Boundaries of the State

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Abstract

Formal conceptions of state capacity have mostly focused on indirect measures of state capacity – by, for instance, using tax revenues as a proportion of GDP as a proxy for state capacity. Yet, this *input* view of state capacity falls short, especially since cross-country empirical evidence suggests that similar tax revenues, as a percentage of GDP, can produce starkly different *outputs* – both in classic economic terms and in broader terms that citizens would recognize as *good outcomes*, such as life expectancy, infant mortality, deaths of despair, and equality of opportunity. This paper argues that conventional views of state capacity ignore one crucial *boundary of the state* or dimension of state capacity, namely its capacity to gather and process information, and how the presence or lack of such informational capacity constrains governments in responding to crises, such as the recent energy price shock. Our framework provides the analytical toolkit to examine how this informational boundary of the state shapes the incentives for policymakers to resort to untargeted and/or distortionary policy instruments, as opposed to targeted and non-distortionary ones, in responding to crises. In doing so, our framework draws attention to the need to redefine the boundaries of the state, the firm and notions of property rights around data and information more generally. The policy response to the energy crisis following the invasion of Ukraine provides the empirical context upon which we bring this theoretical apparatus to bear, though the latter can be straightforwardly extended to other recent crises.

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1 Introduction

Governments around the world have had to contend with a number of shocks and crises in the past three decades or so – ranging from the global financial crisis, the European debt and subsequent austerity crises, the 2015 migration crisis, uncertainty and de-globalization shocks, the COVID-19 crisis, and, most recently, the energy crisis. The ability of democratic political systems to respond effectively to these (often forseeable) crises, such as climate change, has been increasingly called into question (Stasavage, 2020b; Mittiga, 2022). Many point to (liberal) democracies' lack of state capacity or their inability to optimally deploy their existing capacity as a key reason for concerns about their potential to produce good outcomes and thereby retain legitimacy (Schularick, 2021).

Against the backdrop of this debate, this paper studies a dimension of state capacity that has increasingly been recognized as important, but remains understudied: the ability to gather, analyze, and ultimately leverage policy-relevant information when designing and implementing (unconventional) fiscal policy, particularly in response to crises. Specifically, we examine the significance of this *informational* dimension of state capacity for demarcating the *boundaries of the state* – the set of shocks governments can effectively deal with if they choose to do so – in the context of the 2022 energy crisis that many governments had to grapple with in the wake of the Russian invasion of Ukraine.

We do so by contrasting two starkly different policy responses to the crisis, the British and German ones, through the lens of British data. Our analysis of the UK policy response demonstrates a democratic government's failure to optimally leverage its informational resources. In contrast, the German response – especially when compared against the backdrop of UK data – was much less distortionary, though its design and implementation were severely constrained by Germany's low informational capacity, particularly its lack of granular, high-quality administrative data. As a result, the German government had to rely on a rather coarsely targeted transfer scheme, whereas in the UK such data were available but not utilized. Given that Germany and the UK have, broadly speaking, similar energy demand profiles, comparing these two policy responses helps us elucidate key political economy mechanisms that can drive suboptimal policy responses.

Different factors can limit the development or optimal use of the state's informational capacity. A lack of available high-quality data, crisis complexity, notably their heterogeneous impacts, and an absence of in-house statistical and data analysis expertise can prevent governments from responding to crises with the necessary agility and speed.[1] In the absence of such capacity, the resulting policy responses may be poor value for public money. Mistaking a failure of policy implementation for a failure of policy direction can then create incentives to pursue 'public-service-focused' austerity, thus further eroding the state's agility to engage in effective real-time problem solving (Fetzer, 2019a; Fetzer and Feld, 2023; Hoddinott et al., 2022).[2]

Our paper focuses on the costs of insufficient informational capacity as well as the political dynamics underlying the under-utilization of such capacity. Specifically, we make four contributions. First, we provide descriptive cross-country and England-focused evidence on key design features of energy support policies. The former suggests that, across the board, countries responded by deploying support measures that were both untargeted and distortionary. The latter suggests that the UK's policy response, in addition to being regressive and inefficient, came with a specific political skew disproportionately benefiting (some) supporters of the incumbent party at the cost of benefiting the average supporter.

Second, drawing on this evidence, we develop a theoretical framework to shed light on the ways in which informational capacity shapes policymakers' incentives to respond to an energy crisis. We conceptualize this problem as a policymaker allocating a given budget for energy support measures between targeted lump-sum transfers and untargeted subsidies. In addition, consumers are heterogeneous and differ in their income levels, while the policymaker observes only a noisy signal of true consumer types. The variance of the signal reflects the informational capacity

[1] For Covid-19-related examples, see e.g. Fetzer and Graeber, 2020; Fetzer, 2021a.

[2] Duque et al. (2024) suggest that austerity, lengthy administrative processes, and skill deficits – exacerbated by demography – often impede the public sector's ability to adopt cost-saving technology. In fact, low-quality data and low skill levels can produce errors that erode trust, in part due to a media multiplier driven by availability heuristics (Besley et al., 2020).

of the state. Our central theoretical result demonstrates that only a policymaker who attaches greater weight to the welfare of high-income, as opposed to low-income, types opts for the untargeted policy instrument and does so only when the informational capacity at her disposal is low.

Third, we leverage granular data to juxtapose the British and German policy responses. The reason for comparing these two countries is that their policy responses differed starkly, among others, in the extent to which they preserved the signal value of prices. To demonstrate this point, we evaluate the actual policy choices – relative to a large vector of fiscally neutral and potentially superior alternatives, which would, however, have required a higher degree of informational state capacity. Our simulations demonstrate that the lack of informational capacity resulted in substantial inefficiency and that particularly (very) high-income Conservative supporters disproportionately benefited from this.

Fourth, guided by our theoretical framework, we attempt to rationalize the observed policy choices. The analysis suggests that a lack of informational state capacity – combined with political economy considerations arising from policymakers attaching different welfare weights to different groups in society – was likely an important factor in shaping policy in response to the energy price shocks. We argue that sharp informational boundaries between the state, households, and firms, as well as the resulting stickiness in the flow of data between economic actors are crucial and hitherto under-researched factor explaining observed policy choices.[3]

Studying the effects of informational capacity (or lack thereof) and its sluggish deployment is of first-order importance for several reasons. First, the fiscal volume of support measures introduced in the wake of the energy crisis is nothing short of gigantic (Arregui et al., 2022; Sgaravatti et al., 2023): across Europe, €768 billion has been earmarked to help consumers cope with rising energy prices, with German and British energy support policies costing roughly €265 billion and £103 billion, respectively.[4] Second, the support measures implied, in many cases, an expansion

[3]Declining levels of trust in institutions may be another salient factor that undermines governments' ability to respond effectively (Algan et al., 2017; Besley and Dray, 2022; Besley et al., 2023).

[4]This is equivalent to approximately 7% of Germany GDP and 4.6% of UK GDP in 2021.

of fossil fuel subsidies, which, as of 2022, were roughly $7 trillion globally (Black et al., 2023). This is especially jarring, given that these 'dirty' subsidies must be phased out quickly to avert the worst of the climate crisis. Third, the underlying *design* of the support measures likely matters for their economic and political efficacy. Therefore, insufficiently effective measures could further undermine societal cohesion, at least to the extent that societal cohesion is a function of the (perceived) efficacy of crisis response. The British and German interventions stand in rather stark contrast in this respect. Finally, unlike other sudden and unexpected crises, such as the COVID-19 pandemic, which brought to the fore significant differences in countries' approaches to protecting lives and livelihoods and, more broadly, to distributing the economic burden of policies (Kaplan et al., 2020), the 2022 energy crisis, just like the climate crisis – was predictable well in advance. Consequently, it is possible to evaluate policy choices against alternative policies that were available to policymakers *at the time*, rather than with the benefit of hindsight.

Situating our contribution in the literature This paper is related to several strands of literature on state capacity and the political economy of policy choices. First, our research is related to the literature on the determinants and boundaries of state capacity.[5] Besley and Persson (2009, 2010, 2011) develop a theoretical framework for analyzing how different types of states develop, depending on rulers' coercive power and societies' cohesiveness. In their model, rulers can invest in both fiscal and legal capacity, which, in turn, affect the level of public good provision.

We loosely draw on and extend this framework by considering an additional dimension of state capacity, namely informational capacity. The literature on state capacity – both in economics and political science – is strongly historically oriented, that is, it aims to explain the emergence of centralized states (Wang, 2021). As a result, this literature analyzes the informational capacity of states largely in

[5]In exploring the informational constraints on policymaking, it builds on works examining how states developed the capacity to collect taxes via centralized state bureaucracies as well as legal systems. See, e.g. Levi, 1989; Tilly, 1993; Spruyt, 2002; Dixit, 2004, 2010; Fukuyama, 2011; Mann, 2012; Beramendi et al., 2019; Grzymala-Busse, 2020; Sánchez de la Sierra, 2020; Dahlström and Lapuente, 2022; Li et al., 2022; Garfias and Sellars, 2021, 2023; Albers et al., 2023.

non-digital form. In his seminal work, James C. Scott (1999), coined the term *legibility* to capture the extent to which governments could *read* their citizens through the introduction of, for instance, cadastres. While Scott (1999) provides qualitative case-study evidence for the legibility, recent work has extended this work both empirically and theoretically (Lee and Zhang, 2017; Ansell and Lindvall, 2020; Brambor et al., 2020; Bowles, 2023; Martin, 2023; Garifas and Sellars, 2023).

What little quantitative work exists on the informational dimension of state capacity focuses mainly on the use of data and information to develop the extractive capacity of states, their ability to collect taxes (Pomeranz, 2015; Brockmeyer et al., 2019; Naritomi, 2019; Slemrod, 2019; Slemrod and Keen, 2021; Weigel, 2020; Balan et al., 2022; Bergeron et al., 2023). Our paper, by contrast, focuses on the state's role in gathering and analyzing (granular) data to deliver cost-effective and targeted fiscal interventions. This is particularly important in light of the rapid evolution of ICT and AI technologies[6] and their potential impact on the ability of governments to implement such interventions.[7] The role that information and data play in our analysis highlights the importance of debates around privacy, 'digital' property rights, and information governance. Poorly defined or enforced property rights relating to individuals' data can undermine their 'production' or use (Posner and Weyl, 2018; Jones and Tonetti, 2020; Acemoglu et al., 2022; Fetzer, 2022b), leading to an underproduction of knowledge public goods, while likely resulting in rents in the form, for example, of the growth and concentration of superstar firms in some ICT sectors (Autor et al., 2020b; Cunningham et al., 2021). The negative externalities of inadequately defined and enforced digital property rights are exacerbated by the public sector's sluggishness in leveraging administrative and other data[8] as

[6]See Margalit and Raviv (2023) for experimental evidence on bureaucrat's willingness to use AI.

[7]A notable literature discusses the means of modern autocrats or 'spin dictators', who use information heavily to both control and repress citizens (Weidmann and Rød, 2019; Guriev and Treisman, 2019, 2020, 2022; Dimitrov, 2022; Beraja et al., 2023). Narratives or stories can be used to engineer behavioral change, but they can also exacerbate or shape economic shocks (Besley et al., 2020) or can be used as hybrid weapons in a service sector trade escalation. See also Tirole (2021) for an analysis of the opportunities for social control these new technologies open up, even in democratic societies.

[8]This is sometimes because of legal barriers concerning the use of highly granular data, conflicts of interest, or low-quality data. Globally, there are two diametrically opposing views on the role that data or information should play in shaping welfare.

well as deploying cutting-edge data science tools to design long-term policies and short-term responses to crises.[9]

On the methodological side, our paper relates to works that use micro- and macro-simulation methods for policy evaluation while seeking to account for heterogeneity between households. In macroeconomics, the growing popularity of heterogeneous-agent New Keynesian (HANK) models exemplifies this approach (Kaplan et al., 2018; Sargent, 2023).[10] In applied work, micro- and macro-simulation can be fruitfully applied when rich household-level data is available and/or there is no plausibly exogenous variation in policy. This paper complements this research by (i) zeroing in on the importance of granular data, data science and statistical skills, and well-defined property rights over data in shaping (more) effective policy, and (ii) adding an implicit (spatial) political economy dimension to this literature.[11]

Finally, by presenting a political economy rationalization of some of the most important design features of countries' responses to the energy price shock, the paper speaks to the literature on populism and, more broadly, zero-sum politics (see, e.g., Fetzer, 2019b; Chinoy et al., 2023)[12] in two ways. First, our empirical evidence suggests that the UK's response to the energy crisis via the *Energy Price Guarantee* not only disproportionately benefited a small electoral group, but also did so in a regressive way. In addition to that, this policy also engendered significant negative social and economic externalities.[13] Second, our findings are suggestive of an "unholy" electoral coalition between high- and low-income households. The

[9]High levels of privacy around personal data may facilitate tax evasion (Alstadsæter et al., 2019), which, even in the absence of actual evasion, can nevertheless shape narratives around growing inequalities (Piketty and Saez, 2003; Auten and Splinter, 2023) with low transparency and high distrust. This is especially true when people's everyday environments worsen in ways they find difficult to comprehend or accept, or when they attribute these negative changes to the consequence of low (performative) state capacity (Fetzer, 2020, 2021b).

[10]See Auclert et al. (2023); Bayer et al. (2023) for studies of the energy price shock in that tradition.

[11]These 'technological' dimensions strongly influence state capacity and policy outcomes. Athey and Wager (2021) examine how policymakers can optimally adjust policies when only observational data is available to them. Acemoglu et al. (2022) suggest that data oversharing can mean that it is welfare-enhancing to shut down data markets. Jones and Tonetti (2020) show how the non-rivalrous nature of data can provide a justification for granting users property rights over their data, which chimes well with the informally derived recommendations by Posner and Weyl (2018).

[12]See Fetzer (2019a) and Fetzer et al. (2023b) for some examples.

[13]In the context of the energy crisis, Fetzer (2023a) documents how untargeted energy subsidies have likely caused a sharp increase in crime, in particular in areas with energy-inefficient homes.

high-income political right effectively designs self-serving, distortionary, and fiscally costly energy subsidies, such as a price cap that lower-income households may support because it may appeal to their perceptions of fairness[14], or, if they are subject to their own mental models or cognitive constraints, they may find it especially easy to understand.[15]

The remainder of the paper proceeds by first presenting some motivating evidence and outlining the context in more detail. Next, we set out our conceptual framework to illuminate the trade-offs between equity, efficiency, and informational capacity. Drawing on that framework, the fourth section employs counterfactual policy simulations to bring this framework to bear on fine-grained, household- and individual-level data from the UK. The fifth section concludes.

Cross-country variation in crisis response: Quantitative motivating evidence The two different approaches pursued by the UK and Germany as well as a broader analysis of cross-national differences in crisis response demonstrate the relevance of a key theoretical construct in (public) economics: the trade-off between equity and efficiency in designing and implementing policy.

(Figure 1)

Analysis of data collected by the *International Monetary Fund* (IMF) show a positive relationship between the share of financial support that was untargeted versus distortionary. Untargeted measures, like uniform price subsidies, are less equitable since their impacts depend on consumption levels rather than needs. They also distort price signals and waste resources.

Ideally, policy support would be both targeted and non-distortionary to minimize the trade-off between equity and efficiency. In this respect, the German and

[14]For a discussion relating to universal basic income, see e.g. Ghatak and Maniquet (2019).

[15]Theoretically, Gabaix (2020) introduces bounded rationality into a New Keynesian model. Alternative mechanisms could be: biased perceptions of within- and between-group inequality (Hvidberg et al., 2023) or a media multiplication channel through which isolated, individual stories are amplified in a highly polarized (social) media ecosystem exacerbated by limited statistical literacy (Besley et al., 2020).

UK approaches stand, as noted above, in rather stark contrast to one another. Germany's *Gaskommission* designed a system that sought to emulate a targeted approach by utilizing the income tax system, with higher earners paying more for additional consumption. While still imperfect, this approach was closer to the first-best outcome than the one pursued by the UK. The UK implemented a uniform price subsidy, in combination with lump-sum transfers that were fully untargeted and distortionary. This comparison highlights how information availability shapes the equity-efficiency boundary governments face in responding to crises.

Further motivating evidence from regression analyses reveals notable correlations between energy consumption and political preferences in the UK. At the local area level, a positive relationship exists between (ward-level) Conservative Party vote share in local council elections and electricity/gas usage.

Analysis at the individual level also shows higher average energy bills among those who prefer the Conservative Party. Interestingly, the relationship between position in the income distribution and energy bills exhibits a U-shaped pattern, with individuals that lean Conservative having, in relative terms, notably larger bills at both the very bottom and very top of incomes.

This suggests that populists have managed to assemble a somewhat unholy coalition comprising both extremes of the income distribution: the ultra-wealthy and the very poor. These groups stand to benefit most from untargeted subsidies, which helps explain the persistence of such policies in the UK and US, despite their inequitable and inefficient nature. This (largely correlational) evidence helps rationalize why a political economy mechanism can imply societal tolerance of inefficiency through broad-based support measures.

Conceptual framework The model provides a framework for examining the policymaking trade-offs between equity, efficiency, and informational capacity, notably access to (granular) information. It compares two scenarios: equity refers to the weights governments attach to different groups of citizens, like low- versus high-income citizens. Efficiency, by contrast, refers to the extent to which policies rely on market mechanisms versus blanket subsidies. Information access captures governments' information (or lack thereof) about citizens' true characteristics, including income levels or energy consumption patterns.

