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Speculating on shale: Resource-making and the 'politics of possibility' in Poland and the UK

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ABSTRACT

This paper focuses on the speculative character of knowledge and action in relation to subterranean resources, drawing on the curtailed histories of shale gas development in Poland and the UK. It adopts a political-economic orientation towards speculation rather than a narrowly financial one, seeking to understand the 'politics of possibility' associated with speculative resources. Specifically, we build on work in political geography to understand speculation as a form of productive 'resonance' replicating across epistemic, economic, and political domains. Thinking of speculation as resonance – as synchronous vibration across different areas of social life, stimulated by and intensifying uncertainty - offers a novel way of thinking about the possibilities of subterranean resources for forging political alignments. We show how speculation was integral to demonstrating the resource potential of shale in both Poland and the UK, and consider how this speculative character of shale subsequently infiltrated into economic and policy realms. Resonating across these domains, and amplifying epistemic uncertainties about shale, speculation produced a politics of possibility orientated towards 'gambling' on potential outcomes. By taking seriously the political possibilities of the uncertainties attached to subterranean resources, we extend the value of speculation as a concept for analysing the constitutive role of uncertainty in political-economic governance.

1. Introduction

Over the last decade, Poland and the UK emerged (and subsequently waned) as European 'laboratories' for shale gas development, the national territories in Europe within which America's 'shale gas revolution' might be replicated and take root. Both countries became fertile (under)grounds for geological projections, industry ambitions and political objectives that referenced the future possibilities associated with unconventional natural gas from shale rock formations. Optimistic but uncertain estimates of resource availability (e.g., EIA/ARI, 2011; 2013; Andrews, 2013) spurred high (geo)political and socio-economic hopes for commercial gas production from domestic shales while also fuelling public debates and local resistance (e.g., Bomberg, 2017; Jaspal et al., 2014; Lis & Stasik, 2018; Short & Szolucha, 2017). Polish policy-makers, industry experts and media pundits savoured the prospect of domestic unconventional gas resources remedying the country's dependence on Russian imports and improving national energy security (Johnson & Boersma, 2013; Kuchler & Höök, 2020; Lis & Stankiewicz, 2016; Wachtmeister et al., 2021). British policy-makers and industry representatives eagerly eyed the possibility that home-grown unconventional gas could offset declining offshore gas production on the UK Continental Shelf, reverse growing gas imports and facilitate a low-carbon transition by 2050 (Bomberg, 2017; Cotton et al., 2014; Fletcher & Bradshaw, 2023; Kama & Kuchler, 2019).

To date, however, no commercial production of unconventional gas from shales has been established in either country. In Poland, no prospecting and exploration activities have taken place since 2017 (Wachtmeister et al., 2021). Both domestic and international extractive companies have abandoned their efforts, and the Polish "shale gas laboratory" (Blake, 2014) has failed to provide adequate results. In July 2012, Poland had emerged as the frontrunner in Europe's shale gas "revolution" by holding the highest number of 111 valid concessions (Wachtmeister et al., 2021). By November 2017, however, the number of active concessions had dwindled to just 20. Out of the 72 test wells drilled in Poland between 2010 and 2016, only 25 hydraulic fracturing and nine micro-fracturing treatments were carried out (MŚ, 2016).

In the UK, just eight exploration wells have been drilled since 2011, and only one of these was partially fracked (Preston New Road in

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Lancashire). The fracking process in Lancashire triggered a series of earthquakes that led the government, ahead of a General Election, to abandon its support for high-pressure fracking and impose a moratorium (November 2019) until such time as scientific evidence would show unacceptable levels of seismicity could be prevented (Fletcher & Bradshaw, 2023, p. 3). The moratorium, combined with concern about UK shale's global climate impact and challenges associated with the planning process, have cast doubt on whether home-grown unconventional gas production can ever become commercially viable (Kama & Kuchler, 2019). As early as 2019, the former Chairman of Cuadrilla (the primary firm seeking to develop UK shale resources) bluntly stated that "fracking in the UK doesn't make much sense" and that "it was a test to see if it worked" (Vidal, 2019). The brief government of Liz Truss lifted the moratorium in September 2022, rhetorically linking "extracting our huge reserves of shale gas" to national energy security and rising energy costs while channelling populist scepticism over net zero, but was not long enough in power for its actions to be implemented or challenged (Groves, 2022).[1] With lifting the moratorium bound to tests of climate, seismicity and local consent, shale gas in the UK "faces an unforgiving future" (Fletcher & Bradshaw, 2023, p. 24).

