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Fractured politics? The comparative regulation of shale gas in Europe

Thijs Van de Graaf, Tim Haesebrouck and Peter Debaere

Department of Political Science, Ghent University, Gent, Belgium

ABSTRACT

European countries have developed strikingly different responses to shale gas and fracking. Some have imposed outright bans, while others have issued permits and even awarded generous tax breaks to the industry. To explain this puzzling variance, this article builds a theoretical framework that focuses on energy security, economic competitiveness, the party composition of government, public opinion, multilevel governance and democratic tradition. It then conducts a qualitative comparative analysis (QCA) of the regulation of shale gas in 16 European Union member countries. We find that the level of public concern is a sufficient condition for restrictive regulation. Other conditions only work in combination with others, while energy security and democratic tradition have no impact on the regulation of shale gas and fracking. The findings indicate that the uptake of shale gas is not simply a function of structural factors such as geology or population density, but rather the result of political factors.

KEYWORDS Comparative public policy; hydraulic fracturing ('fracking'); (risk) regulation; shale gas; qualitative comparative analysis (QCA).

1. Introduction

Thanks to technological breakthroughs such as horizontal drilling and hydraulic fracturing (or 'fracking'), shale gas production has soared dramatically in the United States (US) since 2007. The US shale gas revolution has lowered the country's domestic gas prices, CO_2 emissions and energy import dependency, but it has also raised concern over the related environmental, safety and health risks. While the US, Canada and China are so far the only countries where shale gas is produced in commercial quantities, shale formations rich in gas can be found all over the world. Estimates of shale gas resources in Europe are comparable in magnitude to those for the US (EIA 2013). This begs the question of whether and to what extent Europe will replicate the US shale gas revolution.

CONTACT Thijs Van de Graaf thijs.vandegraaf@ugent.be
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European countries have developed strikingly different responses to this question. Some, such as France and Bulgaria, have completely banned shale gas exploitation. Others, such as Poland and the United Kingdom (UK), have issued permits and even awarded generous tax breaks to support shale gas extraction. Moreover, many countries have experienced remarkable policy swings over time. Romania, for example, granted a permit to Chevron in March 2012, then enacted a moratorium in May, only to lift it seven months later. At present, 18 European Union (EU) member states are estimated to have recoverable shale gas reserves and eight countries have banned fracking (*cf*. infra).

At the outset, it is worth mentioning that there is no specific EU regulation on shale gas, only a set of non-binding recommendations (European Commission 2014). Of course, some of the environmental, health and safety issues associated with shale gas and fracking are addressed by existing EU rules. Yet, the EU essentially leaves national governments in charge of deciding on whether or not to allow shale gas extraction. Our goal is not to explain the absence of a common EU policy on shale gas which, in itself, is not surprising, given that the Lisbon Treaty (Art. 176 A) explicitly designates energy exploitation and the energy mix as the exclusive sovereign prerogative of the member states.

Instead, we address a different question: why have some EU member countries prohibited fracking for shale gas while others have embraced the new technology? This question matters empirically, since the regulation of shale gas in EU member countries has an effect on environmental protection, economic competitiveness, energy security and human health in the EU. It is also theoretically relevant, as the variance in European regulations of shale gas presents a puzzle to scholars of comparative politics and risk regulation. Prior studies have suggested a myriad of structural factors to explain divergence in the embrace of fracking, including geology (e.g., the structure of shale formations and water availability), geography (e.g., population density), deep regulatory structures (e.g., subsoil mineral rights ownership), energy security (e.g., high vulnerability to import disruptions), and market structures (e.g., existence of a gas service industry and infrastructure) (McGowan 2014).

While important, these structural factors alone offer an incomplete explanation of variation and its causes. Countries that have similar shale endowments and market structures, or are governed by similar laws (e.g., directives at the EU level), do not necessarily adopt similar policies towards fracking. A case in point are Bulgaria (where fracking is banned) and Poland (no ban) (Goldthau and LaBelle 2016). Moreover, most of these structural factors are relatively stable over time and are outside of the reach of the conscious influence of present actors. As such, they cannot explain the frequent occurrence of policy reversals with regard to fracking. An exclusive focus on structural factors, finally, neglects the critical role of political factors and

agency in shaping regulation of risky technologies such as shale gas (Bomberg 2017). This study argues that it is only through a combination of structural and political factors that the varying uptake of shale gas in Europe can be fully understood.

