha^{\alpha}} P_G^{1-\alpha} P_B^{\alpha} \tag{C.1.2}$$

Lower energy firm productivity translates into higher energy prices for a given level of energy generation.

The use of brown energy inputs results in a public bad, carbon emissions ($\mathcal{E}_t$):

$$\mathcal{E}_t = (1 - g_t) B_t \tag{C.1.3}$$

Besides affecting energy prices, the prevailing policy also decreases the emissions associated with brown energy usage. This is analogous to the use of a scrubber on coal-fired power plants. For these power plants, sulfur dioxide emissions decrease, but subject to installation and increased maintenance costs paid by the plant. A higher value of g_t is a "greener" policy. Higher g_t will decrease the emissions associated with energy generation, but also increase the price of energy.

C.2 Final-Good Producer

The final good (Y_t) is produced using energy (E_t) and capital (K). The representative final good producer combines energy and capital using a Cobb-Douglas production technology. The problem of the producer is to maximize profits taking the price of the consumption good as given. In general, profits are positive because capital is scarce.

$$\Pi_t = \max_{E_s} \mathbb{E}_t \left[\sum_{s \geq t} q_s \left(E_s^{\lambda} K^{1-\lambda} - P_{s,E} E_s \right) \right] \tag{C.2.1}$$

The amount of emissions generated in final good production depends on the production technology of both the final good producer and the energy producing firms. Higher values of α and λ both correspond to higher carbon emissions per unit of output. Higher values of λ will make production more energy intensive. Higher values of α correspond to a greater share of brown fuel used in production.

The policy g_t will affect final good production through the price of energy. Greener g_t will depress production because it raises the cost of energy, which the final good producer uses as an intermediate input.

Proposition 11 (Final Good Production)**.** *Equilibrium final-good production is given by*

$$Y_t = \hat{\alpha} \left(1 - g_t\right)^{\frac{\alpha\lambda}{1-\lambda}} K \text{ where } \hat{\alpha} > 0 \tag{C.2.2}$$

Likewise, we can solve for the total amount of emissions produced.

Lemma 5 (Equilibrium Emissions)**.** *Equilibrium emissions is given by*

$$\mathcal{E}_t = \overline{\alpha}\left(1 - g_t\right)^2 \;\; \textit{where } \overline{\alpha} > 0 \tag{C.2.3}$$

C.3 Household's Problem

Households are heterogeneous, the i^{th} household's problem is to maximize expected utility

$$\max_{vote_i, C_{i,s}} \mathbb{E}_t \left[\sum_{s \geq t} \beta^{s-t} \log\left(C_{i,s} - \theta_i \mathcal{E}_s\right) \right] \tag{C.3.1}$$

subject to an intertemporal budget constraint

$$\mathbb{E}_t \left[\sum_{s \geq t} q_s C_{i,s} \right] \leq \mathbb{E}_t \left[\omega_i \sum_{s \geq t} q_s \left(P_B B_s + P_G G_s\right) \right] + \omega_i \Pi_t \tag{C.3.2}$$

Households are uniformly endowed with an ownership share ω_i of the final-good producer and are entitled to an ω_i share of the final-good producer's profits. They likewise are entitled to the same share of the proceeds from the sale of natural resources, B_t and G_t. Conceptually, this is akin to owning a share in a mining firm or solar panel manufacturer that is under contract to elastically supply coal or solar panels at a price P_B or P_G.

Assumption 1. *I assume that* $\frac{\alpha\lambda}{1-\lambda} = 1$

For tractability, in the analysis I make Assumption 1. This assumption does not meaningfully change the economic interpretation of the model, but allows for analytic solutions to the government's problem.

APPENDIX D

PROOFS AND DERIVATIONS

Lemma 1 (Contingent Claims)**.** *The i^{th} agent will trade in the contingent claims market until*

$$\frac{P_j}{P_k} = \frac{\beta^{t_j-1}/\tilde{C}_{i,j}}{\beta^{t_k-1}/\tilde{C}_{i,k}} \text{ where } \tilde{C}_{i,j} = C_{i,j} - \theta_i \mathcal{E}_j \tag{5.4.1}$$

that is, until the ratio of marginal utilities are equated with the ratio of the prices of the contingent claims state-by-state.

Proof. The portfolio-allocation decision of the i^{th} household deciding whether to invest incrementally more in a contingent claim that pays out in the j^{th} state is given by

$$\max_{X_j} \log\left(\tilde{C}_{i,1} - P_j X_j\right) + \beta^{t_j} \log\left(\tilde{C}_{i,j} + X_j\right) \tag{D.0.1}$$

Taking the first-order condition and evaluating it at equilibrium (such that the expression is satisfied when $X_j = 0$) yields

$$P_j = \beta^{t_j} \frac{1/\tilde{C}_{i,j}}{1/\tilde{C}_{i,0}} \tag{D.0.2}$$

Combining the expressions for states j and k yields the desired result. □

Proposition 1 (Stochastic Discount Factor)**.** *The agent with disutility of emissions $\overline{\theta}$ who consumes $\overline{C}_t$, with utility given by*

$$U_{M,t} = \sum_{t' \geq t} \beta^{t'-t} \log\left(\bar{C}_t - \bar{\theta}\mathcal{E}_t\right) \tag{5.4.2}$$

has a stochastic discount factor given by

$$M_{t,t'} = \beta^{t'-t} \frac{\bar{C}_t - \bar{\theta}\mathcal{E}_t}{\bar{C}_{t'} - \bar{\theta}\mathcal{E}_{t'}} \tag{5.4.3}$$

This is a valid SDF.[1]

Proof. Start from the expression

$$P_j = \beta^{t_j} \frac{\tilde{C}_{i,0}}{\tilde{C}_{i,j}} \tag{D.0.3}$$

Now, if we integrate over the population we have

$$\frac{P_j}{\beta^{t_j}} \left(\int_i C_{i,j} df(\theta_i) - \mathcal{E}_j \int_i \theta_i df(\theta_i) \right) = \int_i C_{i,0} df(\theta_i) - \mathcal{E}_0 \int_i \theta_i df(\theta_i) \tag{D.0.4}$$

Since we know that

$$\int_i C_{i,j} df(\theta_i) = \bar{C}_j \text{ and } \int_i \theta_i df(\theta_i) = \bar{\theta}$$

this expression simplifies to

$$\frac{P_j}{\beta^{t_j}} \left(\bar{C}_j - \bar{\theta} \mathcal{E}_j \right) = \bar{C}_0 - \bar{\theta} \mathcal{E}_j \tag{D.0.5}$$

which implies that

$$P_j = \beta^{t_j} \frac{\bar{C}_0 - \bar{\theta} \mathcal{E}_0}{\bar{C}_j - \bar{\theta} \mathcal{E}_j} \tag{D.0.6}$$

This is the same pricing equation as one implied by an agent with $\theta_i = \bar{\theta}$ and $C_{i,t} = \bar{C}_t$, which completes the proof. □

Lemma 2 (Uniform Valuation)**.** *Every household's relative valuation across any two pairs of states is the same as that of agent M.*

Proof. Immediate consequence of Lemma 1. □

Proposition 2 (Dictatorial Solution)**.** *The dictatorial solution to the government's problem, denoted $g^\star(\theta_G)$ is given by*

$$1 - g^\star(\theta_G) = \frac{1}{2} \frac{\hat{\alpha}}{\bar{\alpha}} \frac{1}{\theta_G} \tag{5.6.1}$$

1. "Valid" means that any security's price is given by the expected value of the discounted (by the SDF) future payoff (Kim and Korajczyk (2018)).

Proof. To find the maximizer, consider the problem of the government if it could not be removed from office, i.e. $C = 0$ and with certainty the government will be re-elected.

$$\begin{aligned} &\max_{g_t} \log\left(\bar{C}_t - \theta_G \mathcal{E}_t\right) \\ \Leftrightarrow &\max_{g_t} \log\left(\hat{\alpha}\left(1 - g_t\right) K - \theta_G \bar{\alpha}\left(1 - g_t\right)^2 K\right) \end{aligned}$$

Taking the derivative with respect to g_t and solving yields the desired expression. □

Proposition 5. *The voter with the median value of θ_i, denoted θ_M, is the median voter. The median voter's choice will always win the election.*

Proof. WLOG, consider the indifference condition of agent M between the challenger and incumbent.

$$\mathbb{E}_t\left[\log\left(\tilde{C}_{M,k}\right) \mid \text{Incumbent}\right] = \mathbb{E}_t\left[\log\left(\tilde{C}_{M,k}\right) \mid \text{Challenger}\right] \tag{D.0.7}$$

Re-arranging we can write this as

$$\mathbb{E}_t\left[\log\left(\tilde{C}_{M,k}\right) \mid \text{Incumbent}\right] - \log\left(\tilde{C}_{M,j}\right) = \mathbb{E}_t\left[\log\left(\tilde{C}_{M,k}\right) \mid \text{Challenger}\right] - \log\left(\tilde{C}_{M,j}\right) \tag{D.0.8}$$

Apply Lemma 1 this becomes

$$\mathbb{E}_t\left[\log\left(\frac{P_{j,t}}{P_{k,t}}\right) \mid \text{Incumbent}\right] = \mathbb{E}_t\left[\log\left(\frac{P_{j,t}}{P_{k,t}}\right) \mid \text{Challenger}\right] \tag{D.0.9}$$

Applying Lemma 2 and re-arranging yields

$$\mathbb{E}_t\left[\log\left(\tilde{C}_{i,k}\right) \mid \text{Incumbent}\right] = \mathbb{E}_t\left[\log\left(\tilde{C}_{i,k}\right) \mid \text{Challenger}\right] \tag{D.0.10}$$

which implies that the indifference condition also holds for the arbitrary i^{th} agent. Any

difference condition will also hold. This implies that every agent has the same ordering between the challenger and the incumbent and if agent M prefers the incumbent, so will every other agent. □

Lemma 6. *The preferences* $\log\left(\hat{\alpha}\left(1-g_t\right)K-\theta\bar{\alpha}\left(1-g_t\right)^2K\right)$ *are single-peaked in* g_t.