The model we develop examines a country with two types of citizens that have either high or low incomes/energy consumption. The government can choose between targeted group-specific transfers and broad price subsidies. But it may not know individuals' true incomes due to limited information access. We posit that the lack of informational access represents a core boundary of the state. The model then contrasts how, as the boundaries of the state, proxied by information or data access, change, the incentives to employ different tools of providing support to households change. If the government knows citizens' incomes perfectly, it has an incentive to target aid directly without distorting (relative) prices. If, however, information is limited, the government must accept some inefficiency as a result of implementing broad subsidies. Our model reveals that governments would only choose broad, untargeted subsidies if they have a strict preference for high-income earners over low-income ones. This simple model provides testable insights into how informational constraints shape trade-offs between fair, efficient and well-targeted policy solutions when information is imperfect.

The model not only helps us theoretically rationalize governments' actual responses to the energy crisis; it also sheds light on alternative policies that would have allowed governments to respond more effectively to the crisis. In this way, the model provides a framework for exploring governments' best policy responses using counterfactual policy simulations. These policy simulations have the additional virtue that they account, to a greater extent than the relatively simple model, for real-world complexity. This, in turn, means the simulation exercises map the model more closely to the empirical policy trade-offs.

Operationalizing the conceptual framework empirically Indeed, we construct over 57,000 counterfactual energy subsidy policies for the UK, varying targeting approaches using granular household consumption data. This approximates the model by estimating "quotas" – consumption amounts subsidized at different rates for households grouped by observable characteristics. By simulating a wide range of targeting precision levels – from individualized to postcode-level –, while holding the total budget constant, the exercise captures different "information capacities", comparable to the model parameter β.

Outcomes are then evaluated against the trilemma between equity, efficiency, and informational capacity or targeting precision. Political skew, the relative preference for the Conservative party, assesses "equity" by analyzing the correlation between votes and energy consumption. Market exposure reflects "efficiency", the degree to which the government relies on market-based mechanisms, as opposed to broad subsidies. Grouping size, the level at which targeting occurs, is taken as a proxy for "informational capacity" since more data reveals targeting.

This higher-dimensional approach offers new insights by mapping simulated policies onto the conceptual framework. It sheds light on real-world trilemma trade-offs faced by data- and revenue-constrained governments.

Situating our contribution in the literature This research connects to literature on the determinants and boundaries of state capacity. In exploring informational constraints on policymaking, it relates to work examining how states developed the capacity to collect taxes via centralized state bureaucracies as well as legal systems (Levi, 1989; Tilly, 1993; Ertman, 1997; Finer, 1999; Spruyt, 1996, 2002, 2009; Dixit, 2004, 2010; Fukuyama, 2011; Mann, 2012; Beramendi et al., 2019; Grzymala-Busse, 2020; Sánchez de la Sierra, 2020; Dahlström and Lapuente, 2022; Li et al., 2022; Garfias and Sellars, 2021, 2023; Albers et al., 2023).

Besley and Persson (2009, 2010, 2011) develop a theoretical framework for analyzing how different types of states develop, depending on ruler's coercive power and society's cohesiveness. In their model, rulers can invest in both fiscal and legal capacity, which, in turn, affect the level of public good provision. Pigouvian states, for instance, have high fiscal and legal capacity and provide an efficient level of public goods.

In this paper, we loosely draw on and extend this framework by considering an additional dimension of state capacity, namely informational capacity. Given that the literature on state capacity in both economics and political science is strongly historically oriented, i.e. aims to explain the emergence of centralized states (Wang, 2021), it analyzes the state's informational capacity only in non-digital form. In his seminal work, anthropologist and political scientist, James C. Scott, coined the term *legibility* to capture the extent to which governments could *read* their citizens through the introduction of, for instance, cadastres. While Scott (1999) provides merely qualitative, case-study evidence for the legibility, recent work has extended and modified Scott's work both empirically and theoretically (Lee and Zhang, 2017; Stasavage, 2020a; Brambor et al., 2020; Ansell and Lindvall, 2020; Bowles, 2023; Martin, 2023).

While this small sub-literature on informational capacity improves earlier work by providing systematic, quantitative evidence, it is almost entirely historical and cannot therefore be applied directly to the modern world. Indeed, this literature largely fails to examine the importance of precisely targeted policy interventions and the impact of the ICT and AI revolutions on governments' ability to implement such interventions, though there are notable exceptions on the literature on the means modern autocracies use to control and repress their citizens (Weidmann and Rød, 2019; Guriev and Treisman, 2020, 2022; Chen and Greitens, 2022; Beraja et al., 2023).

On the methodological side, our paper relates to works that use micro- and macro-simulation methods for policy evaluation, while seeking to account for heterogeneity between households. In macro-economics, for instance, the growing popularity of heterogeneous-agent, New Keynesian (HANK) models exemplifies this approach (Kaplan et al., 2018; Sargent, 2023).[16] In applied work, micro- and macro-simulation models can be fruitfully applied when rich household-level data is available, and no plausibly exogenous variation in policy exists.

In addition, this research relates to a growing body of literature examining the role of data, skills, information, and property rights over data in effective policymaking. Several papers have found these "technological" dimensions strongly influence state capacity and outcomes.

Athey and Wager (2021) show how policymakers can optimally adjust policies

[16] See Auclert et al. (2023) for an analysis of the energy price shock in that tradition.

when only observational data are available to them. Acemoglu et al. (2022), for instance, examine how the fact that individuals do not take into account the externalities of sharing their data online leads to an over-provision of data, which can make it welfare-enhancing to shut down data markets. The model by Jones and Tonetti (2020) illuminates how the non-rivalrous nature of data can provide a justification for granting users property rights over their data. The informally derived recommendations or reform proposals by Posner and Weyl (2018) are in a similar vein.

Overall, this paper contributes new evidence on how data, skills, and information shape the boundaries of effective policymaking, as governments navigate societal challenges amid technological change.

Broader implications: Informational capacity, effective crisis response and austerity The United Kingdom – even more than the United States – provides a unique context to study the nexus between crisis response, producing zero-sum politics, whose unintended consequences may further the rise of populism. Fetzer (2019a) and Fetzer et al. (2023b), for instance, show that many austerity measures did not, in effect, reduce public spending due to their adverse impact on the economy. Instead, austerity has eroded state capacity and directly contributed to the pressures that led then Prime Minister David Cameron to call a referendum on the UK's EU membership. The ensuing protest vote by the British public to leave the European Union has since resulted in further erosion of the economic base and has disproportionately affected areas where the effect of austerity on the Leave vote was particularly strong (Fetzer and Wang, 2020).

The response to COVID-19 turbo-charged many of the tendencies that were already visible, but less pronounced in governments' responses to the global financial crisis and trade shocks. A notable theme that emerges from this literature is the importance – in economic, political, and, more broadly, social terms – of the unintended consequences engendered by policy measures deemed economically and/or politically smart at the time of their adoption. Fetzer and Schwarz (2021) show that Trump's trade war with China, a calculated political gamble, which at the time many pundits thought tactically clever, led to strategic retaliation from the Chinese government, which adjusted its tariff scheme so that Republican districts were most affected. This is in line with other research which shows that Trump's trade policies proved electorally costly for the GOP in the 2018 midterms (Kim and Margalit, 2021). The literature on the political consequences of the China shock, moreover, demonstrates that trade liberalization, a policy many economists consider welfare-enhancing, can have deleterious political consequences (Colantone and Stanig, 2018; Autor et al., 2020a).

During the COVID-19 pandemic, the unintended and often disastrous nature of the consequences of hastily crafted policy responses figured prominently. In his analysis of the UK's "Eat-Out-to-Help-Out" scheme, a policy designed to kickstart economic activity in the UK after the initial lockdown, Fetzer (2022c) shows how subsidizing restaurant visits ultimately helped spread the virus, leading to many (avoidable) infections. As for states' lack of administrative capacity: Fetzer and Graeber (2020) analyze the effect of a now infamous "excel error" on the evolution of infections in the UK in late 2020. The UK government used an old binary excel format to record data related to tests, not realizing that the maximum number of rows is 64,000. Due to that oversight, it failed to record and therefore track many infections. Fetzer and Graeber (2020) leverage this quasi-random break in the contact trace chain to provide an estimate of the 'costs', measured in infections, of inadequate administrative capacity, a direct consequence of the outsourcing industry that austerity helped facilitate.

The paper proceeds by first outlining in more details the context, discussing the data sources and motivating evidence. Then we will present our conceptual framework to illuminate the trilemma between equity, efficiency, and informational capacity. Drawing on that framework, the next section uses counterfactual policy simulations to bring this framework to bear on fine-grained, household- and individual-level, data from the UK.

2 Context, Data and Motivating evidence

In the following section, we present some motivating evidence that sheds some light on the underlying, yet latent political economy considerations that may help us understand why energy subsidies were designed in the specific fashion.

2.1 Cross-country evidence

The fiscal envelope associated with the response to the energy crisis is astonishing. Since the start of the energy crisis in September 2021, €768 billion has been allocated and earmarked across European countries to shield consumers from the rising energy costs (Sgaravatti et al., 2023). A total of €657 billion was pledged in the EU, of which €265 billion has been earmarked by Germany alone. The UK response saw an ex ante spend of €103 billion in the UK, with a big component being the *Energy Price Guarantee* (EPG), which provides a critical piece of motivation for our theoretical model and empirical analysis.

Naturally these large fiscal interventions have attracted a fair amount of scrutiny as to whether fiscal support has been extended in a cost-efficient and -effective manner. Helping households cope with the economic ramifications of higher energy prices should be clearly limited in time; it should allow the price mechanism to work to incentivize short-term energy savings and longer-term investments to reduce energy consumption. Furthermore, it should provide support to lower-income households to avoid other negative externalities that may arise with such a de-facto income shock.

(Figure 1)

Figure 1, adapted from Arregui et al. (2022), suggests there is a positive correlation between the extent to which countries adopt *untargeted* policy measures and *distortionary* ones. That is, a higher share of untargeted policies is associated with more distortionary policies. There are many potential factors at play here that shape this response. There could, for example, have been technical challenges and political considerations that may have prevented a swift deployment of targeted and nonprice-distorting measures. Data gaps could reflect confidentiality, stringent privacy rights, or technical implementation constraints. For example, policymakers may lack information on households' bank accounts to provide direct transfer. This paper formally examines some of these considerations using data from the UK and, in doing so, introduces a framework to help qualify the likely relevance of each of these three considerations, namely the efficiency of crisis response, its equity, and constraints implied by governments' informal capacity.

2.2 Within-country evidence

To showcase the likely relevance of a political economy channel and how it may have featured in the political decision-making processes that led to energy price support interventions in many (European) countries, we follow Fetzer (2019a) in leveraging granular data on the results of UK local elections at the ward level between 2008 and 2019. We construct a simple unweighted long-term average of Conservative party vote share across elections and local councillors at the ward level. There are roughly 7000 different wards for which such a long-term Conservative party vote share measure can be constructed. Averaging across elections allows us to net out candidate- or election-level idiosyncratic factors. We combine the ward-level results with granular, detailed data on postcode-level domestic energy consumption data.[17] The latter provides the median, mean, and sum of energy consumption – electricity and gas – of all households living in an area. As with the election data, we can remove the idiosyncratic time-factors by averaging the moments across the different years for which data is available.

Using the above data allows us to estimate a simple linear regression of the following form:

$$e_i = \alpha_{r(i)} + \beta \times x_{c(i)} + \nu \times p_w + \epsilon_d$$

The dependent variable, e_i, here measures the long-term mean or median energy

[17] See here for the raw data: `https://www.gov.uk/government/publications/postcode-level-domestic-gas-and-electricity-consumption-about-the-data`.

consumption, averaged across the mean or median household in a postcode. This is regression on a set of area fixed effects that are coarser than the ward level – the level at which the political preference measure is available. Furthermore, we add a vector of control variables from the most recent (2021) census, capturing characteristics of the resident population in an area. The parameter of interest is ν, which captures the relationship between a ward's w longer-term Conservative party vote share, p_w, and an area's energy consumption.

Revealed local political preferences The results from estimating the above regression are visually presented in the form of binned scatter plots (figure 2) for median gas and electricity consumption respectively. Both panels exhibit very similar patterns, implying that the results do not differ substantially when using natural gas or electricity consumption as our dependent variable. They suggest that in areas, in which households have higher median levels of energy consumption – relating to both gas and electricity – electoral support for the Conservative party in local elections is, on average, structurally and persistently higher. The implication being that Conservative voters likely benefit more from untargeted energy price subsidies in absolute terms due to their likely higher energy consumption footprint.

(Figure 2)

Local inequality proxies Figure 3 uses an alternative moment of the distribution of energy consumption, which helps shed some light on the latent political economy mechanisms at play. In generating figure 3, we follow exactly the same approach as above, except that here the independent variable is – not the median (or mean) of energy consumption – but rather, the difference between the mean and the median. This difference can be construed as a proxy of the skewness of the energy consumption distribution. If mean energy consumption is significantly higher than median consumption, this suggests there are some households with disproportionately high levels of energy of consumption. Conversely, if the mean is lower than the median, this suggests there are some lower-income households in rather wealthy segregated neighborhoods.

(Figure 3)

We find that indeed electoral support for the Conservative party is strongly predicted by this measure of inequality in energy consumption. Support is notably higher in areas with greater inequality in energy consumption. Such spatial inequality may have its origin in historically shaped spatial institutions, as analyzed in great detail in Fetzer (2023b). The notable V-shaped pattern between electricity consumption skewness and Conservative party support is consistent with a pattern of policymaking that has been observed in the UK and a some other Western countries, in particular those with majoritarian two-party systems, and has been coined as zero-sum thinking (Drutman, 2019, 2020, 2021; Gidron et al., 2020; Boxell et al., 2022; Hahm et al., 2023; Chinoy et al., 2023; Burn-Murdoch, 2023a).

2.3 Individual-level data

To further highlight that the results obtained using aggregate data are robust, we further leverage individual-level micro-data. We leverage data from the *Understanding Society* (USOC) study to document that there is a positive correlation between higher fuel and energy use, on the one hand, and support for the Conservative party, on the other. The USOC study is mostly used for cross-sectional purposes. It has been previously used in Fetzer (2019a) and is described in more detail in that paper.

Energy bills are self-reported in pounds per year at the household level, h. Individuals either express they feel closer to one party or the other. A narrow support measure is constructed as a binary indicator if an individual states that they feel closer to the Conservatives than to other political parties. For the individuals that do not feel particularly close to any party, a broader measure of support for the Conservatives can be derived by considering whether they would vote for the Conservatives if a general election was held tomorrow.

We estimate a range of specifications to explore the extent to which households of Conservative party supporters are subject to higher energy bills vis-à-vis their peers. The specification follows very closely that estimated above.

$$e_{h,i} = \alpha_{r(i)} + \beta \times x_{c(i)} + \nu \times p_i + \epsilon_d$$

The results are presented in Table 1. On average, Conservative party supporters – depending on the degree of saturation of the empirical specification – have annual energy bills that are between 2 to 6 percentage points higher than those of comparable individuals, who do not support the Conservatives. Unsurprisingly, however, this result masks considerable heterogeneity.

(Table 1)

Figure 4 classifies households into percentiles based on the empirical distribution of their self-reported incomes. We then estimate a specification, where we control for the income bin as a fixed effect, while also interacting the income bin with a dummy variable indicating whether or not a survey respondent supports the Conservative party. Each dot that is represented as a solid circle refers to a differential that is statistically significant at the 5% level. A total of 100 point estimates are plotted in figure 4, with our dependent variable being either the level of energy bills or their log. We also estimate a loess fit to highlight the non-linear nature of the relationship between energy bills and conservative party support across the income distribution. This non-linearity was already evident in the aggregated analysis of ward-level election data, with the skew of the energy consumption distribution as our independent variable (see figure 3).

(Figure 4)

Our individual-level analysis reveals a U-shaped relationship when using the log of energy bills as our dependent variable. This suggests that, among households in the lowest income percentile, those supporting the Conservatives have, on average, up to 35% higher energy bills. At the top end of the income distribution, in the upper two percentiles, Conservative-leaning households appear to have at least 20% higher energy bills than their non-Tory supporting counterparts. The average effect documented in table 1 holds almost across the entire empirical support of the income distribution, though not at its extremes. There Conservative-leaning households seem to have much higher energy bills than those not supporting the Conservatives.

This may reflect a political equilibrium of some kind that allows rather distortionary policies to prevail because they garner the most vocal support from the extremes in society, namely its most- and least privileged members. This represents the likely political coalition which populists appear to be keen to forge. The fact that the relationship is U-shaped when estimating the regression in relative terms, while following a pronounced hockey-stick shape when focusing on the levels of energy points to the importance of considering the *incidence* of price subsidies, like the *Energy Price Guarantee* (Fetzer, 2022a). Unlike lump-sum transfers, such blanket subsidies primarily benefit privileged households with high energy consumption.[18]

In this paper we especially zero in on the differences between the UK's and Germany's policy response to the energy crisis. In some ways, they represent polar opposites approaches to drawing on the toolkit of economic theory to devise schemes to cushion the energy price shock for households. The first-best policy would have relied on the price mechanism as a signal of relative scarcity, combined with targeted, non-distortionary transfers to help households with surging energy bills. The scheme developed by the German *Gaskommission* resembles that approach fairly closely. The UK government, by contrast, chose to fiddle with the price mechanism, thereby distorting the price signal received by private actors, while eschewing targeting of any kind in its transfer policy.

