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Fuel riots: definition, evidence and policy implications for a new type of energy-related conflict

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Abstract

'Fuel riots' are a distinct type of energy-related conflict. We provide the first fuel riots database and explore their social, economic and environmental drivers. The analysis demonstrates links between fuel riots and high international crude oil price in countries characterised by weak state capacity, deficient governance, fuel scarcity and poor economic performance. We suggest a potential causal pathway for fuel riots: when international fuel prices spike, net fuel-importing countries bear higher costs. If these countries are politically unstable and their government inefficient, the likelihood of fuel riots is high. Wealthier countries can absorb price increases and maintain subsidies, as opposed to poorer societies where fuel riots are more likely. Our findings demonstrate the role of state capacity and socio-economic conditions in enabling conflict and will inform policy by identifying fertile ground for fuel riots, i.e. societies likely affected by increases in fuel prices due to scarcity and climate action (such as carbon taxes). We propose that policies which better control international prices and action designed to reduce political instability in vulnerable countries are key to preventing fuel riots. Fuel subsidy reform must anticipate popular opposition and mitigate its impact upon vulnerable populations to reduce the likelihood of instability and minimise hardship.

Keywords: fuel riots; energy protests; environmental conflict; energy security; fuel price; energy policy

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1. Introduction

The period 2008-2011 saw an apparent upsurge of incidents of unrest associated with social deprivation, in several countries. This has driven interest in natural resources, socio-economic conditions, and environmental changes as factors which may exacerbate or cause instability and conflict (Raleigh et al. 2015; Burke et al. 2009). As an example of these dynamics, research on instability related to rising food prices has explored if food riots may be an indicator of broader risks of unrest (Hendrix and Haggard 2015; Bellemare 2014; Smith 2014; Natalini et al. 2015; Weinberg and Bakker 2015). Fuel riots have received far less attention, yet fuel insecurity is a key consequence of global social-ecological stresses as growing scarcity and increasing prices have an impact upon societies. This is particularly relevant today, for two principal reasons.

Firstly, the link between fuel insecurity and instability is increasingly acute in fragile and conflict-prone societies, as a result of state incapacity in parallel with growing demands on the part of consumers. Thus, environmental stresses and fluctuating international fuel prices are having an inflationary impact upon local fuel prices at a time when many states are unable to mitigate rising prices or manage societal grievances. In the context of broader social, ecological and political stresses – both local and global – fuel insecurity may therefore be an indicator of potential instability and conflict. It also provides a link between international economic trends, national institutional capacity and effectiveness, and local security dynamics.

Secondly, the impacts of fuel insecurity can be seen not only in low and middle income societies – as is generally the case with food insecurity – but across a range of countries with different levels of economic capacity, as a result of recent pressures. In particular, pressure to introduce carbon taxes and reduce fuel subsidies in order to reduce greenhouse gas emissions has generated strong and sometimes violent popular protests in different contexts (such as those in France at the end of 2018 and Ecuador in 2019). In light of forecasts for the availability of fossil fuels and pressures to decrease their use, there is therefore a pressing need to understand how fuel insecurity may contribute to societal instability, in conjunction with other social, political and institutional factors. This can contribute to debates about the driving forces of instability in relation to issues of social justice, economic downturns, and human security, as well as the unintended consequences of climate action aimed at reducing fossil fuel use. In addition, the inter-linkages across space (between global and local) and sectors (environmental, socio-economic, political) in the relationship between fuel insecurity and instability provide important insights into how complex global stresses have an impact in the local context and, most importantly, how these can be taken into account in future policies.

Instability related to fuel price increases – whether the result of external inflationary pressures or the withdrawal of price subsidies – can be explored as a key proxy for deeper conflict drivers, at a time when instability and societal fragility are increasing (Dupuy and Rustad 2018). In broader

perspective, this subject also provides an unexplored angle for the idea of 'synchronous failure', a process which describes how multiple stresses in different social-ecological systems combine to generate instability and disruption both locally and globally (Homer-Dixon 2015). In turn, this topic demonstrates how action to reduce climate change – through, for example, fuel subsidy reform – can generate significant political and societal opposition. Results from this analysis will provide key insights on the connections between these different topics and inform energy policies at different levels aimed at preventing energy-related conflict in fragile contexts and managing resistance to interventions aimed at reducing the use of fuel.

This paper explores fuel riots as a form of energy-related intra-state conflict, and presents the first database of events of this phenomenon, occurring globally. This data shows that fuel riots are significantly affected by high international fuel prices, national political instability and government ineffectiveness, national availability of the resource, and economic development. The overarching research question is whether and how governance capacity and performance (in conjunction with socio-economic conditions) determine the incidence of fuel riots during times of increasing fuel prices and decreasing availability.

2. Background and context

No peer-reviewed academic research is available to date specifically on the significance of fuel riots. However, previous research has explored other types of fuel-related conflict and its relationship with scarcity, abundance, and energy prices. This research is fragmented and often points to contradicting results. In terms of interstate conflict, a key theme in existing research is whether high oil prices encourage oil-exporting states to act more aggressively and whether such states are more conflict-prone, with a significant amount of research finding a positive relationship (Colgan 2013; Colgan 2010; Hendrix 2017; Weeks 2012; Friedman 2006). The question of whether states engage in 'oil wars' – international wars driven by the desire to secure access to oil – is more contested (Meierding 2016; Colgan 2014). In terms of a possible relationship between energy prices and intrastate armed conflict and instability, the evidence is equally controversial. A significant amount of research has found that abundant natural resources, and in particular oil, is a 'curse', particularly in states with fragile institutional capacity, since it fuels corruption, neopatrimonialism, rebellion and sectarian conflict (Le Billon 2013; Ross 1999). On the contrary, different research findings suggest that oil abundance, including the sudden discovery of oil, does not significantly increase the likelihood of intrastate armed conflict irrespective of other factors and conflict drivers (Cotet and Tsui 2013). Some research also suggests a positive link between oil price spikes and democracy in oil exporting countries (Brückner et al. 2012). In terms of other essential commodities, research has found a strong link between prices and conflict (Besley and Persson 2008; Brückner and Ciccone 2010; Dube and Vargas 2013; Bazzi and Blattman 2014). Most of this research focuses upon a possible link between oil and armed conflict and rebellion, rather than fuel prices as a source of instability

below the level of armed conflict. A specific focus upon the significance of fuel riots is a conspicuous gap in these debates, given the importance of riots and the possibility for major protests – whatever their cause – to escalate into broader political movements. Pressures to reduce carbon fuel use through increased taxation or the reduction of subsidies - and thus drive consumption costs up - is a new dimension to this topic that provides added salience.