Proof. The first derivative is given by

$$\frac{\partial f}{\partial g}=\frac{-\hat{\alpha}K_t+2\theta\bar{\alpha}\left(1-g_t\right)K_t}{\hat{\alpha}\left(1-g_t\right)K_t-\theta\bar{\alpha}\left(1-g_t\right)^2K_t} \tag{D.0.11}$$

The second derivative is given by

$$\frac{\partial^2 f}{\partial g^2}=\frac{-2\theta\bar{\alpha}K\overbrace{\left(\hat{\alpha}\left(1-g_t\right)K-\theta\bar{\alpha}\left(1-g_t\right)^2K\right)}^{>0\text{ by assumption}}-\left(2\theta\bar{\alpha}\left(1-g_t\right)K-\hat{\alpha}K\right)^2}{\left(\hat{\alpha}\left(1-g_t\right)K_t-\theta\bar{\alpha}\left(1-g_t\right)^2K_t\right)^2}<0 \tag{D.0.12}$$

The first derivative is zero at a single point and the second derivative is every negative implying single-peakedness. □

Proposition 4 (Government's Strategy)**.** *Denote the unconstrained maximizer of the government as* $g^\star$ *and the constrained policy choice as* $g^{\star\star}$*. An equilibrium strategy that satisfies sequential rationality for the incumbent government under the conjectured equilibrium is given by*

$$g^{\star\star}\left(\theta_G\right),\hat{g}=\begin{cases}g^\star\left(\theta_G\right),g^\star\left(\theta_G\right) & \text{If } g^\star\left(\theta_G\right)\in\left[\underline{g},\bar{g}\right]\\ f\left(\theta_G,\overline{g}\right),\overline{g} & \text{If } g^\star\left(\theta_G\right)>\overline{g}\\ f\left(\theta_G,\underline{g}\right),\underline{g} & \text{If } g^\star\left(\theta_G\right)<\underline{g}\end{cases} \tag{5.6.4}$$

where

$$1-f\left(\theta,s\right)=\frac{\mathcal{C}\left(1-s\right)+\hat{\alpha}K}{\mathcal{C}+2\theta\bar{\alpha}K} \tag{5.6.5}$$

Proof. First, it is immediate that for $g^{\star}(\theta_G) \in \left[\underline{g}, \overline{g}\right]$ the incumbent government can do no better than implementing $g^{\star}(\theta_G)$ and truthfully reporting $\hat{g} = g^{\star}(\theta_G)$.

Now consider the case where $g^{\star}(\theta_G) \notin \left[\underline{g}, \overline{g}\right]$. WLOG assume that $g^{\star} \geq \overline{g}$. Because preferences are single-peaked, it follows that if the government truthfully reports, its utility is maximized at $g_2 = \hat{g}_2 = \overline{g}$. Suppose that the government misreports, i.e. reports s and implements g. The government's problem is then

$$\max_{\{g\}} \log\left(\hat{\alpha}(1-g)K - \theta\bar{\alpha}(1-g)K - \frac{C}{2}\left((1-g)-(1-s)\right)^2\right) \tag{D.0.13}$$

The first-order condition is given by

$$\frac{-\hat{\alpha}K + 2\theta\bar{\alpha}(1-g)K - \mathcal{C}(s-g)}{\hat{\alpha}(1-g)K - \theta\bar{\alpha}(1-g)^2K - \frac{\mathcal{C}}{2}(s-g)^2} = 0 \tag{D.0.14}$$

Re-arranging gives the expression above. It is immediate that when the government misreports the cost of doing so is minimzed when $\hat{g} \in \left\{\underline{g}, \overline{g}\right\}$. Finally, it follows from a limiting argument that the incumbent is strictly better off misreporting than truth-telling when $g^{\star}(\theta_G) \notin \left[\underline{g}, \overline{g}\right]$. □

Proposition 5. *Under the threshold voting rule, the type that is indifferent between misreporting and truthfully reporting $\hat{g}_2 = \bar{g}$ and $\hat{g}_2 = \underline{g}$, denoted $\theta^H(\bar{g})$ and $\theta^L(\underline{g})$ respectively, is given by*

$$\theta^H(\overline{g}) = \frac{1}{2}\frac{\hat{\alpha}/\bar{\alpha}}{1-\overline{g}} \text{ and } \theta^L(\underline{g}) = \frac{1}{2}\frac{\hat{\alpha}/\bar{\alpha}}{1-\underline{g}} \tag{5.6.7}$$

Proof. First, notice that any type θ_G with $g^{\star} \geq \bar{g}$ will have an incentive to misreport. Why is this? WLOG consider a type where $g^{\star} \geq \bar{g}$. The derivative $\frac{\partial U_{G,2}}{\partial g}\,|_{g=\bar{g}}$ will be strictly positive. say δ. The government can report $\hat{g} = \bar{g}$ and implement $\bar{g} + \epsilon$ with an increase in utility of $\epsilon \times \delta$ where $\epsilon < \frac{1}{C}$. This is less than the cost $C\epsilon^2$ by assumption and so the government does strictly better by misreporting.

Now we need to solve for the θ_G that is indifferent between $g^\star$ and $\bar{g}$. By the prior argument, this is the type for which $g^\star = \bar{g}$. This is given by

$$1 - \bar{g} = \frac{1}{2}\frac{\hat{\alpha}}{\bar{\alpha}}\frac{1}{\theta_G^\star}$$

$$\theta_G^\star = \frac{1}{2}\frac{\hat{\alpha}}{\bar{\alpha}}\frac{1}{1-\bar{g}}$$

the proof for $\underline{g}$ is symmetric. □

Proposition 6 (Voter Beliefs)**.** *For actions on the equilibrium path, voter beliefs* (μ) *are given by*

$$\mu\left(\theta_G \mid \hat{g}_2\right) = \begin{cases} \left(g^\star\right)^{-1}\left(\hat{g}_2\right) & \text{If } \hat{g}_2 \in \left(\underline{g}, \overline{g}\right) \\ \mathcal{U}\left(\underline{\theta}_G, \theta^L\left(\underline{g}\right)\right) & \text{If } \hat{g}_2 = \underline{g} \\ \mathcal{U}\left(\theta^H\left(\overline{g}\right), \overline{\theta}_G,\right) & \text{If } \hat{g}_2 = \overline{g} \end{cases} \quad \text{and } \mu\left(\theta_C\right) = \mathcal{U}\left(\underline{\theta}_C, \overline{\theta}_C\right) \tag{5.6.8}$$

are derived from Bayes' rule.

Proof. Follows immediately from Bayes rule and Equation (5.6.4). □

Equations (5.6.2) and (5.6.3) can be rewritten more explicitly as

$$\int_{\underline{\theta}_G}^{\theta^L(\underline{g})} U_{M,2}\left(g^{\star\star}\left(\theta_G\right)\right) df\left(\theta_G \mid \theta_G \leq \theta^L\left(\underline{g}\right)\right) = \int_{\underline{\theta}_C}^{\bar{\theta}_C} U_{M,2}\left(g^\star\left(\theta_C\right)\right) df\left(\theta_C\right) \tag{D.0.15}$$

and

$$\int_{\theta^H(\overline{g})}^{\overline{\theta}_G} U_{M,2}\left(g^{\star\star}\left(\theta_G\right)\right) df\left(\theta_G \mid \theta_G \geq \theta^H\left(\overline{g}\right)\right) = \int_{\underline{\theta}_C}^{\bar{\theta}_C} U_{M,2}\left(g^\star\left(\theta_C\right)\right) df\left(\theta_C\right) \tag{D.0.16}$$

Proposition 7 (PBE)**.** *The incumbent government's strategy given by equation 5.6.4, the median voter's threshold voting rule with thresholds determined by the equations D.0.15 and D.0.16 and voter beliefs given in equations 5.6.8 are a PBE.*

Proof. To verify that the equilibrium is a Perfect Bayesian equilibrium, we need to verify that the actions of voters and governments are sequentially rational and that beliefs satisfy Bayes rule where possible. Sequential rationality for the government is guaranteed by Proposition 4; for voters, by construction from Equation (5.5.1). Finally, Equation (5.6.8) guarantees that for actions along the equilibrium path beliefs are satisfy Bayes rule. □

Beliefs off the equilibrium path are given by

$$\mu\left(\theta_G \mid \hat{g}_2\right) = \begin{cases} \mathcal{U}\left(\underline{\theta}_G, \theta^L\left(\underline{g}\right)\right) & \text{If } \hat{g}_2 < \underline{g} \\ \mathcal{U}\left(\theta^H\left(\overline{g}\right), \overline{\theta}_G,\right) & \text{If } \hat{g}_2 > \overline{g} \end{cases} \text{ and } \mu\left(\theta_C\right) = \mathcal{U}\left(\underline{\theta}_C, \overline{\theta}_C\right) \tag{D.0.17}$$

These beliefs satisfy the intuitive criterion.

Lemma 3. *If $\overline{g} \neq \underline{g}$, then $\underline{g} = g^\star\left(\underline{\mathcal{G}}\right)$ for the green party and $\overline{g} = g^\star\left(\overline{\mathcal{B}}\right)$ for the brown party.*

Proof. This follows from single-peakedness. If any type θ reports truthfully, then it must be a type such that $U_{m,2}\left(g^\star\left(\theta\right)\right) \geq \mathbb{E}\left[U_{M,2} \mid \text{Challenger}\right]$ By single-peakedness we know that for any type $|\theta' - \bar{\theta}| < |\theta - \bar{\theta}|$ we will have $U_{m,2}\left(g^\star\left(\theta'\right)\right) \geq U_{m,2}\left(g^\star\left(\theta\right)\right)$ and so also $U_{m,2}\left(g^\star\left(\theta'\right)\right) \geq \mathbb{E}\left[U_{M,2} \mid \text{Challenger}\right]$. It follows that those types closest to $\bar{\theta}$ will report truthfully which completes the proof. □

Lemma 4 (Small Firm Profits)**.** *The equilibrium profits of the small-firm are given by*

$$D_{t,j} = \hat{\alpha}_j \left(1 - g_t\right)^{\frac{\alpha\lambda_j}{1-\lambda_j}} K_j \text{ where } \hat{\alpha}_j > 0 \tag{5.8.3}$$

Proof. The payout of the small firm is given by

$$D_{t,j} = \max_{\{E_{t,j}\}} P_t \left(E_{t,j}^{\lambda_j} K_j^{1-\lambda_j} - P_{t,E} E_{t,j}\right) \tag{D.0.18}$$

Following the same steps as in the proof of Proposition 11 yields the desired expression where $\alpha_j > 0$. □

Proposition 8. *The period-1 SDF can be written as*

$$M_{1,2} = \beta \frac{\hat{\alpha} - \bar{\theta}\bar{\alpha}}{\hat{\alpha}\left(1 - g_2\right) - \bar{\alpha}\bar{\theta}\left(1 - g_2\right)^2} \tag{5.8.4}$$

Proof. This follows immediately from Equation (5.4.3), the expressions

$$\bar{C}_t = \hat{\alpha}\left(1 - g_t\right) K \text{ and } \mathcal{E}_t = \bar{\alpha}\left(1 - g_t\right)^2 K$$

and that g_1 is normalized to zero. □

Proposition 9 (Expected Returns)**.** *Expected returns are given by*

$$\mathbb{E}\left[R_1^i\right] - R_1^f = -R_1^f \, Cov\left(\beta \frac{\hat{\alpha} - \bar{\theta}\bar{\alpha}}{\hat{\alpha}\left(1 - g_2\right) - \bar{\alpha}\bar{\theta}\left(1 - g_2\right)^2}, R_1^i\right) \tag{5.8.5}$$

Proof. This follows immediately from Proposition 8 and the well-known equation

$$\mathbb{E}\left[R_t^i\right] - R_t^f = -R_t^f \mathbb{C}\left(M_{t,t+1} R_t^i\right)$$

□

Proposition 10 (Price of Energy)**.** *The price of energy is increasing in g_t according to the expression*

$$P_{t,E} = \left(1 - g_t\right)^{-\alpha} \alpha^\star \text{ where } \alpha^\star \equiv \frac{(1-\alpha)^{\alpha-1}}{\alpha^\alpha} P_G^{1-\alpha} P_B^\alpha \tag{C.1.2}$$

Proof. State-by-state the utility will provide energy at marginal cost. So we can write the utility's time-t problem as

$$\max_{\{B_t, G_t\}} P_{t,E}\left(1 - g_t\right)^\alpha B_t^\alpha G_t^{1-\alpha} - P_B B_t - P_G G_t \tag{D.0.19}$$

Taking the first-order condition, we have

$$P_{t,E}\left(1-g_t\right)^{\alpha}\alpha B_t^{\alpha-1}G_t^{1-\alpha}=P_B$$
$$P_{t,E}\left(1-g_t\right)^{\alpha}\left(1-\alpha\right)\left(\frac{B_t}{G_t}\right)^{\alpha}=P_G$$

Combining the two first-order conditions and solving for $P_{t,E}$ yields the desired expression.

