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Fueling protest? Climate change mitigation, fuel prices and protest onset

Nina von Uexkull *, Espen Geelmuyden Rød, Isak Svensson

Department of Peace and Conflict Research, Uppsala University, Box 514, SE-751 20 Uppsala, Sweden

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ABSTRACT

Mitigating global warming requires a rapid reduction in the use of fossil fuels which form the foundation of modern economies. Fossil fuel reduction is crucial for minimizing future loss and damage associated with a changing climate, but a challenging task. In diverse contexts, climate-friendly policies that increased fuel prices have sparked massive, at times violent, protests, ultimately leading to a reversal of those policies. However, to what extent and under what conditions fuel prices and policies affect protest more generally is poorly understood. Addressing this gap, we study how fuel prices affect the likelihood of protest onset. We theorize that increases in fuel prices may create economic grievances through their impacts on the cost of living and income. We also suggest that the likelihood of protest following such price increases would be particularly high where attribution of blame to government policies is feasible, such as in fuel subsidizing states, as well as when governments are seen as being able to provide a remedy such as in petroleum producing states. We evaluate our theoretical framework using global country-level monthly statistics 2003–2015, combining protest data with data on the price of gasoline, fuel policies, and country characteristics, and subject our results to placebo and sensitivity tests. Our study finds that gasoline price hikes increase the likelihood of protest onset across the global sample. In line with our theoretical framework, we also find evidence for a clustering of such relationships in the presence of subsidies and oil production, where the attribution of fuel prices to government (in)action tends to be higher. These results highlight the need for policymakers to anticipate public responses to price increases. This study lays the groundwork for more detailed investigations into climate-friendly subsidy and tax reforms.

1. Introduction

Climate change is one of the greatest threats human societies and ecosystems face (Steffen et al., 2018). Mitigating the extent of global warming requires rapid decarbonization of global economies and a reduction in fossil fuel use and production. Raising the cost of fossil fuel consumption is one key strategy to promote this transition to low-emission societies. However, in various contexts, such as in France, Nigeria, and Kazakhstan, policies that increased domestic fuel prices have been withdrawn following massive protests. It is conceivable that fear of social unrest and instability in the short term hinders policymakers from implementing necessary steps to prevent dangerous climate change. Yet, fear of societal disruptions following domestic fuel price hikes may not always be justified. Understanding why and under what conditions energy-related unrest occurs is fundamental for identifying adequate responses.

Addressing this important question, we study how fuel prices and policies, specifically gasoline taxes and subsidies, affect the likelihood of protest onset. We make empirical and theoretical contributions. Empirically, we – for the first time – study the relationship between domestic fuel price changes and protest onset globally 2003–2015. While there is previous research on the link between global oil prices and protest, it has either not studied the role of domestic price policies (Ishak & Farzanegan, 2022; Vadlamannati & de Soysa, 2020), or only studied fuel riots, and not included peaceful protests including those more indirectly affected by fuel prices (McCulloch et al., 2022; Natalini et al., 2020). Theoretically, we develop an argument focusing on economic grievances that formulates expectations based on the degree of attribution of price changes to government policies. In particular, we suggest that fuel price hikes increase the propensity for public protests since they are generally widely shared unexpected economic shocks. We also suggest that the likelihood of protest following such price increases would be particularly high where attribution of blame to government policies is feasible, such as in fuel subsidizing states, as well as when governments are seen as being able to provide a remedy (such as in petroleum producing states). We thus see our analysis of structural

* Corresponding author.
E-mail addresses: nina.von_uexkull@pcr.uu.se (N. von Uexkull), espen.g.roed@pcr.uu.se (E.G. Rød), isak.svensson@pcr.uu.se (I. Svensson).

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conditions associated with attribution in relation to economic grievances as an important contribution to the literature on protests and civil resistance.

This study holds substantial real-world relevance, as protests are the predominant mode of public contention, particularly in industrialized countries, which are also major greenhouse gas emitters. Such protests have the potential to significantly shape public policy, extending their impact beyond environmental and energy sectors. This is for example evident in the way Western countries responded to the recent aggression of the Putin regime against Ukraine in 2022 which seemed to be shaped by fear that rising fuel prices as a result of sanctions would lead to domestic unrest (The Telegraph, 2022).

We evaluate our theoretical arguments using country-level monthly statistics from 2003 to 2015, combining protest data with global statistics on gasoline prices and country characteristics. Results show that domestic fuel price increases are associated with a higher likelihood of protest onset across the global sample. Further, there is evidence of a clustering of such relationships in the presence of subsidies and oil production in line with the theoretical framework.

We proceed as follows. We first describe earlier research on climate change mitigation and social unrest and protest more generally. Next, we outline our theoretical framework on restrictive fossil fuel policies and protest. We then detail our research design and present results. The final section concludes.

2. Previous research

The speed of the transition to low-emission societies in this decade is decisive for meeting the goals outlined in the Paris Agreement of 2015 for avoiding dangerous climate change and keeping global temperatures well below 2 degrees warming (IPCC, 2021). In order to have a reasonable chance to meet the Paris Agreement target, close to 60 percent of known oil and fossil methane gas reserves and 90 percent of coal must remain unextracted (Welsby et al., 2021). Global carbon dioxide (CO_2) emissions would need to reach 'net zero' around 2050 (IEA, 2021). The main measures to achieve the transition to low-emission economies are restrictive demand-side climate policies such as carbon taxes and supply-side policies such as moratoria or quotas on fossil fuel production and a simultaneous increase in renewable energy production and use (Green & Denniss, 2018).

Societal norms, incentives, and politics are essential in societies' transformations of their energy systems and are important for understanding what impacts this transition may have (Otto et al., 2020; Winkelmann et al., 2022). However, while there is a significant body of research exploring the implications of climate change for violent and non-violent conflict and unrest (e.g., Augsten et al., 2022; Koubi, 2019; van Weezel, 2020; von Uexkull et al., 2023), the implications of policies to mitigate global warming have received scant attention (Gilmore & Buhaug, 2021; Sovacool et al., 2023). Only few potential pathways between climate change mitigation and conflict have been scientifically explored. Existing studies have, for example, investigated the impacts of biofuel production, reforestation, or conservation initiatives on land-use conflict (Bergius et al., 2020; Hunsberger et al., 2018). Relatedly, recent work has mapped protest to low-carbon energy production projects such as dams (e.g., Del Bene et al., 2018; Kim, 2021; Temper et al., 2020). Also, mainly conceptual work has begun to outline potential future tensions over resources needed for renewable energy systems (Månsson, 2015; Ting & Seaman, 2013). Recent waves of youth-led protests, such as Fridays for Future, have also stimulated research into peaceful pro-climate activism (Cologna et al., 2021; Piggot, 2018).

Highly relevant to our work is also the broader field of research on drivers of political protests and popular uprisings (e.g., Chenoweth & Ulfelder, 2016; Karakaya, 2018; Schaftenaar, 2017). The study of economic grievances in particular as an explanation for protest has a long history (e.g., Gurr, 1970). A common critique against grievance-related explanations is that grievances (especially economic ones) are too prevalent to explain the relatively rare events of uprisings and protests (Lichbach, 1989). Scholars have therefore started to identify more precise conditions under which economic grievances can lead to protests (e.g., Quaranta, 2016; Smith, 2014). In this body of work, some studies also explore the role of global oil prices for protest. Vadlamannati and de Soysa (2020) explore the role of global oil price fluctuations on anti-government protests and find that both high oil costs and low costs can lead to protests (in oil-importing and oil-producing countries respectively), but conditional on availability of foreign reserves. Ishak and Farzanegan (2022) find that negative oil price shocks increase the propensity for protests in oil-dependent countries with smaller shadow economies.