3 Conceptual framework

This paper presents a trilemma outlining the trade-offs policymakers face in designing optimal energy subsidies. The first dimension concerns *pork incentives*: the incumbent may skew transfers toward her voter base—or herself—to gain political

[18]Naturally, a question arises how such an equilibrium can be upheld politically. Narratives and distractions as well as bread and games are likely part of the answer.

advantage.[19] Such targeting can lead to the use of inefficient policy instruments, lowering overall welfare.

The formal model compares a price subsidy to a targeted lump-sum transfer. Under rational consumer behavior and accurate market prices, the lump-sum transfer is (unsurprisingly) unambiguously more efficient. However, policymakers may avoid it if it limits their ability to favor their core constituency.

The tension between political and economic efficiency depends largely on the government's informational capacity. With granular, high-frequency data on household energy use, targeted lump-sum transfers become viable and preferable to distortionary price subsidies. In contrast, limited information pushes policymakers toward untargeted price subsidies.

(Figure 5)

Figure 5 illustrates the trilemma, with each vertex representing one of the three dimensions. The empirical evidence highlights the pork-barrel nature of the UK's energy crisis response, revealing a strong correlation between energy use and support for the incumbent Conservative party. This suggests politically aligned heterogeneity in energy consumption, giving politicians incentives to favor policies that benefit their base.

We next present a formal model that formalizes the key intuitions discussed above. We then map the model to data by comparing the UK government's energy crisis response to feasible alternatives, showing that the chosen policy is a clear outlier across multiple dimensions.

3.1 Formal Framework

In this section, we formally model the policymaker's problem in deciding on a policy response to the energy crisis. Consumers are heterogeneous in their income and

[19] There is a rich literature in economics and political science documenting the theoretical and empirical relevance of pork-and-barrel politics (Cox and McCubbins, 1986; Myerson, 1993; Carey and Shugart, 1995; Dixit and Londregan, 1996, 1998; Lizzeri and Persico, 2001; Dahlberg and Johansson, 2002; Bawn and Thies, 2003; Volden and Wiseman, 2007; Battaglini and Coate, 2008; Tavits, 2009; Drazen and Eslava, 2010; Huber and Ting, 2013; Maskin and Tirole, 2019; Rickard, 2020; Catalinac et al., 2020; Catalinac and Motolinia, 2021; **?**).

therefore their demand for energy, assuming that energy is a normal good. A policymaker has a fixed, exogenously determined budget to split between lump-sum transfers and a subsidy program. The policymaker has exogenous preferences over the transfer that each consumer type receives, and only imperfectly observes each consumer's type. This provides a tractable framework to analyze the trade-off between efficiency, redistribution and the benefit of higher informational capacity, and how these outcomes are affected by policymakers' preferences, which themselves derive from the political constraints they face.

Consumer Demand We begin by modeling consumer energy demand, allowing us to express each consumer's equivalent variation as a function of the policymaker's choices. This highlights the efficiency loss from using subsidies instead of lump-sum transfers. There are two consumer types, $\theta = H, L$, with incomes $m_H > m_L$. Consumers allocate income between energy (x) and a composite good (y), priced at 1. The pre-crisis energy price is p^{-1}, rising to $p^0 > p^{-1}$ during the crisis.

After the crisis, consumers receive a mix of lump-sum transfers and price subsidies. We evaluate the policy's effect by calculating each consumer's equivalent variation: the monetary transfer needed at post-crisis prices $(p^0, 1)$ to match the utility achieved under the government's policy mix between lump-sum transfer and price subsidy.

Let $g \in \mathbb{R}^+$ denote the lump-sum transfer given to the consumer, and $g_s \in \mathbb{R}^+$ the governments total expenditure on the subsidy program. In the appendix we derive the following expression for the "equivalent transfer" of a consumer with type θ, which we denote U_θ:

$$U_\theta = g + f_\theta(g_s)$$

With $f'_H(g_s) + f'_L(g_s) \leq 1 \ \forall g_s$, $f_H(g_s) > f_L(g_s) \ \forall g_s$, $f'_H(g_s) > f'_L(g_s) \ \forall g_s$, $f_H(g_s) < 1 \ \forall g_s$, $f_H(0) = f_L(0) = 0$, $f'_H(0) + f'_L(0) = 1$, $f'_H(0) > \frac{1}{2}$, $f'_L(0) < \frac{1}{2}$, and $f'_H(g_s) + f'_L(g_s) < 1$ for $g_s > 0$. U_θ, $f(.)$ and the properties of $f(.)$ are fully derived in the appendix; we briefly explain the intuition here.

Lump-sum transfers raise a consumer's equivalent variation one-for-one, so g enters U_θ linearly. In contrast, subsidy spending g_s affects U_θ via the "subsidy benefit" function $f_\theta(.)$, which differs by consumer type. The combined marginal benefit of subsidy spending is always weakly less than one ($f_H'(g_s) + f_L'(g_s) \leq 1$), due to the **deadweight loss of commodity subsidization**—the counterpart to deadweight loss from taxation. Subsidies distort prices, reducing consumer welfare by impairing optimal consumption choices.

Subsidies always benefit high-income consumers more than low-income ones ($f_H'(g_s) > f_L'(g_s)$ and $f_H(g_s) > f_L(g_s)$) due to their higher energy demand. The first pound spent yields a full benefit ($f_H'(0) + f_L'(0) = 1$), as the marginal deadweight loss is 0 at $g_s = 0$. For all $g_s > 0$, deadweight loss becomes positive, reducing total marginal benefit: $f_H'(g_s) + f_L'(g_s) < 1$.

$f_H'(0) > \frac{1}{2}$ and $f_L'(0) < \frac{1}{2}$ follow from $f_H'(0) + f_L'(0) = 1$ and $f_H(g_s) > f_L(g_s)\ \forall g_s$, and make explicit the fact that the first pound spent on the subsidy program (which will accrue a total consumer benefit equal to 1) benefits the high income consumer by more than 50p and the low income consumer by less. $f_H(0) = f_L(0) = 0$ is trivially true.

There are two consumers, indexed by i, with types (θ_1, θ_2) taking values (H, L) or (L, H). The policymaker observes only a noisy signal (ω_1, ω_2), which can be (h, l) or (l, h). The policymaker correctly believes one is high-income and one low, but receives only a noisy signal as to which one is which[20], with:.

$$Pr\Big((\theta_1, \theta_2) = (H, L) \mid (\omega_1, \omega_2) = (h, l)\Big) = Pr\Big((\theta_1, \theta_2) = (L, H) \mid (\omega_1, \omega_2) = (l, h)\Big) = \beta$$
$$Pr\Big((\theta_1, \theta_2) = (L, H) \mid (\omega_1, \omega_2) = (h, l)\Big) = Pr\Big((\theta_1, \theta_2) = (H, L) \mid (\omega_1, \omega_2) = (l, h)\Big) = 1 - \beta$$

[20]We model the problem as one involving two consumers of different types to make the proofs clearer This approach is analytically identical to a model with N consumers, divided evenly between high and low types, where the policymaker receives a different binary signal for each consumer.

$\beta \in [0.5, 1]$ can be interpreted as the informational capacity of the state, which, for now, we consider exogenous.

The policymaker's problem The policymaker seeks to maximize the sum of the expectation of some concave function of consumer benefit U_θ subject to an exogenously determined budget G. Therefore, the policymaker solves the following problem:

$$\max_{g_s, g_\omega \forall \omega} \sum_i^2 \mathbb{E}_{\theta_i}\left[\Delta_{\theta_i} c\left(U_{\theta_i}\right) | \omega_i\right]$$

$$\text{subject to} \quad g_s + \sum_i^2 g_i \leq G$$

Here g_s is the expenditure on the subsidy program, g_i is the lump-sum transfer given to consumer i and G is the exogenously determined budget. Δ_{θ_i} is the weight the policymaker places on the utility of consumer with type θ_i (with $\Delta_H + \Delta_L = 1$), and $c(.)$ is some function which satisfies $c'(.) > 0$ and $c''(.) < 0$.[21]

The policymaker can condition lump-sum transfers g_i only on the signals received. We define g^l and g^h as the transfers to consumers receiving signals l and h, respectively. Using the probabilities defined above and the definition of U_{θ_i}, and noting the budget constraint will bind, the problem can be rewritten as:

[21] As income is exogenous in this model, it is appropriate to consider the policymaker as having concave preferences over the *equivalent transfer* each consumer receives, rather than having linear preferences over each individual's concave utility function, as is common in analyses of a social planner's maximization problem, where wealth and income are normally endogenous. A caveat worth mentioning is that, naturally, an *equivalent transfer* to a lower-income consumer increases utility by more than an equal *equivalent transfer* to a higher-income consumer. This consideration is here reflected in the relative values of the Δ parameters. Additionally, the concavity of $c(.)$ generates risk aversion in the policymaker's decisions, which drives some important results in the model.

$$\max_{g_s, g^h, g^l} \quad \beta \Delta_H c\big(g^h + f_H(g_s)\big) + (1-\beta)\Delta_L c\big(g^h + f_L(g_s)\big)$$
$$+ \beta \Delta_L c\big(g^l + f_L(g_s)\big) + (1-\beta)\Delta_H c\big(g^l + f_H(g_s)\big)$$
$$\text{subject to} \quad g_s + g^l + g^h = G$$

Solving the policymaker's maximization problem yields the following three first-order conditions (derived in full in the appendix):

The uncertain lump-sum redistribution condition

$$\begin{aligned} &\beta\Big(\Delta_H c'(g^h + f_H(g_s)) - \Delta_L c'(g^l + f_L(g_s))\Big) \\ &= (1-\beta)\Big(\Delta_H c'(g^l + f_H(g_s)) - \Delta_L c'(g^h + f_L(g_s))\Big) \end{aligned} \tag{1}$$

This condition describes the policymaker's incentive to distribute lump-sum transfers in such a way as to disproportionately benefit her favoured consumer type, while acknowledging the constraint imposed by uncertainty about their true types. This mechanism is clearer when comparing the case where $\beta = 1$ to $\beta < 1$. With $\beta = 1$, the condition simplifies to a "certain" lump-sum redistribution condition:

$$\frac{\Delta_H}{\Delta_L} = \frac{c'(g^l + f_L(g_s))}{c'(g^h + f_H(g_s))} \tag{2}$$

That is, under absolute certainty about consumer types, the policymaker uses lump-sum transfers to exactly achieve her preferred distributive outcome, whatever the values of $f_L(g_s)$ and $f_H(g_s)$. In an uncertain world, however, $\beta < 1$ and the right-hand side (RHS) of equation (1) becomes relevant. When equation (2) holds and provided that $\Delta_H \neq \Delta_L$, we get:

$$\frac{\Delta_H}{\Delta_L} \neq \frac{c'(g^h + f_L(g_s))}{c'(g^l + f_H(g_s))}$$

As a result, the policymaker has to deviate from the "preferred" condition of (2) in order to satisfy (1). This makes explicit that the policymaker has to shade her lump-sum transfers closer to each other than she would optimally like in order to insure against the risk that she has incorrectly identified the consumer's type. We refer to this effect as the "uncertainty cost of redistributing via lump-sum".[22]

The high-type transfer-subsidy balance condition

$$\begin{aligned} & f_H'(g_s)\beta\Delta_H c'(g^h + f_H(g_s)) + f_L'(g_s)(1-\beta)\Delta_L c'(g^h + f_L(g_s)) \\ +& f_L'(g_s)\beta\Delta_L c'(g^l + f_L(g_s)) + f_H'(g_s)(1-\beta)\Delta_H c'(g^l + f_H(g_s)) \\ =& \beta\Delta_H c'(g^h + f_H(g_s)) + (1-\beta)\Delta_L c'(g^h + f_L(g_s)) \end{aligned} \tag{3}$$

The low-type transfer-subsidy balance condition

$$\begin{aligned} & f_H'(g_s)\beta\Delta_H c'(g^h + f_H(g_s)) + f_L'(g_s)(1-\beta)\Delta_L c'(g^h + f_L(g_s)) \\ +& f_L'(g_s)\beta\Delta_L c'(g^l + f_L(g_s)) + f_H'(g_s)(1-\beta)\Delta_H c'(g^l + f_H(g_s)) \\ =& \beta\Delta_L c'(g^l + f_L(g_s)) + (1-\beta)\Delta_H c'(g^l + f_H(g_s)) \end{aligned} \tag{4}$$

(3) equates the marginal benefit to the policymaker of a pound spent on the subsidy and a pound spent on lump-sum transfer to the high type, and (4) does the same for the lump-sum transfer to the low type. Note, the marginal benefit of subsidy expenditure is one that accrues by raising the equivalent variation of both consumer types in both states of the world.

Proposition 1. *When there is no uncertainty over consumer types, the policymaker will not spend any budget on the subsidy program.*

Proof. Let $\beta = 1$. Then, (3) becomes:

$$\begin{aligned} & f_H'(g_s)\Delta_H c'(g^h + f_H(g_s)) + f_L'(g_s)\Delta_L c'(g^l + f_L(g_s)) \\ =& \Delta_H c'(g^h + f_H(g_s)) \end{aligned}$$

[22]Consider, for instance, a policymaker with $\Delta_H > \Delta_L$. Such a policymaker would like to set lump-sum transfers such that $g^h > g^l$. However, under uncertainty, she has to consider the world where she has got the consumers the wrong way round, and so will shade the lump-sum transfers closer together than she would otherwise like in order to insure for the possibility that it is in fact the H types who end up with the g^l transfer and vice versa.

and (4) becomes

$$\begin{aligned}&f'_H(g_s)\Delta_H c'(g^h+f_H(g_s))+f'_L(g_s)\Delta_L c'(g^l+f_L(g_s))\\=&\Delta_L c'(g^l+f_L(g_s))\end{aligned}$$

Summing these two equations yields

$$\begin{aligned}&2\Big(f'_H(g_s)\Delta_H c'(g^h+f_H(g_s))+f'_L(g_s)\Delta_L c'(g^l+f_L(g_s))\Big)\\=&\Delta_H c'(g^h+f_H(g_s))+\Delta_L c'(g^l+f_L(g_s))\end{aligned}\tag{5}$$

As is pointed out above, when $\beta = 1$, the uncertain lump-sum redistribution condition reduces to the certain lump-sum redistribution condition:

$$\frac{\Delta_H}{\Delta_L}=\frac{c'(g^l+f_L(g_s))}{c'(g^h+f_H(g_s))}\tag{6}$$

Combining (5) and (6) implies:

$$\begin{aligned}&2\Big(f'_H(g_s)\Delta_H c'(g^h+f_H(g_s))+f'_L(g_s)\Delta_H c'(g^h+f_H(g_s))\Big)\\=&2\Delta_H c'(g^h+f_H(g_s))\end{aligned}\tag{7}$$

Which simplifies to

$$f'_H(g_s)+f'_L(g_s)=1$$

The only value of g_s for which the above condition holds is $g_s = 0$, which, in turn, follows from the properties of $f_\theta(.)$. □

This result is a manifestation of the deadweight loss of commodity taxation. If the policymaker has full information, she can achieve her redistributive objectives solely through lump-sum transfers and thus only stands to lose by introducing distortionary subsidies. In this special case, $g_s = 0$ and lump-sum transfers are pinned down by:

$$\frac{\Delta_H}{\Delta_L} = \frac{c'(g^l)}{c'(g^h)} \tag{8}$$

Proposition 2. *Under uncertainty, the policymaker will spend budget on the subsidy program only if* $\Delta_H > \Delta_L$.

Proof. We outline the intuition of the proof here, while relegating the full mathematical proof to the appendix. Consider a policymaker with $\Delta_L > \Delta_H$ under a situation of uncertainty ($\beta < 1$). Such a policymaker will balance her expenditure on lump-sum transfers g^l and g^h to satisfy her uncertain lump-sum redistribution condition (1). This condition can be rearranged to:

$$\frac{\Delta_H}{\Delta_L} = \frac{\beta c'(g^l + f_L(g_s)) - (1-\beta)c'(g^h + f_L(g_s))}{\beta c'(g^h + f_H(g_s)) - (1-\beta)c'(g^l + f_H(g_s))} \tag{9}$$

Suppose $g_s = 0$ and therefore that the policymaker only uses the policy instruments g^h and g^l. As we saw above, under a situation of full certainty ($\beta = 1$), the policymaker would want to achieve a low $c'(g^l + f_L(g_s))$ and a high $c'(g^h + f_H(g_s))$ by setting g_l high and g_h low. The presence of uncertainty ($1 - \beta > 0$), however, means the policymaker must consider the second term of the numerator and the second term of the denominator. A high g_l results in a low $c'(g^l + f_H(g_s))$ and a low g_h results in a high $c'(g^h + f_L(g_s))$, which prevents the policymaker from being satisfying the uncertain lump-sum redistribution condition by setting g_l and g_h as far apart as she would have done under full certainty. She, instead, has to bring the two closer together. This is simply a restatement of the "uncertainty cost of redistribution via lump-sum" described above.

Does this policymaker benefit from increasing g_s and diverting funds from lump-sum expenditures g^l and g^h? The marginal gain from increasing g_s, shown in (12), reveals that it raises the equivalent variation for both consumers, with a larger increase for the H consumer ($f_H(g_s) > f_L(g_s); \forall g_s$). However, shifting funds to the subsidy also incurs the deadweight loss of commodity subsidization. Since

$f_L(g_s) + f_H(g_s) \leq 1$ and $f_H(g_s) > f_L(g_s)$, for a policymaker with $\Delta_L > \Delta_H$, increasing g_s above 0 is never optimal. Even under maximum uncertainty ($\beta = \frac{1}{2}$), a pound spent on g^l benefits the policymaker more than a pound spent on the subsidy, given the lower benefit to the L type and the deadweight loss.