□

Proposition 11 (Final Good Production)**.** *Equilibrium final-good production is given by*

$$Y_t=\hat{\alpha}\left(1-g_t\right)^{\frac{\alpha\lambda}{1-\lambda}}K \text{ where } \hat{\alpha}>0 \tag{C.2.2}$$

Proof. The problem of the final good producer is

$$\max_{\{E_t\}} P_t\left(E_t^{\lambda}K^{1-\lambda}-P_{t,E}E_t\right) \tag{D.0.20}$$

We can then solve state-by-state for the optimal energy usage, the relevant first-order condition is

$$\lambda E_t^{\lambda-1}K^{1-\lambda}=P_{t,E} \tag{D.0.21}$$

Plugging in for the price of energy, we can then solve for the equilibrium energy as

$$E_t=K\left(\frac{\alpha^{\star}}{\lambda}\right)^{\frac{1}{\lambda-1}}\left(1-g_t\right)^{\frac{\alpha}{1-\lambda}} \tag{D.0.22}$$

This implies that

$$Y_t=\left(1-g_t\right)^{\alpha\frac{\lambda}{1-\lambda}}\left(\frac{\alpha^{\star}}{\lambda}\right)^{\frac{\lambda}{\lambda-1}}K$$

□

Lemma 5 (Equilibrium Emissions)**.** *Equilibrium emissions is given by*

$$\mathcal{E}_t = \overline{\alpha}\,(1-g_t)^2 \;\; \textit{where } \overline{\alpha} > 0 \tag{C.2.3}$$

Proof. From the optimality condition of the energy firm we know that

$$\frac{B_t}{G_t} = \frac{P_B}{P_G}\frac{\alpha}{1-\alpha} \tag{D.0.23}$$

Combining this equation with the the production function of the energy firm we can show that

$$E_t = (1-g_t)^{\alpha} B_t \left(\frac{P_G}{P_B}\frac{\alpha}{1-\alpha}\right)^{\alpha-1} \tag{D.0.24}$$

Now, returning to the optimality condition of the final-good producer, we know that

$$\lambda E_t^{\lambda-1} K^{1-\lambda} = \alpha^{\star}\,(1-g_t)^{-\alpha} \tag{D.0.25}$$

$$\Rightarrow E_t = K\left(\frac{\alpha^{\star}}{\lambda}\right)^{\frac{1}{\lambda-1}} (1-g_t)^{\frac{\alpha}{1-\lambda}} \tag{D.0.26}$$

Plugging in for B_t we have

$$B_t = \alpha^{\star}\left(\frac{\alpha^{\star}}{\lambda}\right)^{\frac{1}{\lambda-1}} (1-g_t)^{\frac{\alpha\lambda}{1-\lambda}}\, K \tag{D.0.27}$$

This implies that

$$\mathcal{E}_t = (1-g_t)^{\frac{\alpha\lambda}{1-\lambda}+1}\,\alpha^{\star}\left(\frac{\alpha^{\star}}{\lambda}\right)^{\frac{1}{\lambda-1}} K \tag{D.0.28}$$

as desired. □

D.1 Additional Figures

This section provides additional figures and numerical solutions that are helpful in understanding the mechanics of the model but did not warrant inclusion into the main text.

Figure D.1
Threshold Equilibria

This figure displays the strategies of the green and brown parties. The upper and lower dashed grey lines are $\underline{g}$ and $\overline{g}$ respectively. The solid blue line displays the implemented policy. The dashed yellow line displays the dictatorial policy the government would implement in the absence of political constraints.

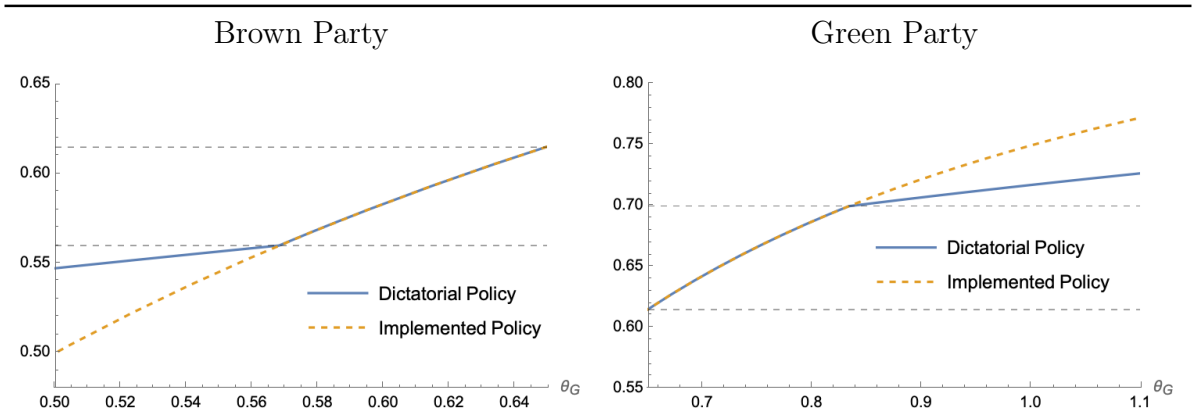


Figure D.2
Equilibrium Bounds Numerical Solutions

This figure displays numerical solutions for the equilibrium bounds. The left-hand side panel displays the equilibrium bounds for the Green party and the right-hand side panel displays the equilibrium bounds for the Brown party. Notice that as the expected utility under the challenger increases the bounds move closer together. For the green party $\overline{g}$ decreases and for the brown $\underline{g}$ increases.

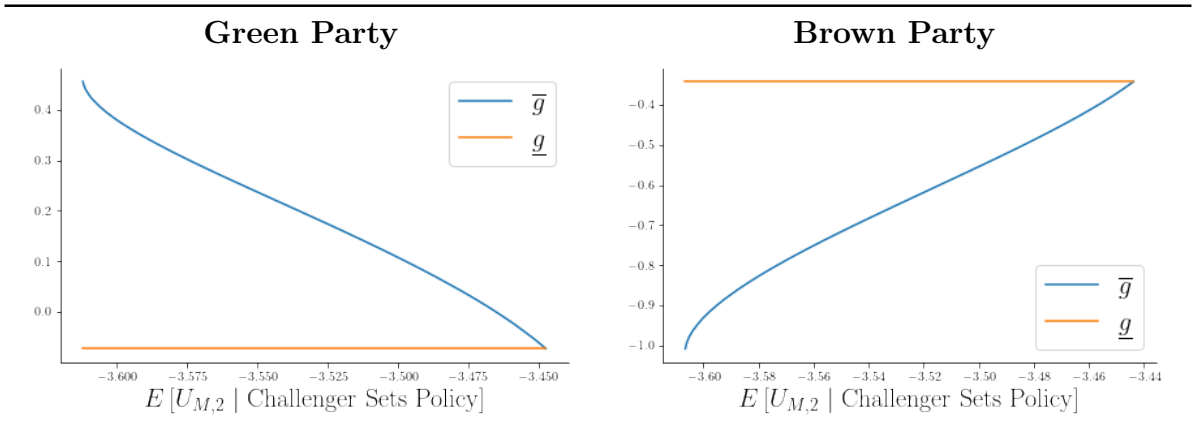


Figure D.3
Risk-Free Rate

This figure displays the risk-free rate under the brown and green party as a function of the expected utility under the challenger.

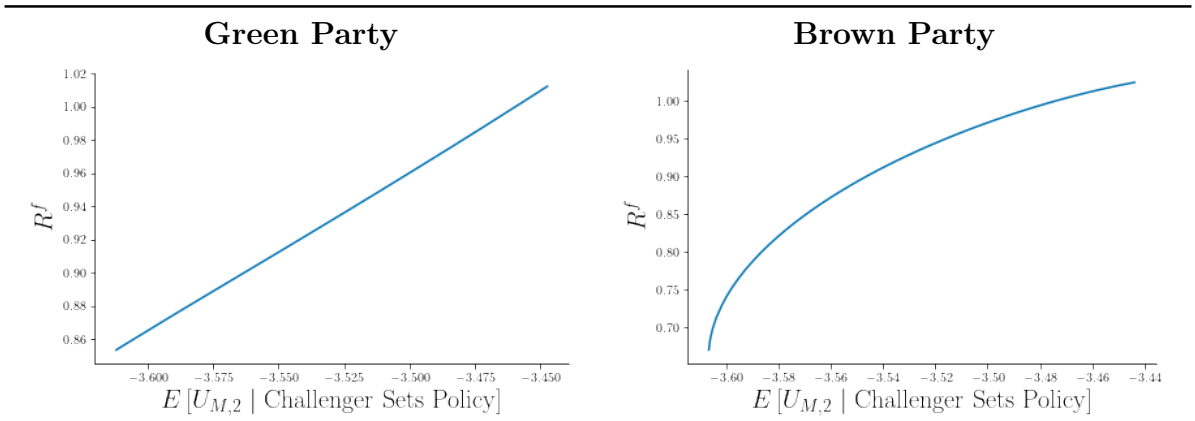
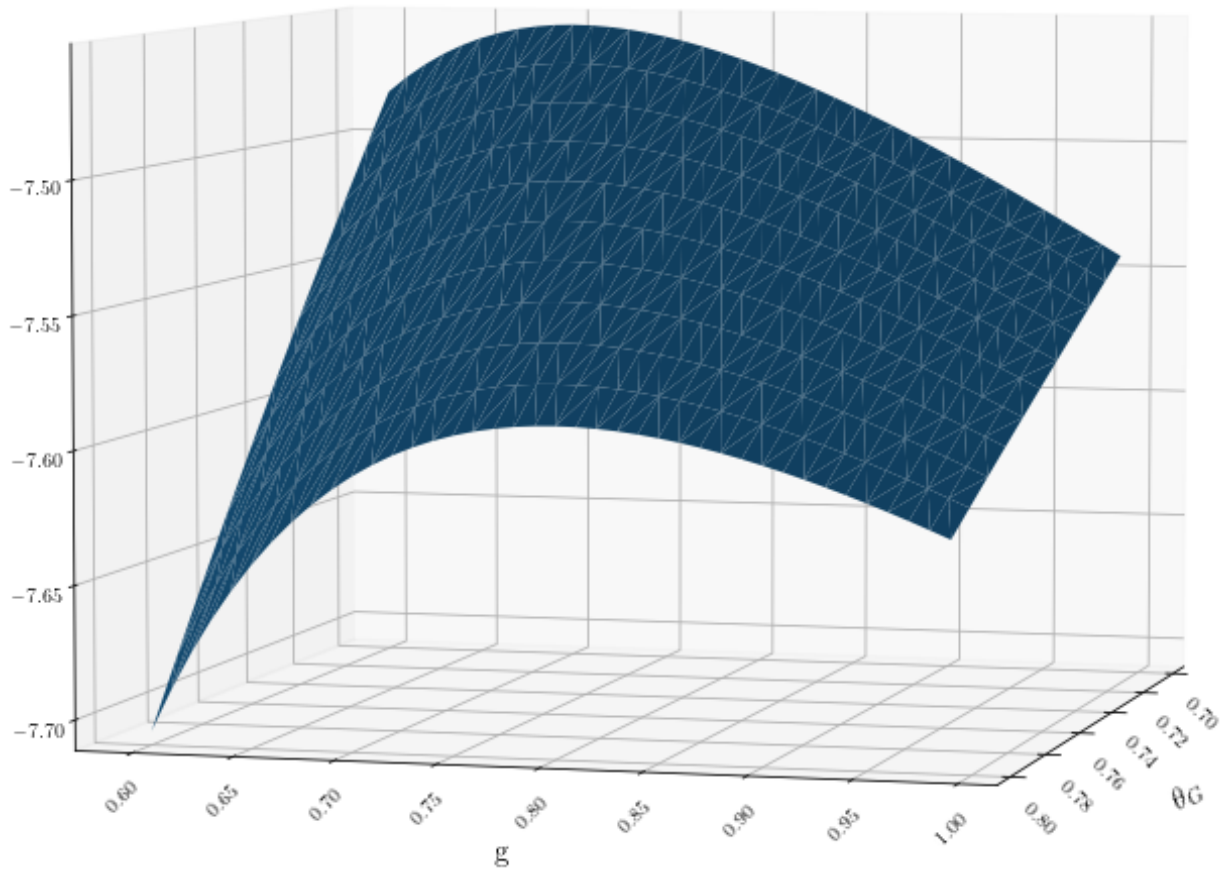