Fuel subsidy reform is, theoretically, an important driver of contemporary societal instability – including fuel riots – that is anecdotally demonstrated in a number of cases, including Sudan in 2013, France and Jordan in 2018, and Egypt, Iran and Ecuador in 2019. This provides a direct link between global changes in fuel use and local political dynamics, and illustrates how government interventions can generate significant opposition. Subsidies, in the form of domestic undercharging, have been estimated to be $5.3 trillion in 2015 globally, which constituted some 6.5% of global GDP (Coady et.al. 2017; see also Kyle 2018). The environmental impact of such subsidies – as a result of fossil fuel usage – is also substantial (Cheon et.al. 2013; Bordoff et.al. 2015; Burniaux et.al. 2014), and there is increasing pressure to reform such subsidies as states aim to meet international agreements on reducing climate change emissions (Intergovernmental Panel on Climate Change 2001; Parry et.al. 2014; Intergovernmental Panel on Climate Change 2014). For many countries, economic downturns and public fiscal constraints also generate pressure to reduce subsidies as a part of austerity programmes. Although there is some disagreement about the global value of subsidies and thus their significance (McKitrick 2017), these pressures have led governments to commit to subsidy reform and carbon taxes, and this results in price inflation – or the threat of inflation.

Existing research on the impact of food price increases (Bellemare 2014; Hendrix and Haggard 2015) – which are comparable in terms of their effect upon households – suggests that subsidy reductions, or the prospect of such reductions, can generate acute grievances which may be manifested in riots, in particular in societies which are vulnerable to instability and more prone to conflict in general. Yet, as Kyle (2018) demonstrates, rising fuel prices – including through the reduction of subsidies – have occurred in a number cases without significant resistance or upheaval, and this is linked to perceptions of fairness and legitimacy in governance and the cultivation of popular support for change. Given that pressures to reduce fossil fuel usage are likely to continue into the future, the management of fuel subsidy reform and the mitigation of the impact of this reform is a pressing but under-explored challenge. Therefore, while though fuel subsidy reform provides an effective tool for reducing climate change emissions and is an important part of economic reform, existing research (Ross, et al. 2017; Kyle 2018; Blondeel et al. 2019) points to the difficulties that governments have in implementing such reform and the importance of framing reform in the context of broader policy packages aimed at social protection and normative goals. Fuel riots may therefore suggest a major political obstacle to energy policy changes which need to be anticipated and managed.

A number of theoretical lines of inquiry provide the starting point for the analysis in this paper. Fuel riots may be an expression of absolute deprivation, where fuel importing countries cannot protect their economies from rising fuel costs, and significant numbers of people are tipped into abject poverty. In this scenario, it would be expected that societies which experience major, recurring fuel riots reflect a high proportion of household income committed to domestic fuel, low incomes, and relatively weak social protection. Weak government capacity to mitigate the increase of fuel prices – or an unwillingness to mitigate price increases – may also be relevant. A related but alternative theoretical model posits that fuel riots are not necessarily an expression of absolute destitution, but rather contentious politics more broadly, associated with inequality, poor and unresponsive governance, corruption, and a history of instability. In this scenario, fuel riots may be associated with societies – notably not only low-income ones – where there are existing grievances related to government performance, perceived corruption or absence of accountability. It is in this scenario that fuel riots may be an indicator of broader political fault lines and the potential for wider instability.

An overriding theoretical model which is relevant to absolute deprivation *and* contentious politics is to consider the role and significance of state capacity and performance in the onset of instability related to fuel prices, across societies which have different social and economic conditions. State capacity and performance play a key role in determining how and to what degree international fuel price increases are translated into the domestic market – and thus, how exposed consumers are to increases – and in cushioning households from price increases. In theory, consolidated states which have a high level of institutional capacity and excess fiscal resources are better placed to cushion households in this way and provide societal resilience. In such states – which are more likely to be middle or high income societies – a relatively lower proportion of household income tends to be spent on essential fuel needs, which provides a further cushion. Moreover, we would expect functioning democracies to be more sensitive to increasing social precarity and more accountable and responsive, and thus more likely to intervene in order to mitigate the effects of sharp price inflation. All of these theoretical assumptions seem to be supported by the broad relationship between consolidated democratic governance, income levels, and public service delivery.

In contrast, states which perform poorly in terms of human development – a measure of human health, longevity, education and standard of living (UN Development Programme 2019) – are less likely to be consolidated, democratic states, and theoretically less likely to be resilient to price shocks. However, there are a number of countervailing factors at work. Some consolidated democracies have taken the lead in implementing fuel subsidy reductions in line with commitments to reduce climate change emissions, which can generate opposition. In addition, democracies are certainly prone to riots and ongoing instability linked to price inflation in various commodities. For example, Hendrix and Haggard (2015) demonstrate that democracies are more likely to experience urban unrest during periods of high food prices than autocracies,

because of their permissive political systems. While there may be comparisons between the dynamics of instability related to food price and fuel price inflation, the latter may be experienced in a broader range of societies and regime types, given the pressure to reduce carbon fuels.

Government interventions thus play a major role in mitigating the impact of fuel price increases and dampening the expression of grievances related to this in a variety of settings. However, the role of governments depends both on their capacity and their willingness to act in this way, which is not equally shared. Low-income countries which have weak institutions and fragile public finance reserves, and also net oil importing countries, are theoretically more vulnerable to fuel price increases and less able to cushion consumers from price shocks. Yet anecdotal evidence – provided from the widespread public protests in France in 2018, for example – suggests that it is not only low-income countries which are vulnerable to instability related to fuel price grievances. Indeed, as pressures to reduce fuel usage grow in line with attempts to reduce climate change gasses, government interventions – to increase fuel tax or reduce subsidies, for example – can generate grievances in otherwise highly functional states, with critical and unresearched consequences for policy design and implementation. This suggests that societies which are heavily dependent upon fuel use, both at the national and household levels, may be vulnerable to this type of instability even though they are not low-income countries.