Most closely related to our research aims is recent work on fuel-related violent riots as a distinct phenomenon. Two pioneering works are Natalini et al. (2020), who suggest that poor, net fuel-importing, politically unstable and inefficient governments are likely to see fuel riots and that the risk of fuel riots increase with global petroleum prices. Extending this work, McCulloch et al. (2022) find that countries that subsidize prices and hold prices fixed are more likely to see fuel riots. Beyond these global studies, which allow for detecting structural drivers and identify countries at risk of seeing unrest, case studies provide a nuanced view on specific protest episodes related to climate-friendly policies. For example, recent research scrutinizes the aims of the 'Yellow Vests' in France and the attitude of the French population following the massive waves of protests initiated by the movement in 2018 and onwards (Jetten, et al., 2020; Martin & Islar, 2021). Similarly, there are case studies on upheaval related to fuel subsidies in a handful of countries such as Nigeria, Ecuador, Chile and Indonesia (e.g., Agbonifo, 2023; Diaz Pabon & Palacio Ludeña, 2021; Skovgaard & van Asselt, 2018).

We make three contributions to this body of work: First, we present a global study of the relatoinship of domestic fuel prices and protest more generally. Fuel prices affect transportation costs, in turn affecting the costs of food and other basic goods. Given their visibility, they may also be the trigger of protest over more fundamental political issues. Even if grievances over fuel costs are a trigger, opposition groups may strategically select which issues to frame mobilization on depending on political opportunity structures. While riots with explicit fuel-related demands covered in earlier work are important to study (McCulloch et al., 2022; Natalini et al., 2020), they do thus not include the full range of more indirectly fuel-driven protests. Second, we study both peaceful and violent protests. Energy-related protests, violent or not, may, for example, prevent governments from implementing ambitious climate policies (Piggot, 2018).[1] The focus on fuel riots in previous research may thus overlook these types of protests, a lacuna that our research contributes to filling. Third, we develop a unifying theoretical framework that formulates expectations based on the magnitude of price changes and the degree of attribution to government action and inaction, which points to the importance of subsidies, taxes, and oil production. In testing this framework, we also contribute to the broader literature on economic grievances as drivers of protests focusing on questions of how different issues can be more mobilizing than others when such issues are more attributional to governments and can help to mobilize across cleavages (Abbs, 2019; De Juan & Wegner, 2019; Javeline, 2003; Thomson, 2018).

[1] It is important to note that we are not making any a priori judgments about the legitimacy of the aims of the involved actors. For example, it is conceivable that instability and large-scale protests in authoritarian and repressive states could put them on a path of democratization beneficial to local populations in the long run. Context-sensitive interpretation of research results is key especially when considering policy implications.

2.1. Theoretical framework

We focus on fossil fuels in theorizing how climate change mitigation policies shape protest onset and dynamics. Specifically, we zoom in on demand-sided climate policies aimed at restricting fossil fuel use (cf. Table 1), namely variations in taxes that increase the price of fossil fuels and subsidies that lower the price. Both work via the price mechanism: changing the cost of fuel shapes incentives for switching to alternatives or reducing use (Lin & Li, 2011; Mundaca, 2017). These are relevant measures of global climate change mitigation policies, since fuel is relevant for all countries globally which otherwise vary greatly in their economic structures and specific climate change mitigation potential and strategies (Aldy & Pizer, 2016; Martinez-Alvarez et al., 2022).

Carbon taxes have been introduced in a handful of countries. Ending fossil fuel subsidies, in general, would cut global CO2 emissions by about a fifth and hence have major climate benefits, according to estimates by the International Monetary Fund (Coady et al., 2017). Due to these dynamics, cutting fossil subsidies is referred to as a 'social tipping point' that may lead to self-reinforcing social change towards decarbonized economies (Otto et al., 2020). The progress in reforming fossil fuel subsidies has been mixed so far, however (Ross et al., 2017; Skovgaard & van Asselt, 2018). In fact, during the Covid-19 pandemic, major economies almost doubled their fossil fuel subsidies according to OECD estimates (OECD, 2021). Following the energy crisis in the wake of the Russian invasion of Ukraine in 2022, several countries have added further fuel subsidy programs.

Governments often justify policy decisions affecting fuel prices by economic rather than environmental reasons (Skovgaard & van Asselt, 2018). However, the environmental impact of such pricing policies cannot be overlooked even if they are not framed in such terms. Changes in fuel prices, whether through taxes or subsidies, directly influence consumption patterns and, consequently, emissions that drive climate change (Green & Denniss, 2018). Public acceptance or resistance to these changes can significantly influence the success or failure of these policies. This connection underscores the importance of better understanding public reactions to price changes, including taxes and subsidies.

Specifically, we here choose to study fuel prices and fuel policies in relation to protests, defined as public gatherings of a group of people opposing the government (Weidmann & Rød, 2019). Discontent may be expressed through political institutions, but we are primarily interested in the onset of protest. These may occur parallel to, or as an alternative to, electoral and other institutional processes. Protests are carried out by unarmed civilians and are predominantly peaceful but can involve a degree of violence, such as property damage or clashes with security forces. Protests can also be a first step to escalation to armed conflict and major instability (Della Porta et al., 2017).

While we recognize that grievances, resource mobilization, political opportunity, and framing-based explanations are complementary for the occurrence of social protests (Chenoweth & Ulfelder, 2017; Snow et al., 2008; Tarrow, 2011; Weidmann & Rød, 2019), our focus here is on the role of economic grievances in mobilizing protests. Research on economic grievances as drivers of protests, which we will discuss below, has identified some of the key conditions, out of which three are of particular importance in this context: the nature of the grievances (unexpected and widely shared), the attribution of blame, and – relatedly – the identification of a simple remedy. We thus theorize that fuel prices mainly affect protests through increasing economic grievances since fuel price hikes tend to be unexpected economic shocks affecting large parts of the population. Moreover, we argue that fuel prices' protest potential should be conditional on the attribution of blame to government policies as well as the perception of the government's capabilities to provide remedies for fuel price shocks. These three conditions lead to three testable hypotheses.

Rising fuel prices can negatively affect well-being and economic status by increasing cooking, heating, lighting, and transport costs and indirectly heightening prices of other basic goods, including food (Arze del Granado et al., 2012; Boyd-Swan & Herbst, 2012). Fuel prices affect society as a whole, and shocks are often unexpected. Widely shared grievances arising from an unforeseen change of circumstances, especially those that cut across existing social cleavages, have larger mobilizing potential and should theoretically be expected to be associated with a higher propensity for protests. Emerging literature suggests that food price shocks increase social unrest where opportunities for mobilization are favorable (e.g., Costello et al., 2015; Rudolfsen, 2021). Like food prices, fuel prices can create cross-cutting cleavages that affect different segments of societies and thereby serve to mobilize dissent (Abbs, 2019). Along these lines, collective concerns about rising fuel prices may create superordinate goals that can bridge societal divides and thereby build up the basis for larger coalitions of opposition movements. Rapid fuel price increases may create focal points or "trigger events" (Nepstad, 2015, p. 91) for mobilization.[2]

Given the complexity of how fuel prices are set, we expect that consumers are largely unaware of specific compositions of retail prices and mostly react to price increases from what they perceive to be an acceptable price. Since fuel needs to be purchased regularly, consumers have a good sense of price changes while the exact composition of prices is complicated for people to measure and disentangle. Hence, we expect people primarily to react to actual price changes rather than responding preemptively to potentially extended debates within government about subsidy or tax reforms. For example, in Sweden, 'the Fuel Uprising' campaign mobilized around demands to lower high energy prices on social media (Wahlund & Palm, 2022). However, the Swedish energy price fluctuations are primarily attributable to global markets rather than climate policies. Hence our first expectation is that a sharp increase in prices, for whatever reason, may lead to frustration and grievances, eventually leading people to take to the streets.