Figure D.4
Government's Utility

This figure displays the government's utility as a function of the implemented policy g and the government's type, θ_G.

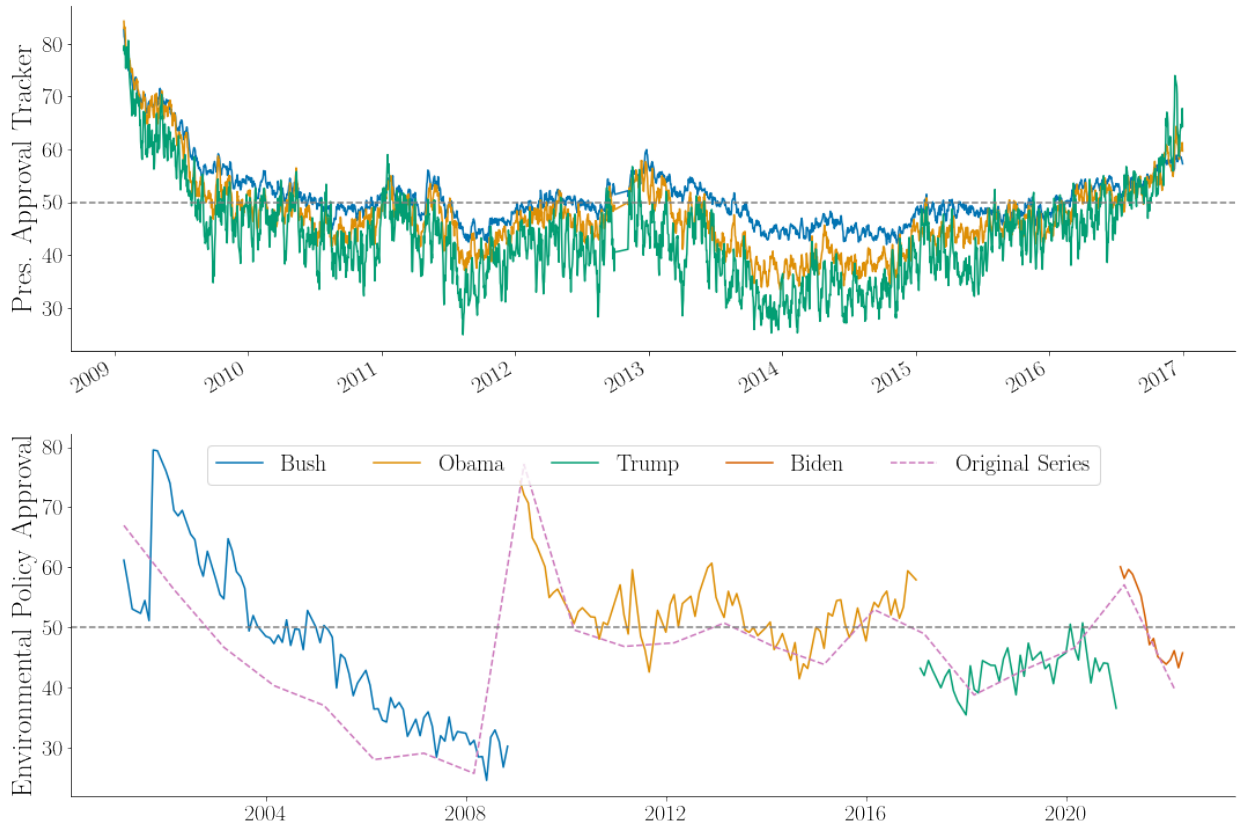


D.2 Data

D.2.1 Gallup

Figure D.5
Gallup Polling Series

This figure displays two time-series. The first is daily Presidential approval ratings from the Gallup weekly tracker. These numbers are taking from daily polls of approximately 1000 households each day. I plot a rolling, seven day average of the approval rating from these polls. The second displays responses to a question asking whether the "President Do Good/Poor Job of Improving Nations Energy Policies". I code "Good" as 1 and "Poor" as 0.



D.2.2 White House Transcripts

This section of the appendix provides additional detail about the dataset of policy announcements. Section describes the unused dataset of Clinton policy announcements and some of

the reasons they are unused. Section provides detailed information about the words associated with each topic and how I classify each topic.

Clinton Policy Announcements

The transcripts for President Clinton are the least organized and are the only transcripts that do not include precise times. These documents usually list the start time of a speech, but not the end time. These times are sometimes approximate. The Clinton press documents are also the only documents not to include the timezone of the speech. For these speeches, I programmatically search for location strings and geolocate these locations using the Google maps API. I then use the same API to find the appropriate timezone for that locality. Even after this procedure, some documents cannot be geolocated, for example those that are simply listed as "aboard Air Force One". I do not use these observations. From manual inspection, they are frequently broadcast from locales, such as Air Force One, from which it would be impossible to broadcast from live.

The huge number of speeches delivered by President Clinton seems to reflect a greater propensity to record low profile events that in later administrations would not constitute a remark. For example, uniquely, President Clinton's administration records the content of his remarks to campaign donors at a private residence.

President Clinton's remarks also never include ending times of speeches. The stated times are also sometimes approximate. For example instead of specifying that a remark started at 4:00 PM or 4:05 PM, these transcripts frequently only list 4 PM with a single digit's precision. Because of the lack of ending times and approximate starting times, much of the analysis excludes communication from President Clinton's time in office.

Topic Classifications

Table D.1
Topics

This table reports each topic estimated using LDA from the transcripts of Presidential remarks and the eight words most associated with that topic. I list the manually assigned topic label. The topic label is based on a subjective judgement what accurately describes the most frequent words in a given topic. Those topics that do not have a natural label have no entry in the "Topic Label" column.

	Topic Label	Eight Most Important Unigrams							
1		bear	flag	hussein	assign	bushcheney	interior	particular	reform
2	Women	women	girl	men	equal	woman	issu	gender	pay
3	Bill Passage	administr	would	fund	bill	committe	program	request	provid
4	Judicial System	prison	sentenc	pardon	releas	commut	grant	former	serv
5	Native Americans	nativ	indian	tribal	tribe	alaska	american	reserv	navajo
6	NATO	nato	europ	european	poland	allianc	union	alli	secur
7		sad	attach	2018	januari	graham	fit	song	contributor
8	Agriculture	farmer	agricultur	food	farm	iowa	rural	crop	produc
9	Press Secretary	press	secretari	releas	brief	transcript	mike	statement	presid
10	Asia-Pacific	region	asia	pacif	australia	apec	indonesia	asean	asian
11	Iraq	iraq	iraqi	govern	forc	secur	troop	coalit	baghdad
12	Democratic Politicians	siewert	jake	podesta	gore	transit	crowley	wrap	bradi
13	American People	peopl	year	work	want	countri	america	say	american
14	Small Business	busi	small	compani	owner	employe	loan	entrepreneur	capit
15	Senators	bob	dole	lehrer	patti	murray	michel	mcgovern	kemp
16	NASA	space	nasa	nation	moon	explor	station	astronaut	launch
17	Awards	award	medal	present	citat	read	prize	presidenti	nobel
18	Great Americans	great	peopl	know	want	well	think	countri	thank
19	Filler Words	think	robert	obvious	look	laughter	hous	mani	well
20	Thank You	peopl	thank	make	want	got	good	work	way
21	Conservatives	base	consider	conserv	call	cancel	strateg	separ	sadden
22		wide	hardwork	compel	3118	tubervill	intern	profound	task
23	Emergency	emerg	nation	order	execut	continu	declar	state	unit
24		caleb	nashvill	burgess	somer	countryand	covarrubia	welland	gladwin
25	Finance	financi	bank	market	system	crisi	reform	consum	loan
26	Investigations	inform	investig	report	hous	general	white	depart	offic
27	Drugs	drug	traffick	opioid	use	addict	abus	control	effort
28		laughter	one	like	life	time	young	year	first
29	Law and Crime	law	crime	polic	enforc	offic	communiti	crimin	justic
30	Security Relationships	state	unit	presid	countri	relationship	cooper	also	secur
31		led	colorado	intend	also	howev	derail	hea	passag
32	Laws	act	law	author	section	state	public	determin	unit