There are, therefore, increasing pressures for governments to refrain from interventions aimed at reducing the cost of fuel used for household consumption or mitigating price inflation, in the interests of managing climate change (Intergovernmental Panel on Climate Change 2001; Intergovernmental Panel on Climate Change 2014). Societal instability associated with fuel price spikes – or the threat of increases – therefore reflects a significant challenge to the reform of energy policies that must be better understood in order to inform energy policy development.

3. A definition of fuel riots

The concept of 'fuel riots' is imprecise and has been applied to different events, with little discussion of a definition in the literature. The term 'fuel' is broad, which makes it difficult to identify which energy resource is the subject of the grievance. In this paper fuel riots are defined as incidents of significant unrest – riots, demonstrations, major protests – where grievances over fuel prices, the prospective removal of subsidies, or fuel availability were specifically identified as a factor which motivated people involved in the violent event. In this context, fuel refers to a refined product: oil or gas used for essential heating, cooking, and for running vehicles. In order to qualify as a relevant event for this study, grievances related to the price and availability of fuel need not be the only factor which drives incidence of instability; indeed, such riots often occur in societies which also experience protests and upheavals related to other social, economic and political issues. However, according to this definition, fuel-related grievances must be an explicit

contributing factor as expressed by participants, and this makes them a distinct category of events.

Using the definition above, we collected data for fuel riots for the period 2005-2016, following the methodology discussed in the next section. Figure 1 shows the number of fuel riots in countries for the whole period.

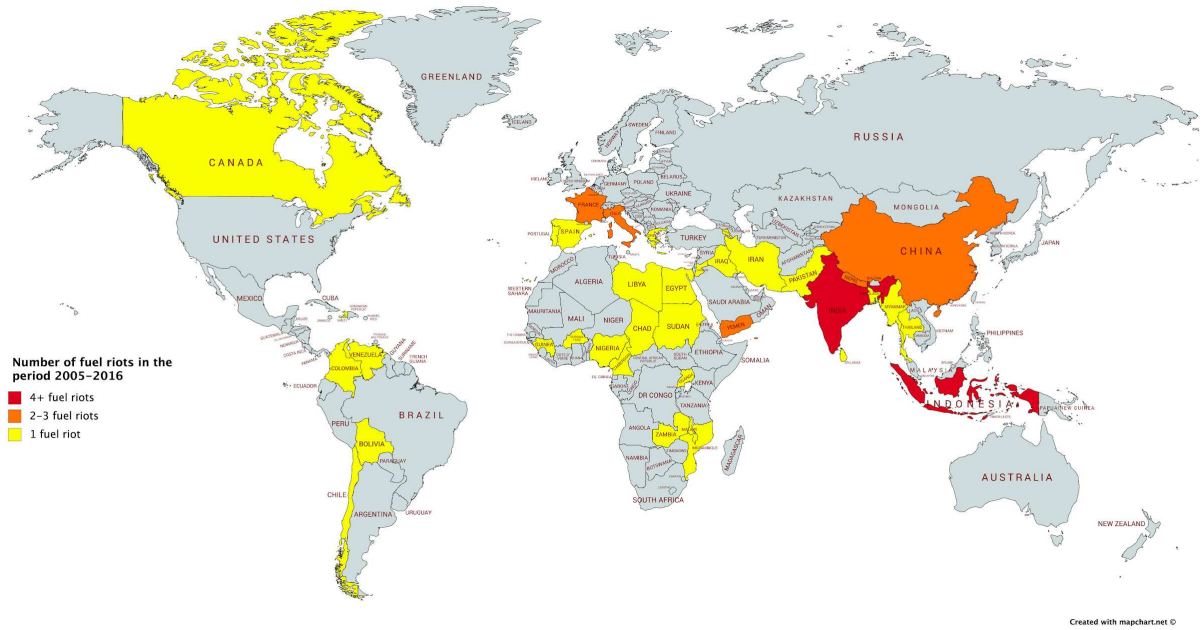

Figure 1. Number of fuel riots in countries for the period 2005-2016.

The map clearly shows that this type of event is not confined to any one geographical area nor does it show a clear developed/developing country divide, but rather every continent and countries with different characteristics can experience these events. However, countries that experienced more than one episode seem to be concentrated in South/South-east Asia. The countries that experienced the largest number of fuel riots throughout the period are India (6), Indonesia (5), China (3), Yemen (3), Nepal (2), France (2), Italy (2), with all other countries experiencing only one episode.

4. Methodology

Data collection. The analysis in this paper is based upon an original database for fuel riots covering the period 2005-2016, the only database for this type of event available at this time. Data was collected for events that met the definition of fuel riots explained in Section 2 by undertaking an exhaustive search of publicly available media sources using combinations of keywords (such as “fuel riot”, “fuel conflict”, “fuel violent protest”, etc.) to identify news articles

in English that reported the occurrence of relevant violent events. Search terms were adopted following a pilot stage during which a variety of search terms, in combination, were assessed for their effectiveness in identifying relevant events and excluding false reports. Reports of events were corroborated by double checking to confirm relevance and avoid duplication. Although rudimentary, the 'manual' data collection constituted the best and easiest option to avoid duplicates and to collect a database that was accessible and open-source (for a discussion on empirical challenges on event data collection with an example for food riots see for instance Newman (2020)).