Such a perspective helps to plug several gaps in the literature. A recent review of the political science literature on shale gas found that 'investigations into the regulatory governance of shale gas remain scarce' (Goldthau 2016: 74). To the extent that regulation is addressed at all, it is often done in evaluative-prescriptive rather than in explanatory ways. Moreover, the bulk of this literature takes the form of small-*n* case studies focusing on one or just a few European countries (e.g., Goldthau and LaBelle 2016; Johnson and Boersma 2013; Metze 2017), US states (e.g., Davis 2012), or Canadian provinces (e.g., Carter and Eaton 2016). A notable exception is McGowan (2014), who studies the regulation of fracking in a number of EU countries, but his study does not take into account developments beyond 2012.

This article will heed the calls by McGowan (2014) and Goldthau (2016) to examine shale gas through the lens of regulatory governance. We first develop a theoretical framework based on general theories of regulation as well as dedicated shale gas studies. Next, we map shale gas regulations in 16 EU member countries during the period 2010–2015, and categorize them on a continuum ranging from 'permissive' to 'restrictive' regulations. Through a qualitative comparative analysis (QCA), we identify the combinations of conditions that best explains the observed regulatory outcomes. To preview the findings, our analysis reveals that different paths can lead countries to embrace or oppose fracking and, in most of these paths, public opinion is the decisive factor.

2. Theoretical framework

Why governments choose different courses of action – or decide not to act at all – is the basic question that lies at the heart of comparative policy studies (Engeli and Allison 2013; Gupta 2012). Comparative regulatory research has identified a wide, yet often conflicting, range of explanatory variables for regulatory divergence across countries. These explanations are drawn from a myriad of fields, including risk analysis, cultural theory, economics, sociology and political science. They are often summarized under the rubric of 'interests, ideas and institutions' (Baldwin *et al*. 2012).

2.1. Interests

Public interest theories centre on the idea that regulation is developed in pursuit of interest-related objectives, as opposed to group, sector or individual

self-interests (Baldwin *et al*. 2012). The most prominently cited public interest that might be served by allowing shale gas exploitation is security of energy supply (McGowan 2014). Having a secure supply of energy is vital for any country's economic growth, military power and social peace. Therefore, governments invariably treat energy security as a strategic priority (Van de Graaf *et al*. 2016). Security of supply concerns are often more elevated for natural gas than for oil, since gas is more difficult to store and transport, and hence more prone to geopolitical extortion. We can thus hypothesize that the more a country relies on imported natural gas to satisfy its domestic energy needs, and the more vulnerable these gas imports are to (political or technical) disruption, the more likely the government is to support domestic shale gas extraction.

> H1: Countries with high dependence on vulnerable gas imports are more likely to adopt permissive shale gas regulations.

Another interest-driven explanation centres on the level of economic development. Previous research has established that richer countries have 'both more reason and more means to control pollution' (Lenschow *et al*. 2005: 810), and thus have stricter environmental policies. Börzel (2002) even identifies the level of economic development, broadly measured by gross domestic product (GDP) per capita, as the most important factor that explains whether a country is an environmental leader or laggard at the European level. These findings are broadly in line with the so-called 'environmental Kuznets curve', which posits that environmental quality first declines and then improves as countries become richer (Ekins 1997). From this perspective, we would expect poorer countries to be relatively more concerned about economic benefits than about environmental costs and health risks, in contrast to more economically advanced countries.[1]

> H2: Economically less advanced countries are more likely to adopt permissive shale gas regulations.

2.2. Ideas

Ideational accounts can be unpacked in two major tenets. One tenet points to changing (party) ideologies that shape approaches towards regulation. It has been established that differences in party composition of government matter in public policy in constitutional democracies (Schmidt 2002). While political parties and governments have traditionally been positioned along an ideological left–right scale, it is possible to position them on a green–brown scale. This gives an indication of whether parties and governments strongly support environmental protection even at the cost of economic growth ('green' preferences), or take the inverse position ('brown' preferences).

According to this hypothesis, the more governmental parties have green preferences, the more likely they are to oppose shale gas.

> H3: Countries ruled by governments with 'brown' ideological preferences are more likely to adopt permissive shale gas regulations.