	Topic Label	Eight Most Important Unigrams							
33	Judicial System	court	judg	suprem	justic	senat	law	nomin	nomine
34		implement	laplant	session	draper	condit	braveri	247	evan
35	Foreign Leaders	minist	prime	franc	canada	french	itali	canadian	kingdom
36	Welfare	welfar	reform	work	state	waiver	recipi	requir	move
37		view	happen	bid	swift	byron	releas	rear	430
38	Applause	applaus	laughter	america	thank	great	everi	want	come
39	Global Development	global	develop	commit	secur	support	unit	includ	intern
40	Holidays	christma	holiday	right	okay	yes	season	thanksgiv	tree
41	Social Security	secur	social	retir	save	benefit	surplus	system	trust
42	Military Technology	mine	landmin	antipersonnel	demin	ottawa	antitank	leahi	oslo
43	Terrorism	war	iraq	world	terror	enemi	terrorist	freedom	unit
44	Documents	ctc	ctceitc	vita	eitc	prep	newslett	today	nonfil
45	America	presid	american	america	state	trump	great	today	peopl
46	Homeownership	puzzl	2000	behav	inc	shake	homeless	accompani	homeownership
47	Presidents	presid	bush	georg	reagan	former	clinton	call	carter
48	Veterans	veteran	militari	famili	servic	serv	spous	care	support
49	First Lady	ladi	mrs	first	visit	penc	second	art	melania
50	Clinton Press Briefing	stephanopoulo	georg	packag	stimulus	consult	review	exact	senat
51	Assistants	secretari	depart	deputi	assist	deleg	commerc	cabinet	brown
52	Missouri Politicians	imus	volkmer	sadden	kraning	bcfp	hannib	mccord	nation
53	America	american	work	year	new	help	today	make	nation
54	Spain	spain	spanish	aznar	rajoy	rota	spaniard	letizia	strength
55	God Bless America	american	day	famili	live	nation	one	honor	today
56	Jobs and Taxes	that	job	tax	cut	american	make	got	weve
57	Vice President	vice	harri	nevada	penc	vega	las	reid	truman
58	Eyesight	eye	vision	loss	sight	eyesight	impair	visual	dilat
59	Hodgepodge	ari	recognit	535	heavi	brighter	calcul	opt	valentin
60	Internship	fed	reg	internship	friday	twotofour	undergradu	preced	deadlin
61	Filler Words	get	know	that	peopl	want	thing	like	think
62	West Virginia	virginia	west	coal	commonwealth	warner	miner	byrd	hampton
63	Military	forc	militari	defens	unit	oper	state	secur	nation
64	Officeholders	serv	univers	director	state	offic	depart	member	assist
65	Clinton Press Briefings	mccurri	mike	would	hous	work	white	address	issu
66		mind	ahi	architect	edmond	promis	attribut	care	extens
67	Community Service	communiti	servic	program	help	organ	work	opportun	peopl
68	Infrastructure	infrastructur	invest	build	project	communiti	job	bridg	billion
69	World Affairs	world	said	america	look	year	state	ive	abl
70	Judaism	jewish	israel	celebr	jerusalem	embassi	holocaust	wish	light
71	China	china	chines	right	human	taiwan	hong	kong	beij

	Topic Label	Eight Most Important Unigrams							
72	Burma	burma	burmes	san	suu	kyi	aung	myanmar	ethnic
73	Donald Trump	presid	trump	donald	american	2018	administr	sign	2017
74		continu	stabl	chanc	likewis	202	272900	alabama	believ
75	Africa	africa	african	south	contin	nigeria	countri	kenya	aid
76	Trade	trade	agreement	market	export	unit	world	negoti	product
77	Drunk Drivers	drive	drunk	driver	alcohol	drink	impair	audio	obamawhitehousearchivesgov
78		valuabl	sympathi	strength	appreci	librari	benson	154	scowcroft
79	Abortion	abort	right	protect	reproduct	decis	roe	women	wade
80		school	educ	student	colleg	teacher	learn	high	children
81	Supply Chains	suppli	chain	product	manufactur	port	industri	critic	ship
82	Jobs	job	economi	econom	invest	creat	growth	busi	new
83	Railways	board	disput	mediat	railroad	arbitr	useri	railway	creation
84		sadden	level	encompass	embark	white	footstep	complaint	subscrib
85	Iraq	iraq	resolut	council	saddam	iraqi	secur	hussein	continu
86		buckley	weekend	shower	ahead	good	fragil	brownsvill	ecstat
87	Russia-Ukraine Conflict	russia	ukrain	russian	putin	sanction	ukrainian	alli	action
88		thompson	fight	eleven	peroug	meet	said	choic	agreement
89		gordon	hallmark	afflict	trampl	tread	nasdaq	christi	11157
90		may	kay	draper	advanc	reform	secur	sinc	educ
91		night	addit	symbol	colorado	433	keith	5th	3743
92	Clinton Press Briefings	myer	dee	think	hes	work	hous	continu	white
93	War	armi	marin	sergeant	soldier	enemi	general	honor	war
94	Syria	syria	assad	syrian	regim	intern	unit	militari	weapon
95	Food	kid	food	healthi	eat	school	move	parent	meal
96	Faith	faith	religi	church	prayer	christian	freedom	muslim	religion
97		amount	parti	extend	refus	growth	born	1st	tragedi
98	Hispanic	hispan	latino	mayo	heritag	cinco	caucus	hector	cesar
99	Political Figures	rep	sen	ami	potus	realdonaldtrump	barrett	applaud	mike
100	Accidents	poison	accident	packag	childresist	household	lock	681	450
101	Russia	russia	russian	yeltsin	berger	clinton	reform	moscow	sandi
102	Gulf Oil Spill	oil	gulf	spill	drill	respons	allen	coast	admir
103	Filler Words	make	weve	sure	peopl	that	got	work	everybodi
104	Tax Cuts	tax	cut	pay	famili	american	plan	incom	percent
105	Elections	year	four	vote	senat	well	presid	booo	time
106	Health Care	health	care	insur	cost	plan	system	peopl	coverag
107	Cybersecurity	secur	cyber	cybersecur	infrastructur	nation	critic	sector	threat
108		octob	norman	curtail	bathrob	order	aviat	perish	reinvent
109	Sudan	sudan	darfur	sudanes	rebel	khartoum	bashir	danforth	envoy
110	Latin America	mexico	america	hemispher	colombia	brazil	mexican	latin	chile

	Topic Label	Eight Most Important Unigrams							
111	Afghanistan	afghanistan	afghan	troop	taliban	secur	forc	mission	pakistan
112	Politics	american	republican	presid	would	hous	congress	jay	need
113	Creditor-Debtor	red	cross	bankruptci	chapter	debtor	blood	creditor	repay
114	Questions	think	would	one	question	well	weve	also	take
115	Climate Change	climat	energi	chang	emiss	clean	reduc	carbon	develop
116	Accident Compensation	gearan	mark	compens	radiat	experi	otool	paster	miner
117		crowley	colonel	pontiff	token	effect	col	turbul	milwauke
118	Baby Formula	formula	evict	infant	fda	tenant	import	moratorium	rental
119		period	assign	five	washington	nonpubl	omaha	hendrix	work
120	Korea	korea	north	korean	south	kim	nuclear	missil	peninsula
121	California	california	san	los	angel	francisco	barbara	diego	boxer
122	India-Pakistan	india	pakistan	indian	prime	minist	pakistani	modi	kashmir
123	Federal Emergency	feder	emerg	area	fema	affect	state	assist	local
124		106	jumpstart	carpent	top	focus	polici	state	suggest
125	Japan	japan	japanes	minist	prime	abe	tokyo	framework	ambassador
126	Germany	germani	chancellor	german	merkel	berlin	kohl	angela	schroeder
127		hay	kendal	lyttl	eve	garrison	tesk	lefkowitz	cosponsor
128	Boy Scouts	scout	jambore	otherwis	arrog	scoutmast	guid	boy	pois
129	White House	hous	white	staff	offic	welcom	room	washington	visitor
130	Event	event	speech	trip	night	day	hell	morn	travel
131	Spanish Language	que	los	para	las	por	una	con	del
132	State of the Union	tweet	3122	statement	potus	sotu	tonight	3922	arpa
133	Presidential Transition	presidentelect	transit	smooth	20th	forward	presidentselect	awesom	peru
134	Sports	team	game	laughter	coach	play	olymp	player	sport
135	Central America	central	guatemala	salvador	hondura	america	costa	caus	rica
136	Presidential Administration	presid	sarah	hous	white	trump	look	thank	administr
137	Gun Violence	gun	violenc	weapon	check	background	ban	shoot	law
138	Mongolia	meyer	mongolia	nobl	mongolian	affair	regret	swift	transpond
139	House of Representatives	dear	speaker	sincer	letter	repres	text	chairman	report
140	Venezuela	venezuela	venezuelan	maduro	regim	freedom	hemispher	juan	restor
141	Delivery	friendship	send	deliv	star	alley	assist	democraci	robust
142	Pacific Islands	terri	compact	palau	mcauliff	dorothi	micronesia	trusteeship	99658
143	Donna Shalala	reed	shalala	bruce	walter	donna	vento	vladeck	deparl
144	Term	vice	term	district	expir	member	unit	state	servic
145	Central Asia	kazakhstan	uzbekistan	azerbaijan	moldova	turkmenistan	kyrgyzstan	tajikistan	armenia
146	Vietnam	vietnam	vietnames	klein	miss	account	war	remain	hanoi
147		capp	representativeelect	walter	ralph	loi	aggress	replac	length
148		russert	tier	mtop	cfius	firrma	1211a	6500	1211d
149	Medical Doctor	doctor	medic	physic	donor	donat	exam	exercis	mariano

	Topic Label	Eight Most Important Unigrams							
150	Coronavirus	test	state	american	peopl	governor	health	hospit	coronavirus
151		promot	kurt	martorana	substitut	consul	feel	movement	thaci
152		corinthian	give	total	creativ	2002	asset	adult	comfort
153	LGBT	gay	discrimin	equal	transgend	gender	sexual	orient	right
154	Budgets	budget	cut	deficit	spend	billion	year	propos	tax
155	Conflict	sadden	perish	releas	civil	rout	accommod	conveni	14000
156		born	aug	politburo	1948	oct	jan	sept	deputysecretari
157	Thanks	thank	want	much	work	today	great	know	presid
158	US States	state	governor	florida	carolina	counti	north	south	texa
159	Technology	technolog	scienc	research	internet	inform	new	innov	comput
160	Iran	iran	nuclear	sanction	iranian	deal	agreement	weapon	intern
161	Anthrax	anthrax	mail	ridg	sampl	spore	antibiot	envelop	daschl
162	Anti-Trust	antitrust	merger	dept	paper	roosevelt	kanter	jonathan	1776
163		american	would	jonathan	begin	test	fourth	dwight	zoellick
164	Turkey-Greece	turkey	greec	greek	turkish	cyprus	erdogan	coup	turk
165	VOA	voa	cowan	assign	polit	held	villag	slam	accomplish
166	Colin Powell	powel	colin	alma	speedi	lighthous	hukil	haylett	brogan
167	Municipalities	new	citi	york	mayor	jersey	chicago	kansa	philadelphia
168	Economic Figures	percent	rate	year	increas	growth	sinc	economi	unemploy
169	Race	black	right	race	civil	king	african	racial	equal
170	Media	cavuto	brownstein	forward	unleash	denomin	minut	time	success
171	Funding	program	million	fund	provid	billion	state	assist	new
172	Art	art	music	nation	human	american	perform	artist	museum
173	Domestic Violence	victim	violenc	traffick	abus	sexual	domest	human	survivor
174	Discussion	presid	think	well	would	say	know	said	talk
175	Energy	energi	oil	price	gas	fuel	product	use	power
176	Birth Certificate	certif	birth	hawaii	sideshow	longform	hawaiian	news	clement
177	Nation	unit	state	nation	day	american	america	year	two
178	Georgia	demonstr	experi	georgia	tuck	easiest	amin	republican	though
179	National Forest	land	nation	park	protect	forest	monument	conserv	area
180	Michigan	michigan	detroit	levin	debbi	flint	carl	dingel	gari
181	National Security Advisors	sullivan	advisor	jake	phone	spoke	convey	hulata	ibrahim
182	Filler Words	year	peopl	america	want	thank	say	countri	elect
183	Federal Employees	feea	richardson	schiff	campbel	alic	depart	hous	depend
184	Clean Air and Water	water	environment	epa	air	clean	environ	protect	pollut
185	Lawmaking	law	state	would	act	protect	action	requir	author
186	Refugees	refuge	migrat	humanitarian	resettl	admiss	number	person	region
187	Air Transportation	transport	safeti	air	airport	travel	flight	airlin	aviat
188	Disabilities	disabl	ada	peopl	blind	employ	individu	access	rehabilit