Large-scale databases containing data for conflict events do exist (such as Global Database of Events, Language and Tone (GDELT 2019) and the Uppsala Conflict Data Program datasets (Croicu and Sundberg 2017)) but these do not provide a source for the data points or classify them by cause. Therefore, in order to generate a dataset of events on incidents of violent instability specifically linked to grievances related to fuel prices and lack of access to energy products, a manual search constituted the best option. As the sources used inconsistently reported information about riot size in terms of number of deaths or injured (if any) or participants, it was not possible to derive a reliable numerical estimation of the riot intensity according to our event definition. Literature on event data collection from news sources also commonly assigns intensity based on the extent of coverage (e.g. number of articles published on the event), which in this case we excluded because media popularity of a riot does not equate to size or significance of the conflict (for a discussion of this topic related to food riots, see Hossain (2018)). We therefore decided to binary code the riot occurrence, which reduced the amount of information available for the analysis but avoided the risk of introducing significant inconsistencies and further uncertainty in the data used. To ensure the reliability of the events data, the most important goal – which was met – was that the definition was rigorously applied in identifying cases, in order to ensure that the events reflected a reliable global picture of instability related to fuel price increases. The final database contains 59 records (fuel riot events) with related references to source newspapers, is displayed in graphical format in Figure 1 and is available in the Supplementary Materials.

Using this events data, the methodology is designed to test the hypotheses reported in the first section of this article. To do so, we explore the relationship between fuel riots and the following variables: 1) *International price of crude oil* was tested in order to establish if international price inflation has an impact upon consumers within local markets. In a parallel academic debate – relating to international commodity prices and food riots – there has been a discussion as to whether international or local prices should be used, given that it is local market prices that consumers are exposed to (Newman 2020). This test is therefore to establish the basic proposition that there is a positive relationship between international fuel markets and instability related to fuel price increases; 2) whether a country is a *net importer of fuel*, which explores the question of whether net importers are more vulnerable to fuel price shocks linked with inflation

in international price of crude oil; 3) two measures of political stability and effectiveness of governance, i.e. *national political stability* and *government effectiveness*, as this is relevant to the theoretical proposition that functional, stable polities are more effective at mitigating the impact of fuel price increases, and less likely to suffer from broader grievances that can be exacerbated by price increases; 4) the type of regime that characterises each country, to test the proposition that illiberal and democratic states (and other forms in-between) are equally susceptible to experiencing fuel riots; 5) linked with this, whether stable, fuel-exporting countries have an increased capacity to cope with high prices is therefore also explored. As a general indicator of national economic capacity – which is associated with institutional effectiveness as well as incomes – *deflated per capita Gross Domestic Product (GDP)* is explored; 6) whether countries with higher GDP which export fuel have an increased capacity to cope with high prices, in order to differentiate between different types of fuel exporters. Finally, we tested *population growth* (% per year), since rapid population growth is associated with an increased likelihood for societies to experience instability.

Data analysis and sources. All statistical analyses were performed using the *R 3.4.4* platform (R Core Team 2018). The mixed-effects models were estimated with the functions *lme4* and *lmerTest*. The relevant tests were based on Satterthwaite's approximation of the degrees of freedom. The quantitative models test our assumption of a causal relationship travelling in the direction of prices to riots by introducing fuel prices as predictor and riots as outcome. It is certainly possible that the opposite direction of causality can occur – because, for example, riots in oil-exporting countries can reduce fuel availability at the international level and have an inflationary effect upon prices – or that there is a mutual influence between the two variables. Given the relatively small size of the data, it was not possible to formally test our assumption about the direction of causality (for example, through the Granger causality test), but nevertheless an examination of the media sources regarding incidents of instability confirms the general nature of fuel riots as being caused by price increases or the threat of increases.

Figures for the variables tested with the models were sourced from different freely available databases. As regards data for fuel prices, we evaluated the effect of the international price of crude oil. This is because oil is the only energy resource with a really global market and international price and retains the world's largest share of total primary energy supply (International Energy Agency 2016). Data for the international price of crude oil was sourced from the US Energy Information Administration (EIA 2018) which provides data for two spot prices: Cushing, Oklahoma (WTI) and Brent, London (Brent). Due to the highly globalised nature of the crude oil market, and that the two tend to move together (Hammoudeh et.al. 2008; Reboredo 2011), the measure for international fuel prices evaluated in this paper is the simple average between the two benchmark prices. Data for the variable 'Net energy production' was sourced from US EIA International Energy Statistics Database (Energy Information Administration 2018). Data for national fuel consumption was subtracted to production for all

countries available to determine whether countries were net importers or exporters for each year. The variables used were: 'Total petroleum and other liquids production' for fuel production and 'Petroleum consumption' for fuel consumption, both available in '1000 bbl/day'. These were transformed to '1000 bbl/year' for consistency with other variables evaluated here. Although there was an inconsistency between the names of the variables available on the online tool and those defined in the metadata provided by the institution, personal correspondence with a data analyst from the institution confirmed that those variables available in the tool were in fact the variables 'Total Oil Supply' and 'Total Petroleum Consumption' defined in the metadata and were therefore selected for our analysis.

To capture political stability and government effectiveness data for two indicators were sourced from the World Bank Worldwide Governance Indicators database (WGI) (World Bank 2018a). The indicator 'Political stability and absence of violence' was chosen following the positive performance with a similar type of events, i.e. food riots (Natalini et al. 2015; Natalini et al. 2019). This indicator measures perceptions of national political stability and is developed by combining different socio-economic variables and expert opinion (World Bank 2018b). The second indicator chosen from the WGI database is on 'Government Effectiveness' to further investigate the significance of quality governance for the occurrence of fuel riots. This indicator measures perceptions of the quality of services and policies provided by the state, its independence from other forces and its credibility in the eyes of the population (World Bank 2018c). For the purposes of this quantitative assessment the scoring system for the indicators was reversed so that countries with negative scores are deemed to be more stable/with effective governance, and those with positive scores are classified as more fragile/with less effective governance. This allowed provision of more intuitive results. Data for the countries' regime type variable was sourced from the Polity IV database (Marshall et al. 2018a). The variable used for this study is 'Polity2', which classifies countries' polity on a scale that ranges from +10 (strongly democratic) to -10 (strongly autocratic) (Marshall et al. 2018b). Finally, GDP per capita, GDP (constant 2010$) and population growth data for the countries and years under consideration were extracted from the World Bank *World Development Indicators* database (World Bank 2018d).