There is a long tradition in comparative public policy that emphasizes the impact of public opinion (e.g., Page and Shapiro 1983). Recent research has broadly confirmed evidence that political leaders are influenced by public majority while making policy choices (Burstein and Linton 2002). Public opinion will thus likely play a critical role in shaping the degree to which unconventional gas reserves are developed in the EU, in the same way that public acceptance and risk perception shape the potential viability of other emerging technologies (Kasperson and Ram 2013). Public attitudes towards shale gas can be a product of socio-demographics, perceptions of risks and benefits, affective imagery, geographic proximity and worldviews (Boudet *et al*. 2014).

> H4: Countries with high levels of public concern over the risks of fracking will more likely adopt restrictive shale gas regulations.

2.3. Institutions

Institutional accounts can take many forms, but one prominent approach claims that institutional structures may vary across countries in the extent to which they provide access to particular interest groups to the regulatory process (Hall and Taylor 1996). Given that many of the benefits of shale gas accrue to the state, while the most adverse risks tend to be local (water use, aquifer contamination, heavy traffic, seismic shocks, etc.), we can hypothesize that countries with unitary governance systems will more likely embrace shale gas than countries with federal or multilevel governance systems. Multilevel systems, by nature, will take local interests more into account. Bernauer and Meins (2003) similarly claim that environmental and consumer interests are more likely to gain ground *vis-à-vis* producers in multilevel regulatory systems, which provide more access points for consumer groups compared with centralized regulatory systems.

> H5: Countries with multilevel governance systems are more likely to adopt restrictive shale gas regulations.

Finally, we build on the hypothesis that regulation is embedded in historical contexts and requires understanding of factors such as state traditions and structures (Thatcher 2002). In this respect, the long-standing and persistent East–West divide in Europe presents itself as a critical factor (Epstein and Jacoby 2014). Evidence from prior research indeed suggests that the communist legacy still weighs heavily on environmental governance in Eastern

European countries, where non-state actors are still much less involved in the policy process (Börzel 2009). Therefore, we would expect the level of social, environmental and human welfare concerns to be higher in the countries of long-standing democratic history compared to 'newcomers' that have long been ruled by authoritarian systems and have less of an embedded history of caring for environmental degradation and social welfare.

H6: Countries with a long-standing democratic tradition are more likely to adopt restrictive shale gas regulations.

3. Research design

3.1 Method and case selection

The remainder of our study will test how well these hypotheses explain variance in the regulation of fracking in a sample of European countries. The case selection was guided by the following criteria. First, our analysis focuses on the member states of the EU, which can be expected to share enough background characteristics to be considered a homogeneous population. Second, our study only includes member states with shale deposits. According to the authoritative study of the German Federal Institute for Geosciences and Natural Resources (Andruleit *et al*. 2013), these are: Austria; Belgium; Bulgaria; Croatia; Czech Republic; Denmark; Estonia; France; Germany; Hungary; Ireland; Latvia; Lithuania; Luxembourg; the Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden; and the UK (see also Figure A1.1 in the Online Appendix). Third, we exclude countries that reported not to have any recoverable shale gas reserves or only very limited or non-profitable resources: Estonia; Latvia; Slovakia; Slovenia; and Sweden.[2] Fourth, Belgium and Croatia were excluded because comparable data on public opinion was not available.[3] This gives us a sample of 16 cases.

This article employs the method of qualitative comparative analysis (QCA). QCA is a case-oriented technique that allows for a systematic comparison of a mid-sized or large number of cases on three to eight conditions. It is geared towards establishing set-theoretic connections between one case property, defined as the 'outcome', and other properties, defined as the 'causal conditions'. Such set-theoretic connections can be interpreted in terms of sufficient and/or necessary causes. A key strength of QCA is that it is capable of capturing a complex form of causality, generally described as 'multiple conjunctural causation' (Schneider and Wagemann 2012: 77). Multiple causation implies that there can be multiple paths towards an outcome; conjunctural causation implies that these paths often consist of a combination of conditions. Therefore, QCA is particularly apt for our study: the number of cases is intermediate ($N = 16$) and our outcome of interest (i.e., shale gas regulation)

is expected to result from a complex interaction of structural and political conditions.

We opt for the fuzzy set rather than the crisp set version of QCA because the outcome and conditions represent complex phenomena, which vary both in kind and in degree. Fuzzy membership scores vary between 1 and 0, depending on the degree to which a variable is present in a given case. The qualitative status of a case depends on its position towards the 0.5 anchor, which indicates whether a variable is either more present or more absent in a given case. The assignment of fuzzy membership scores, or calibration, is described in the following subsections. The raw data and fuzzy membership scores are presented in Section 3 of the Online Appendix.