The same argument, however, does not hold for a policymaker with $\Delta_H > \Delta_L$. For such a policymaker, under maximum uncertainty, it is still the case that a pound spent on g^h could have as much as a $\frac{1}{2}$ chance of being misdirected to the L type. Yet, a pound spent on subsidy benefits this policymaker's favored type (H) by an amount greater than $\frac{1}{2}$, meaning that it can, in fact, be optimal for such a policymaker to incur the deadweight loss of commodity subsidization as it better helps her achieve her distributional goals.

This phenomenon can be illustrated by examining (9). By increasing expenditure on g_s and reducing "risky" expenditures on g^h and g^l, the policymaker can satisfy (9) by controlling the $f_L(g_s)$ and $f_H(g_s)$ components of each $c(.)$ function, instead of relying on g^l and g^h. Policymakers who prioritize high-income consumers ($\Delta_H > \Delta_L$) can partially mitigate the "uncertainty cost of redistribution via lump-sum" using the subsidy. However, this does not hold for policymakers favoring low-income consumers ($\Delta_L > \Delta_H$), as the subsidy only redistributes toward the consumer with higher energy consumption. □

Corollary 1. *Under maximum uncertainty, a policymaker with $\Delta_H > \Delta_L$ is better off than a policymaker with $\Delta_L > \Delta_H$.*

Proof. See appendix. □

Proposition 2 shows that the costs of low informational capacity depend on the policymaker's distributional preferences. While β is exogenous in our model, the result implies that, in a model where it was endogenously determined by investment, the incentive to invest in informational capacity is shaped by these preferences. In the context of energy support, a policymaker who favors high-income, high-consumption households (e.g. due to pork-barrel incentives) has less incentive to improve information capacity, as price subsidies already align with her goals and avoid the targeting costs of lump-sum transfers. However, this leads to greater deadweight loss, since subsidies are inherently less efficient.

3.2 Link to Empirical Analysis

Some further discussion is helpful to better understand the model in the context of our empirical analyses.

In the model, the policymaker chooses between an untargeted subsidy and lump-sum transfers, while the simulations also include a targeted two-tier tariff. A lump-sum transfer is effectively equivalent to a two-tier tariff if all consumers use more energy than their subsidized quota. Formally, this is because a subsidy on a fixed quota shifts the budget line in the same way as a lump-sum transfer of equal fiscal cost—so long as the consumer consumes beyond the subsidized portion and thus faces true market prices at the margin.

Second, the simulations use exposure to market prices as a proxy for the deadweight loss from commodity taxation, rather than measuring it directly. All else equal, policies that expose more of a consumer's consumption to market prices are preferable, as they minimize distortion. While the model captures this loss via the properties of the function $f(.)$, the simulations approximate it by tracking how many consumers face the market price at the margin.

Third, it's useful to clarify the interpretation of Δ_H and Δ_L. A typical policymaker would likely have $\Delta_H < \Delta_L$, reflecting a preference for protecting lower-income households—consistent with the stated aim of the energy crisis response to shield the poorest from hardship.[23] However, the model's most interesting results emerge from comparing this prioritarian policymaker (Adler, 2019; Adler and Norheim, eds, 2022) with one who favors high-income consumers ($\Delta_H > \Delta_L$).

In the simulations, we assume the UK Conservative party pursues pork-barrel objectives—specifically, designing policy to increase the correlation between household transfers and the likelihood of voting Conservative. This aligns with treating the policymaker as having $\Delta_H > \Delta_L$. The observed correlation between energy

[23]Much of the coverage of the crisis focused on the risk that some consumers would be "forced to choose between heating and eating".

consumption and Conservative support provides a rationale for targeting high-energy users, who are more likely to vote Conservative. Further evidence of an "unholy coalition"—where both high- and low-income households support such policies—reinforces this assumption. While favoring high-consumption (and typically high-income) voters might normally risk alienating lower-income groups, Figure 4 shows that framing the policy as support for high-energy users appeals across the income distribution, mitigating that risk.

This discussion shows how the balance between Δ_H and Δ_L broadly reflects the policymaker's view of which policy stance maximizes re-election prospects.

Propositions 1 and 2 provide the theoretical counterparts to the simulations. Proposition 1 shows that subsidy programs emerge only when informational capacity is low. A policymaker who more effectively leveraged information capacity would instead choose targeted lump-sum transfers to avoid the efficiency losses of subsidies. This aligns with the simulation results, which show that a policymaker with high β can pursue pork-barrel goals without incurring the deadweight loss of commodity subsidization.

Proposition 2 clarifies that the efficiency-distribution trade-off arises only for a policymaker with pork-barrel incentives—that is, one pursuing political goals reflected in $\Delta_H > \Delta_L$. As noted earlier, the desire to favor a core voter base may lead policymakers to adopt less efficient policies that reduce overall welfare. Corollary 1 extends this logic, showing how such political dynamics can also deter investment in informational capacity, even when doing so would improve welfare. The simulations below confirm this mechanism.

We now illustrate the trade-offs outlined above within the three-dimensional parameter space depicted in Figure 5. Specifically, we map the theoretical framework to the data to empirically visualize how UK policymakers navigated the tensions between efficiency, distributional goals, and informational capacity in their response to the energy price shock. This exercise not only clarifies the UK government's policy choices, but also highlights the set of feasible alternatives and helps explain the cross-country variation in crisis responses that motivates our theoretical analysis (see Figure 1).

4 Counterfactual policy scenarios

We next describe how we map the theoretical framework to granular synthetic data on millions of individual households and individual-level household data drawing on simulation techniques at scale. These simulation techniques effectively allow us to evaluate the actually implemented policies – focusing in particular on the British and German examples as two almost diametrically opposite policy choices – relative to a broad menu of policy alternatives that could have been implemented. We perform an ex-ante evaluation of the policies' characteristics and compare them to a broad bundle of ex-ante fiscally equivalent policies that could have been implemented, while implicitly varying β across the exercises. Each policy alternative can be evaluated along empirical dimensions that we can map into the equity, efficiency and informational capacity dimensions discussed above.[24]

For the simulation exercise we hold constant a broad set dimensions. We assume an exogenous market price p_m, while taking the chosen (stylized) policy paths of the UK and Germany as given. The UK policy interventions effectively set a subsidized price p_s through the *Energy Price Guarantee* (Fetzer, 2022a; DESNZ, 2023) at $p_s = \tau p_m$, with $\tau = 55\%$. That is, relative to market prices, consumer facing energy prices were lowered by 45%. The equivalent of the German policy response can be thought of as effectively introducing a subsidized energy consumption quota at the individual household level. With this in mind, we present how we map the key model features to the simulation.

4.1 Mapping model to simulation

Types of households In the model we conceive of a policymaker as choosing between an untargeted energy price subsidy at a financial cost g_s and lump-sum transfers targeted to two types of consumers at a financial cost of g^l and g^h, with a given total budget $g_s + g^l + g^h = G$. Rather than having two types of consumers, for the simulation we allow there to be heterogeneity in the consumer types as

[24]The techniques employed are similar to those presented in section 3 of Fetzer and Schwarz (2021).

measured by their energy consumption level q_i. We leverage both (pseudo) individual household-level energy consumption data q_i for each property introduced in Fetzer et al. (2023a) as well as the individual-level household panel survey data. For each counterfactual energy support policy we can measure the correlation between the consumer facing bill – that is, the likely energy bill minus the subsidy that a household receives – and, for example, its political preferences. This is similar to the exercises that were presented in section 2 as we, in essence, vary β, the government's informational capacity.

Policy space In the feasible set of policy bundles we simulate an untargeted price subsidy g_s, as was implemented via the energy price guarantee, and a broad menu of different two-tier tariffs and lump-sum transfers. In the two-tier tariff structure a consumer faces the subsidized lower price p_s for a quota of q_m units of energy consumption. Consumers face market prices p_m for any energy consumption above that quota q_m. We do not allow prices to vary but set p_m to be the market price that the energy regulator would have allowed energy suppliers to charge consumers had there not been an intervention. We set p_s as the energy regulators set price in the year prior to the energy price shock. The alternative subsidy schemes are simulated such that the total energy bill that households face is held constant, on average. In simulating alternative policies, we allow the total subsidy expenditure to vary within 20% above or below the actual implemented policy in both the UK and the UK equivalent of the German proposal.

Capturing informational capacity In our model the parameter β captures the government's informational capacity. We map this into the simulation as an inference problem. With $\beta \to 1$, a policymaker observes the household level of energy consumption q_i. A two-tier tariff structure would then imply that each household has an individualized quota $q_{m_i} = s \times q_i$, where s captures the faction of consumption that is subsidized. The household would face a subsidized price on the first $\min\{q_i, q_{m_i}\}$ units of consumption and the market price on the remaining $\max\{q_i - q_{m_i}, 0\}$ units of energy consumption.

For $\beta < 1$ we consider different ways of *estimating* the level of $q_{m|x_i} = s \times E(q_i|x_i)$, where ultimately, the informational capacity is captured in the degree to which a government is able to produce an accurate estimate of household level energy consumption using data and resources that would be at the public sectors disposal through its national statistics office. Using data on both (q_i, x_i) we can simulate both more- and less complex ways of estimating $E(q_i|x_i)$ and evaluate the performance of policy alternatives, such as blocked two-tier tariffs or blocked lump sum transfers as alternative policy scenarios, vis-a-vis the performance of the chosen untargeted energy subsidy in a way that we can relate with the theoretical framework.

4.2 Estimation of blocks

We simulate a broad range of alternative policies that are ultimately distinguished in the degree to which they leverage different information x_i in the estimation of a subsidized consumption quota for a type or a block of consumers. The policy bundles or alternatives describe, in essence, an approach to targeting transfers that is conditional on a vector of observables x_i. This is embedded in a two-tier tariff or lump sum transfer by estimating $E(q_{i,-1}|x_i)$ for blocks of consumers or households varying the vector of individual characteristics x_i that are considered. By virtue of the law of iterated expectations, on average, we would expect that the quota that can be estimated from this, as $q_{m|x} = s \times E(q_{i,-1}|x_i)$, produces a transfer schedule that achieves, on average, a similar level of subsidization. Yet, the different features that comprise the vector of observables may render the subsidy scheme more- or less targeted at the individual level.

That is, rather than considering a representative household for the entire country – as is common in micro-simulation approaches – and, rather than anchoring the threshold q_m at which the second-tier tariff kicks in, we estimate a threshold based on a varying vector of data x_i at the individual property level or based on the socio-economic make-up of the population in an area. That is, we construct a large set of *representative households* conditional on a rich feature space that is explicitly observable for the government and not easily malleable by an individual household.

In total, we consider a set of 30 features that we describe next.

Spatial identifiers We consider a broad vector of 13 different spatial identifiers at which a representative household's energy consumption is estimated, ranging from the most granular postcode level – which includes more than one million different households – all the way to the much coarser region level that subdivides England into nine[25] different regions.

Indices of multiple deprivation The indices of multiple deprivation provide a higher- dimensional view of the relative social- and economic deprivation of different parts of the country across a range of domains: income, employment, education, skills and training, health and disability, barriers to housing and services, and a composite deprivation score. Each dimension of relative deprivation is measured and recorded at the level of the lower layer super output area (LSOA). The deprivation features we cover capture the overall multiple deprivation score as well as the main constituent components: income, employment, education- and skills-, health and disability as well as barriers to housing and services deprivation. The use of such indices allows for the two tier tariffs to be stratified broadly by an areas resident populations relative socio-economic deprivation. LSOA's are commonly used in public policy. They are designed as statistical geographies, built from census area blocks, to be comparable having, on average, a similar number of residents. In total there are 32,000 spatial units in England. We construct, for each a measure of both the quintile as well as an indicator of whether a score is above or below the median. This will, for example, identify the most deprived areas based on specific domains across LSOA spatial units. In total, there are six quintile and six binary features.

Council tax band Council tax is a tax payable for the provision of local services. Each residential property in the UK is liable to pay council tax, with the tax being

[25]These nine regions are: London, the North East, North West, East Midlands, West Midlands, Yorkshire, East of England, South West, and South East.

enforced and collected by local authorities. Notionally, council tax liability should be linked to the underlying property value. Yet, the underlying rating lists have not been updated since 1991. This feature is particularly relevant as it constitutes a feature of a potential subsidy or social tariff that could be directly linked to local councils' existing tax collection or enforcement mechanisms and could have been leveraged to extend more targeted energy bill support. The feature is categorical, which implies that a consumption quota could be designed to allow for differentiated levels of subsidized energy consumption for homes in an area.

Property characteristics For each property, we consider four additional features that capture the property's main heating fuel (gas or electricity), the property type (e.g. flat versus detached home), the built age of the property, as well as the size. This constitutes a further four features.

4.3 Feasible policy space

In order to get a comprehensive menu of possible alternative energy subsidy schedules, we construct all potential ways of combining these features to arrive at a reference estimate $E(q_{i,-1}|x_i)$ on basis of which the energy subsidy could be handed out.

Technically, as indicated, we consider 31 features. Combinatorially, there would be $\sum_k \binom{31}{k} = 2^{31} = 2,147,483,648$ ways of selecting different subsets of features. However, for example with spatial identifiers, we consider different blocks in the analysis as the spatial identifiers are broadly nested moving from more to less granular. That is, rather than identifying 2^{31} potential combination of features, in fact, we consider 14×2^{17} potential combinations. This would boil down to still 1,835,008 potential combinations of different features. Simulating this broad set of counterfactual policies is computationally infeasible.

Near population data We reduce dimensionality further. The indices of multiple deprivation scores are either discretized into six binary features (above or below median score) or organized as six features that capture the relative quintile that an LSOA finds itself in in a given deprivation area domain. We consider each of these two groups of features – the binary and the quintile set separately. In total we consider 14×2^{11} ways of sampling features with the binary set of deprivation indices and a further 14×2^{11} for the quintile feature set. The end result is a set of $2 \times 14 \times 2^{11} = 57,344$ combinations of features x_i that could be considered to construct an estimate $E(q_{i,-1}|x_i)$. We further restrain the subset of possible policies to a stratified random sample that broadly covers 5% of the feasible policies. The sample is stratified by policy complexity – as in the absolute count of the number of features that are being considered.

Individual-level data For the simulation results that are leveraging the individual-level survey data that provides us with sharp measurements of political preferences at the individual level, we leverage data for a smaller subset of features as the individual-level data only contains a smaller policy space.

We next describe how we perform a grid search varying the generosity of the subsidy.

4.4 Grid search

We carry out a grid-search or simulation over a broad range $s \in (0.70, 1.3)$. That is, we allow the amount of consumption that is subsidized $q_{m|x}$ to vary within a range around the median, $q_{m|x} = s \times E(q_{i,-1}|x_i)$. This will help identify transfer schedules that may be cheaper to implement but yield similar performance compared to the actually implemented policies. That is, for the set of 1,593 blocks, we estimate different generosity across the search grid of size 60, i.e. we compute $1,593 \times 60 = 95,580$ potential transfer schedules.

4.5 Evaluation of simulated alternatives

We evaluate each of the alternative transfer schedules with different degrees of generosity along a range of dimensions. We focus here separately on the data that is speaking to the near population of data and to the individual-level survey data. Due to fixing of the p_m and p_s, the total bill is the same throughout. Yet, as we vary the generosity by changing s the bill that households face vis-a-vis the subsidy that the government needs to provide changes.

Since we vary the generosity of the transfer schedule across the grid search as we vary s, out of the total $95,580$ transfer schedules, we keep only the bundle of transfer schedules that lie within 20% in their aggregate subsidy spend – both above- and below the reference modelled expenditure that the EPG would have generated.[26]

We then compute the share of consumption that faces the market price p_m as a proxy for the efficiency. This maps to our notion of *efficiency*. Further, we evaluate the degree of equity measured as the share of households that would be left better off with the two-tier block tariff vis-a-vis the UK- and the UK equivalent of the German proposal. We consider this to be a measure of the *equity* dimension within our modelling framework.

To evaluate the degree of political targeting we measure the consumer facing energy bill

To do so, we estimate a regression that captures the degree to which there is a correlation between an individual perception of closeness to the Conservative party or an areas' proclivity to support the Conservative party and the consumer facing energy bill. The consumer facing energy bill is calculated as the bills that households would face net of each specific to each transfer schedule that is a pair $(s, q_{m|x})$. In essence, this allows us to see to what extent the different subsidy schedules are partitioning out the partisanship that is indirectly captured in the energy consumption data that was documented in Section 2.

For $\tau \in \{0, 1, ..., 9\}$, we estimate

$$bill_i^{p_m} - subsidy_{i,q|m_x} = \beta_\tau \times conservative_i + \epsilon_i \quad \text{for} \quad Q_\tau > y_i > Q_{(\tau+1)}$$

[26]For the household level simulations we also allow the total spending to vary marginally. Mechanically, this only arises because the survey data does not have data available for each of the household features x_i for all potential blocks. This results in slightly different samples for every different transfer schedule.

where Q_τ denotes the τ-th decile of the income distribution.