There is much anecdotal evidence on actual price increases triggering responses directly or indirectly. For example, in 2005, Indonesia saw fuel prices rise by 29 percent, which caused large-scale protests in the capital and other major cities across the island nation. The protesters argued that this move would raise not only fuel prices but also increase the prices of foodstuffs and bus fares (Osman, 2005). Similarly, in February 2003, workers took to the streets in Ghana, protesting the slow pace of negotiations on a new minimum wage between the government, the Trades Union Congress (TUC), and the Ghana Employers Association. The protests took place against a backdrop of fuel prices increasing 90 percent since the previous month (All Africa, 2003a). At the same time, utility prices were expected to increase 12 percent by the end of the first quarter (All Africa, 2003b).

The discussion leads us to the first hypothesis:

Hypothesis 1. *Domestic fuel price hikes increase the likelihood of protest onset.*

Economic grievances attributed to government policies, where the population can blame the government for the experiences of sudden hardship, should be expected to be associated with a higher propensity for protest. Economic subsidies and higher taxes can be significant in this context. In particular, it is conceivable that the presence of policies

[2] Naturally, not everyone will be affected similarly by price shocks. For example, parts of the population in rural areas that are more strongly reliant on long-distant transport are more exposed to price shocks directly or indirectly. On the other hand, we may also have the urban population more strongly impacted as food consumers through potential add-on impacts on food prices. In contrast, rural populations, to a larger degree, can rely on their own food production (Arndt et al., 2008). We believe it will depend on local contexts in individual countries for who will be most affected and most likely to mobilize. What is important here is that prices change over time, resulting in a perceived short-term worsening of the situation for relevant parts of societies. Fuel price increases may lead to popular grievances increasing the motivation for protests.

Table 1
Overview of key climate policy instruments.

	Supply-side	Demand-side
Restrictive	Supply tax/subsidy reduction, production quota, ban/moratorium	**Carbon tax, consumer-subsidy cuts,** mandatory CO_2 emission standards
Supportive	Renewable energy feed-in-tariffs, Research & development subsidies, government provision of low-emission substitutes	Government procurement policies, subsidies for energy-efficient or low-emission substitutes

Note: Overview adapted from Green and Dennis (2018). The grey box is in focus in this particular paper.

that significantly alter prices, i.e., significant taxes or subsidies, raise the degree of attribution of price changes to the government. The creation of grievances frames is important for the successful mobilization of dissent (Benford & Snow, 2000; Goffman, 1974; Snow et al., 1986) and can, in general, be expected to be facilitated if there is a larger possibility to attribute rising costs to the government and its specific policies, rather than more general and external economic structures (Bergstrand 2014, Javeline, 2003). For protests to occur, "people must be convinced that the state is responsible" (De Juan & Wegner, 2019, p. 36). For example, research on economic crises and protest suggests that economic decline is associated with a higher likelihood of protest when the economic crisis is attributed to government actions (Brancati, 2014). A broader field of research has explored the role of blame attribution in explaining how economic grievances can explain protests such as wage delays in Russia (Javeline, 2003), public social services in South Africa (De Juan and Wegner 2017), and or agricultural collectivization policies in the German Democratic Republic (Thomson, 2018); yet, we do not know whether the blame attribution mechanism can be generalized beyond these individual cases and whether it would apply to the context of fuel-related protest.

An illustrative example of the role of fuel subsidies are the anti-government demonstrations in Sudan in 2011. The protests were calling for an end to the autocratic government practices that had exacerbated corruption, rising prices, and unemployment. The government had recently cut subsidies on petroleum products and sugar (Otterman, 2011). The protests quickly turned violent (Human Rights Watch, 2011). For high taxes, the textbook example is the French Yellow Vest movement emerging in 2018. At first protesting increasing fuel price taxes in a situation where taxes had increased more generally and disproportionally affecting lower income households, the movement subsequently extended demands to other equality issues, such as wealth taxes, with demands reportedly rooted in perceived growing levels of inequalities (Jetten, Mols, & Selvanathan, 2020).

Hypothesis 2a. *A domestic fuel price hike in the presence of subsidies is associated with an increased likelihood of protest.*

Hypothesis 2b. *A domestic fuel price hike in the presence of high taxes is associated with an increased likelihood of protest.*

A third characteristic of economic grievances that can be expected to be associated with protests are perceptions that governments seemingly can make straight-forward decisions to address the issue and alleviate the suffering. Specifically, we suggest that petroleum production is another condition that likely shapes protest behavior in response to domestic fuel price increases.

More generally, oil production often gives states greater control over prices and increases the expectations that market fluctuations are buffered. Oil production and substantive fuel subsidies are linked: Rentier state theory holds that resource-rich regimes that regularly receive external rents use this rent to secure political stability (Beblawi, 1987; Ross, 2015). Fuel subsidies are a particularly attractive political tool for buying off ordinary citizens' support because their benefits are highly visible, yet their costs have low visibility in fuel-producing countries. The cost of providing them is due to selling fuel below international market prices (Houeland, 2020). Moreover, they are comparably easy to implement and do not require efficient bureaucracies and high institutional capacity compared to other ways of supporting specific population groups, such as direct transfers (Skovgaard, 2021). This also raises expectations from the population that oil prices are kept low. Even without active subsidies, we expect there to be higher expectations of potential control of oil prices, given that governments of oil-producing countries will be seen as having control of the resource. Access to cheap oil may become part of the social contract between the state and the citizenry (McCulloch et al., 2021). In these countries, increasing domestic fuel prices may hence be met with domestic resistance.

The 2012 *Occupy Nigeria* protest is a case in point where the local population objected against lifting subsidies that at least let them benefit somewhat from Nigeria's oil riches that otherwise mainly was perceived to benefit the governing elites (Agbonifo, 2023; Fasakin, 2022; Houeland, 2020). Fuel subsidy removal imposed by the federal government resulted in gasoline prices doubling overnight. The administration of President Goodluck Jonathan argued that the subsidies transferred billions of dollars to a "cartel of fuel importers" while decreasing the interest for investment in Nigeria's underperforming refineries (Mark, 2012). After a week-long strike that brought the country to a standstill, the government partly restored the subsidy and union leaders agreed to end the strike (Nossiter & Romero, 2012). The 2012 protests against fuel subsidy removal turned out to be one of the biggest popular mobilizations in Nigeria's history (Houeland, 2020).

Given the above incentives, it is no coincidence that persistent subsidizers of fuel tend to be oil producers (Cheon et al., 2013; Ross et al., 2017). However, the opposite is not true. Not all oil producers do provide subsidies as exemplified by Ghana and Canada in Fig. 2. Oil-producing states' capacity and willingness to implement subsidies for example depends on domestic capacities to refine oil and the cost of domestic production (Favennec, 2022). We still expect that pressure on the oil-producing states – even if they do not provide subsidies – is higher than on other states, given that it is easier for them to accommodate demands for lowering prices and the expectations on them to do so is higher than for other countries. We put forward a third hypothesis:

Hypothesis 3. *Domestic fuel price hikes are associated with an increased likelihood of protest in oil-producing countries.*

3. Material and methods

Our theoretical framework relates domestic fuel prices to the onset of protest. Further, we expect that effects are more pronounced in contexts

where the population attributes price changes to the government. We generally expect fuel price hikes to trigger protests immediately after price shocks. To capture such short-term unrest dynamics, we use the country-month as the unit of analysis. We assemble near-global data on 157 countries from 2003 to 2015. The time period is defined by data availability in the fuel price data.

3.1. Dependent variable

A comprehensive source for protest data is the globally available Mass Mobilization (MM) dataset (Clark & Regan, 2016). The data contain anti-government protest events with 50 or more participants, and the temporal scope for our study is 2003–2015 (Fig. 1).[3] It is coded based on media reports in the LexisNexis database. Our primary dependent variable is protest onset, which we define as protests emerging following at least two months of no protests. Ongoing protest after initial onset is coded as missing.