3.2. Outcome

The outcome of interest is domestic regulation of shale gas exploration and development that may require the use of high-volume hydraulic fracturing. There is a continuum in Europe, ranging from governments that have restrictive regulations of shale gas to those that have permissive regulations. We have developed a novel scale to capture this variation (see Figure 1).[4]

- *Opposition*: A first group of governments is strictly opposed to shale gas and has put in place highly prohibitive regulations. For these governments, the scientific evidence is conclusive and their opposition to shale gas and fracking is principled. Examples are France and Bulgaria, which have put in place open-ended moratoria on shale gas exploration. Both countries have reaffirmed the permanent nature of the ban and cancelled all previously issued exploration permits.
- *Precaution*: A second group of governments has temporarily banned shale gas exploration, pending further scientific evidence on the risks and consequences of its extraction. These governments often refer to the precautionary principle, which is embedded in the EU's Lisbon Treaty. These governments emphasize the temporary character of the moratorium by determining an end-date or suspending rather than cancelling existing exploration projects. This is the case in the Netherlands and Germany, where governments have halted commercial shale gas exploration by fracking until the end of this decade. Romania and the UK have also imposed short bans, in 2012 and 2011 respectively, but these have already been lifted.

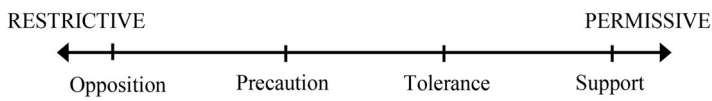


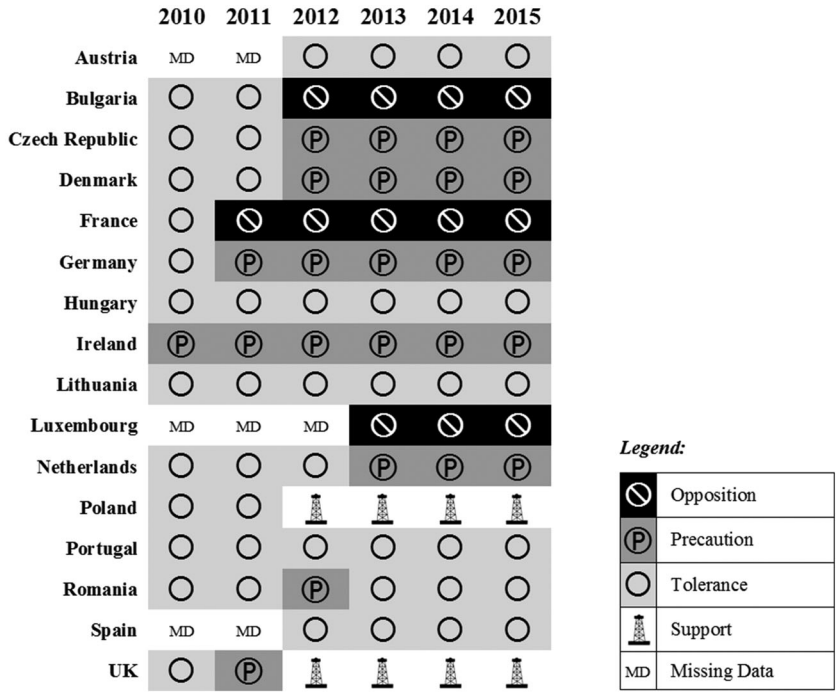
Figure 1. Scale of regulatory attitudes towards shale gas.

- *Tolerance*: A third group allows shale gas exploration and has issued permits, but has not adopted additional measures to encourage fracking. Governments in this group tend to enact legislation that puts additional burdens on the shale gas industry. Spain, for instance, has issued permits for shale gas exploration but has at the same time adopted a new environmental law in December 2013 that includes a mandatory environmental impact assessment for all shale gas projects.
- *Support*: A final group has not only issued permits but also enacted legislation to encourage and speed up shale gas extraction. The UK, for instance, has proposed generous tax breaks for the industry (the tax rate on production income for shale gas companies is only 30 per cent, compared to the typical 62 per cent rate that applies to North Sea gas and oil production) alongside lucrative compensation for communities hosting shale gas rigs.