The dynamic but inconclusive shale gas developments in Poland and the UK have been the subject of scrutiny for several different scholarly domains. Social science research has proliferated on shale, primarily focused on three central themes: public discourse (Bomberg, 2017; Cotton, 2013; Jaspal et al., 2014; Lis & Stankiewicz, 2016; Williams & Sovacool, 2019); public perception and dissent (Cotton, 2015; Lis & Stasik, 2018; Short & Szolucha, 2017; Szolucha, 2018); and governance and policy-making (Adamus & Florkowski, 2016; Cotton et al., 2014; Godzimirski, 2016; Johnstone et al., 2017; Kuchler, 2017). However, less attention has been placed on interrogating the *speculative* character of shale, by which we mean its future orientation, high uncertainties (about the qualities of the underground and volumes of gas available), controversies over claims and discoveries, and the broader 'politics of possibility' with which shale has been associated in each country. There is analytical value, we suggest, in exploring the socio-political dynamics associated with the speculative development of these unconventional energy resources.

Recent work in resource and political geography acknowledges the indeterminate character of the underground and attests to how projections and calculations of its 'qualities' sustain broader political-economic projects (e.g., Braun, 2000; Kama, 2020; Kinchy et al., 2018; Kneas, 2020; Lyall & Valdivia, 2019; Swann-Quinn, 2019; Weszkalnys, 2015). The temporal character of resource development and the politics of resource governance have also been a primary focus (e.g., Kama, 2020; Szolucha, 2018; Weszkalnys, 2008; Zalik, 2015). Yet, for the most part, the distinctively speculative character of knowledge and action concerning uncertainties of the underground has been little examined. Work on speculation in relation to natural resources is primarily associated with logics of investment and processes of financialisation rather than interrogating the broader socio-political character of speculation as an orientation towards a multitude of future possibilities.

Our aim in this paper is to explore the "politics of possibility" (Amoore, 2013) that speculative resources enable in the present, not through anticipating or pre-empting the future but by sustaining uncertainty. We show how speculation on the presence and value of underground resource potential exceeds a narrowly financial realm, highlighting a distinctive mode of social ordering that centres on imagining future possibilities and the maintenance (rather than reduction) of uncertainty. Bridging between work in resource geography and political geography – and diverging from scholarship on technologies of risk management which focus on logics of anticipation and speculation as a form of pre-emptive performance - we show how speculation is a form of productive resonance across epistemic, economic, and political domain. Significantly, speculation here works not to anticipate or pre-empt a particular future (so as to forestall or hasten its arrival) but rather to sustain and amplify uncertainty. Our interest in speculation, then, is not in diagnosing an anticipatory orientation towards a more or less certain future, but in how speculation (in relation to underground resource potential) creates and sustains a multitude of possible futures that usher in chance as a guiding logic. For us, speculation harnesses a field of possible futures that confound pre-emptive planning and anticipatory calculation. The plural possibilities of the future become, instead, a matter of taking chances amid uncertainty – the future as a form of gamble. Importantly, this orientation to chance is not narrowly economic or political but resonates across domains of knowledge, state and economy to create conditions for new political alignments.

We use the cases of shale gas in Poland and the UK to elaborate this argument, harnessing the capacity of exploratory case studies for generating theory and reading Poland and the UK together rather than as isolated instances (Hardwick, 2016). We explore how geo-imaginaries of shale gas potential fuelled a "politics of possibility" (Amoore, 2013) in which subsurface uncertainties amplified projected flows of gas, circulation of capital, and dissemination of political power. We argue there are two primary insights from this perspective. First, speculation around subsurface resources should not be interpreted as merely an outcome of anticipation in the face of (inherent) risks and uncertainties associated with heterogeneous, underground materials. We show, rather, how speculation actively sustains and amplifies uncertainties about the underground as part of a broader political project of governing through possibility (as opposed to governing through anticipation and risk, which is focused on reducing and pre-empting uncertainties). Second, there is no locus or central point from which speculation is generated or legitimised because it works instead through resonance and amplification. Our account contributes to research on resource-making and political geology by investigating the politics of possibility that have formed around shale at the nexus of knowledge production, capital accumulation, and political power. The cases of shale gas in Poland and the UK, then, offer a point of entry into broader conceptual considerations around geo-imaginaries and speculation.