	Topic Label	Eight Most Important Unigrams							
189	Ireland	ireland	northern	peac	irish	patrick	parti	taoiseach	process
190	Egypt	egypt	egyptian	mubarak	govern	transit	aid	tunisia	cairo
191		ltc	contractor	might	realiti	tabl	practition	regist	portman
192	Cancer	cancer	diseas	health	treatment	prevent	research	aid	live
193	Disasters	disast	hurrican	feder	storm	emerg	help	fema	local
194	Treaties	state	treati	unit	convent	senat	ratif	advic	consent
195	Elections	elect	vote	democrat	campaign	parti	republican	voter	polit
196	Radio	radio	station	carri	address	listen	click	broadcast	find
197	Filler Words	think	peopl	presid	would	thing	say	tri	countri
198	Filler Words	applaus	know	work	countri	that	want	barack	peopl
199	Hodepodge	whale	cui	locat	disclosur	near	groom	nevada	classifi
200	Country	presid	state	unit	countri	that	would	well	kind
201	Immigration	border	immigr	secur	law	illeg	countri	enforc	system
202	Minimum Wage	minimum	wage	census	rais	count	sampl	1010	fulltim
203	Nuclear Weapons	nuclear	weapon	treati	missil	secur	chemic	state	materi
204	Health Care	health	communiti	american	presid	biden	access	includ	administr
205	Haiti	haiti	haitian	aristid	democraci	restor	return	island	polic
206	Government Debt	debt	govern	ceil	default	shutdown	negoti	pay	shut
207	Action	return	lie	septemb	endur	unab	depend	destruct	enabl
208	Joe Lockhart	lockhart	joe	think	toiv	hous	white	issu	impeach
209	Federal Agencies	feder	agenc	govern	depart	administr	inform	report	develop
210	Ron Fogleman	recommend	render	jame	campbel	fogleman	serious	someon	general
211	Smoking	tobacco	smoke	cigarett	advertis	children	young	product	industri
212	Meetings	meet	discuss	presid	leader	issu	summit	particip	import
213	Workers	worker	job	work	labor	employ	train	employe	compani
214	Massachussets	massachusett	boston	deval	markey	martha	commonwealth	menino	worcest
215	Filler Words	know	presid	ahead	also	would	well	peopl	american
216	Executive Order	shall	order	section	state	unit	execut	agenc	sec
217	People	peopl	world	nation	must	freedom	right	unit	america
218	Cuba	cuba	cuban	peopl	castro	polici	chang	human	govern
219	Hodepodge	tie	deserv	firm	oxygen	propon	wednesday	event	ana
220	Administration Official	administr	offici	senior	colleagu	background	embargo	name	call
221		newburi	sincer	foundat	caus	concern	septemb	100	willi
222	Vaccines	vaccin	get	peopl	covid19	dose	million	shot	thank
223	Cars	car	auto	industri	ford	compani	plant	motor	vehicl
224	Congress	senat	bill	congress	hous	republican	legisl	pass	vote
225	Nordics	finland	sweden	norway	arctic	denmark	nordic	iceland	niinist
226	Magodonga Mahlangu	holl	woza	magodonga	share	addit	annual	method	bella
227	Home Ownership	home	hous	mortgag	homeown	famili	hud	afford	homeownership

	Topic Label	Eight Most Important Unigrams							
228		tangibl	four	ninth	afflict	rick	liam	walli	ask
229		robin	1990	earlier	push	young	attent	outsid	biscuit
230	State of the Union	state	unit	order	person	nation	execut	sanction	properti
231	Years	2006	2005	2007	2003	2001	2004	2008	2002
232		issu	muratov	ressa	combin	timet	fray	bonni	caen
233	Military Courts	amend	accus	follow	may	evid	militari	read	rule
234	Disaster Response	coast	guard	louisiana	orlean	gulf	mississippi	katrina	cutter
235	Easter Egg Roll	easter	egg	roll	bunni	lotteri	ticket	volunt	malpass
236	Israel-Palestine	peac	israel	palestinian	east	middl	isra	minist	prime
237	Terrorism	terrorist	attack	threat	terror	secur	qaeda	intellig	oper
238		felt	five	boost	teamwork	574	need	toward	discourag
239	Georgia	georgia	atlanta	georgian	max	miller	savannah	zell	shevardnadz
240	Families	children	famili	child	parent	care	mother	support	home
241		pdf	gene	chao	shortfal	html	weather	lesson	unaccept
242	Postal Service	post	offic	build	servic	design	postal	facil	locat
243	ACA Website	websit	enrol	afford	act	insur	sign	problem	marketplac
244		chatter	birthday	discov	bain	ong	2592	accomplish	deliveri
245	Wyoming	terzano	ginni	bradley	wyom	jackson	convey	harrison	wolfensohn
246		health	vol	took	extern	hugh	3246	distinct	repeat
247	Drug Pricing	drug	medicar	prescript	senior	price	benefit	cost	plan
248	White House Officials	preston	corey	staub	ashle	kenton	seongho	holet	nisa
249	Intelligence Agencies	intellig	director	cia	nation	communiti	foreign	agenc	collect
250		newli	call	throughout	wednesday	anniversari	note	polici	foundat
251	Catholic Church	pope	glynn	mari	franci	vatican	ellen	holstein	burk
252	Announcements	presid	announc	intent	nomin	appoint	travel	member	afternoon
253	Act and Proclomation	act	section	proclam	countri	import	unit	state	articl
254		sponsor	1836	conduct	health	improv	violenc	enact	empti
255		2006	georg	carl	undertaken	120	kenneth	note	seven
256	Yugoslavia	bosnia	nato	kosovo	peac	forc	serb	troop	war
257		schedul	boat	pay	part	made	attach	hereof	usc
258	Filler Words	aim	boundless	standard	akin	brimmer	earli	institut	pleas
259	Saudi Arabia	saudi	king	arabia	jordan	princ	yemen	crown	majesti
260		1052	drum	static	4th	entranc	recept	loud	denis

Table D.2
Topic Classifications

This table reports each topic estimated using LDA from the transcripts of Presidential remarks, the label that I manually assign the topic and a broad classification into which I group that particular topic.

		Foreign Affairs	Energy and Climate	Other Environment	Healthcare	Economy	Politics	Public Health	Natural Disasters
1									
2	Women								
3	Bill Passage								
4	Judicial System								
5	Native Americans								
6	NATO	X							
7									
8	Agriculture					X			
9	Press Secretary								
10	Asia-Pacific	X							
11	Iraq	X							
12	Democratic Politicians						X		
13	American People								
14	Small Business					X			
15	Senators						X		
16	NASA								
17	Awards								
18	Great Americans								
19	Filler Words								
20	Thank You								
21	Conservatives								
22									
23	Emergency								X
24									
25	Finance					X			
26	Investigations								
27	Drugs								
28									
29	Law and Crime								
30	Security Relationships	X							
31									
32	Laws								
33	Judicial System								

34						
35	Foreign Leaders	X				
36	Welfare				X	
37						
38	Applause					
39	Global Development	X				
40	Holidays					
41	Social Security				X	
42	Military Technology	X				
43	Terrorism	X				
44	Documents					
45	America					
46	Homeownership					
47	Presidents					X
48	Veterans					
49	First Lady					
50	Clinton Press Briefing					
51	Assistants					
52	Missouri Politicians					
53	America					
54	Spain	X				
55	God Bless America					
56	Jobs and Taxes				X	
57	Vice President					X
58	Eyesight					
59	Hodgepodge					
60	Internship					
61	Filler Words					
62	West Virginia					
63	Military					
64	Officeholders	X				X
65	Clinton Press Briefings					
66						
67	Community Service					
68	Infrastructure				X	
69	World Affairs	X				
70	Judaism					
71	China	X				
72	Burma	X				

73	Donald Trump					X
74						
75	Africa	X				
76	Trade				X	
77	Drunk Drivers					
78						
79	Abortion					
80						
81	Supply Chains					
82	Jobs				X	
83	Railways				X	
84						
85	Iraq	X				
86						
87	Russia-Ukraine Conflict	X				
88						
89						
90						
91						
92	Clinton Press Briefings					
93	War	X				
94	Syria	X				
95	Food					
96	Faith					
97						
98	Hispanic					
99	Political Figures					X
100	Accidents					
101	Russia	X				
102	Gulf Oil Spill			X		
103	Filler Words					
104	Tax Cuts					
105	Elections					X
106	Health Care					
107	Cybersecurity					
108						
109	Sudan	X				
110	Latin America	X				
111	Afghanistan	X				

112	Politics					X			
113	Creditor-Debtor								
114	Questions								
115	Climate Change		X						
116	Accident Compensation								
117									
118	Baby Formula								
119									
120	Korea	X							
121	California								
122	India-Pakistan	X							
123	Federal Emergency								X
124									
125	Japan	X							
126	Germany	X							
127									
128	Boy Scouts								
129	White House								
130	Event								
131	Spanish Language								
132	State of the Union					X			
133	Presidential Transition					X			
134	Sports								
135	Central America	X							
136	Presidential Administration					X			
137	Gun Violence								
138	Mongolia	X							
139	House of Representatives					X			
140	Venezuela	X							
141	Delivery								
142	Pacific Islands	X							
143	Donna Shalala								
144	Term								
145	Central Asia	X							
146	Vietnam	X							
147									
148									
149	Medical Doctor						X		
150	Coronavirus						X		