To determine the outcome, shale gas regulations have been traced in each of the 16 cases, from 2010 until 2015. The coding of the outcome variable is primarily based on information retrieved from the European Commission's questionnaires on the application of its Recommendation 2014/70/EU. The questionnaires sought to determine whether member states grant or plan to grant authorizations for the exploration or production of hydrocarbons that may require the use of high-volume hydraulic fracturing. To cross-check and complement the information from the questionnaires, we have also consulted other open-source information including national and international media, data from international institutions such as the EU and the International Energy Agency (IEA), energy companies and consultancy firms, academic publications, as well as communications by national governments. The obtained data have been triangulated to rule out missing or contradictory information. The results of our coding analysis are depicted in Table 1. A more detailed summary can be found in Section 2 of the Online Appendix.

Table 1 leads to three conclusions. First, it demonstrates the striking variance in shale gas regulation in our sample of countries. While all countries in our sample had a tolerant attitude towards shale gas in 2010, their paths consequently diverged. Second, the table also reveals that some countries have undergone significant policy swings over time. The UK, for instance, switched from tolerance to precaution and then to support. Romania moved from tolerance to precaution and back to tolerance. Third, the table shows that country positions have remained surprisingly stable since 2013. No country has changed its position since then. Eight countries have adopted a rather permissive policy (Austria, Hungary, Lithuania, Poland, Portugal, Romania, Spain and the UK) and eight have adopted a rather restrictive policy (Bulgaria, Czech Republic, Denmark, France, Germany, Ireland, Luxembourg and the Netherlands). Our analysis is geared toward explaining these relatively stable positions, rather than fluctuations over time or the exact timing of policy changes.

Table 1. Regulation of shale gas in selected EU countries, 2010–2015.



The calibration of the outcome is based on the cases' positions on the restrictive–permissive continuum. In order to qualify for membership in the set permissive regulation (receive a score above 0.5), a state has to allow shale gas exploration. States that tolerate shale gas exploration are assigned a score of 0.75, while states that actively support exploration are assigned a score of 1. At the low end of the scale, cases that temporarily ban fracking receive score of 0.25, cases with an open-ended moratorium a score of 0.

3.3. Conditions

The calibration of the conditions is based on the method of transformational assignment, which uses a continuous function to fit base variable values (or raw data) between three qualitative anchors at 1 (full set-membership), 0.5 (point of maximally ambiguous set membership), and 0 (full non-membership) (Thiem and Duşa 2013: 55).[5] The following paragraphs concisely describe the operationalization of the base variables and the choice of the qualitative breakpoints, a more detailed description is provided in Section 3 of the Online Appendix.

First, the base variable for Energy Security (ES), share of domestic gas consumption supplied by unreliable suppliers gci_i, is calculated as given in the following equation:

$$gci_i = id_i^* us_i \tag{1}$$

where id_i is a country i's net import dependence and us_i the share of its gas imports supplied by non-European Economic Area countries. The thresholds for calibrating the base variable build on the upper bounds of Jewell's (2011: 26) three categories of net import dependence. The threshold for full inclusion is fixed at 10 per cent, corresponding to the upper bound of 'low import dependency'; the 0.5 crossover point is fixed at 30 per cent, corresponding to the lower bound of 'intermediate import dependency'; the threshold for full exclusion is fixed at 70 per cent, corresponding to the lower bound of 'high import dependency'.

Second, data on GDP per capita, obtained from the Eurostat database (European Commission 2017), was used as base variable for Economic Development (ED). The cut-off point of maximum ambiguity is fixed at 26,900, which corresponds to the average GDP per capita in the EU. The threshold for full inclusion is fixed at 50,000, in the significant gap in the raw data between Denmark (45,783) and Luxembourg (84,500). The threshold for full exclusion is fixed at 8,000, locating the two cases in our sample that are not in the high income country-category of the World Bank (Bulgaria and Romania) fully out of the set.

Third, the base variable for Green Government (GG) is based on the 2010 Chapel Hill expert survey, which estimates party positions on 13 issues in 28 countries, which asked experts to position parties on a scale between 0 (strongly supports environmental protection even at the cost of economic growth) and 10 (strongly supports economic growth even at the cost of environmental protection) (Bakker *et al.* 2015). In line with previous studies (e.g., Mello 2012: 436–37), party positions (n) are aggregated into an overall measure of executive orientation by summing up each government party's (i) position on the CHES-scale (ch), weighted by its share of the total number of seats held by the governing parties (s), as specified in the following equation:

$$\sum_{i=1}^{n} \frac{s_i ch_i}{s} \tag{2}$$

The 0.5 crossover point is fixed at 5, which corresponds to the middle of the scale of the expert questionnaire. The threshold for full inclusion is fixed at 7, the threshold for full exclusion at 3.