The following section lays foundations for our argument by taking stock of recent scholarly work on resource making. We focus on three themes relevant to our expanded understanding of speculation: (i) an orientation towards the future; (ii) the role of geo-imaginaries; and (iii) the production of social order via the underground. In Section 3, we illustrate our conceptual argument by drawing on the experience of shale gas development in Poland and the UK. In the closing part of the paper (Section 4) we reflect on the implications of our understanding of speculation, and its significance for research on resource-making and political geography more broadly.

2. Resource-making: geo-imaginaries, speculation, resonance

A burgeoning literature on "resource-making" in critical resource geography and environmental anthropology foregrounds the relations and practices through which landscapes and materials are rendered knowable and actionable *qua* resources (Himley, 2021; Kama, 2020, 2022; Kneas, 2017). Work on resource materialities, for example, considers resources as provisional assemblages prone to revision, whose apparent qualities and properties (spatial form, content, abundance, value) are 'worked up' over time by, for example, bringing historical data, market projections and technological expectations into relation (e.g., Bakker & Bridge, 2022; Barry, 2013; Kuchler, 2017; Kuchler & Bridge, 2018; Marston & Himley, 2021; Labussière, 2021; Richardson & Weszkalnys, 2014; Valdivia et al., 2021). Recent scholarship explores this unsettled and provisional character of resources through an interest

[1] The founder of Cuadrilla dismissed lifting the moratorium in September 2022 as merely a "political gesture" because fracking "does not make economic sense" and "no sensible investors" would take the risk. He described the logic of lifting the moratorium as "primarily a political decision – they have to be seen to be doing something" (Harvey, 2022).

in their indeterminacy i.e., resources are materials that have not yet acquired their full form, that are in the process of becoming but have yet to be (Bruun, 2018; Kama, 2020; Li, 2014; Szolucha, 2023; Valdivia et al., 2021). Weszkalnys' work (2015, 2017) on resource potentiality, for example, highlights how resource appraisals and resource infrastructures are not merely ends or outcomes of social practices but (drawing on Agamben) also function socially as ongoing "gestures" of productive potential. This perspective emphasises how infrastructures (petroleum licences, contracts, test wells, drilling rigs) act as an "indeterminate yet sustaining force" even in situations of evident failure: they function as "gestures of what might be … they hold in suspense the possibility that, eventually, they will lead to something" (Weszkalnys, 2017, p. 293). Allied work emphasises how these gestures are part and parcel of the "anticipatory rhythms" of resource-making which hold open a space of possibility even in "the face of contradictory social and material rhythms generated by challenging geological conditions and delays" (Szolucha, 2023, p. 13). Weszkalnys' allusion to the 'pause' as an important temporality of resource development, for example, points not only to the obvious temporary suspension of activity but, more significantly, to the endurance and sustaining of possibility in this period. We find these recent perspectives on resource-making valuable for thinking about how geo-imaginaries, materialised through maps, contracts and the appurtenances of resource extraction, can sustain indeterminacy and thereby affirm possibility.

To explore this further, and to establish our conceptual framework by reference to key arguments in the borderlands of resource geography and political geography, the remainder of this section proceeds in three steps. First, we briefly explore the role of (geo)imaginaries in relation to underground resources. Second, we consider work on speculation and offer an alternative reading to the dominant view of speculation as a pre-emptive and anticipatory action that aims to make the future actionable by reducing uncertainty. We reformulate speculation, drawing on work in political geography on the politics of possibility. Finally, and before putting it to work in Section 3, we consider how speculation – understood as a logic of chance nurtured, sustained and amplified by uncertainty – 'spills-over' from epistemic to market realms, creating a form of productive resonance across epistemic, economic and political domains that offers new opportunities for governance.