As an alternative specification of the dependent variable, we use the onset of major protest episodes, defined as country-months with protests that sum to more than 1000 participants emerging following at least two months since the last major protest episode. The 1000 participants threshold is well-established in research on popular uprisings (Chenoweth & Lewis, 2013). The reason to use this higher threshold here is twofold: First, we are interested in politically relevant events, and the relevance and likelihood of campaign success increases with the number of participants (Chenoweth & Stephan, 2011). The second reason is that we suspect that data quality is more variable with a low threshold. Many protests that include 50 participants will not be reported in the media. In addition, in some countries in our dataset there are protests most of the time, which makes it difficult to capture relevant variation. For example, the U.K. has protest observations in 70 % of country-month observations.

3.2. Independent variable

Our main independent variable is domestic gasoline *price growth*. The variable is constructed based on data from Ross et al. (2017), who provide monthly data on retail gasoline prices per liter in 157 countries from 2003 to 2015 in constant 2015 U.S. Dollar. Gasoline prices were collected from a variety of local and global sources. The covered countries contain 97.1 % of the world's population and represent 98.2 % of all greenhouse gas emissions (Ross et al., 2017).

We operationalize price hikes in two ways. First, we calculate monthly percentage growth. This variable specification follows the logic of a trigger that may immediately spark unrest: a sudden large increase in the domestic price. As an alternative specification, we also use the cumulative price growth over the three preceding months window, which will be less sensitive to short-term volatility and captures more lasting increases.[4] Note here that initial minor protests may cause a downwards change in prices and the models using the cumulative price growth variable may somewhat underestimate the effect of price growth on major protests (see also Supplementary Table A11).

Domestic prices are partly endogenous to internal developments in a country more generally, which is a challenge for causal identification. However, given the ample distortive effects of government and corporate actions, it is important to capture actual retail prices. For many countries, there is an incomplete pass-through of – plausibly exogenous – global market (benchmarking) prices (Kpodar & Abdallah, 2017). This is illustrated in the price data in Fig. 2 below. While fuel prices in Canada largely move in parallel to global benchmarking price fluctuations, domestic prices in Iraq, Nigeria, and Ghana deviate to varying degrees. These countries keep their prices fixed for an extended period of time. Hence global market prices will not at all reflect domestic price dynamics in many countries, which is why we focus on domestic prices in our main models. We complement this analysis by using benchmarking prices as an instrumental variable for fuel-taxing countries in models documented in the supplementary material (Supplementary Table A8).

3.3. Conditioning variables

We theorize that the response to fuel price changes is shaped by the degree of government policies, specifically the extent of subsidies and taxes. The extent of subsidies and consumer taxes are not easily defined and measured, and there is a lack of comprehensive global inventories of government taxes and subsidy policies (Skovgaard, 2021; Mahdavi, Alvarez & Ross, 2022). One approach for specifying subsidies and taxes is to calculate pre-tax subsidies by comparing retail prices to international benchmarking prices, which are, in turn, shaped by international market dynamics and geopolitical crises (Ross et al., 2017). We follow this approach and account for *net subsidies and taxes* using the price gap approach: the pre-tax difference between retail gasoline prices (in USD 2015) compared to international supply cost in percentage units. Average deviations from benchmarking prices, i.e., net implicit subsidies and taxes, are displayed in Fig. 3. We observe countries with high taxes and subsidies across the income spectrum, but higher-income countries tend to have higher taxes.[5]

Further, we theorize that the population expects oil producers to share some benefits of the country's oil revenues by holding fuel prices low. We test this expectation by relying on data on oil rents as the percentage of GDP based on data from the World Development Indicators (WDI, 2021).

3.4. Statistical model and control variables

Our primary identification strategy is to use domestic fuel price data and specify linear probability regression models that include country- and time-fixed effects. We further probe the robustness of the main results using a series of placebo and sensitivity tests and alternative model specifications. Several factors that may also affect protest propensity influence domestic fuel price changes, and we aim to isolate the fuel effects by including control variables capturing such important factors.

- *Months since protest*: If subsidy policies respond to earlier protest events, protest history variables should account for these dynamics. Further, recent protests are likely to trigger new protests in the near future (e.g., Granovetter, 1978; Kuran, 1989). The variable measures the time since last protest in the country in months. We also include a

[3] The MM dataset is globally available but does not cover protests in the U.S. and Israel as the only major countries missing. It has issue/claim coding, including prices and taxes more generally. Of all 15,238 MM events between 1990 and 2020, the maximum time span available in the raw data, 1087 had prices and tax policy as their first demand, and 214 had prices and tax policies as their second demand, which indicates the relevance of price/tax-related protest.

[4] The three-month growth threshold is abitrary, but since we expect price growth to trigger protest in the near future, we believe three months is a reasonable threshold for the time effect. Nonetheless, we include further models with a two-month and a six-month threshold in the appendix, see Supplementary Table A9 and A10.

[5] While the price-gap approach is the only one available at the global level, it is important to note that we do not capture the full range of consumer support policies and subsidies. In countries with taxes according to the price gap approach there may exist different forms – less visible – temporary or permanent subsidies to consumers for example in the form of tax reductions and exceptions (Böhm & Peterson, 2024; IEA, 2023). This is true for many high-income countries. Further, the size of subsidies depends on the chosen definition, for example depending on the inclusion or exclusion of environmental externalities (Skovgaard, 2017).

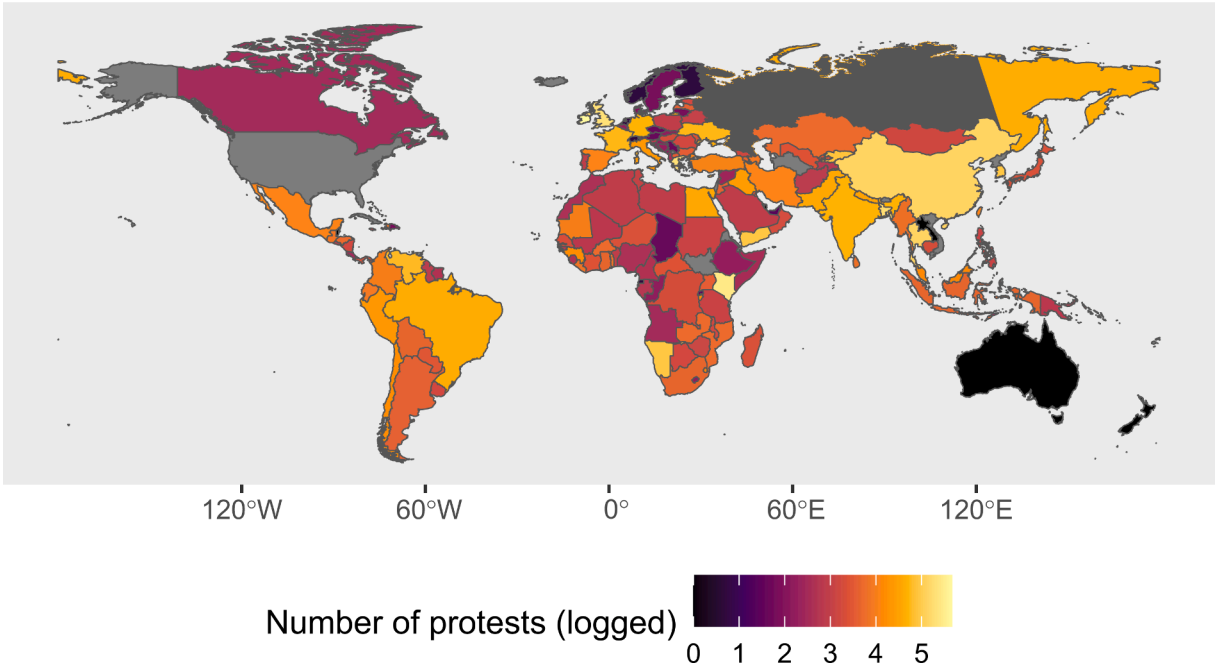

Fig. 1. Protest number (logged) 2003–2015 based on the MM data. Grey areas indicate missing data.