To investigate the effect of prices, governance and fragility, regime type, fuel scarcity, economic performance and population levels on riots, we estimated a logistic mixed-effects model where all the variables listed above were used to predict the occurrence of fuel riots in a given country and year. As some of the variables in our dataset were measured on vastly different scales, which may have biased the estimations, all predictors apart from the ordinal 'regime type' variable were first standardised to have mean zero and standard deviation one. To take into account the repeated observations for the same countries in the period taken into consideration, a random effect[i] was introduced at the country level. Besides the pure fixed effects for the variables, two interaction effects were included in the study: 1) between the Political stability indicator and net

fuel exports and 2) between per capita GDP and net fuel exports, to test the hypotheses that stable, fuel-exporting countries, and wealthy, fuel exporting countries have an increased capacity to cope with high prices, i.e., a resilience going beyond what one should expect on the basis of the pure effects of these four variables.

The results presented here, despite their significance, present limitations, particularly in terms of the data collection method and the data that was collected. The most reliable method to collect event data for environmental conflict still remains manual collection, which can be prone to error unless the occurrence of events are carefully corroborated, which makes the process time consuming. Nevertheless, when the collection of event data using this approach is thorough and subject to careful review – as in this article – the results provide a rigorous representation of this type of social phenomena. The data collected also presents limitations, which mainly relate to missing data – due to lack of availability or non-reporting – and reporting bias. Data for some of the variables tested still have a patchy coverage, therefore making quantitative research challenging. This can simply be due to an impossibility to collect these data for logistic reasons or due to the collection method implemented by the agency or official body in charge or, more seriously, this could be due to lack of reporting. Governments, especially non-democracies, are not always willing to provide this kind of socio-economic data and sometimes purposefully obstruct the release of this information and the reporting of conflict events within their borders. Increased efforts should therefore be dedicated by international organisations such as the United Nations and the World Bank to generate the incentives necessary for these governments to provide data, which will deepen understanding of conflict drivers.

Reporting bias can also have important effects on data for this type of event. Although the use of data derived from newswire sources to identify events is well-established – including in reputable initiatives such as the Uppsala Conflict Data Program – the potential for reporting bias exists (Bellemare 2014; Hendrix and Salehyan 2015; Weidmann 2016). If newswire reports do not include definitional search terms, there is a risk that events will not be recorded as relevant, which can distort analysis due to under-reporting. This is mitigated by the likelihood for events to be reported by multiple news sources – which was confirmed in the process of gathering data on fuel riots for this research – and this reduces the likelihood of omissions. Moreover, a variety of search terms must be piloted in order to generate a high level of reliability in identifying relevant stories, and this was also done in the research for this article. There is also the possibility of bias in reporting in line with fluctuating media interest in fuel riots or riots in general, so that journalists and media organisations may be more active in recording such events at specific times. However, while this may be associated with data on food riots (because they were associated with a conspicuous spike in international food prices between 2008 and 2011) there is less reason to believe that reports of fuel riots reflect time-specific media interest. The fact that newswire data on fuel-related instability exists for earlier historical periods confirms this. We can assume, therefore, that the use of newswire sources does not result in an unduly

distorted or exaggerated picture of the incidence of social unrest. Careful corroboration of recorded events also ensures that definitional requirements are met and that events were not recorded more than once.

5. Results: determinants of fuel riots

Data on fuel riots were collected in line with the definition reported in Section 3 and analysed according to the procedure presented in the methods section (Section 4). A review of the articles gathered in the online search used to collect data points presented a number of general categories of factors as spark for the riots. These were: a) a reduction of subsidies on energy commodities, b) governmental policies that resulted in increased prices of energy or petrol, c) a general increase in the cost of living and commodities, amongst which energy and petrol were significant, and d) some form of actual scarcity of the resource or rationing. These findings clearly identify scarcity and price, and therefore access to fuel, as the principal factors driving the riots. The first statement on energy subsidies could not be formally tested with our methodology due to the lack of historical data from a large sample of countries.

Descriptive analysis suggests a positive relationship between international fuel prices and the occurrence of riots at the country level (Figure 2). This was especially clear for the 2008 peak but the 2011-2013 period also showed both sustained price levels and the occurrence of riots in many countries. In addition, the frequency of riots seemed to decline in parallel with the reduction of prices after 2013.

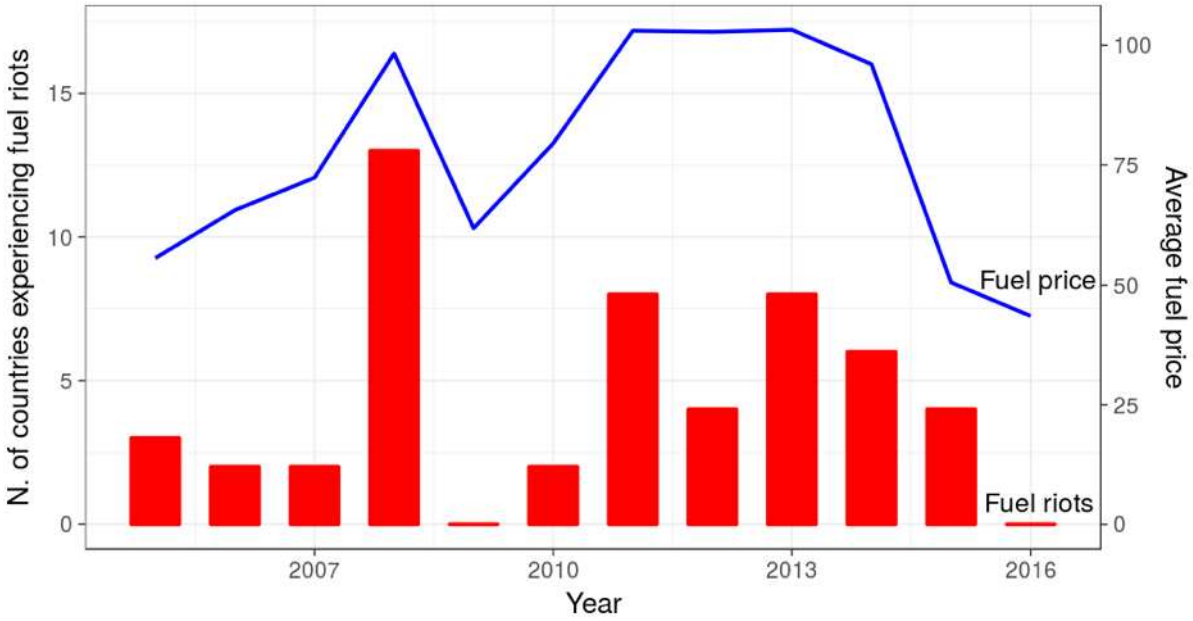

Figure 2. Fuel price and number of fuel riots per year 2005-2016.