It is in the context of this recent work on resource-making and geographies of the future that we think the concept of speculation has untapped analytical value for disclosing how resource-making presages a politics of possibility. However, we diverge from understanding speculation as a technology of pre-emption centred around anticipatory actions and calculative practices that seek to reduce uncertainty and render the future actionable in the present (e.g., Anderson, 2010; de Goede et al., 2014; Szolucha, 2023). We consider speculation a qualitatively distinctive orientation towards future uncertainty - an intention to capture future value in situations where conventional modes of handling indeterminacy (such as calculation, probability) are not effective (Bryant & Knight, 2019). Approaching speculation as more than a project of rational calculation and prospective financial return opens up an expansive understanding of the role speculation may play in relation to resource making at specific historical moments. To speculate, then, is to conjecture based on incomplete knowledge or partial information, a grey area lying between factual and fictitious, mainstream and marginal. The significance of this approach is that it identifies how imagining future value from resources occurs not via rational calculation, but through a speculative mode that is simultaneously affective and strategic, an orientation towards the future that fuses feelings (desire, hope, fear) and intentional action (Bryant & Knight, 2019). In other words, we approach speculation not as a narrowly calculative practice or economic phenomena, but as a socio-political orientation towards the future that takes shape in and around resources. The productive relation between uncertainty and possibility that is central to resource-making – and through which resources are constituted *as future potential* - is mediated by (geo)imagination.

2.1. Geo-imaginaries: resource-making and the underground

The underground has long been a space of imaginative possibilities (Williams, 1990; Woon & Dodds, 2022). The hidden, indeterminate, heterogenous and immense volumetric character of the underground offers particular affordances for speculative futures - the sense of possibility that arises from uncertainties over form, content or future value. Tsing's (2000, p. 141) work on the Bre-X scandal, for example, shows brilliantly how an "economy of appearances" was constructed around the underground in Borneo as "investors speculate(d) on a product that may or may not exist." The uncertain material qualities of subterranean space defy many of the devices designed for ordering and rendering predictable surface phenomena, and often can be known only indirectly through spatial proxies so that the underground's "potentiality becomes an important realm for speculation" (Karwowski, 2015, p. 102). As a consequence, mineral exploration is an inherently speculative enterprise for which uncertainty (and its corollary, possibility) are constitutive properties: as Tsing puts it, exploration companies need to "exaggerate the possibilities of their [prospects] in order to attract investors so that they might, at some point, find something" (Tsing, 2000, p. 119, cited in Gilbert, 2020, p. 18).

Recent work on subterranean imaginaries has two important insights from the perspective of the argument we are seeking to develop. The first centres on the role of geo-imagination in the context of radical uncertainty. Work increasingly foregrounds the imaginative practices and technologies that construct resource 'potential' in the context of uncertain future value, and the way "observation(s) of potentiality" necessarily "reference imperfect empirical proxies" (Weszkalnys, 2015, p. 625). Tsing has made this point in relation to financial speculation on subterranean resources, noting how "in speculative enterprises, profit must be imagined before it can be extracted" (Tsing, 2000, p. 118). Fry and Murphy (2021) explore how the hydrocarbon potential of Mexico's Burgos Basin has been sustained over time through numerical assessment, visualisation, and repeated motifs. These attach subsurface geological matter to a range of future projects, from natural gas production and regional economic development to financial investment and risk management. The literature makes a similar point about the constitutive role of imagination in relation to state projections of subterranean resource potential: Coronil's (1997) work on the Venezuelan state's projection of abundance, industrialisation and modernisation via oil, for example, details some of the imaginative acts and prestidigitations through which states conjure future worlds from subsurface resources. Himley (2021, p. 10) highlights the imaginations and symbolism at work in 19th century scientific efforts to map mineral abundance and project Peru as a "ready-to-exploit resource frontier," showing how these were sometimes at odds with calculative and quantitative aspects of geological science. Importantly, these geo-imaginations fold the future into the present: projections of possible utility and value constitute the resource in the here and now, lending the resource imaginary its social power. For example, volumetric appraisals (e.g. of oil or gas reserves) are "present enactments of possible futures" (De Goede, 2015) that are performed by different actors and by using different means. A second insight is the way imaginaries of resource potentiality are essentially open ended – their constitutive uncertainty gives rise to multiple possible social outcomes without foreclosing any in particular – but, at the same time, geo-imaginaries also become important tools for mediating the productive relation between uncertainty and possibility. The indeterminacy of the resource condition (Weszkalnys, 2015) means there is always a "question of how the resource might eventually materialize" (Kama, 2020, p. 61) so that discussion of resource "potential evokes a field of possible outcomes between un-becoming and actualization" (Kneas, 2020, p. 269).