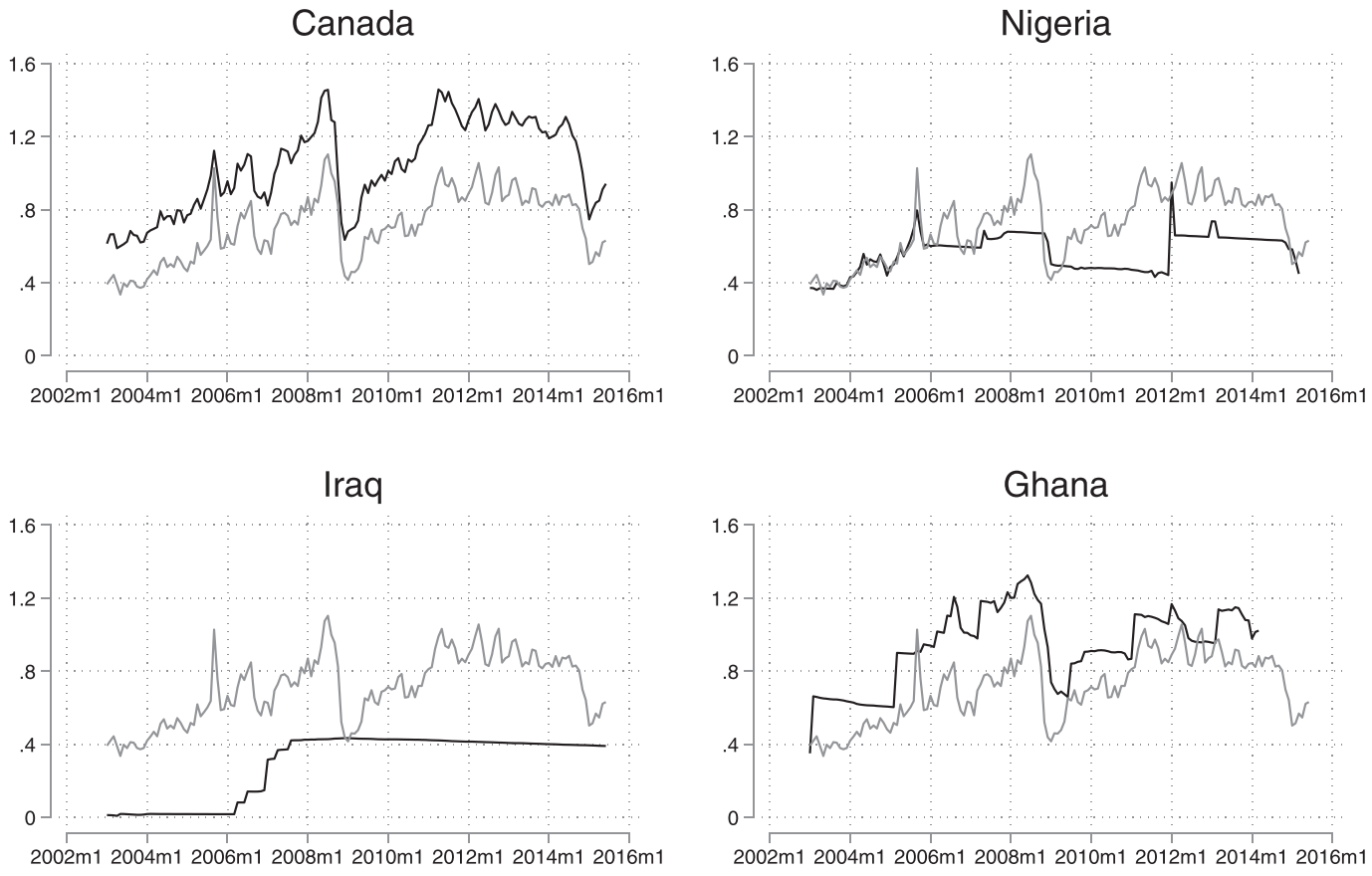

Fig. 2. Domestic fuel price (grey) and global benchmarking price (black) in constant 2015 US Dollars in four countries 2003–2015.

squared and a cubed term of this variable to flexibly account for time dependence in our models (Carter & Signorino, 2010).

- *Logged months since armed conflict:* Conflict and protest events often coincide, for example, because groups use multiple tactics to pressure governments. Armed conflict can also influence the price of fuel. We use data on organized violence from UCDP GED v 21.1 (Pettersson et al., 2021; Sundberg & Melander, 2013).

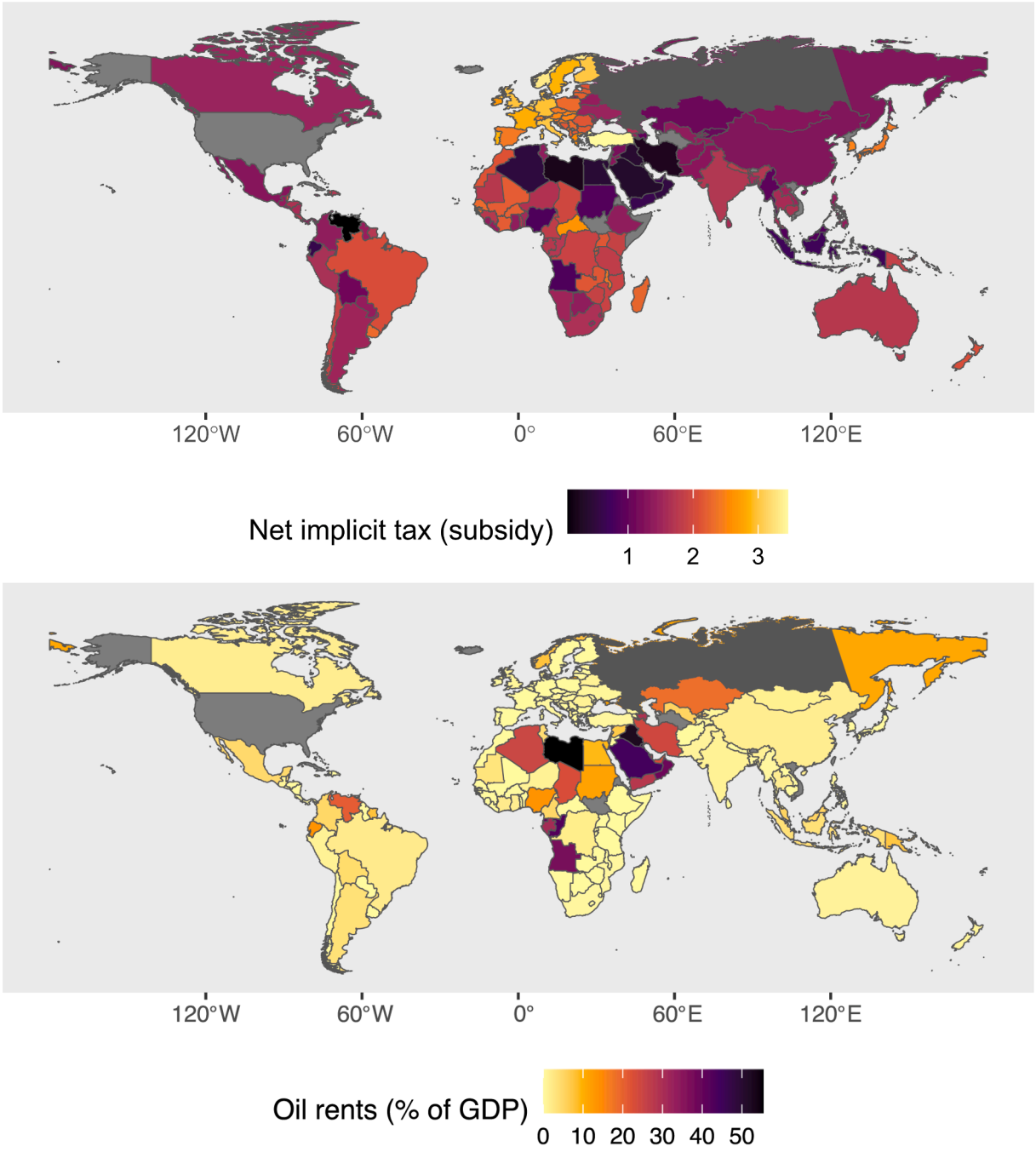

Fig. 3. Global net implicit tax and subsidies (upper panel) and oil rents in % of GDP (lower panel), averaged over 2003–2015. Net implicit tax (subsidy) is shown as the deviation of domestic gasoline prices from country-level benchmarking prices with numbers below '1′ indicating net subsidies and above '1′ net taxes. Oil rents are given in percentage of GDP. Grey-color indicates missing data on the protest and/or the displayed variable.