In Table 1 we present the results from the three quantitative models where we tested the effect of the dynamics identified above on the occurrence of fuel riots in countries. All models therefore had fuel riot (i.e. binary variable 0/1) as the dependent variable and different mixes of economic and political variables as independent variables. In Model 1 we tested the effect of international crude oil prices, regime type, political stability (via the political stability and absence of violence indicator), whether a country is a net fuel exporter and the interaction effect between the last two factors. Results show that the effect of both crude oil price and political stability on the occurrence of fuel riots are positive and highly significant, meaning that countries that are politically unstable are more likely to experience fuel riots and the situation is exacerbated by an increase in fuel prices. The effect of a country being a net fuel exporter is negative and significant, meaning that fuel exporting countries tend to be less prone to experiencing fuel riots - which seems to be intuitive since such countries tend to be more affluent, and less reliant on the international market for the supply of fuel, and are therefore less exposed to spikes in the international price of fuel. However, contrary to our hypothesis, this predictor had no significant interaction effect with political stability, as the interaction term is not significant. In accordance with our proposition, regime type does not significantly affect the occurrence of fuel riots. In theory, the relationship between fuel prices and riots need not be strictly uni-directional; societal instability can have an inflationary impact upon fuel prices at the local level. However, the events included in this study are related to the price to riot direction as all the newspaper articles reviewed connect the demonstrations reported as a clear response to the increase in the price of fuel.

Due to the possible endogeneity that may affect the indicator on political stability and absence of violence, we corroborate our findings on the effect of governance and policy as a key factor in whether a country experiences a fuel riot by testing another variable from the WGI database more specifically connected to the quality of governance, i.e. Government Effectiveness. In Model 2 we added the main variables that we are testing in this study, apart from the Polity variable on regime type as this variable captures similar information and is therefore highly correlated with the new variable introduced. The results from Model 2 confirm the findings from our first model, showing that the quality of policy and governance, in the form of government effectiveness in this case, is indeed a significant factor in the occurrence of fuel riots. In particular, the significance and sign of the relationship shows that countries characterised by effective governments are less likely to experience fuel riots. The effect of international prices of fuel and being a net fuel exporter remain significant and their sign unchanged.

	MODEL		
	1	2	3
INTERCEPT	-4.808***	-5.195***	-4.862***
	(0.363)	(0.403)	(0.460)
FUEL PRICE	0.756***	0.711***	0.748***
	(0.198)	(0.192)	(0.200)
POLITICAL STABILITY (REVERSED)	0.765***		
	(0.200)		
NET FUEL EXPORTS	-0.405*	-0.494*	-0.737**
	(0.173)	(0.201)	(0.242)
NET FUEL EXPORTS × POLITICAL STABILITY (REVERSED)	-0.365		
	(0.247)		
POLITY IV	0.119		-0.057
	(0.216)		(0.242)
GOVERNMENT EFFECTIVENESS (REVERSED)		0.595*	
		(0.239)	
PER CAPITA GDP			-0.680*
			(0.307)
POPULATION GROWTH			0.033
			(0.162)
NET FUEL EXPORTS × PER CAPITA GDP			0.369
			(0.221)
N. OF OBSERVATIONS	1,769	2,132	1,714
LOG LIKELIHOOD	-195.5	-211.6	-193.4
AKAIKE INF. CRIT.	405.1	433.2	402.8
BAYESIAN INF. CRIT.	443.4	461.5	446.4
CONDITIONAL R^2	0.425	0.509	0.455
MARGINAL R^2	0.213	0.135	0.180

Table 1. Logistic mixed-effects model on the occurrence of fuel riots. Model (1) includes the reversed Political Stability indicator as fixed effect, along with regime type, fuel price and net fuel exports. Model (2) includes the Governance Effectiveness indicator as fixed effect, along with fuel price and net fuel exports. Model (3) includes per capita GDP as fixed effect, along with regime type, fuel price, population growth and net fuel exports. All data are standardised

and countries are included as random effects. P-value is provided for each independent variable, with connected standard error in brackets underneath. Significance symbols: *p<0.05; **p<0.01; ***p<0.001.

To further test the robustness of our results, we estimated one more model keeping fixed the variables for crude oil price and net fuel exports and replacing the other predictors. In particular, the deflated *per capita* Gross Domestic Product (GDP) (measured as constant 2010$) and population growth (% per year), both derived from the World Bank database, were included in a third quantitative model. Note that GDP and the WGI indicators are strongly correlated, which means that they provide similar information and the three corresponding fixed effects cannot be simultaneously included in the model. The new variables were standardised using the same procedure as for the previous ones.[ii] Results from the third quantitative model are presented in Table 1 column Model 3 and show that replacing the political stability indicators with *per capita* GDP and the addition of population growth leads to outcomes very similar to the ones from the first model. The effects of crude oil price and net fuel exports remain significant for the occurrence of fuel riots, the first characterised by a positive relationship, whereas the second carries a negative sign. Regime type also remains not significant in determining the occurrence of fuel riots. GDP per capita also has a negative, significant effect, meaning that countries with higher GDP per capita are less likely to experience fuel riots. Population growth and the interaction factor between GDP per capita and net fuel exports both have positive effects on fuel riots, but neither is significant, meaning these two factors do not significantly affect the occurrence of fuel riots in countries. Overall, international price of crude oil, net fuel exports, political stability, government effectiveness and economic development of countries proved to be the best predictors for fuel riots.