Fourth, the base variable that was used for calibrating Public Concern (PC) is the percentage of respondents that would be 'very concerned' if a shale gas

project were to be located in their neighbourhood. The cut-off point of maximum ambiguity is fixed just above the median, at 45 per cent. The anchor for full membership is fixed at 55 per cent, just above the value of France, which has the most concerned public. Cases where less than 25 per cent of the respondents are very concerned about shale gas are considered fully out of the set.

Fifth, as base variable for calibrating Multilevel Governance (MG) we use the cases' aggregated country score on the Regional Authority Index (RAI) (Hooghe *et al*. 2016). Based on the scale of theoretically possible values at the regional level, which ranges from 0 (lowest level of regional authority) to 30 (highest level of regional authority), the 0.5 crossover point is fixed at 15.[6] This value is situated just below the RAI-score of the Netherlands, which is generally described as a 'decentralized unitary state' (Gupta *et al*. 2007: 172; Hulst 2005: 100). The threshold for full exclusion is fixed at 10, corresponding to the RAI-score of Romania, a state 'with a strong centralist tradition' in which 'only some tentative first steps towards decentralisation were taken' (Bochsler and Szöcsik 2013: 431). The threshold for full inclusion is set to 25. This way, the two states with a long 'established federal (Germany) or regionalist (Spain) tradition' are located fully inside the set (Cole and Loughlin 2003: 266).

Sixth, the base variable for the cases' democratic history builds on the Democratic Stock (DS) variable (*cf*. Gerring *et al*. 2005), which captures both the differences in degree and in duration of democracy, and the Polity2 variable of the Polity IV dataset (Marshall *et al*. 2016). The crucial 0.5 threshold is fixed at 100, in the large gap in the data between Hungary and Portugal. The threshold for full exclusion is fixed at 0. Given that a score below 0 on the Polity2 index corresponds to a non-democratic country, cases with a score below 0 can be considered fully out of the set of democratic tradition. The threshold for full inclusion is fixed at 360, between France and Spain.

4. Results and discussion

The fsQCA procedure involves several stages, which were carried out with the QCA package for R, version 1.1-4 (R Development Core Team 2014; Thiem and Duşa 2013). The assessment of necessity and sufficiency is based on two descriptive measures that vary between 0 and 1: consistency and coverage (Ragin 2008: 44–68). Consistency provides a descriptive measure of the empirical evidence for sufficiency/necessity and approaches unity as the data provide stronger support. Coverage describes the empirical relevance of a sufficient or necessary condition and approaches unity as a condition becomes more relevant.

What are the necessary and sufficient conditions for permissive regulations? The results of the analysis of necessity, presented in Section 3 of

the Online Appendix, reveal that the consistency of one condition exceeds the recommended 0.9 threshold: the absence of green government (∼GG). Its low coverage value of 0.57 suggests that it might constitute a trivial necessary condition.[7] The analysis of sufficiency builds on a truth table, which is presented and discussed in Section 3 of the Online Appendix (Ragin 2008: 124–44). Table 2 presents the solution that results after Boolean minimization was applied to the truth table.[8] This solution shows that two combinations of conditions consistently lead to permissive regulations. More specifically, we see that the absence of public concern consistently results in permissive regulations in countries that have a low level of economic development or if both green government and multilevel governance are absent. The high consistency of 0.829 provides strong evidence that the solution indeed corresponds to sufficient combinations. The high coverage of 0.791 indicates that the solution explains a significant share of the outcome's presence.

Under which conditions did the cases adopt restrictive regulations? The analysis of necessity, presented in Section 3 of the Online Appendix, reveals that none of the consistency values of the conditions (or their negation) exceeds the recommended 0.9 threshold. The truth table is presented and discussed in Section 3 of the Online Appendix. The minimized solution, presented in Table 2, shows that a concerned public and a green government are sufficient conditions for restrictive regulations. Likewise, states with a multilevel governance system consistently adopt restrictive regulations if they have a high level of economic development. The consistency of the solution equals 0.800, providing strong evidence that the different pathways indeed corresponds to sufficient combinations. Its high coverage of 0.854 indicates that the solution explains a significant share of the outcome's absence.