151						
152						
153	LGBT					
154	Budgets					X
155	Conflict					
156						
157	Thanks					
158	US States					
159	Technology					
160	Iran	X				
161	Anthrax					
162	Anti-Trust					X
163						
164	Turkey-Greece	X				
165	VOA					
166	Colin Powell					
167	Municipalities					
168	Economic Figures					X
169	Race					
170	Media					
171	Funding					
172	Art					
173	Domestic Violence					
174	Discussion					
175	Energy		X			
176	Birth Certificate					
177	Nation					
178	Georgia					
179	National Forest					
180	Michigan					
181	National Security Advisors					
182	Filler Words					
183	Federal Employees					
184	Clean Air and Water				X	
185	Lawmaking					
186	Refugees					
187	Air Transportation					
188	Disabilities					
189	Ireland	X				

190	Egypt	X							
191									
192	Cancer								
193	Disasters								
194	Treaties	X							
195	Elections								
196	Radio								
197	Filler Words								
198	Filler Words								
199	Hodepodge								
200	Country								
201	Immigration						X		
202	Minimum Wage						X		
203	Nuclear Weapons	X							
204	Health Care				X				
205	Haiti	X							
206	Government Debt								
207	Action								
208	Joe Lockhart								
209	Federal Agencies								
210	Ron Fogleman								
211	Smoking								
212	Meetings								
213	Workers								
214	Massachussets								
215	Filler Words								
216	Executive Order								
217	People								
218	Cuba	X							
219	Hodepodge								
220	Administration Official								
221									
222	Vaccines								X
223	Cars								
224	Congress								
225	Nordics								
226	Magodonga Mahlangu								
227	Home Ownership								
228									

229						
230	State of the Union					X
231	Years					
232						
233	Military Courts					
234	Disaster Response					
235	Easter Egg Roll					
236	Israel-Palestine	X				
237	Terrorism	X				
238						
239	Georgia					
240	Families					
241						
242	Postal Service					
243	ACA Website				X	
244						
245	Wyoming					
246						
247	Drug Pricing				X	
248	White House Officials					
249	Intelligence Agencies					
250						
251	Catholic Church					
252	Announcements					
253	Act and Proclomation					
254						
255						
256	Yugoslavia	X				
257						
258	Filler Words					
259	Saudi Arabia	X				
260						

D.2.3 Trade and Quote (TAQ)

In Figure D.6 I plot the returns to the same strategy as shown in Figure A.2, except that I consider investing in the ETF SPY as opposed to a VIX futures ETF. Returns are on average higher under Democratic presidents. Had an investor pursued this strategy they would have gained an approximately twenty percent cumulative return. However, this masks the negative returns such an investor would have received during the Bush and Trump administrations. In the appendix, I list the corresponding figures for a bond and TIPS ETF in Figures D.7 and D.8. The patterns are less striking for these two ETFs. There is signficant upward movement in the Bond ETF before the policy rate hits the zero-lower bound in 2009. There is a strong negative trend in the TIPS ETF.

Figure D.6
Cumulative SPY Returns around Announcements

This figure shows the returns to a strategy that alternatively holds SPDR S&P 500 ETF (SPY) or cash. The first trading strategy holds the ETF ten minutes before to ten minutes after Presidential remarks. The second holds the ETF on the same time window but the prior day and the third the same time window the following day.

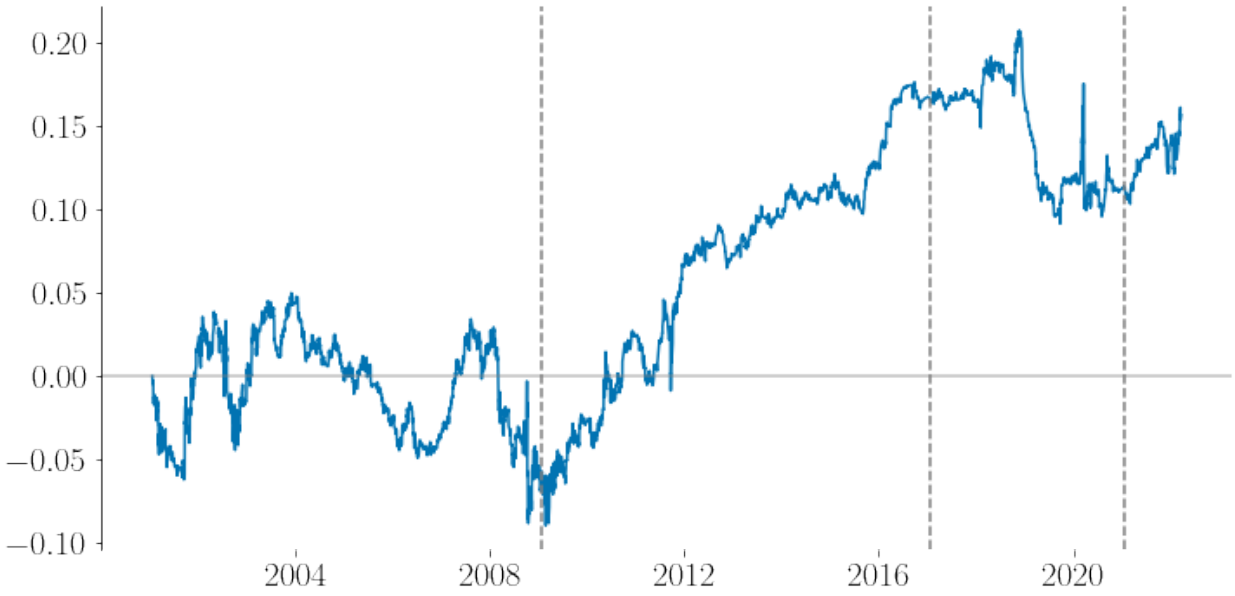


Figure D.7
Vanguard Total Bond Market Index Fund ETF (BND)

This figure displays the returns to a strategy that alternatively holds the ETF BND and cash. Most periods the strategy holds cash. Ten minutes before an announcement the strategy purchases the ETF BND. Ten minutes after the announcement ends the strategy liquidates the postion in BND.

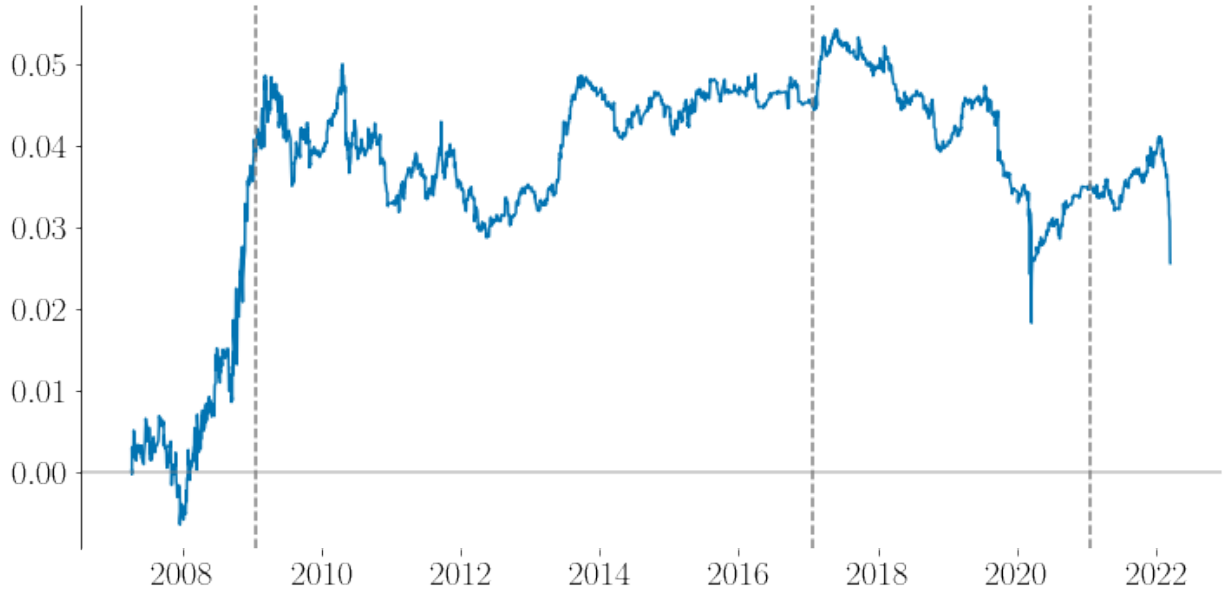


Figure D.8
iShares TIPS Bond ETF (TIP)

This figure displays the returns to a strategy that alternatively holds the ETF TIP and cash. Most periods the strategy holds cash. Ten minutes before an announcement the strategy purchases the ETF BND. Ten minutes after the announcement ends the strategy liquidates the postion in BND.

Table D.3
Top Holdings

This table displays the top 10 holdings of selected ETFs as of September 12, 2022.

Materials Select Sector SPDR Fund (XLB)	SPDR S&P Metals & Mining (XME)	Health Care Select Sector SPDR Fund (XLV)
Linde PLC	ATI Inc.	UnitedHealth Group Incorporated
Sherwin-Williams Company	Nucor Corporation	Johnson & Johnson
Air Products and Chemicals Inc.	Steel Dynamics Inc.	Pfizer Inc.
Corteva Inc.	United States Steel Corporation	Eli Lilly and Company
Freeport-McMoRan Inc.	Uranium Energy Corp.	AbbVie Inc.
Ecolab Inc.	Commercial Metals Company	Thermo Fisher Scientific Inc.
Nucor Corporation	Reliance Steel & Aluminum Company	Merck & Co. Inc.
Dow Inc.	Aloca Corporation	Abbott Laboratories
Albemarble Corporation	Cleveland-Cliffs Inc.	Danaher Corporation
Newmont Corporation	Consol Energy Inc.	Bristol-Myers Squibb Company
Consumer Staples Select SPDR Fund (XLP)	**iShares Biotechnology ETF (IBB)**	**Consumer Staples Select SPDR Fund (XLE)**
Procter & Gamble Company	Gilead Sciences Inc.	Exxon Mobil Corp.
Coca-Cola Company	Regeneron Pharmaceuticals Inc.	Chevron Corp.
PepsiCo Inc.	Vertex Pharmaceuticals Inc.	Shulumberger Ltd.
Costco Wholesale Corporation	Amgen Inc.	EOG Resources Inc.
Walmart Inc.	Moderna Inc.	ConocoPhillips
Mondelez International Inc. Class A	IQVIA Holdings Inc.	Marathon Petroleum Corp.
Altria Group Inc.	Illumina Inc.	Pioneer Natural Resources Co.
Philip Morris International Inc.	Biogen Inc.	Valero Energy Corp.
Colgate-Palmolive Company	Biontech SE ADR	Phillips 66
Estee Lauder Companies Inc. Class A	Mettler Toldeo Inc.	Occidental Petroleum Corp.

APPENDIX E

ROBUSTNESS CHECKS

Table E.1
VIX Matching Estimator

This table reports results from a matching estimator of the form:

$$R_t = \beta \times \mathbb{I}\{\text{Announcement}\} + \nu_{\text{pair}}$$

where the indicator takes the value one if the return corresponds to an announcement. There is a fixed effect for each announcement and control pair. The control group is defined as either the return to the ETF the next day around the same time window, the prior day around the same time window or a different time the same day.