6. **Discussion**

The findings presented in this paper demonstrate a strong relationship between the international price of crude oil, national scarcity of fuel, the national political stability and government effectiveness, national economic development, and the occurrence of fuel riots in countries. Politically unstable countries are more likely to be affected by fuel riots, as are those characterised by ineffective governance which are larger importers of fuel products. Conversely, the level of economic development of a country has a significant (negative) effect on the occurrence of riots, meaning that wealthy countries are less likely to experience fuel riots. Interestingly, regime type does not significantly impact the occurrence of fuel riots, meaning that both ends of the regime spectrum (totalitarian regimes and democracies) and those in-between are similarly susceptible to experiencing this type of event. These results constitute initial evidence that fuel riots are indeed connected to the level of economic development, the level of political stability and the quality of governance in a country; higher incomes, higher political stability and higher quality governance independently make a country better able to cope with

high fuel prices. Moreover, although economically developed countries have also experienced fuel riots, such instability is less likely than in developing countries. Similarly, any type of regime is equally susceptible to fuel riots, meaning that the denial of freedoms and other forms of repression in illiberal states does not make these countries more susceptible to these types of events. This is largely in line with the expectations discussed in the theoretical discussion, despite high-profile cases – most obviously, in France – of fuel-related protests in economically affluent countries which have robust and effective institutions. In addition, we provide initial evidence for the connection between national scarcity of fossil fuels and social upheaval, which is a critical finding since fossil fuels are a finite natural resource and this suggests the likelihood of increased occurrences of fuel riots in the future. Increased scarcity, in addition to increased pressure to reduce usage through the withdrawal of price subsidies and the application of taxation, will have a general inflationary effect upon prices which will be experienced differently according to societal conditions, with the likelihood of protests in the most vulnerable settings.

One interpretation of these results is that when the international price of crude oil spikes, the economies of net fuel-importing countries are more exposed to higher prices as demand for crude oil is often inelastic. Countries therefore have no choice but to pay a higher price for oil on the international market. If these countries are also politically unstable and suffer from poor governance, the likelihood of a violent fuel-related event in the country is high, particularly if they already face social or political challenges which are likely to have built up resentment in the population. Therefore, higher prices are capable of tipping an already fragile situation into open conflict and violent demonstrations, as reflected in the events collected in this database. However, rich countries with high levels of *per capita* GDP have a greater capacity to implement measures to control prices. It is not unusual for national governments to implement subsidies to guarantee the affordability of basic commodities, especially to protect the poorest sections of the population. This is also consistent with the results from the review of media sources that was undertaken to collect the database for fuel riots: most of the articles cited the actual or prospective removal of fuel subsidies as the direct cause of the violent event.

The results from the analysis presented here provide an interesting parallel with previous studies on food riots (Natalini et al. 2015; Natalini et al. 2019; Newman 2020) where research found a strong, significant effect of the international price of food and national political fragility on food riots. It is therefore possible to suggest that food and fuel riots are driven by similar, resource-specific factors. The striking similarity between food and fuel riots merits further attention in future research. However, as indicated above, there are also important differences between the politics and impact of food price inflation and fuel price inflation. Food price shocks are largely beyond the control of most states in terms of timing, and the mitigation of the impact of sharp food price increases is linked to state capacity. For this reason, serious instability linked to food price increases generally only occurs in relatively poorer or middle-income societies with broader problems related to governance, and societies which have other conflict drivers.

However, the impact of fuel price increases may well be found in a more diverse range of societies because of the prospect of fuel subsidy reform. Societies with highly advanced economies and robust institutions – such as France – as well as middle-income societies have experienced protests related to fuel price inflation as there is broad pressure to reduce fossil fuel use.

This reinforces the importance of treating fuel-related instability as a distinct phenomenon and points to the increased likelihood of such instability in the future in various societies, and not only those which are susceptible to food riots. Indeed, although other data exist for riots and protests generally, other sources do not identify instability specifically related to fuel price increases. Moreover, general data on riots reflects somewhat different trends. Figure 3 presents a trend of all riots (defined as 'mob violence' and 'violent demonstrations') between 2005-2016 (the period covered in the analysis of this paper) using the Armed Conflict Location and Event Data Project (ACLED (2020)) since ACLED does not have a category for fuel-related riots. It shows a more pronounced upward trajectory of all riots which provides broader context for fuel riots. This suggests that the spikes in fuel riots occurred in the context of a general increase in instability in many societies – which raises the possibility that social grievances and political frustrations underpinned instability generally – but it also suggests that fuel-related instability is a distinct phenomenon as the trends show a different pattern.

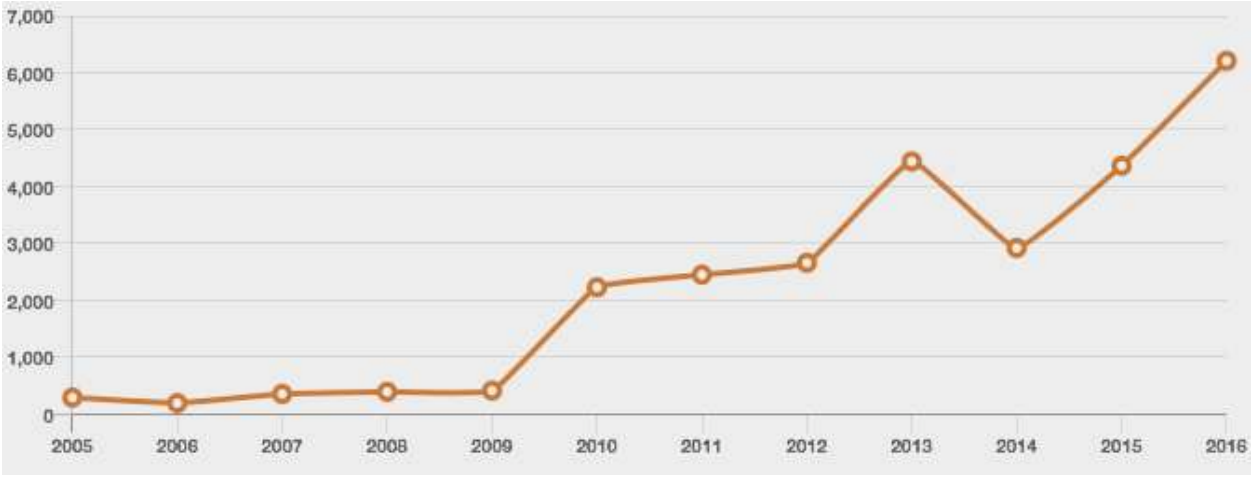

Figure 3. Plot with the number of riots for the period 2005-2016 obtained from the Armed Conflict Location and Event Data Project (ACLED) database.