Table 2. Solutions permissive and restrictive regulation.

	Solution	Consistency	Coverage		Cases
			Raw	Unique	
Permissive regulation	∼PC*∼ED	0.890	0.755	0.132	Spain, *Romania, Portugal, Hungary, Lithuania, Poland*
	∼PC*∼GG*∼MG	0.811	0.659	0.036	UK, *Romania, Portugal, Hungary, Lithuania, Poland*
	Total	0.829	0.791		
Restrictive Regulation	GG	0.821	0.339	0.080	Denmark
	PC	0.809	0.691	0.315	Bulgaria, Czech Republic, Ireland, Luxembourg, *Germany, Austria, France*
	MG*ED	0.769	0.298	0.081	Netherlands, *Germany, Austria, France*
	Total	0.800	0.852		

Notes: [PR] Permissive Regulation; [GG] Green Government; [MG] Multilevel Governance; [PC] Public Concern, [ED] Economic Development; [∼] indicates the absence of a condition.

In QCA, cases can be covered by multiple paths (Ragin 2008: 63–8). Cases that are uniquely covered by a path are in regular font, cases that are covered by multiple paths are in italic.

In summary, the results of the QCA show that there are two sufficient combinations for permissive regulation. First, permissive regulations result if the absence of public concern is combined with low economic development. Second, permissive regulations result if the absence of public concern is combined with the absence of multilevel governance and the absence of a green government. Conversely, there are three sufficient combinations for the absence of the outcome. First, green government leads to restrictive regulations. Second, restrictive regulations result if high economic development is combined with multilevel governance. Third, restrictive regulations result if the public is concerned about shale gas exploitation. However, one of the cases covered by the latter two paths, Austria actually adopted a permissive regulation.

The case of Austria warrants some further attention: although there was a high level of public concern and Austria is an economic developed country with a multilevel governance system, the Austrian government did not adopt restrictive shale gas regulations. Nevertheless, case-based information suggests that public opinion did have an impact on Austria's shale gas regulation. Although the Austrian government did not ban shale gas exploration, it did subject fracking – even for exploratory and test drilling – to a mandatory environmental impact assessment following protests in lower Austria (Lang 2014). After this environmental impact assessment was imposed, Austrian energy company OMV abandoned its plans to produce shale gas. At the time of writing, no request for the exploration of shale gas in Austria has been made, suggesting that the obligatory environmental assessment *de facto* banned shale gas in Austria.

5. Conclusions

This article makes a two-fold contribution to the extant literature. First, it provides a broader empirical base of knowledge on how public policies are designed and chosen in the field of energy policy. We are the first to systematically map and code shale gas regulations in 16 EU member states (*cf.* Section 2 of the Online Appendix). Second, the article contributes to theory development in the field of comparative environmental policy by testing six hypotheses on the regulation of shale gas in Europe. Rather than seeing the spread of risky technologies such as fracking merely as the product of material realities (e.g., attributes of the technology or geological conditions) or as a function of having the 'right' regulations in place, this article points to the complex interplay of public and private interests, ideational factors, and institutional and political contexts in producing regulation.

Our analysis shows that public opinion is vital to explain regulatory bans on fracking in Europe. The countries in our sample with strong public concern have invariably adopted restrictive regulations. Survey research in the US

has shown that public attitudes to fracking are related to a host of variables, including socio-demographic factors, environmental attitudes, political ideology and affective imagery (Boudet *et al*. 2014). Public concern might also be influenced by framing strategies adopted by different political coalitions (Bomberg 2017; Metze 2017), as well as focusing events (Davis 2012). The strength and success of protest campaigns and anti-fracking mobilization might also shape public opinion. These elements, which are exogenous to our model, might help to explain the remarkable policy swings that some countries have experienced with regard to shale gas regulation.

It should be noted that a green government and the combination of a multilevel governance system and advanced economic development also results in restrictive regulations, irrespective of public opinion. Conversely, the absence of public concern only leads to permissive regulations if combined with either the absence of economic development or the absence of both a multilevel governance system and a green government. In simple terms, public concern is a key ingredient to explain fracking moratoria, but restrictive policies can also be adopted in the absence of a concerned public opinion.