2.2. Speculation: from pre-emptive action to amplification of uncertainty

Speculation has become one of the main conceptual tools for

thinking about the relation between uncertainty and future possibility. In resource geography speculation provides a way to think about the anticipation of future financial value obtainable from natural resources, what Kneas (2020) refers to as the placing of potential. The orientation towards that future here is anticipatory, and anticipated future economic value is made actionable in the present through pre-emptive calculative practices. This work acknowledges how resource "potential evokes a field of possible outcomes" but focuses on how, given those possibilities, value is secured in the present (Kneas, 2020, p. 269). It approaches speculation, then, as a means of capturing value from the 'upside' possibilities of resource exploration and development (Kneas, 2020, p. 277). Armed with this perspective, research on speculation in resource geography identifies the actions and devices through which projections of future value are attainable from resources (Li, 2014; Ouma, 2020); and highlights the morally-laden distinction between investment and speculation as orientations to the future under conditions of uncertainty (Gilbert, 2020; Kneas, 2020; Phimister, 2003).

We think the concept of speculation in resource geography has untapped analytical value, however, if loosened from its associations with anticipation and pre-emptive calculation. Here political geography offers a more plural palette for thinking about speculation's relation to geographies of the future and, we suggest, offers a way to extend current thinking about anticipation and potentiality within resource geography. Like resource geography, long-standing work within political geography views speculation as an 'anticipatory logic', a mode of knowing and inhabiting an open and contingent future that makes it actionable in the present (Anderson, 2010, Aradau & Van Munster, 2011). A focus of this work has been on security, and how the uncertainty and indeterminacy of the future (exemplified by surprising events or emergencies, such as an accident or a terrorist attack) are reduced and made manageable through technologies of risk or practices of anticipation. The same interest in pre-emption and calculation extends to work on speculation as a logic fusing economy with security, and which foregrounds the role of technologies of calculation, data analytics and modelling within 'speculative security culture' (de Goede et al., 2014, p. 412; Cooper, 2008, Aradau & Van Munster, 2011). From this perspective, financial speculation and security pre-emption are "not so much about predicting the future but act on multiple potential futures that are rendered actionable (or liquid) in the present" (de Goede et al., 2014, p. 413).

More interesting, for us, however, is work in political geography that loosens the link between speculation and anticipative pre-emption. A starting point here is Amoore (2013) whose observations on the "politics of possibility" highlight a rather different orientation towards uncertainty to that of pre-emptive calculation: an embrace of uncertainty and amplification of possible futures, with decisions made "on the basis of future possibilities" (Amoore, 2013, p. 12). In other words, it is the unknowability and unpredictability of the future, as opposed to anticipation and pre-emption, that necessitates and sustains the imagination of possibilities. The significance of this perspective is that here speculation is not about managing or controlling the future (e.g., through various epistemic techniques or political apparatuses) but about nurturing and sustaining uncertainty.

Rather than subjecting speculation to the "discipline of rational calculation" (O'Malley, 2003, p. 249) that seeks to anticipate and pre-empt the future, we consider speculative performance as a form of gambling interested in sustaining uncertainty. As Amoore (2013, p. 5) points out, "unknowability of the future" is essential for capital accumulation, so that this speculative relation to future possibilities is central to contemporary "casino capitalism" (Harvey, 1989, p. 332) and the "economy of appearances" (Tsing, 2000, p. 118). Recollecting Foucault's insight that the "economy … is always and inescapably concerned with the unfolding of future possibilities", Amoore argues that the "necessary unknowability of the future … so central to profit, speculation" sits awkwardly with sovereign power (2013, p. 5). The essence of this tension is that "the unpredictable and incalculable elements that can never be amenable to sovereign power are the very source of economic profitability" (Amoore, 2013, p. 6). Yet, Amoore notes, when compelled to (re)act in the face of uncertainty, sovereign power turns to precisely such speculative practices, "incorporating the very unknowability and profound uncertainty of the future into imminent decision" (Amoore, 2013, p. 9). This is precisely because uncertainty generates values that lie not just in one future but in *the multitude of possible futures* that can be imagined arising from it, and that can be acted upon in the present through speculative practices. Massumi's (2009) discussion of threat-potential in late liberalism conveys a similar understanding of the relation between indeterminacy, multiple futures, and the amplification of possibility. Significantly, Massumi highlights indeterminacy as more than a simple lack of determination and, instead, as "indiscriminate possibility" - "*a determination to be determined* of a coming event, welling into formation" (2009, p. 161). What we find useful here, in both Amoore and Massumi, is an understanding of indeterminacy and possibility that is one-step removed from determinations of presence or calculations of probability. This work in political geography highlights the operative force of the "incipience of an event, as yet to be determined, overfull with really felt potential" and "the unstable holding-together of divergent possible ascriptions" – it names, in short, "indiscriminate potential" (Massumi, 2009, p. 161).