6. Conclusions and policy implications

In this paper we provided the first definition, database and evaluation of drivers of fuel riots, which is a distinct and unexplored type of energy-related conflict. Our quantitative analysis found a significant relationship between fuel riots and the international price of crude oil, national political stability of countries, national government effectiveness, whether a country is a

net exporter of fuel, and national GDP per capita. According to these results, fuel riots are more likely (globally) when the international price of crude oil is high. The countries most affected are those characterised by low levels of national political stability and ineffective governance. Being a net fuel exporter and having high levels of GDP per capita make countries less likely to experience such events.

These findings open a new stream of research on fuel riots and provide critical evidence for the development of future energy policies by highlighting the relevance of national and international crude oil and fuel prices for politically unstable contexts. In addition, our findings contribute to the study of environmental conflict, specifically by providing empirical evidence for the nexus between scarcity and insecurity of natural resources and environmental stresses as a catalyst for conflict. The findings also provide a significant contribution to the field of security and conflict analysis by engaging with a number of theoretical debates about the social, economic and political drivers of instability and their role in 'contentious politics'. Our results support the theoretical model which combines absolute deprivation and contentious politics as both are relevant for fuel riots in various contexts. State capacity and performance are critical to the onset of instability related to rising fuel prices, across societies which reflect different social and economic circumstances. In the context of climate change and increasing pressures on governments for climate action, these results are particularly significant. Measures implemented to reduce the use of fossil fuels are likely to involve the introduction of carbon taxes and the reduction of subsidies. This was the case in France in late 2018, where the newly introduced carbon tax was met with violent upheavals from the 'Gilets Jaunes' movement (Carattini et al. 2019; Hope 2019), which is classified as a fuel riot according to the definition used in this paper (Natalini 2019). A number of other anecdotal cases mentioned in this paper suggest a pattern of instability associated with the introduction – or planned introduction – of increased fuel prices. Again, this points to the likelihood of increasing numbers of fuel riots (and other types of resource-related conflicts) in the future, unless preventive action is taken.

Policy changes which result in unwelcome price increases can be less controversial when they are framed as a part of a broader set of 'problem linkages', in this case equity and environmental protection (Blondeel et al. 2019). Yet material interests on the part of individuals are also highly significant. As others (Kyle 2018) have found, citizens can be open to subsidy reform in the context of broader policies which provide social protection, and when perceptions of government legitimacy are positive and underpinned by trust. A number of measures might therefore be explored to better manage the impact of rising fuel prices and mitigate the impact upon vulnerable communities. These could involve, for instance: a) wider involvement of civil society representatives in the design and implementation of fuel regulation and pricing policies, in anticipation of their social impact, b) increased and improved communication of the rationale behind the implementation of these measures, which needs to reach communities who are likely to be most affected, c) the mitigation of the impact of fuel price increases through monetary or

fiscal measures to protect the most deprived parts of the population who cannot switch to more expensive sustainable options as swiftly as others, to ensure their access to basic resources such as heating, and d) redirecting revenue (in case of a fuel tax) or saved expense (in case of a slashed subsidies) to fund social support.

These preventive measures find support in recent research (Carattini et al. 2019) but as Kyle (2018) suggests, the overall quality of governance and the credibility of official promises to mitigate the impact of subsidy reform are key determinants of whether such policies will be accepted or if resistance will occur. As the case for fuel subsidy reform becomes increasingly compelling, and opposition to higher prices creates social and political obstacles to taking such action, a general lesson is that the reduction of subsidies must anticipate the controversy that will ensue, and it must be undertaken in the context of a range of social protection measures and incentives. A failure to manage this expected resistance may contribute to the national backsliding on climate action that has been observed by others (Ross et al. 2017). This broader context, and the political challenges associated in particular with fuel subsidy reform, is not currently explored in detail within the Intergovernmental Panel on Climate Change process (2001; 2014), and greater attention to this is needed within policy circles and academia.

Future research in this field should focus both on the methodological and empirical aspects of fuel riots. As mentioned in the methodology section of this paper, one possible future development of research on fuel riots is to corroborate our findings with alternative data gathering methods. Projects that harness large amounts of computing power to gather conflict data are currently being developed (such as the GDELT database), however these are still in their infancy and require further time and development.

Further research on fuel riots could aid the development of energy policy in countries at risk of energy-related unrest and design targeted policies to prevent instability. Further research could also provide additional insights into the variables that we found to have a significant effect on the occurrence of fuel riots. For instance, based on our results for the 'Political stability and absence of violence' indicator, other individual, less aggregated measures of political fragility and social freedoms might be tested. These could encompass social and political freedoms, but also the capacity of national governments and the provision of basic services, to better understand the conditions that make countries more prone to fuel riots. Additionally, if reliable and comprehensive data on fossil fuel subsidies and policy change related to these are released or collected in the future, this can be used to formally test the hypothesis that fossil fuel subsidy removal is a trigger for fuel riots, as our results seem to suggest.

Data availability

The database of fuel riots collected as part of this research with references is available in the Appendix of this paper. The full database used to run the quantitative models described in this paper is available for download in the Supporting Information.

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Declaration of interest

The authors declare no conflict of interest.

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[i] Note that in this paper we use the definition from the statistical mixed models literature for these effects, where fixed effects indicate parameters that are assumed as constant, while random effects are parameters that vary randomly around zero according to a joint multivariate normal distribution (Wooldridge, 2010).

[ii] A further model (not shown in the Table) including both a first and a second degree GDP was estimated to check for non-linear relations between this variable and riots. However, the quadratic term resulted to be non-significant.