Our results also indicate that variance in shale gas regulation can be explained *without* reference to certain factors. First, our model did not include the size of shale reserves as a factor. Shale reserves are estimates at best, and it is difficult to know the information policy-makers had at their disposal at a certain point in time. Poland's reserves have been corrected downward significantly over the past few years. Second, the model did include democratic tradition as one of the hypothesized explanations, but it proved redundant. The reason probably is that, except for Spain and Portugal, there is strong correlation between economic development and democratic tradition (see Table A3.1 of Section 3 of the Online Appendix). Our analysis shows that economic development better explains variance in regulatory positions on shale gas, which is in line with previous research findings (e.g., Börzel 2002; Lenschow *et al*. 2005).

More surprising, perhaps, is that energy insecurity is not a strong predictor of permissive regulation. Energy security concerns are often cited as a key motivation for countries to support fracking, particularly Eastern EU member states that are highly dependent on Russia (e.g., Johnson and Boersma 2013). One explanation might be that countries with strong extractive industries (oil, gas and coal), and hence less dependence on imports, will adopt a minimal regulatory response to fracking because the fossil fuel industry holds a privileged position within the state and can effectively veto proposals that threaten their interests (Davis 2012). This line of reasoning might help to explain the case of the UK, which has emerged as a big supporter of fracking in spite of low energy security concerns, yet it is less apt to explain the cases of the Netherlands and Denmark.

While our method allows for systematic and reproducible research and parsimonious results, there are certainly limitations involved. One is the relatively small number of conditions that can be included (compared with, for example, large-*N* statistical inference), the difficulty in operationalizing certain variables that may be of interest like 'protests', 'framing' and 'social mobilization' (which can be better captured with methods like process-tracing), or the sensitivity of the model to the calibration of conditions.

At the moment, European shale gas prospects are bleak. Except perhaps for the UK, not much is happening in Europe. Several international majors (e.g., Chevron and ExxonMobil) have pulled out of Eastern Europe owing to disappointing geology and low gas prices. Even so, it is clear that the emergence of fracking and shale gas has opened up a vast array of research questions for scholars of public policy and governance, which have only recently begun to be addressed. Since public acceptance emerged as a crucial factor in our study, future research could further examine the trends and drivers of public opinion on shale gas, and the conditions under which contested technologies such as fracking acquire a 'social licence'.

Notes

1. Next to energy security and economic development, environmental and health protection are also public interests that figure prominently in debates about fracking. Yet, we treat these items under the rubric of 'ideas' rather than 'interests' because our cases do not vary in environmental risk or health risks associated with fracking; they vary in the *perception* of these risks. The environmental and health concerns are captured by our two hypotheses on 'ideas' (*cf*. infra).
2. Information on this criterion was retrieved from the European Commission's questionnaires in 2014 and 2015 on the application of its Recommendation 2014/70/EU on minimum principles for the exploration and production of hydrocarbons using high-volume hydraulic fracturing. It is not possible to determine which position these countries would have taken if they would have had recoverable deposits. In consequence, they cannot be meaningfully assigned an outcome value and are, therefore, excluded from the analysis.
3. Croatia was not included in the 2012 Eurobarometer survey, which examined the degree of concern over shale gas. In Belgium, shale gas is regulated at the regional level, for which no public opinion data were available.
4. Carter and Eaton (2016) propose a three-point scale that includes: (1) moratoria; (2) permits with revised regulations; and (3) permits without revised regulations. While items 2 and 3 correspond largely to our categories of 'tolerance' and 'support', we make a distinction between open-ended and temporary bans.
5. The calibration of the conditions was achieved with calibrate function of the QCA package for R, version 1.1-4.
6. The empirical range of values at the country level can be higher than 30 in countries with more than one regional tier.

7. Two additional tests, presented in Section 3 of the Online Appendix, confirm that relevance of the absence of green government is a trivial necessary condition.
8. This solution corresponds to the most parsimonious formula, which is the only solution type that is 'guaranteed to reflect causation' (Baumgartner 2015: 854). The conservative and intermediate solutions, two alternatives to this parsimonious solution, are presented in Section 3 of the Online Appendix.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Thijs Van de Graaf is an assistant professor at the Department of Political Science of Ghent University, Belgium.

Tim Haesebrouck is a post-doctoral researcher at the Department of Political Science of Ghent University, Belgium.

Peter Debaere is a post-doctoral researcher at the Department of Political Science of Ghent University, Belgium.

ORCID

Thijs Van de Graaf http://orcid.org/0000-0003-3372-3830

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