We find this a productive perspective in relation to speculation on subsurface energy resources. This is not only because of the 'double uncertainty' such resource futures involve (combining the uncertainty of subterranean material qualities and the uncertainty of the future); or because subterranean resources involve precisely this tension between knowledge production, economy and sovereign power. Rather, it takes us away from thinking about speculation as a logic of pre-emption or a practice of calculating future probabilities and, instead, directs attention to the way uncertainty and indeterminacy amplify possibility. It is, then, around the unknowability of such resources and the futures that might be harnessed to them – what are the qualities of subterranean earth, and what might these qualities do? - that one would expect to find speculative imaginations as a means for acting in the present. As "nobody knows what will be found (if anything); what the eventual social and economic benefits might be (if any); and when potentiality will be turned into actuality (if at all)," speculation offers a way of "buy (ing) into indeterminate futures" (Bryant & Knight, 2019, p. 99). In this way, speculation works by imagining possible futures as a way of orienting to and acting in the present. In short, this perspective helps us to show how resource-making works through and presages a politics of possibility.

2.3. From speculative spill-overs to resonance and the politics of possibility

If the origins of work on speculation lie primarily in the economic realm and are closely tied to the logics of finance, then recent work on speculative practices in relation to resources go beyond this 'economic' orientation to consider how speculation involves conjunctures of knowledge, market relations and the state (Lyall & Valdivia, 2019). We find this work provocative because - like us - it seeks to highlight how the significance of speculation lies in its more-than-economic nature and capacity to spill-over from one domain to another. Such spill-overs are analytically interesting because, by acknowledging how speculation creates associations and alignments between different domains, they potentially offer a way to think about speculation as a mode of socio-political governance. The way geological knowledge (and the uncertainties it generated about the qualities of the underground) spill into the market domain of mineral speculation is picked up by Bridge and Frederiksen (2012) in their examination of tin-mining in northern Nigeria in the early 1900s. Like Braun (2000), Himley (2021) and Kneas (2017), these authors demonstrate how as material qualities of the subsurface were rendered visible and knowable, this newly discovered mineral opulence was converted into a space of "commercial opportunity" for London-based financial speculators (Bridge & Frederiksen, 2012, p. 376). Lyall and Valdivia (2019, p. 349) similarly show state

power in Ecuador ("a speculative petro-state") hinged on the way state actors "successfully gamble on volatile markets on behalf of the nation". Speculation here is placed neither within the financial nor political realm, but at the intersection of populistic policies and market forces. In this way the authors show how speculation (which underpins the management of risks concerned with oil price volatility) also organises and legitimates a populist government.

By disclosing "powerful volumetric imaginaries of shale gas potential" in Poland and the United Kingdom, Kuchler (2017) demonstrates that geological knowledge production relies on speculative apparatuses that translate "known unknowns" (Kuchler, 2017, p. 35) into political possibility. In this account, speculation obscures historical and incomplete geological information by turning it into an intelligible source of data. Likewise, Kama and Kuchler (2019) illustrate how, despite large uncertainties surrounding geological prospecitivity of national shale gas resources, the European geological survey has embarked on a challenging task of producing "more reliable estimates". As a result, "these speculative appraisals have become central to the geopolitical imagination of energy sovereignty" in Europe and, consequently, have "reshaped the politics around the 'geos'" (Kama & Kuchler, 2019, p. 136).