When evaluating the properties of different policies, of particular interest to us are the coefficient estimates β_0 and β_{10}. Even holding constant the average effect of $conservative_i$ on the consumer facing energy bill (that is, the estimate for β that would result from the above regression if we didn't filter for a particular income percentile τ), it may be the case that different policies favour different parts of the income distribution differently - i.e. have a different balance between β_0 and β_{10}. Indeed, figure 11 illustrates such distributional properties of a set of counterfactually simulated policies, relative to those distributional properties of the UK's implemented policy. These lend further evidence for the idea that the implemented policy was a reflection of the policymaker's preference for high income consumers.

4.6 Discussion of simulation results

We present the results in visual form either as univariate or bivariate kernen densities.

Figure **??**

Near population data Panel A - conservative party vote %: This figure documents that counterfactual policies that would have achieved a similar degree of political targeting for the average conservative party vote share, showing that block tariff policies utilising more informational capacity could have produced a greater degree of partisan targeting than the factual policy. This finding demonstrates an analogue of proposition 1: that when informational capacity is fully utilised, distributional aims can be more fully achieved than they could be using non-targeted subsidies.

Consumption facing marginal costs: This figure documents that counterfactual policies could have been conceived that would have preserved the signal value of prices for a much higher share of consumption even than the German proposal. This echoes the result from the model that fully leveraging informational resources allows for a route to achieving one's distributional aims which do not incur the deadweight loss of commodity subsidisation.

% of blocks with less than 10 households: This figure makes a point that is not explicitly articulated by the model - that the cost of more fully utilising informational capacity is likely not to be as high as might be feared, at least on the privacy dimension

% of winners relative to UK/DE: shows that these counterfactual policies do not sacrifice average consumer welfare (?)

Degree of partisanship: Could have implemented transfer schedules that are superior achieving similar level of political targeting (implying a low β), or could have implemented policies that are far less partisan, implying the degree of partisanship was a choice by the policymaker (implying $\Delta_H > \Delta_L$).

Degree of Unholiness: the differential energy use between conservatives and non-conservative voters is highest for top earners. This reinforces the notion that $\Delta_H > \Delta_L$. i.e. not only does the UK's policy favour conservative voters, but the extent to which it benefits conservative voters is higher for those in the highest income bracket. As mentioned in the section above which describes the empirical approach, this point is elucidated by figure ("joint distribution" - slide 51), which shows that many fiscally neutral policy alternatives achieve a similar benefit to the average conservative party supporter, but less disproportionate support to the highest income decile than the UK implemented policy.

"Why?" slide: Our model gives a neoclassical rational explanation for the policies. i.e. if it is the case that consumers act rationally, and that the policymaker expects consumers to act rationally, our model shows that the rationale for this would be that the UK policymaker has a low and $\Delta_H > \Delta_L$. There are also, however, alternative possible explanations which become salient if we ease the restriction of rationality on the part of consumers or the policymaker. First, the result of failure of consumer rationality could be that the deadweight loss of commodity taxation is non existent or small, as consumers do not respond to marginal incentives; such an explanation is still consistent with a rational policymaker who is aware of this behaviour of consumers. Alternatively, even if consumer rationality holds, the results could be explained by a government which faces cognitive constraints, or by a government whose policy is more the result hysteresis than of optimisation (the EPG was a policy first introduced several years prior, for which institutional arrangements are already set up).

5 Conclusion

In this paper, we examine – both conceptually and empirically – one crucial *boundary of the state*, namely its capacity to gather and process information, in the context of the UK and German responses to the energy price shock in late 2022. Our conceptual framework goes beyond conventional economic reasoning – which focuses on the trade-off between equity and efficiency – by introducing a constraint on informational capacity policymakers face in the real world.

The result is a trilemma between the efficiency of crisis response, policymakers' distributional preferences, and the government's informational capacity. A key result of our model is that limited informational capacity – which might exist by virtue of stringent data protection laws or a lack of technical ability to gather and process highly granular, high-frequency information – forces policymakers to rely on relatively broad, i.e. poorly targeted or completely untargeted, subsidies in trying to cushion the energy price shock, and that this incentive is particularly strong for policymakers whose core constituency primarily consists of high-income households.

Indeed, our conceptual framework can help us rationalize two almost diametrically opposed responses to the energy price shock – the highly targeted, relatively non-distortionary German response and the UK's highly distortionary, untargted one. Our model brings out one potentially important explanation for these starkly different responses by two advanced industrial democracies. In the UK, as our simulations further bear out, the government's *Energy Price Guarantee* is, given some level of (non-perfect) informational capacity, only optimal when assuming a strong preference for high-income over low-income households on the part of policymakers. Since the Conservative's core constituency is, to a significant extent, drawn from that group (Burn-Murdoch, 2023b), our theoretical and empirical considerations elucidate the political rationale behind the a policy that looks very different from the first-best policy, as suggested by conventional neo-classical economic reasoning. The German response was much closer to that policy, with deviations reflecting, at least partly, the fact that the German government's notoriously low informational capacity meant that individualized transfers could not be easily implemented.

Turning from the specific context of our analysis to the broader context, our theoretical results and empirical findings speak to debates about improving governments' ability to boost state capacity by improving data access, the bureaucracy's digital literacy – its capacity for analyzing high-frequency data in real time – and coordination between public and private actors. Our analysis demonstrates the costs of failing to improve governments' informational capacity and, more broadly, its performative state capacity – its ability to deliver policies that achieve its intended objectives and thus minimize negative unintended consequences. Given that the energy crisis is likely to rear its ugly head again this winter and that governments will face other, but structurally similar crisis as countries seek to decarbonize their economies, the ability to design and implement effective relief measures will certainly remain crucial and, perhaps, even grow in importance.

Finally, our analysis can help inform debates about the best strategies for governments to harness the possibilities opened up by technological change, particularly the emergence of (generative) artificial intelligence,[27] without sacrificing accountability – without enabling bureaucrats and/or politicians to infringe on civil liberties and political rights in nefarious ways. Putting in place regulation and institutions, or reforming existing ones, to navigate the tension between the embrace of new technological possibilities and the importance of civil liberties as well as political rights is of first-order importance for increasing liberal democracy's chances of survival in the 21st century.

[27] See Margalit and Raviv (2023) for experimental evidence on bureaucrats' willingness to employ AI tools.

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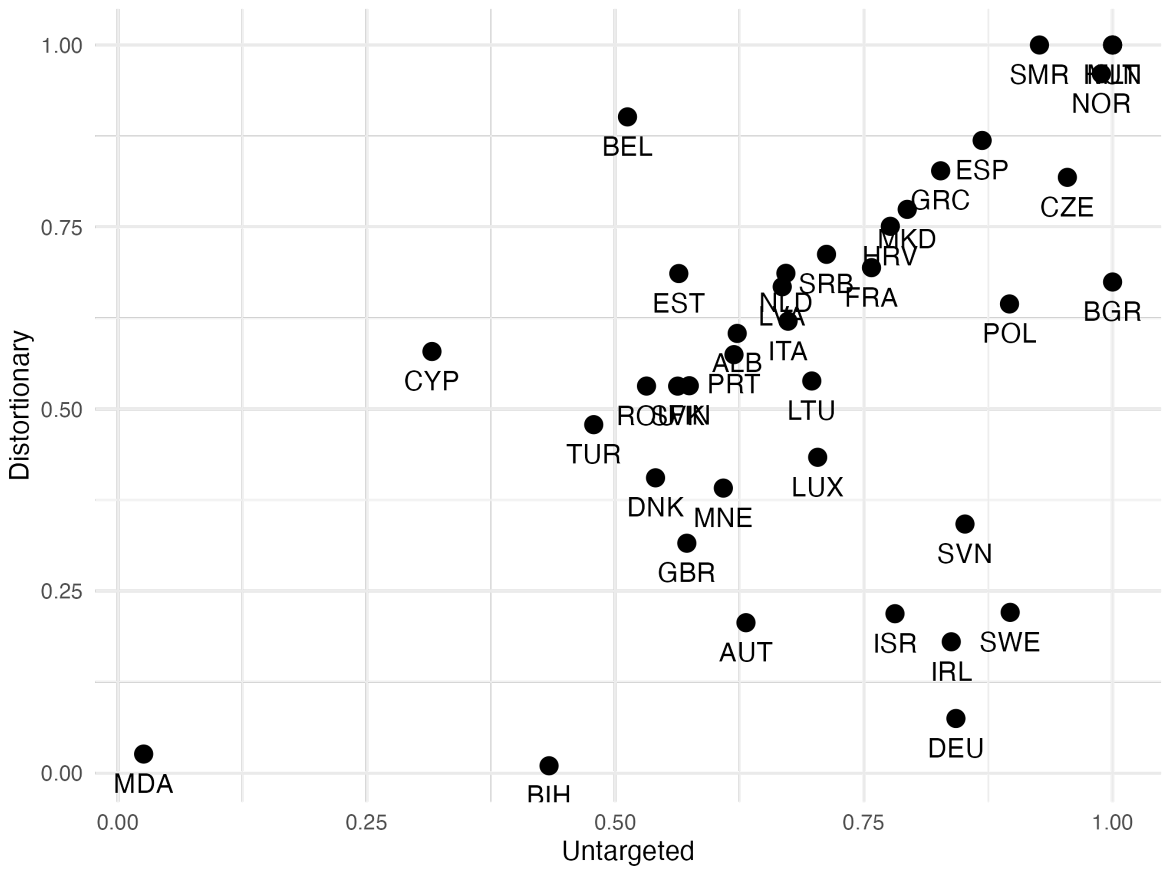
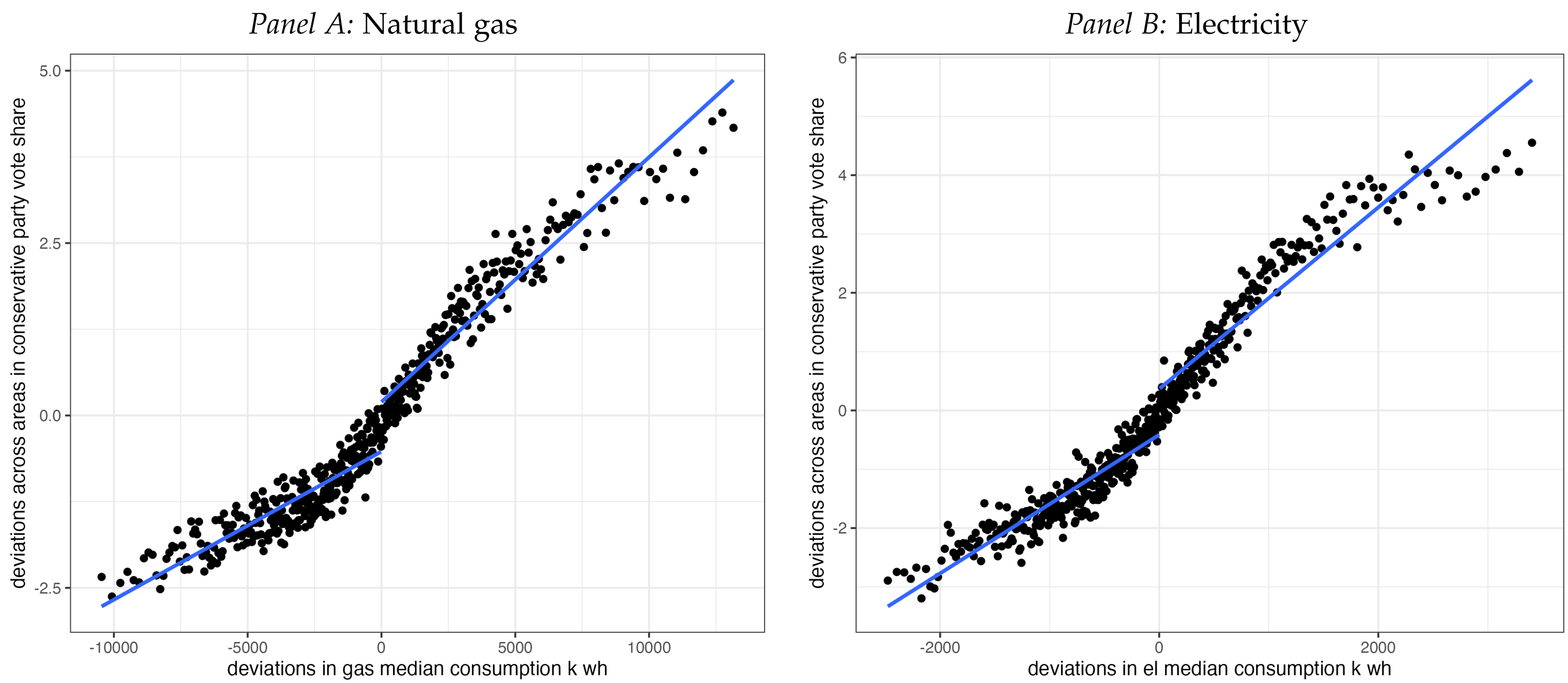
Figures and tables

Figure 1: Untargeted versus distortionary policy measures in support of households



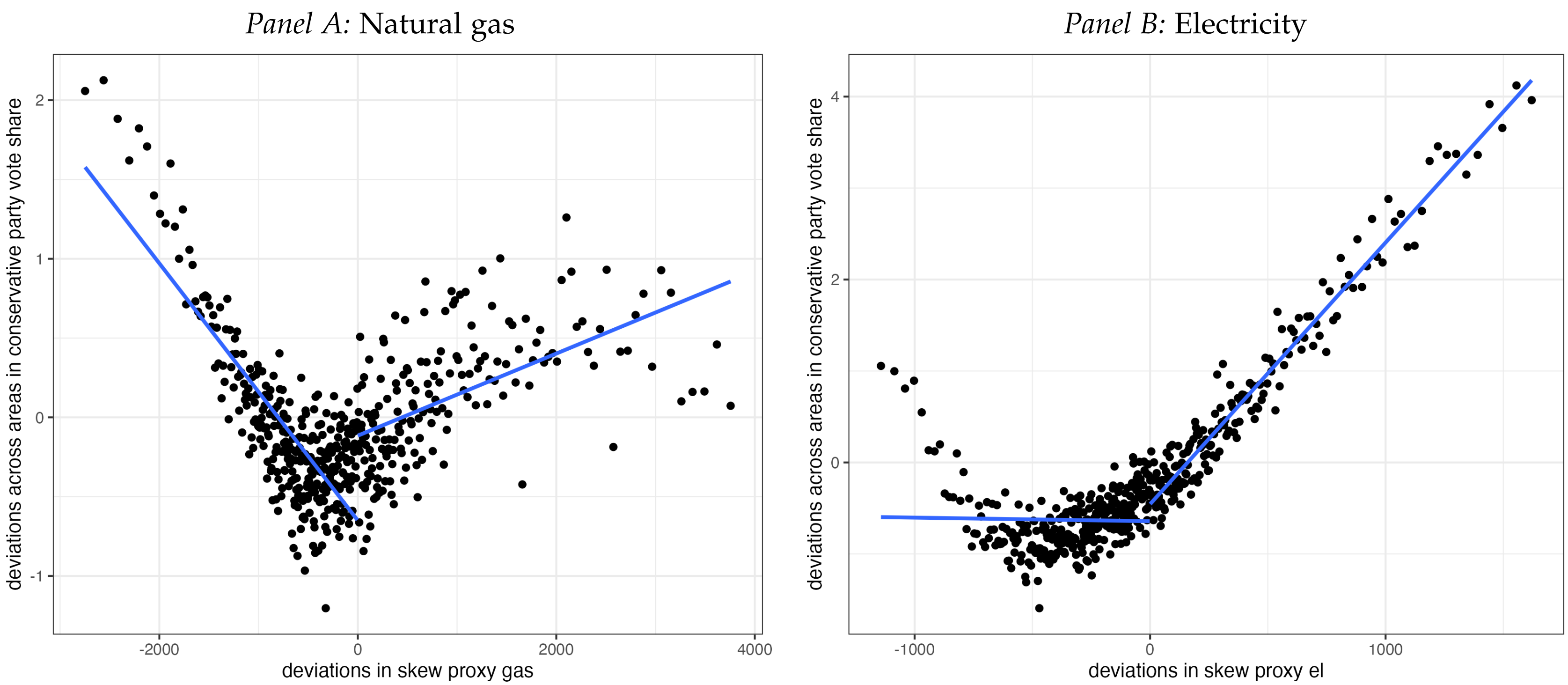
Notes: This figure plots the share of the fiscal response that is classified as using policy mechanisms that are not targeted and/or distorting the signal function of prices. The underlying data is taken from Arregui et al. (2022) and rescaled. A linear regression would yield an R^2 of approximately 22%.