- *Crude oil price growth:* In models of domestic fuel prices, we also control for the global oil price to more directly capture impacts on producer states' income which may lead them to adjust their domestic policies. Growth in monthly oil price data in nominal U.S. dollars is taken from the World Bank (World Bank, 2022).
- *GDP per capita growth:* General economic crises may both affect fuel prices and protest occurrence, which we account for by including GDP per capita growth. We use annual percentage growth from the previous year, reflecting the available temporal resolution of the data (World Bank, 2021).
- *Log-transformed population:* Areas with larger populations may inherently have a higher likelihood of protests simply due to more people being present. To account for this annual data on population size is taken from the World Development Indicators, lagged by one year (WDI, 2021).
- *Log-transformed GDP per capita*: Annual data on GDP per capita is taken from the World Development Indicators, lagged by one year (World Bank, 2021).
- *Democracy*: Political regime type is associated with the opportunity for mobilization. At the same time, the presence of fuel subsidies is often, but not always, associated with autocratic regimes and a lack of democratization (Fails, 2019). We use the polyarchy indicator to proxy regime type in its linear and quadratic form, lagged by one year (Coppedge et al., 2021).

4. Results

In Model 1, we start by estimating the relationship between monthly fuel price change and protest onset in an ordinary least squares regression model that includes country and year-fixed effects and protest history variables to mitigate potential issues of reverse causation. We then introduce our alternative three-month variable in models 2 and 3. Across models, domestic fuel price growth is positively related to protest onset in line with our first hypothesis. Results are more stable in the specification with the cumulative independent variable. In substantive terms, a doubling of the fuel price corresponds to an estimated increase in the likelihood of protest onset by ten percentage points. In Table 3, we instead use an indicator of larger protests (>1000 participants/month) as the dependent variable. Here, the price indicator remains positive but is no longer significant for the monthly growth variable. Overall, we find support for Hypothesis 1 in that domestic fuel price shocks increase the likelihood of protest onset in the all protest models.

Next, we investigate whether price effects are more pronounced where expectations on the government to avoid spikes are higher. In order to use all information available, we use an interaction of price growth and a flexible polynomial of the net implicit taxes/subsidies to capture these potential heterogeneous effects. We use a dummy variable to capture higher expectation on the government in the presence of any oil production in our main models. We expect here that oil production as such is important for raising expectations on the state to hold prices low, including high-income countries that are not dependent on oil.

Figs. 4 and 5 display the results for the 3-month price growth variable. They generally indicate positive point estimates throughout most of the global sample. There is more certainty about a significant effect of gasoline prices on all protests in subsidizing countries where the confidence interval does not include 0. However, the finding does not hold for major protests. Fig. 5 further indicates that oil producers tend to see protests following price increases in line with expectations and hypothesis 3. In contrast, there is no significant relationship in other countries.

4.1. Robustness

Endogeneity is a concern when using domestic prices as we do. Though we control for country characteristics that correlate with price changes, oil production, taxes, and country-fixed effects, there may still be omitted variables biasing estimates. Since our main results point to a direct impact of fuel price hikes, we zoom in on Table 2, Model 1, which is the comparatively weaker 1-month price change specification. We probe the robustness of our results in several ways. First, we conduct a placebo simulation test to explore whether the results in the main analysis could be generated by chance. We randomly allocate the values of our independent variable price change within each country year. The placebo simulation generates 1,000 different datasets through random allocation of price change values and estimates Model 1 in Table 2 on each dataset. Fig. 6 plots the distribution of the coefficients from this exercise. The red vertical line shows the estimated effect of the model estimated on the actual data. Given that values are randomly reshuffled, the coefficients from the placebo simulation are normally distributed around '0' (no effect). The red line is located towards the tail of this distribution, telling us that the estimated coefficient is unlikely to have been generated by chance.

Our second test gauges the omitted variable bias needed to overturn the results in our main regression model. We follow the sensitivity analysis procedure described by Cinelli and Hazlett (2020). We use the *sensmakr* package in R to generate the results displayed in Fig. 7 (Cinelli et al., 2020). As for the placebo test, we re-estimate Model 1 in Table 2 for the sensitivity analysis.

The left plot in Fig. 7 shows how the point estimate for our price variable would change if we included a hypothetical confounder at least as strong as the log of time since the last conflict. The right plot displays how the t-value would change. Time since conflict events is a useful confounder since it strongly predicts both protest onset and price change. The left plot shows that a hypothetical confounder that is one to three times as strong as the time since the last conflict would reduce the estimate from 0.1 to 0.08. We would, in other words, expect the estimate to be only marginally reduced in our most extreme case of omitted variable bias. However, the point estimate would remain positive. In the right plot in Fig. 7, we see that the t-value in the most extreme case of confounding would be reduced from 2.2 to 1.8. Based on these tests, we consider the evidence for our hypothesis fairly robust to omitted variable bias.

Additional tests documented in supplementary material include an estimation of main results by dropping one each country in the sample (Figs. A5 and A6), logistic regression specifications (Tables A2 and A3), controlling for general inflation (Tables A4 and A5), models estimated on split samples for subsidizing and taxing observations (Tables A6 and A7) as well as models using benchmarking prices as an instrumental variable for domestic price changes in taxing countries (Table A8). Using benchmarking prices as instrument in countries with implicit taxes did not indicate a significant relationship in this specific subset. The models of large fuel protests are generally more sensitive to model specifications. Overall, these additional tests corroborate our main results and point to a general relationship between fuel price changes and protest onset that is more pronounced in subsidizing, rather than fuel-taxing, countries as well as oil-producing countries.

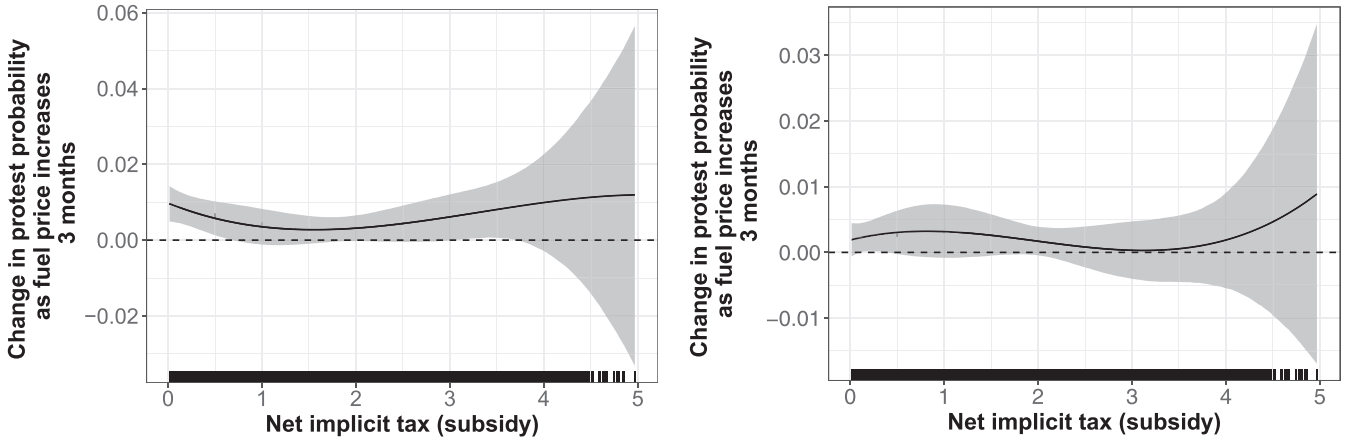

Fig. 4. Marginal effects of a three-months fuel price change by 5 percent (approx. 1 standard deviation) over range of (lagged) net implicit subsidy and tax values for protest (left) and large protest (right). Control variables set to their mean values. Rug plots (bottom) indicate observations.