	VIXM	VXZ	VIXY	VXX
		Next Day		
Briefing Day Indicator	-0.00063**	-0.00048**	-0.00098**	-0.00097**
	(-2.50)	(-2.12)	(-2.13)	(-2.37)
Constant	1.00***	1.00***	1.00***	1.00***
	(5610.8)	(6248.3)	(3074.1)	(3442.5)
Observations	1618	1960	1618	1960
R^2	0.398	0.378	0.396	0.397
		Prior Day		
Briefing Day Indicator	-0.00062**	-0.00019	-0.00071	-0.00067
	(-2.44)	(-0.85)	(-1.46)	(-1.57)
Constant	1.00***	1.00***	1.00***	1.00***
	(5606.5)	(6410.6)	(2906.2)	(3307.5)
Observations	1618	1960	1618	1960
R^2	0.391	0.387	0.373	0.382
		Same Day		
Briefing Day Indicator	-0.00078**	-0.00015	-0.0011*	-0.00072
	(-2.53)	(-0.56)	(-1.86)	(-1.44)
Constant	1.00***	1.00***	1.00***	1.00***
	(4540.4)	(5312.3)	(2434.1)	(2812.5)
Observations	1347	1637	1347	1637
R^2	0.361	0.353	0.360	0.368

Table E.2
Raw Return Regressions

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Climate Speech$_t$ is the topic model posterior measure of climate speech for the remark occuring at time t and takes values between zero and one. R_t is the return to the indicated ETF in basis points.

Dependent Variables:	Basic Materials (XLB)	Mining (XME)	Energy (XLE)	Utilities (XLU)	Technology (XLK)	Biopharm (IBB)	Technology (XLV)	Cons Staples (XLP)	Cons Discret (XLY)	Total Market (VTI)
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables										
Remark	-0.0150	0.0434	0.0026	-0.0018	0.0094	0.0040	0.0124	0.0107	0.0016	0.0047
	(-0.7224)	(1.185)	(0.1184)	(-0.1128)	(0.5691)	(0.2059)	(0.9352)	(0.9174)	(0.1014)	(0.3349)
Climate Speech × Remark	2.622**	3.011*	1.663	0.9297	0.8131	-0.5068	-0.5445	0.4829	0.6952	1.046
	(2.429)	(1.920)	(1.295)	(1.143)	(1.304)	(-0.4020)	(-0.6200)	(0.9258)	(0.9715)	(1.540)
Fixed-effects										
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics										
Observations	1,848,643	1,574,501	1,848,645	1,848,644	1,848,647	1,848,636	1,848,646	1,848,644	1,848,646	1,848,642
R^2	0.00211	0.00248	0.00199	0.00161	0.00193	0.00209	0.00183	0.00157	0.00197	0.00138
Within R^2	2×10^{-6}	2.38×10^{-6}	6.8×10^{-7}	2.94×10^{-7}	4.17×10^{-7}	7.55×10^{-8}	3.56×10^{-7}	4.42×10^{-7}	1.76×10^{-7}	4.58×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table E.3
Brown minus Green Returns – Alternative Portfolios

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Climate Speech$_t$ is the topic model posterior measure of climate speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: energy (XLE), mining (XME), basic materials (XLB), technology (XLK) and consumer discretionary (XLY).

Dependent Variables:	XLB - XLK	XLB - XLY	XLB - XLP	XME - XLK	XME - XLY	XLM - XLP	XLE - XLK	XLE - XLY	XLE - XLP
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Remark	-0.0243	-0.0167	-0.0257	0.0270	0.0296	0.0183	-0.0067	0.0010	-0.0081
	(-1.470)	(-1.048)	(-1.429)	(0.8978)	(0.9970)	(0.5484)	(-0.3439)	(0.0510)	(-0.4104)
Climate Speech × Remark	1.808**	1.927**	2.139**	2.257*	2.455*	2.643*	0.8489	0.9679	1.180
	(2.344)	(2.451)	(2.122)	(1.722)	(1.668)	(1.797)	(0.7713)	(0.9140)	(0.9761)
Fixed-effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics									
Observations	1,848,643	1,848,643	1,848,643	1,574,501	1,574,501	1,574,501	1,848,645	1,848,645	1,848,644
R^2	0.00139	0.00142	0.00164	0.00213	0.00218	0.00232	0.00159	0.00165	0.00173
Within R^2	1.28×10^{-6}	1.14×10^{-6}	1.71×10^{-6}	1.35×10^{-6}	1.61×10^{-6}	1.31×10^{-6}	1.72×10^{-7}	2.14×10^{-7}	3.33×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table E.4
Brown minus Green Regression

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Energy Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Energy Speech$_t$ is the topic model posterior measure of energy speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: energy (XLE), mining (XME), health care (XLV), technology (XLK), and biotechnology (IBB).

Dependent Variables:	XLB - XLK	XLB - XLY	XLB - XLP	XME - XLK	XME - XLY	XLM - XLP	XLE - XLK	XLE - XLY	XLE - XLP
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables									
Remark	-0.0228	-0.0079	-0.0106	0.0298	0.0307	0.0282	-0.0128	0.0021	-0.0006
	(-1.349)	(-0.4857)	(-0.5792)	(0.9884)	(1.038)	(0.8430)	(-0.6512)	(0.1107)	(-0.0303)
Energy Speech × Remark	0.4863	-0.4481	-1.227	0.6655	0.9929	-0.1744	1.152	0.2175	-0.5611
	(0.6562)	(-0.5333)	(-1.406)	(0.5552)	(0.7126)	(-0.1199)	(0.9220)	(0.3028)	(-0.8227)
Fixed-effects									
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics									
Observations	1,848,643	1,848,643	1,848,643	1,574,501	1,574,501	1,574,501	1,848,645	1,848,645	1,848,644
R^2	0.00139	0.00142	0.00164	0.00212	0.00218	0.00232	0.00159	0.00165	0.00173
Within R^2	6.22×10^{-7}	3.33×10^{-7}	1.99×10^{-6}	7.32×10^{-7}	1.06×10^{-6}	3.28×10^{-7}	1.08×10^{-6}	4.91×10^{-8}	2.81×10^{-7}

Clustered (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table E.5
Alternative Measures of Environmental Remarks

This table displays regressions using an alternative measure of whether the announcement contains a substantial amount of climate speech. Instead of the raw topic model-implied climate topic posterior, an announcement is classified as a climate announcement if this posterior is above the indicated threshold.

Dependent Variable:	XLB - XLV						
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables							
Remark	-0.0205	-0.0205	-0.0205	-0.0198	-0.0205	-0.0216	-0.0284
	(-1.182)	(-1.179)	(-1.179)	(-1.135)	(-1.175)	(-1.238)	(-1.621)
Climate Topic $\geq 7\% \times$ Remark	0.4251*						
	(1.898)						
Climate Topic $\geq 6\% \times$ Remark		0.4042*					
		(1.831)					
Climate Topic $\geq 5\% \times$ Remark			0.4042*				
			(1.831)				
Climate Topic $\geq 4\% \times$ Remark				0.1859			
				(0.9955)			
Climate Topic $\geq 3\% \times$ Remark					0.2171		
					(1.466)		
Climate Topic $\geq 2\% \times$ Remark						0.2351*	
						(1.724)	
Climate Topic $\geq 1\% \times$ Remark							0.3513***
							(3.611)
Fixed-effects							
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics							
Observations	1,848,643	1,848,643	1,848,643	1,848,643	1,848,643	1,848,643	1,848,643
R^2	0.00159	0.00159	0.00159	0.00159	0.00159	0.00159	0.00160
Within R^2	1.3×10^{-6}	1.23×10^{-6}	1.23×10^{-6}	6.18×10^{-7}	8.35×10^{-7}	1.15×10^{-6}	4.18×10^{-6}

One-way (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table E.6
Alternative Numbers of Topics

This table displays alternative measures of climate speech. The topic model implied posterior is calculated using different topics models with alternative numbers of topics, as opposed to 260 topics in the baseline model. To estimate this regression I find the climate topic in each of these documents and regress returns on the posterior implied by these alternative topic models.

Dependent Variable:	XLB - XLV		
Model:	(1)	(2)	(3)
Variables			
Remark	-0.0260	-0.0136	-0.0132
	(-1.469)	(-0.4828)	(-0.4701)
Climate Speech (240 Total Topics) × Remark	1.572*		
	(1.947)		
Climate Speech (250 Total Topics) × Remark		3.365**	
		(2.387)	
Climate Speech (270 Total Topics) × Remark			3.324**
			(2.541)
Fixed-effects			
Date	Yes	Yes	Yes
Fit statistics			
Observations	1,848,643	325,888	325,888
R^2	0.00159	0.00743	0.00743
Within R^2	1.71×10^{-6}	1.37×10^{-5}	1.4×10^{-5}

One-way (Date) co-variance matrix, t-stats in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table E.7
Alternative Measures of Environmental Remarks

This table reports regression results of the form

$$R_t = \beta_1 \times \mathrm{I}\{\text{Announcement}_t\} + \beta_2 \times \mathrm{I}\{\text{Announcement}_t\} \times \text{Climate Speech}_t + \nu_t$$

on a minute-by-minute panel of returns. ν_t are date fixed effects. $\mathbb{I}\{\text{Announcement}\}$ takes the value one if that minute was during or within a ten-minute window around an announcement that satisfies the screens in Table B.2. Climate Speech$_t$ is the topic model posterior measure of climate speech for the remark occuring at time t and takes values between zero and one. R_t is the return to a brown minus green portfolio expressed in basis points. The returns to this portfolio are calculated as the difference in returns between pairs of five industry ETFs: energy (XLE), mining (XME), basic materials (XLB), technology (XLK) and consumer discretionary (XLY). The coefficients are cluster as indicated in the bottom panel.

Dependent Variables:	XLB - XLV		XLE - XLV		XLB - XLK		XLE - XLK	
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Remark	-0.0144	-0.0144	0.0086	0.0086	-0.0094	-0.0094	0.0136	0.0136
	(-0.3795)	(-2.076)	(0.2465)	(0.3619)	(-0.3014)	(-1.170)	(0.4489)	(0.6874)
Climate Speech × Remark	3.713*	3.713***	3.581**	3.581**	2.293*	2.293	2.161*	2.161**
	(2.076)	(6.970)	(2.167)	(3.475)	(1.987)	(2.347)	(2.032)	(3.223)
Fixed-effects								
Date	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics								
Co-variance	Year	President	Year	President	Year	President	Year	President
Observations	325,888	325,888	325,888	325,888	325,888	325,888	325,888	325,888
R^2	0.00744	0.00744	0.00846	0.00846	0.00593	0.00593	0.00727	0.00727
Within R^2	1.8×10^{-5}	1.8×10^{-5}	1.64×10^{-5}	1.64×10^{-5}	6.58×10^{-6}	6.58×10^{-6}	5.87×10^{-6}	5.87×10^{-6}

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*