Figure 2: Relationship between energy consumption and political preferences, as measured by ward-level Conservative party vote shares in local elections



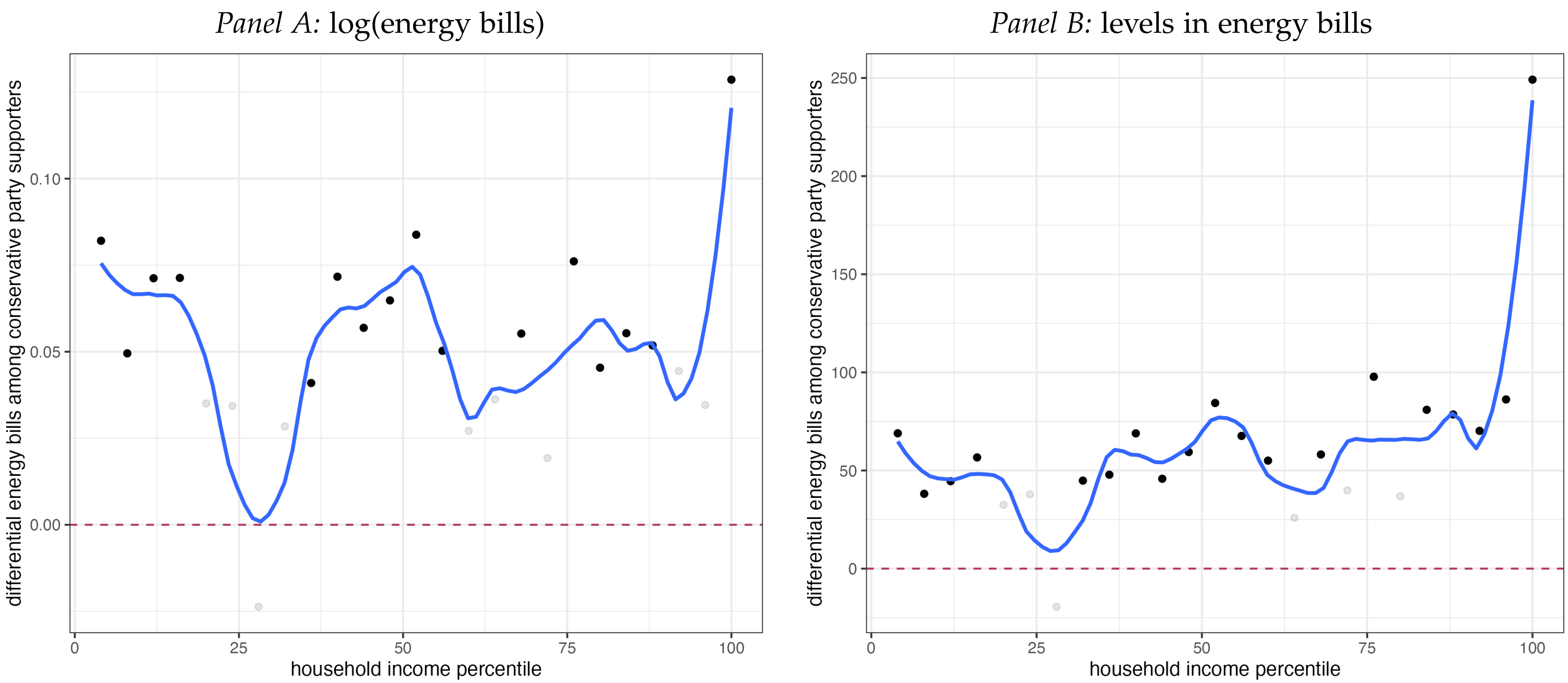
Notes: This figure suggests a strong positive relationship between higher levels of energy consumption and political preferences. The figure presents the results from regressions capturing the relationship between the energy subsidy and the Conservative party vote share. Energy consumption is measured as the long-term average of the median household consumption in a postcode. There are around 1,102,781 postcodes for which this measure is available in the period from 2013 to 2020 inclusive. The measure is demeaned by local-authority-level fixed effects to center the data. The vertical axis represents the ward-level vote share that Conservative party candidates running for local council garnered from 2010 onwards. The underlying micro-data was used previously in **?**. The simple average of Conservative party vote share is computed to generate a longer-term measure, capturing stable political preferences, on the basis of the candidate-by-ward-by-year dataset. This is done to net out fluctuations in vote shares due to, for instance, variation in candidate-specific characteristics. This measure is available for 6,032 wards and, as with energy consumption, local-authority-level fixed effects (2021 boundaries) are removed. The combined dataset has 888,564 observations. For ease of visualization, we present a binned scatterplot with 500 bins, where the averages of the residualized measures are computed both for the horizontal and vertical axis. Two linear regressions are fitted, allowing both the intercept and the slope to change around the center of the explanatory variable.

Figure 3: Relationship between proxy measure of energy consumption inequality, measured as the difference between mean and median, and political preferences, as measured by ward-level Conservative party vote shares in local elections



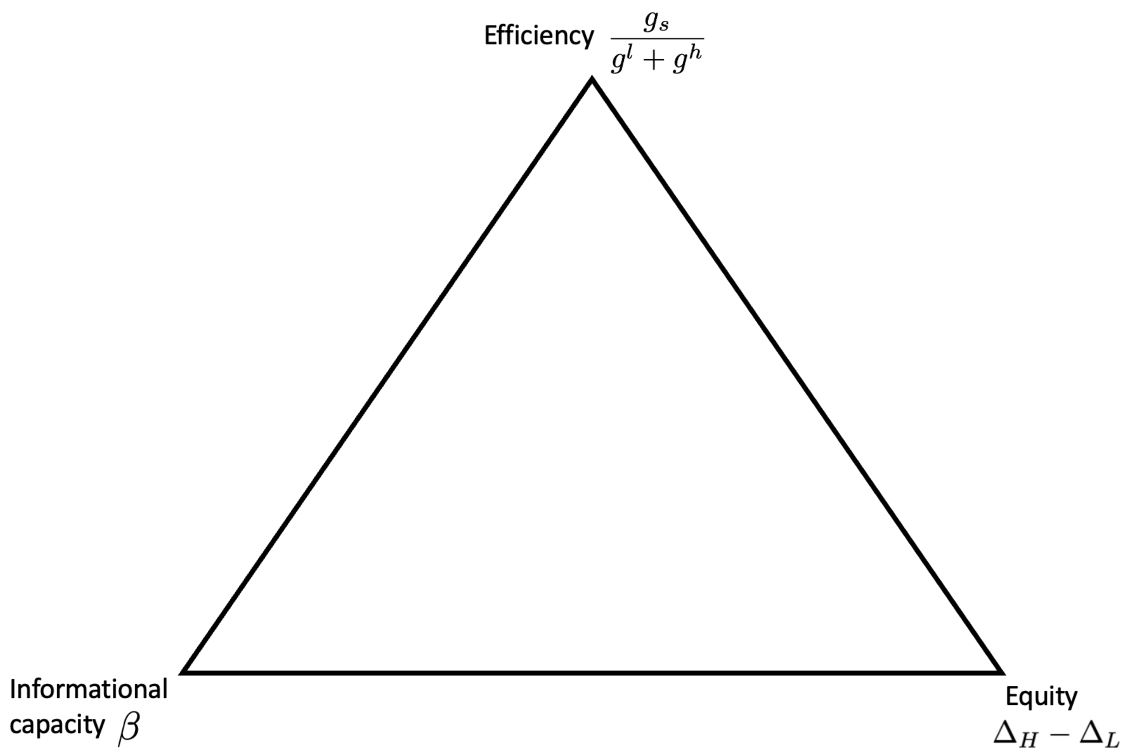
Notes: This right-hand panel of this figure visualizes the V-shaped pattern between natural gas consumption inequality and the support for the Conservative party. The left-hand panel, by contrast, shows that the relationship between electricity consumption inequality and Conservative party support roughly follows the shape of an inverted L. The variables on the x-axes are proxies for the skew of the distribution of electricity and natural gas consumption respectively, with positive values indicating a right-ward skew (mean greater than median) and negative values indicating a left skew. There are around 1,102,781 postcodes for which this measure is available from 2013 to 2020 inclusive. The measure is demeaned by local authority level fixed effects to center the data. The vertical axis takes the ward-level Conservative party vote share that Conservative candidates running for local council were able to achieve from 2010 onwards across elections. The underlying micro-data has been used previously in **?**. The simple average is computed to produce a longer term measure of stability of political preferences from the candidate by ward by year level dataset. This measure is available for 6,032 wards and as with the energy consumption local authority level fixed effects (2021 boundaries) are removed. The combined dataset has 888,564 observations. For ease of visualisation a binned scatterplot has been computed with 500 bins in which the average of the residualized measures are computed both for the horizonal and vertical axis. Two linear regressions are fit allowing both intercept and slope to change around the centered data.

Figure 4: Heterogeneity in the relationship between household income, political preferences and energy consumption – proxied via energy bills



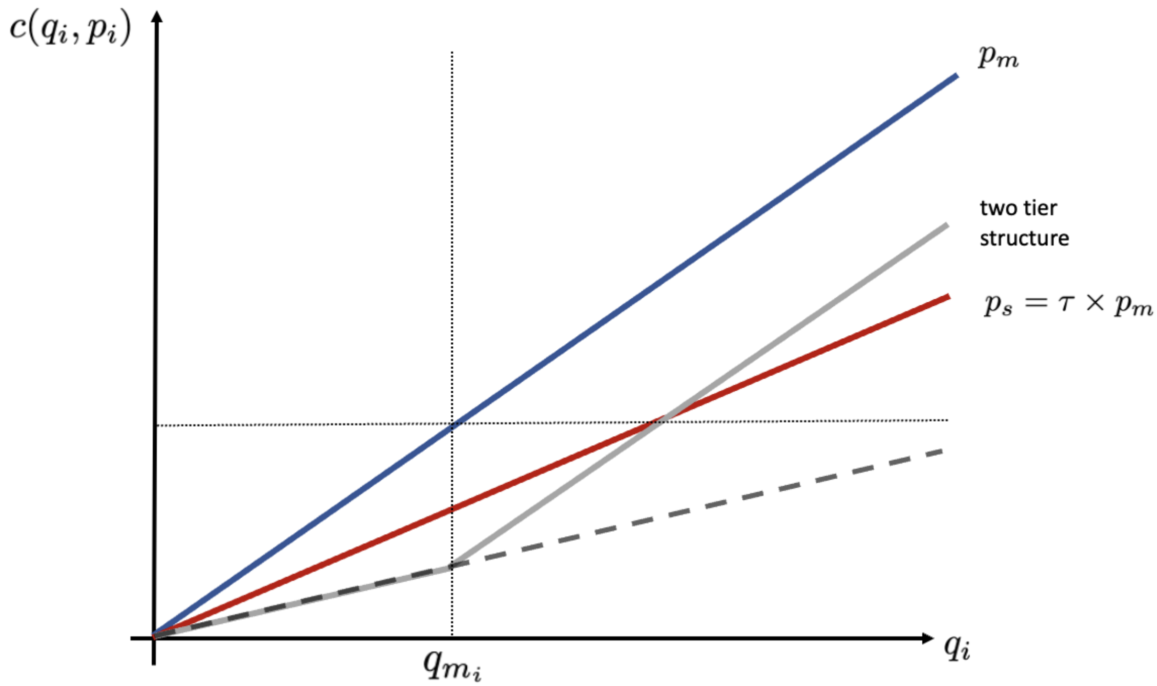
Notes: Each of the two panels plots 100 point estimates capturing the differential energy bills – in logs and levels respectively – among Conservative party supporters vis-à-vis non-Conservative party supporters (or non-voters) by their respective household income percentile. Each dot represents a point estimate associated with a specific household income percentile. Dots are faintly colored if the specific point estimate is not significant at the 5% level. Dots are solid when they are statistically significant for at least the 5% level. A loess fit across the point estimates is presented to highlight the non-linear nature of that relationship. Each regression controls for the following fixed effects: local authority, household size, year and month of the interview, the household income percentile and the survey wave. Panel A uses a log functional form for the energy bills, while Panel B uses levels. The figure suggests that energy bills are strongly increasing in absolute terms among Conservative party supporters across the income distribution, as evidenced by the positive level effect relative to the horizontal dashed line. There is notable heterogeneity, however, at the extremes, with energy consumption – in relative terms – being notably higher among low incomes compared to high incomes. The effect in absolute terms is only visible in the top 5 percent of the household income distribution.

Figure 5: Equity, efficiency and privacy as salient dimensions



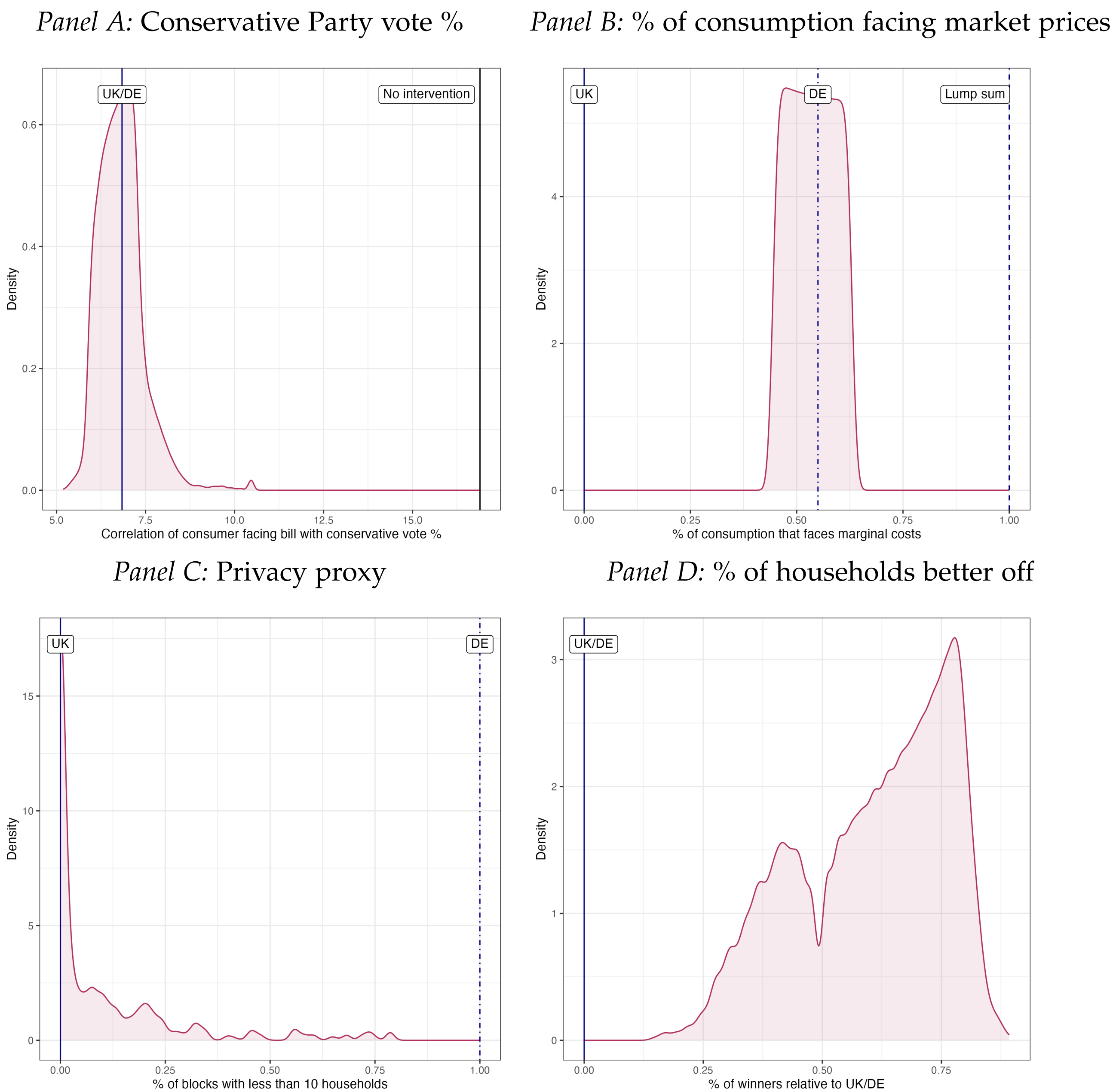
Notes: This figure presents a stylized depiction the model parameters and their inter-relationships. The trade-off between equity and efficiency is measured or parameterized by the relative preference a policymaker exhibits for favoring one group over another, $\Delta_H > \Delta_L$, and the relative expenditure on lump-sum transfers vis-à-vis the targeted ones to some specific group $\frac{g_s}{g^l+g^h}$. The equity-efficiency trade-off is significantly shaped by the informational capacity of the state. Proposition 1 posits maximal information capacity of the state when $\beta = 1$. In this case, the policymaker has no incentive to spend any share of her budget on untargeted transfer since the welfare losses from the distortion of relative prices can be avoided via a targeted lump-sum transfer. That is, the equity-efficiency trade-off disappears, even if the policymaker favors one group over the other. Proposition 2 shows that a policymaker will always spend some money on a price subsidy program – which is less efficient than a targeted lump-sum transfer – as long as informational capacity is constrained, that is, if $\beta < 1$. This requires that the policymaker favors one group strictly over another, i.e. $\Delta_H > \Delta_L$. Holding constant β, the extent to which an incumbent in this state of the world relies on inefficient policies is a function of the difference in the welfare weights, viz. $\Delta_H - \Delta_L$. Lastly, corollary 1 highlights that, with minimal informational capacity, a policymaker will always be better off if she values $\Delta_H > \Delta_L$.