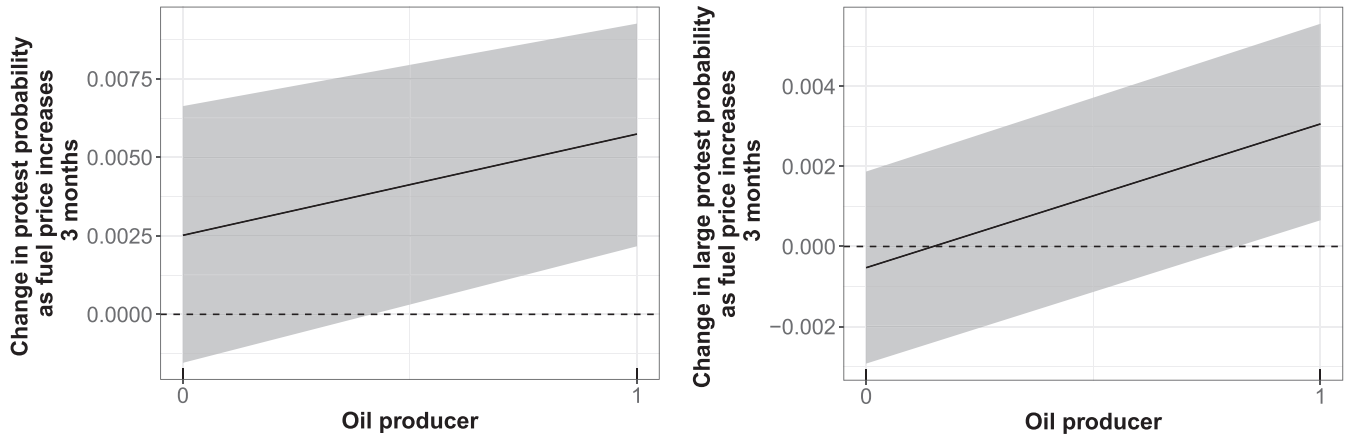

Fig. 5. Marginal effects of a fuel price change by 5 percent (approx. 1 standard deviation) for oil producing countries and other countries for protest (left) and large protest (right). Control variables set to their mean values.

Table 2
Estimated effect of fuel price changes on protest onset.

	Dependent variable: protest onset		
	(1)	(2)	(3)
Gasoline price growth 1 m	0.102*		0.016
	(0.047)		(0.052)
Gasoline price growth 3 m		0.093**	0.088**
		(0.029)	(0.033)
Months since protest	−0.002**	−0.002**	−0.002**
	(0.0003)	(0.0003)	(0.0003)
Months since protest ^{2}	0.00002**	0.00002**	0.00002**
	(0.00000)	(0.00000)	(0.00000)
Months since protest ^{3}	−0.00000**	−0.00000**	−0.00000**
	(0.000)	(0.000)	(0.000)
Logged months since armed conflict	−0.010*	−0.010*	−0.010*
	(0.004)	(0.004)	(0.004)
Crude oil price	−0.00004	−0.0003	−0.0003
	(0.0002)	(0.0002)	(0.0002)
Democracy	0.229	0.234	0.233
	(0.230)	(0.230)	(0.230)
Democracy^2	−0.240	−0.243	−0.242
	(0.261)	(0.262)	(0.262)
GDP pc growth	0.007	0.005	0.005
	(0.022)	(0.022)	(0.022)
Logged GDP pc	−0.004	−0.003	−0.003
	(0.016)	(0.016)	(0.016)
Logged population	0.045	0.044	0.044
	(0.040)	(0.040)	(0.040)
Country S.E.	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes
Observations	15,395	15,395	15,395
Adjusted R^2	0.079	0.079	0.079

Note: *p < 0.05; **p < 0.01; ***p < [0.001].

Table 3
Estimated effect of fuel price changes on large protest onset.

	Dependent variable: Large protest onset		
	(4)	(5)	(6)
Gasoline price growth 1 m	0.025		−0.030
	(0.033)		(0.043)
Gasoline price growth 3 m		0.044*	0.056*
		(0.018)	(0.025)
Months since large protest	−0.001**	−0.001**	−0.001**
	(0.0002)	(0.0002)	(0.0002)
Months since large protest^2	0.00001**	0.00001**	0.00001**
	(0.00000)	(0.00000)	(0.00000)
Months since large protest^3	−0.00000**	−0.00000**	−0.00000**
	(0.000)	(0.000)	(0.000)
Logged months since armed conflict	−0.005	−0.005	−0.005
	(0.003)	(0.003)	(0.003)
Crude oil price	−0.0003*	−0.0005**	−0.0005**
	(0.0002)	(0.0002)	(0.0002)
Democracy	0.083	0.083	0.084
	(0.213)	(0.214)	(0.214)
Democracy^2	−0.107	−0.107	−0.108
	(0.236)	(0.236)	(0.236)
GDP pc growth	−0.012	−0.013	−0.013
	(0.014)	(0.014)	(0.014)
Logged GDP pc	−0.017	−0.016	−0.016
	(0.012)	(0.012)	(0.012)
Logged population	0.017	0.016	0.016
	(0.029)	(0.029)	(0.029)
Country S.E.	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes
Observations	17,765	17,765	17,765
Adjusted R^2	0.065	0.065	0.065

Note: *p < 0.05; **p < 0.01; ***p < [0.001].

5. Discussion and conclusion

In this paper, we study gasoline prices and protests globally and specify a theoretical framework that points to economic grievances and blame attribution as important mechanisms in the relationship. Findings indicate that soaring fuel prices can lead to protests across the global sample that are directly or indirectly linked to such price changes. In line with our theoretical framework, there is evidence of a clustering of such relationships in the presence of subsidies and oil production, where populations have greater expectations that prices are held low. In contrast, price-protest relationships are weaker in countries without oil production and with substantive taxes.

These findings are broadly in line with earlier work on riots related to fuel that found that countries that subsidize prices and hold prices fixed are more likely to see fuel riots (McCulloch et al., 2022). Importantly, we find here that protests more generally respond to price changes, not only protests explicitly concerning fuel prices. The effect can be explained by the indirect effects of fuel on prices on basic needs and the function of visible shocks like fuel prices as triggers of protests around more fundamental grievances. Our findings also demonstrate that fuel prices drive both riots and peaceful protests. A comprehensive set of robustness checks corroborates the main results.