Figure 6: Hypothetical energy bills under different energy tariffs with perfectly price-inelastic energy demand



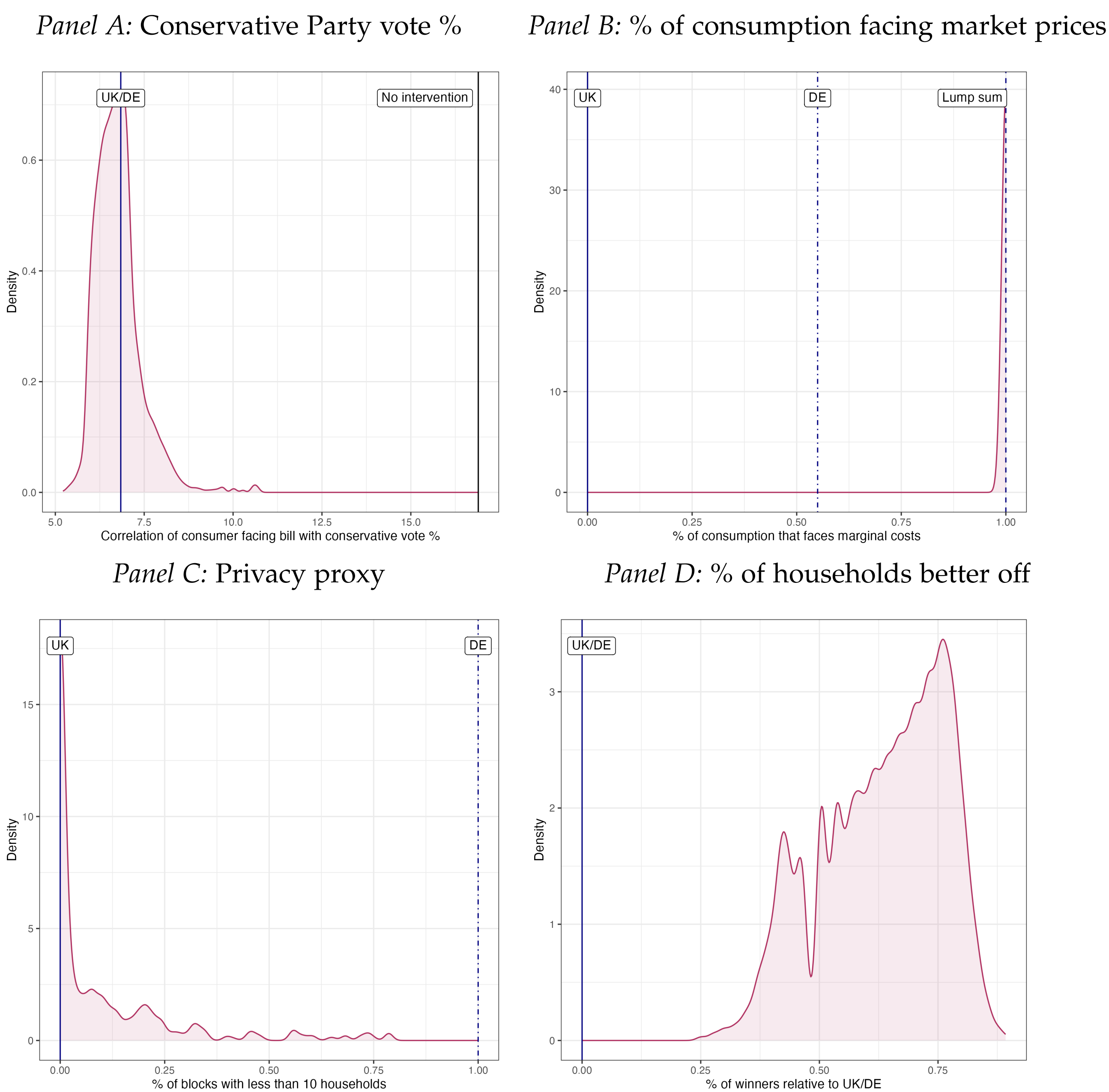
Notes: The figure plots energy bills for a household i under different energy prices and energy tariffs. The price p_m represents the market price, while p_s, displayed here by the red solid line, represents a subsidized price – a price that is subsidized by a factor of τ, relative to the market price. The dashed grey line represents energy bills under pre-war energy prices. The grey solid line visualizes the energy bills consumers would face under a two-tier tariff structure. There exists a quota q_{m_i} such that for each individual household i the energy cost are given as follows under the two-tier tariff. Up to q_{m_i}, each household pays the subsidized price, p_s. Beyond that level of consumption, the household then will pay the market price, p_m.

Figure 7: Characterization of the empirical distribution of fiscally neutral two-tier tariff alternatives vis-à-vis equivalents of the UK and German policy responses respectively



Notes: These figures show the empirical distribution that results from evaluating a broad range of fiscally neutral alternative two-tier block tariffs based on a range of metrics, relative to the policies that were implemented in the UK (*Energy Price Guarantee*) and Germany (two-tier individualized tariff) respectively. Panel A documents the correlation between consumers facing bills, net of subsidy amount, and Conservative party vote share, with the correlation derived from an exercise akin to what is presented in Table 1. Panel B presents the empirical distribution in the % of consumption facing market prices under the policy alternatives. Panel C visualizes the distribution of the share of two-tier tariff blocks that are estimated to include fewer than 10 households, which speaks to the privacy or informational capacity dimension. Panel D presents the empirical distribution of the share of households that, all else equal, would be better off vis-à-vis an individualized two-tier tariff or the untargeted price subsidy, as was implemented via the EPG in the UK.

Figure 8: Characterization of the empirical distribution of fiscally neutral lump-sum transfer alternatives vis-à-vis equivalents of the UK and German policy responses respectively

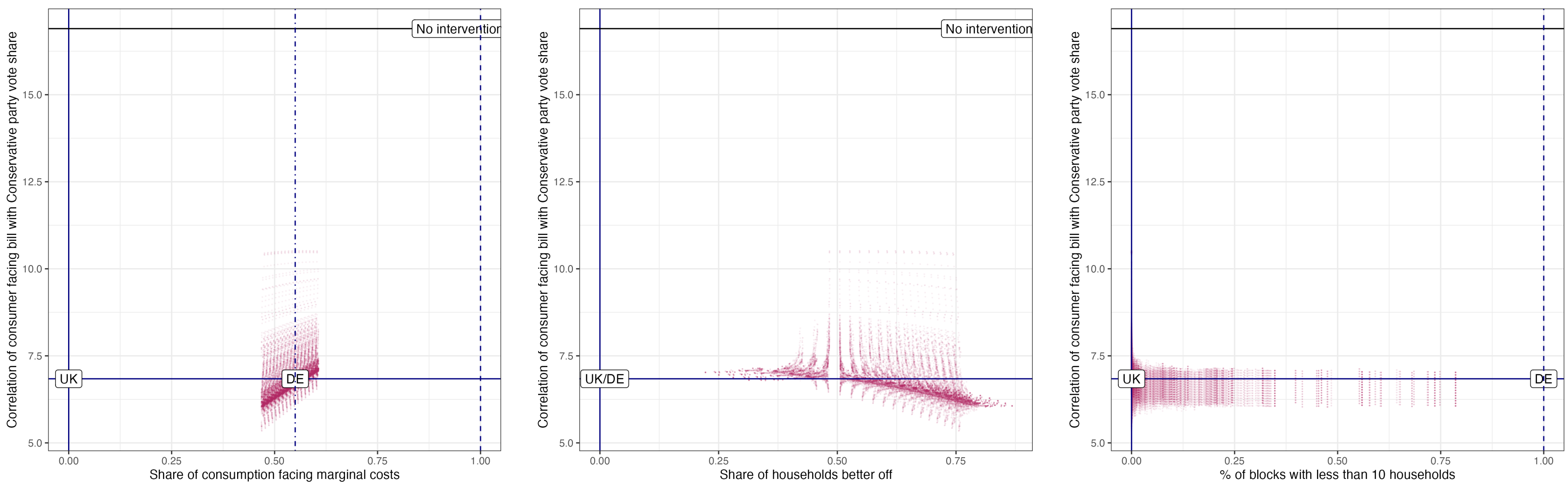


Notes: This panel of figures displays the empirical distribution evaluating a broad range of fiscally neutral alternative lump-sum transfer policies designed around consumer blocks or archetypes on a range of metrics vis-à-vis the implemented policy of the *Energy Price Guarantee* in the United Kingdom and an equivalent two-tier individualized tariff as was implemented in Germany. Panel A documents the correlation in consumer facing bills net of lump-sum transfer amount with Conservative party vote share in an exercise akin to what is presented in Table 2. Panel B presents the empirical distribution in the % of consumption that faces market prices under the policy alternatives. Panel C presents the distribution of the share of two-tier tariff blocks that are estimated to include fewer than 10 households to speak to the privacy dimension. Panel D presents the empirical distribution fo the share of households that, all else equal, would be better off vis-à-vis an individualized two-tier tariff or the untargeted price subsidy as was implemented via the EPG in the UK.

Figure 9: Characterisation of (absence of) trade-offs in the design of energy support policies

Trade-off between degree of political targeting and...

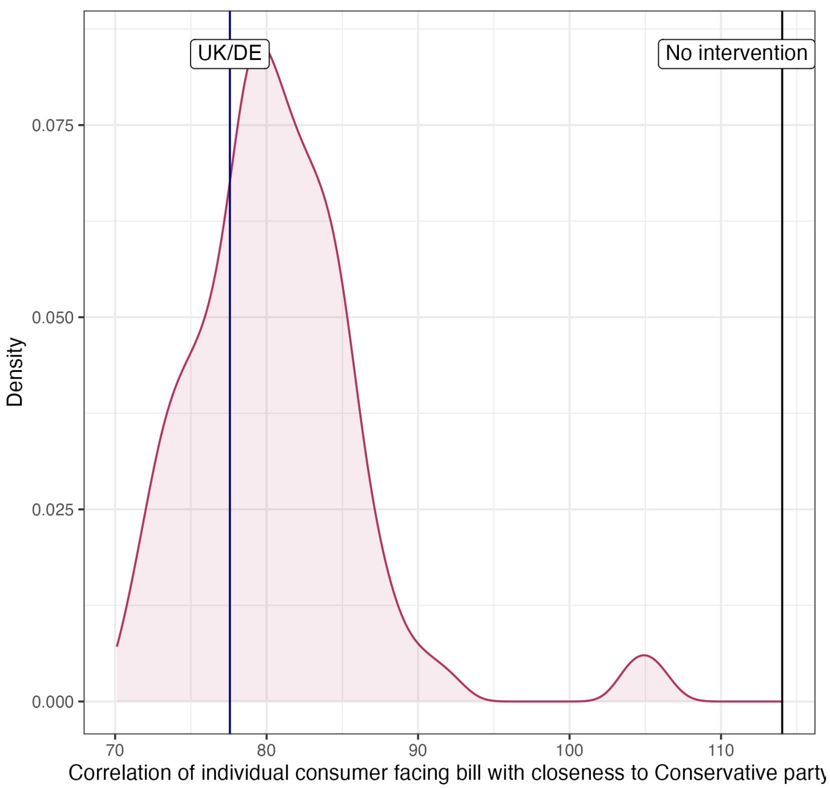
Panel A: Efficiency *Panel B:* Equity *Panel C:* Privacy



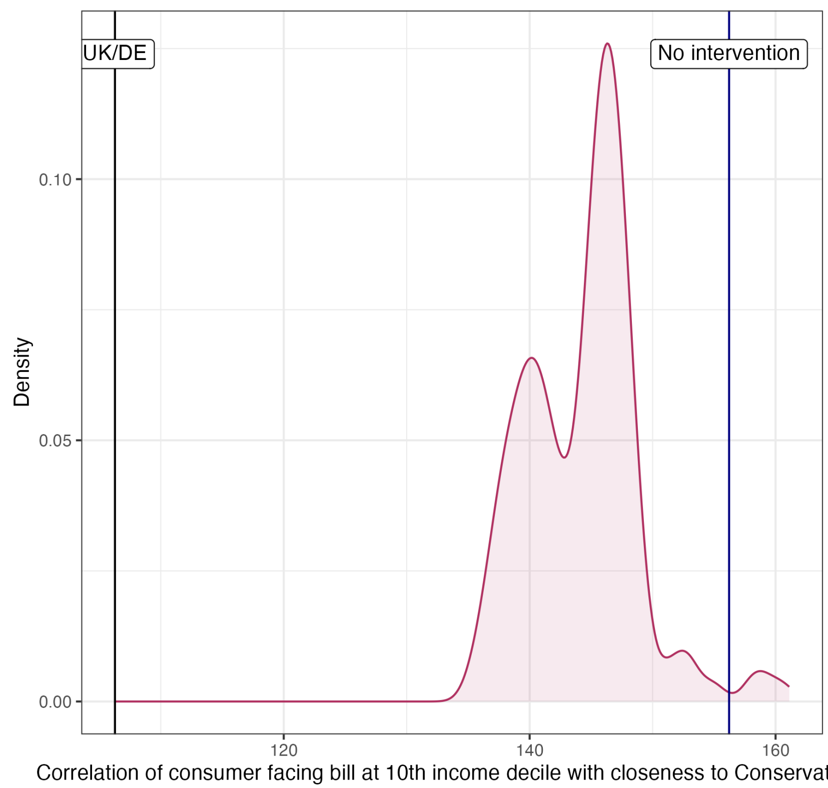
Notes: This panel of figures displays the empirical distribution evaluating a broad range of fiscally similarly generous alternative energy support measures such as two-tier tariffs that could have been implemented in the UK. These are plotted in two dimensions with each dot representing a policy alternative. They are plotted against the correlation with the degree of political partisanship in the micro data. The UK chosen policy is indicated with UK on the graph. The UK version of the German policy support is indicated as DE. The No-intervention benchmark is also illustrated. In total four dimensions are shown: Panel A focuses on the (absence of a) trade-off between efficiency (the share of consumption facing market prices) and the degree of political targeting. Panel B displays the empirical distribution of the (absence of a) trade-off between the degree of political targeting and the share of households that would be better off. Panel C displays the trade-off between privacy measured as the degree of statistical infer-ability of the degree of financial support to households based on the socio-economic characteristics considered and the degree of political targeting.

Figure 10: Empirical distribution of fiscally neutral policy alternatives vis-à-vis equivalents of the UK and German policy responses respectively characterisation of the *average* degree of political targeting and the partisanship for the top 10 income percentile

Panel A: Partisanship



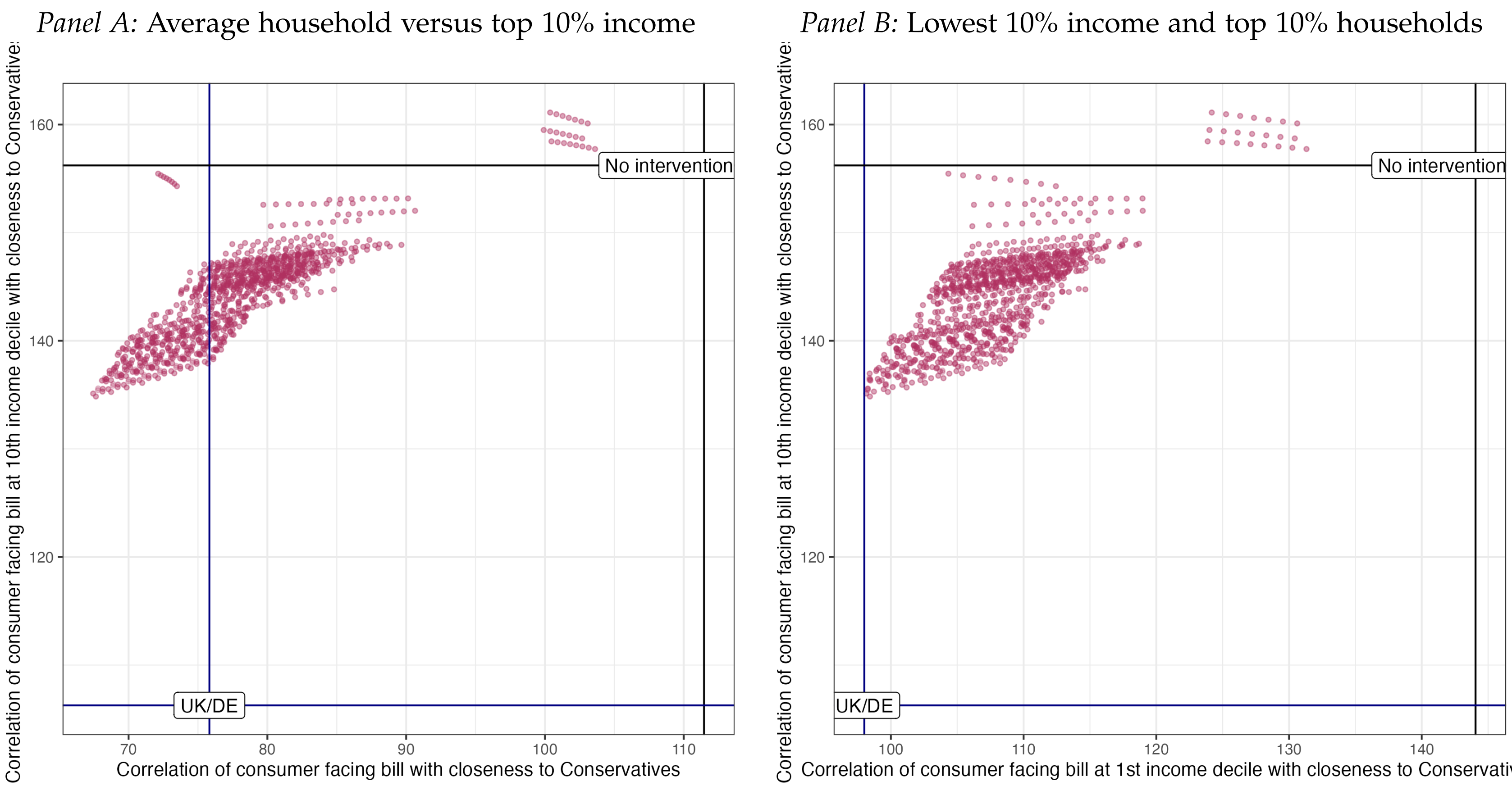
Panel B: Unholiness



Notes: This panel of figures displays the empirical distribution evaluating a broad range of fiscally neutral alternative lump-sum transfer policies designed around consumer blocks or archetypes on a range of metrics vis-à-vis the implemented policy of the *Energy Price Guarantee* in the United Kingdom and an equivalent two-tier individualized tariff as was implemented in Germany. Panel A documents the correlation in consumer facing bills net of lump-sum transfer amount with Conservative party vote share in an exercise akin to what is presented in Table 2. Panel B presents the empirical distribution in the % of consumption that faces market prices under the policy alternatives. Panel C presents the distribution of the share of two-tier tariff blocks that are estimated to include fewer than 10 households to speak to the privacy dimension. Panel D presents the empirical distribution fo the share of households that, all else equal, would be better off vis-à-vis an individualized two-tier tariff or the untargeted price subsidy as was implemented via the EPG in the UK.

Figure 11: Absence of trade-off between partisanship and degree of unholiness

Correlation between energy bills and household income among conservative party supporters by household income for



Notes: This panel of figures displays the empirical distribution evaluating a broad range of fiscally neutral alternative lump-sum transfer policies designed around consumer blocks or archetypes on a range of metrics vis-à-vis the implemented policy of the *Energy Price Guarantee* in the United Kingdom and an equivalent two-tier individualized tariff as was implemented in Germany. Panel A documents the correlation in consumer facing bills net of lump-sum transfer amount with Conservative party vote share in an exercise akin to what is presented in Table 2. Panel B presents the empirical distribution in the % of consumption that faces market prices under the policy alternatives. Panel C presents the distribution of the share of two-tier tariff blocks that are estimated to include fewer than 10 households to speak to the privacy dimension. Panel D presents the empirical distribution fo the share of households that, all else equal, would be better off vis-à-vis an individualized two-tier tariff or the untargeted price subsidy as was implemented via the EPG in the UK.

Table 1: Individual-level analysis of relationship between energy consumption – proxied by bills – and political preferences

	(1)	(2)	(3)	(4)	(5)
Panel A: Narrow political preferences					
Close to Conservatives	62.88***	62.66***	70.65***	53.85***	17.20**
	(9.839)	(9.900)	(8.389)	(8.231)	(7.427)
Dependent variable mean	1,285.9	1,285.9	1,285.8	1,285.8	1,285.8
R^2	0.06310	0.09982	0.24690	0.25743	0.31639
Observations	90,589	90,589	90,553	90,553	90,553
Panel B: Broader political preferences					
Close to or would vote Conservatives	58.49***	57.55***	67.04***	49.90***	16.54***
	(8.351)	(8.365)	(6.769)	(6.645)	(6.037)
Dependent variable mean	1,278.7	1,278.7	1,278.6	1,278.6	1,278.6
R^2	0.05269	0.08023	0.22331	0.23221	0.28306
Observations	157,061	157,061	157,008	157,008	157,008
Regression specification:					
Local authority & Year x Month of interview	Additive	Interacted	Interacted	Interacted	Interacted
Income and household size			X	X	X
Tenure				X	X
Property characteristics					X

Notes: This table presents results documenting the correlation between individual-level expressed political preferences and the estimated energy bill as a proxy for household energy consumption. Political preferences are measured as an indicator of an individual feeling close to the Conservative party (Panel A) or an individual feeling close or expressing electoral support for the Conservatives if a national election were held tomorrow (Panel B). Across columns changing sets of control variables are included in the regression in addition to the log value of the price paid in pounds the regression also controls for the year of the transaction as a fixed effect. Lastly, the fixed effect of the nearest conservation area is included. Standard errors provided in parentheses are clustered at the district level, with stars indicating *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Appendix to "Boundaries of the State"

For Online Publication

6 Appendix: Representative agent's equivalent two-tier tariff

We begin by describing how we arrive at a representative household's equivalent two-tier tariff. The UK's *Energy Price Guarantee* effectively reduced energy prices that households faced by 50% vis-à-vis the market price p_m that would have prevailed from October 2022 onwards (Fetzer, 2022a; DESNZ, 2023). There is an equivalent formulation, whereby households could have received a subsidized price p_s set at the 2021 October energy prices on the first 50% of consumption q_i, while facing market prices p_m on the remaining 50% of consumption. The "market price" could have been set as per the *Office of Gas and Electricity Market's* (Ofgem's) regular energy price cap that would have applied without intervention (Ofgem, 2023).

More formally, with any two-tier tariff, consumers face two different sets of prices p_s and p_m, where p_m denotes the market price, while p_s denotes the subsidized price, with $p_s < p_m$. For the sake of the simulation, we set p_s equal to the energy price that prevailed in the year prior to the Russian invasion of Ukraine, which, in turn, is equal to the energy price cap set by Ofgem in October 2022. The energy price cap sets the maximal unit price per kilowatt hour (kWh) that energy suppliers can charge customers, and is reviewed on a quarterly basis (**?**). This price is designed to allow energy firms to cover their cost, while also allowing for a profit margin in the regulated industry. For price p_m that constitutes the market rate is the energy price cap that was announced in October 2022 thus represents the price that energy suppliers would have been able to maximally charge customers. The *Energy Price Guarantee* reduced that price cap by around 50%.

The subsidy is designed so that the representative household faces the subsidized price p_s on the first q_m units of consumption. That is, we can write the representative household's estimated bills under such a two-tier tariff scheme as follows:

$$E(C^{\text{Two Tier}}) = E(\min\{q_m, q_i\}) \times p_s + E(\max\{q_m - q_i, 0\}) \times p_m$$

The amount of subsidy that the representative household receives S_i can be written as

$$E(S^{\text{Two Tier}}) = E(\min\{q_m, q_i\}) \times (p_m - p_s)$$

The *Energy Price Guarantee* (EPG), rather than setting a two-tier price system, can be represented as a wedge $\tau \in (0, 1)$ that lowers the price consumers face, relative to the market price p_m. That is, we can write the total bills that a representative household faces as

$$E(C^{\text{EPG}}) = E(q) \times \tau \times p_m$$

and the implicit subsidy as:

$$E(S^{\text{EPG}}) = E(q) \times (1 - \tau) p_m$$

We take τ as given based on the design parameters of the EPG (DESNZ, 2023). This allows us to identify the corresponding q_m threshold that would produce the same bills and subsidy volumes under a two-tier tariff. For ease of exposition, let $q_m = s \times q$, this then implies that the two-tier tariff that is equivalent to the EPG can be computed by solving the following system of equations

$$E(C^{\text{EPG}}) = E(C^{\text{Two Tier}})$$

$$E(S^{\text{Two Tier}}) = E(S^{\text{EPG}})$$

Using the supplied data, we see that, with $s \approx 0.5$, the two-tier tariff produces, at the household level, the same value of a subsidy and bills as the EPG generated.

That is: setting $q_m = 0.5 \times E(q)$, with the prices p_m and p_s exogenously given, a two-tier tariff would generate the same expected energy bill compared to the energy price cap. The notable difference, though, is the role that prices play: in the two-tier tariff solution, the signal value of market prices p_m is maintained.

Households' expectations could further be anchored in a dynamic fashion by announcing a dynamically declining threshold q_m over time, following best practices around subsidies in form of a sunset clause.

6.1 Individualized two-tier tariff

The two-tier tariff solution that is fiscally equivalent – ex ante – to the rather blunt *Energy Price Guarantee* (EPG) also maps to an individualized two-tier tariff. A policy alternative that would be (much) more targeted than a blunt intervention in energy-price-setting behavior would introduce an individualized quota upon which a subsidized price is levied $q_{mi} = s \times q_{i,-1}$, where the quota is set based on, for instance, last year's energy consumption. The individual-level two-tier tariff solution that is – ex-ante – equally costly to the EPG would set $s = 0.5$ – due to the *law of iterated expectations*.

In terms of *implementability*, such a transfer system would require data on an individual households' energy consumption. Such data may not be available to policymakers by virtue of data protection law or other privacy considerations. The German policy approach was to administer individualized transfer through private-sector entities. Furthermore, to hold constant preferences over redistribution or inequality, the lump-sum transfer associated with the individualized quota was passed through the income tax system, meaning that high-income households – who receive a large implicit lump-sum transfer – have to pay income tax on that transfer, commensurate with their income.

The individualized tariff, by setting an individualized quota, has desirable properties: it preserves the signal value of prices for the bulk of consumption. Given the existing research on two-tier tariffs and the evidence suggesting that consumers respond to average, rather than marginal, prices (Ito, 2014), both tariffs are ex-ante equal as they would produce the same *average increase* in bills. Yet, in the context of the two-tier tariff, the signal value of prices is maintained, while it is weakened in the case of the EPG.

Individualized tariffs also come with further implementation constraints or limitations since they require granular data that may not be in the public domain, or can only by gathered and/or used by infringing on data protection laws or other privacy regulations. As regards the implicit subsidy, all else equal, the fiscally neutral individualized two-tier tariff and the EPG would produce the same level of household subsidization.

6.2 Targeted lump-sum transfer

In addition to considering the two-tier tariff and the individualized two-tier tariff, we next consider an alternative – a targeted lump-sum transfer. This may be particularly easily *implementable* given that it essence, it would just require sending out physical checks or even, taking the form of providing council tax credits whereby the support is becoming more targeted by simply indirectly reducing another type of financial burden – council tax – that households face.

Naturally the key distinction here is that, implicitly, with such a lump-sum transfer, households that have consumption *below* the given block that is subsidized $q_{m|x}$, implicitly are left *better off*. But it is a particularly easily implementable way of providing targeted support for households affected by rising energy bills.

$$E(S^{\text{Lump Sum}}) = s \times E(q_m|x)$$

The amount of the subsidy that a household gets is now just a constant. For the purpose of the aggregate comparisons across different transfer schedules, however, we consider a lump sum transfer as effectively providing an energy price of 0 for the first q_m units of consumption and market price for the rest for ease of comparison.[1]

[1]With a targeted lump-sum transfer, the share of consumption that faces marginal cost is 100%.

7 Deriving consumer equivalent variation functions in full:

There are two consumer types, $\theta = \{H, L\}$. Consumers have income m_θ (with $m_H > m_L$) and can purchase two goods: energy (good x) and another good (good y) representing all other consumption. The price of y is normalised to 1; the price of energy is p^{-1} before the energy crisis, and rises to p^0 as a result of the crisis.

Consumers have preferences $u(x, y)$ over the two goods, with $u_1(x, y) > 0$, $u_2(x, y) > 0$, $u_{11}(x, y) < 0$, $u_{22}(x, y) < 0$, $u_{21}(x, y) \geq 0$ and $u_{12}(x, y) \geq 0$. As the price of the non-energy good is fixed at 1, the price vector at any time can be completely described by the price of energy, p. Denote the Marshallian demand of consumer of type θ for energy $x(p; m_\theta)$ and the Hicksian demand of a consumer at utility level u^n for energy as $h(p; u^n)$. Consumers are identical in all ways apart from income and so have identical Hicksian demand functions, conditional on a particular utility level.

The consumer receives support from the policymaker in the aftermath of the crisis in the form of a mix of lump-sum transfers and a subsidy on price. We proceed by measuring the consumer's utility from the policy response in money metric terms by calculating the consumer's equivalent variation. That is, we compute the transfer of wealth to the consumer at prices $(p^0, 1)$ that would be required for her to achieve the same utility at this price vector, compared to the utility she achieves from the mix of lump-sum transfer and subsidy the policymaker decides to implement.

The equivalent variation of any lump-sum amount g the policymaker transfers to the consumer is equal to the size of that lump-sum transfer.

Let $g^e_\theta(s)$ be the amount of money the policymaker spends on subsidizing a consumer with type θ by imposing a subsidy of s, such that $g_s = g^e_H(s) + g^e_L(s)$ is the total amount the policymaker spends on the subsidy program. s is the subsidy the policymaker places on the price of energy which results in the total expenditure g_s. If the policymaker gave g^e_θ as a lump-sum amount to the consumer with type θ, the equivalent variation of this transfer would be equal to g_θ^e. The actual equivalent variation of the subsidy program is, however, equal to:

$$g_\theta^e(s) - DWL_\theta(s)$$

where $DWL_\theta(s)$ is the deadweight loss of commodity subsidization that arises as a result of consumer with type θ being subsidized at s for their energy consumption. The deadweight loss is equal to $g_\theta^e(s) - EV(p^0, p^0 - s; m_\theta)$, where $EV(p^0, p^0 - s; m_\theta)$ is the equivalent variation of the policy, which decreases the price of energy from p^0 to $p^0 - s$ for a consumer with income m_θ.

Let u_θ^p be the utility a consumer with income m_θ achieves when the price of energy is p. Then, the cost to the policymaker of subsidizing consumer type θ with a subsidy of size s is

$$g_\theta^e(s) = sh(p^0 - s; u_\theta^{p^0 - s})$$

The equivalent variation of this subsidy to this consumer is:

$$EV(p^0, p^0 - s; m_\theta) = \int_{p^0 - s}^{p} h(p; u_\theta^{p^0 - s}) dp$$

and thus the deadweight loss function can be written in full as

$$DWL_\theta(s) = sh(p^0 - s; u_\theta^{p^0 - s}) - \int_{p^0 - s}^{p} h(p; u_\theta^{p^0 - s}) dp$$

As is shown in **?**, as $h(p; u^n)$ is strictly decreasing in p, the deadweight loss is strictly positive for all $s > 0$. Further, the derivative of this loss function with respect to s is equal to 0 for $s = 0$ and is strictly positive for all $s > 0$.

Thus, while the total cost to the government of the subsidy program is

$$g_s = g^e_H(s) + g^e_L(s),$$

the total benefit (measured as total equivalent variation) accruing to consumers is $\phi_H(s) + \phi_L(s)$, where $\phi_\theta(s) = g^e_\theta(s) - DWL_\theta(s)$, and $\phi'_H(s) > \phi'_L(s)$ (and $\phi_H(s) > \phi_L(s)\ \forall s$) because $u_H^{p0-s} > u_L^{p0-s}$. Further, following the above reasoning, the properties of the deadweight loss function, $\phi_\theta(0) = g^e_\theta(0)$ and $\phi'_\theta(0) = g^e_\theta(0)$ because $DWL'_\theta(0) = 0$.

As g_s is strictly increasing in s, $\phi'_H(s)$ and $\phi'_L(s)$ can be rewritten as implicit functions of g_s (which we define $f_H(g_s)$ and $f_L(g_s)$) that satisfy all of the properties described in the main body of the paper.

Deriving first-order conditions for the policymaker's problem: Defining the Lagrangian multiplier λ, the first derivatives of the Lagrangian of the problem are:

$$g^h: \quad \beta\Delta_H c'(g^h + f_H(g_s)) + (1-\beta)\Delta_L c'(g^h + f_L(g_s)) = \lambda \tag{10}$$

$$g^l: \quad \beta\Delta_L c'(g^l + f_L(g_s)) + (1-\beta)\Delta_H c'(g^l + f_H(g_s)) = \lambda \tag{11}$$

$$\begin{aligned} g_s: \quad & f'_H(g_s)\beta\Delta_H c'(g^h + f_H(g_s)) + f'_L(g_s)(1-\beta)\Delta_L c'(g^h + f_L(g_s)) \\ & + f'_L(g_s)\beta\Delta_L c'(g^l + f_L(g_s)) + f'_H(g_s)(1-\beta)\Delta_H c'(g^l + f_H(g_s)) = \lambda \end{aligned} \tag{12}$$

Combining the equations yields the uncertain lump-sum redistribution condition and the two subsidy balance conditions:

- The uncertain lump-sum redistribution condition: Combining (10) and (11) and rearranging yields:

$$\begin{aligned} & \beta\Big(\Delta_H c'(g^h + f_H(g_s)) - \Delta_L c'(g^l + f_L(g_s))\Big) \\ = & (1-\beta)\Big(\Delta_H c'(g^l + f_H(g_s)) - \Delta_L c'(g^h + f_L(g_s))\Big) \end{aligned} \tag{13}$$

- The subsidy balance conditions: Combining (12) with (10) or (10), respectively, yield the high-type transfer subsidy balance condition:

$$
\begin{aligned}
&f_H'(g_s)\beta\Delta_H c'(g^h + f_H(g_s)) + f_L'(g_s)(1-\beta)\Delta_L c'(g^h + f_L(g_s)) \\
+&f_L'(g_s)\beta\Delta_L c'(g^l + f_L(g_s)) + f_H'(g_s)(1-\beta)\Delta_H c'(g^l + f_H(g_s)) \\
=&\beta\Delta_H c'(g^h + f_H(g_s)) + (1-\beta)\Delta_L c'(g^h + f_L(g_s))
\end{aligned}
\tag{14}
$$

and the low-type transfer subsidy balance condition:

$$
\begin{aligned}
&f_H'(g_s)\beta\Delta_H c'(g^h + f_H(g_s)) + f_L'(g_s)(1-\beta)\Delta_L c'(g^h + f_L(g_s)) \\
+&f_L'(g_s)\beta\Delta_L c'(g^l + f_L(g_s)) + f_H'(g_s)(1-\beta)\Delta_H c'(g^l + f_H(g_s)) \\
=&\beta\Delta_L c'(g^l + f_L(g_s)) + (1-\beta)\Delta_H c'(g^l + f_H(g_s))
\end{aligned}
\tag{15}
$$

Proof of Proposition 2:

Proof of Corollary 1: The $\Delta_L > \Delta_H$ policymaker will choose $g_h = g_l$ and $g_s = 0$, and the $\Delta_H > \Delta_L$ policymaker will choose $g_s \neq 0$. The corollary then follows from the fact that $\Delta_H = 1 - \Delta_L$.