Our study contributes to the broader literature on economic grievances and grievances more generally as drivers of protests. In particular,

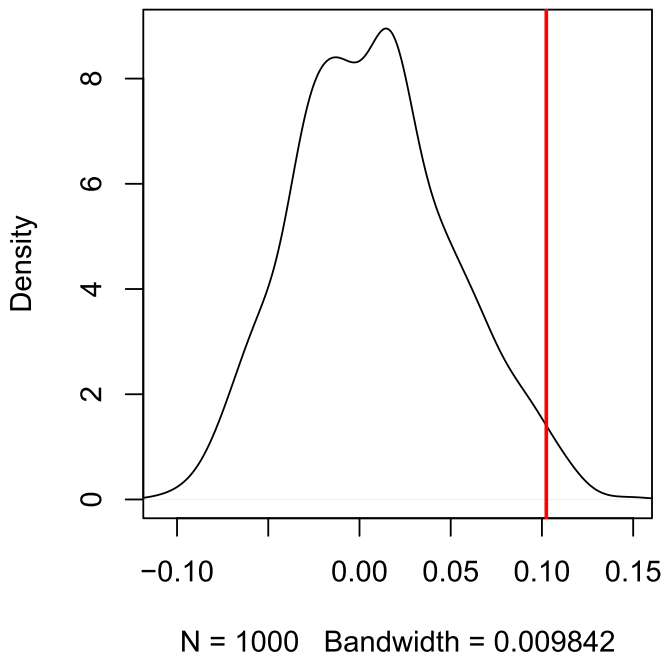

Fig. 6. Placebo simulation. The figure shows the distributions of coefficients when the values of price change are randomly assigned within country years in a placebo simulation. The vertical line indicates the estimated coefficient in Model 1, Table 2.

in line with the emerging scholarly discussion focusing on questions of how different issues can be more mobilizing than others when such issues are more attributional to governments and can help to mobilize across cleavages (Abbs, 2019; De Juan & Wegner, 2019; Javeline, 2003; Thomson, 2018) we here demonstrate that fuel prices in general, but in particular for subsidizing and petroleum-producing countries, increase the propensity for the mobilization of protests.

This mapping of global relationships forms a base for future context-specific studies into climate-friendly subsidy and tax reforms. A limitation of our study is that taxes and subsidies could only be studied using indirect measures in relation to global marked prices, in the absence of comprehensive data on taxes and consumer-subsidy policies at the global level. Future research should investigate changes in government policies in more depth, precision and nuance ideally collecting more nuanced such data across a number of cases.

A particularly critical question for further research is the policy design of taxes and subsidy reforms, respectively. Public transformation policy research emphasizes the need for complex policy packages that bundle policy instruments to create synergies and compensate losers. For fuel subsidy cuts research emphasizes the "packaging" of policies so that the most vulnerable in societies are protected (McCulloch, 2023; Schaffitzel et al., 2020; Skovgaard & van Asselt, 2018) though see also (Harring et al., 2023). For carbon taxes, earmarking additional revenues for environmental purposes may help to increase acceptance (Beiser-McGrath & Bernauer, 2019; Carattini et al., 2018) as well as simultaneous tax cuts in other fields (Jagers et al., 2019). However, we have little evidence for the effectiveness of these approaches across cases.

A related point is the speed of change. Sweden's carbon tax, introduced as early as the 1990s and successively increasing since then, has been hailed as a success story for the climate (Andersson, 2019). However, even these incremental changes have recently been questioned by fractions of society during generally high price levels. Further research is required on the optimal speed and timing of policy changes.

The framing surrounding the fuel prices is also important to take into account. Most of the price spikes are not the result of climate policies but rather due to fiscal or other economic reasons unrelated to countries' environmental concerns though their effects on consumers are similar (Skovgaard & van Asselt, 2018). It is possible that fuel price increases can be accepted somewhat more readily if they are framed and anchored in a climate change mitigation framework. However, it is questionable whether reframing is enough to garner support (Fesenfeld & Rinscheid, 2021). Interestingly, case study evidence from Sweden and France indicates that protest participants were not climate change deniers. They could even accept climate policies but lacked trust in government more generally (Driscoll, 2023; Ewald et al., 2022). Finally, it could also be relevant to explore whether protests as a result of price increases demonstrated here have further implications for support to politicians in

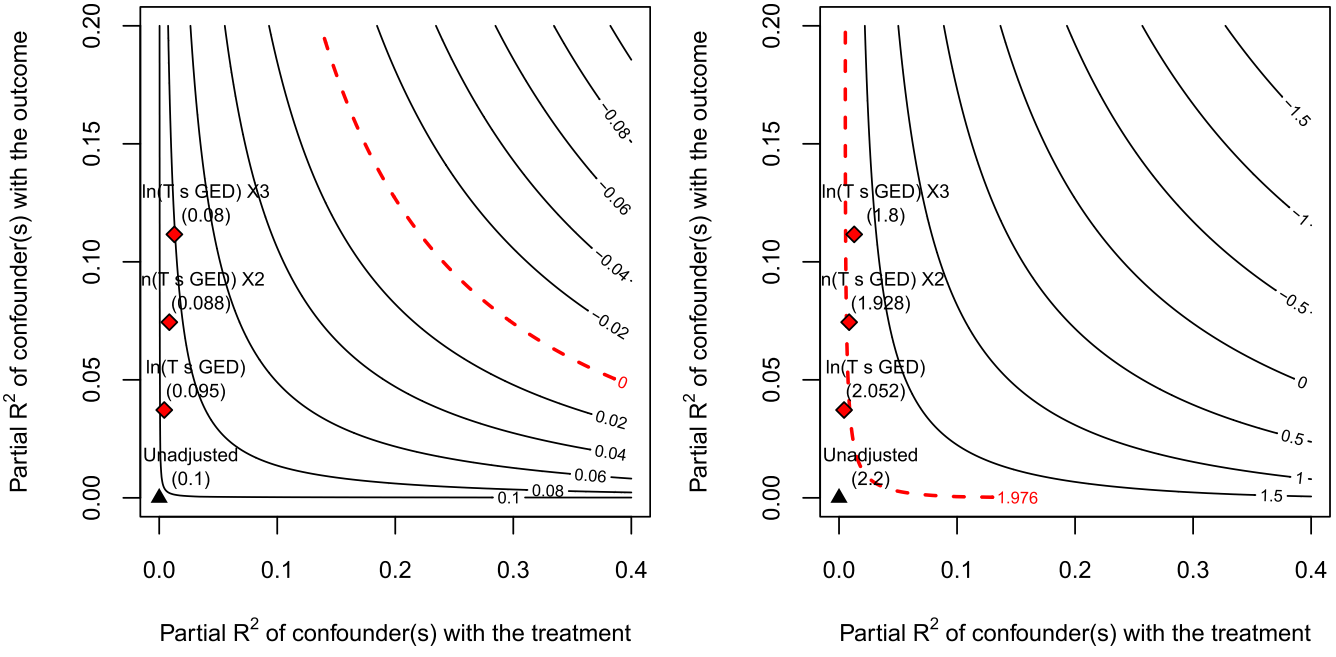

Fig. 7. Sensitivity analysis. The left plot shows point estimates for our main independent variable when including hypothetical confounders, which are one to three times stronger than the time since the last conflict ln*(T s GED)* based on Model 1 in Table 2. The right plot shows t-values for our independent variable using similar hypothetical confounders. Additional alternative model specifications and tests are documented in the appendix, corroborating the results presented here.

elections and their political survival.

Though not always framed as an environmental issue, increasing the price of fossil fuels is a vital instrument to incentivize the reduction of greenhouse gas emissions and mitigate climate change. However, mitigating climate change may be a conflictual process generating winners and losers and, consequently, dissent and outrage in some contexts. Indeed, earlier work emphasizes how difficult it is to reform fuel subsidies and points to a track record of failures in reform attempts (Mahdavi et al., 2022; Martinez-Alvarez et al., 2022; McCulloch, 2023). In this study, we have explored one of the elements of this process – increasing fuel prices as a driver of protests – and found it indeed to link to protest across the global sample. Further work on the conditions under which governments can implement reforms for increasing the price of carbon while preserving societal peace is an ever-so-urgent task.

CRediT authorship contribution statement

Nina von Uexkull: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Espen Geelmuyden Rød:** Conceptualization, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – Review & Editing. **Isak Svensson:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

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

Data availability

Replication data will be made available upon publication at https://www.pcr.uu.se/data/replication-data/

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.worlddev.2024.106536.

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