Ultimately, however, we find these accounts of speculative conjuncture limiting and unable to offer a convincing account of governance. This is because they tend to restrict conjuncture to a rather simple form of bi-lateral causality (perhaps 'infection' is a better metaphor), in which a given speculative practice originating in one domain (knowledge production, market or state) is subsequently transferred to another. It is here that Weszkalnys's (2015) work on 'gestures of potentiality' offer a fruitful problematisation of the communicative and socially-productive character of speculation in relation to resources and extractive industries. In her work on the promise of oil in São Tomé and Príncipe, she critically examines how the highly uncertain potential of "first oil" is generated with help of speculative epistemologies. A key feature of her account, however, is the way this potential is sustained by practices, techniques and infrastructures that, initially intended to "realize petroleum", instead "become gestural in the absence of significant commercial discoveries" (Weszkalnys, 2015, p. 616). Like other authors (Kama & Kuchler, 2019; Kuchler, 2017), Weszkalnys (2015) points to the origin of speculation in the fragmented and obscured character of geological knowledge production but, more significantly, she demonstrates how this fable of oil potentiality is sustained to keep capital investments and state resources mobilised. From this perspective, speculation is understood as the "observation of potentiality both in terms of remaking and of producing new facts" (Weszkalnys, 2015, p. 617), so that gestures of potentiality work to postpone failure and prevent first oil turning into loss. Similarly, we find particularly productive Szolucha's (2018, p. 349) suggestion that it is through "the generative forces of speculation about future possibilities" that the "disjunctive temporalities of the state, markets, and science" can coalesce to form a successful bid for shale.[2] It is precisely this sense of interaction and mutual amplification associated with speculation – a less intentional and more multiple form of interaction than implied by bi-lateral causation between domains - that we wish to capture in thinking about resource making as a "politics of possibility."

Our goal is to develop an expanded understanding of speculation as a form of productive and relational resonance across epistemic, economic, and political domains made possible by uncertainty that creates new opportunities. There are two 'moves' at work here. The first is to see speculation as a productive force that generates and sustains: this goes beyond narrow accounts of speculation as a set of financial practices generated by economic actors, to conceptualise speculation as performative and relational force working across epistemic, economic and political domains, and deriving its productivity from the multitude of possible futures. The second is that speculation does not have a common central point (nexus) from which it is generated: instead, speculation is a productive force because of the way it interacts and reacts across different domains: for Amoore (2013, p. 4), economy and security interpenetrate and combine to create a structure of governance that is achieved via "a point of resonance on the horizon." Amoore's understanding of resonance draws on Connolly's work (2005, 2008) on the 'capitalist-evangelical assemblage' of the United States under George W. Bush, which posited 'resonance' as an alternative way of thinking about causation in relation to the interactions creating right wing political alignments. As Connolly explained, "in politics diverse elements infiltrate into the others, metabolizing into a moving complex—causation as resonance between elements that become fused together to a considerable degree. Here causality, as relations of dependence between separate factors, morphs into energized complexities of mutual imbrication and inter-involvement, in which heretofore unconnected or loosely associated elements fold, bend, blend, emulsify, and dissolve into each other, forging a qualitative assemblage resistant to classical models of explanation" (Connolly, 2005, p. 870).

The insight of this perspective – speculation as resonance – is the way "it displaces causal understandings of the mutual dependence among factors, making visible the multiple ways in which "in politics, these diverse elements infiltrate each other, metabolizing into a moving complex'" (Amoore, 2013, p. 5; citing Connolly, 2008). Here we have a qualitatively different way of understanding how speculation works that takes us a long way beyond simple 'spill-overs', in which excess in one domain ends up contaminating another. Instead, the insight of resonance is reciprocal excitation – that different things "are caught up with one another other, and affect one another" (Page, 2018, p. 29). In the case that follows, we draw on this perspective of 'resonance' to show how speculation around shale has permeated the three spheres of knowledge, market, and the state, augmenting them into a dynamic assemblage wherein the three spheres infiltrate each other (Amoore, 2013; Massumi, 2005). We focus on the amplifications and intensifications of speculation that result, and the way speculation proliferates across new spaces of application to become unremarkable and ubiquitous as a mode of governance. By understanding resonance as "a convergence of affective fields" we can also consider the intended "desired affect" of speculation and its associated politics of possibility (Page & Dittmer, 2016, p. 76). We show in the next section how a key element of this desired affect is that of 'giving it a go' – in other words, gambling in the face of uncertain odds and multiple possible outcomes.

3. Gambling on shale: the politics of possibility in Poland and the UK

In this section we illustrate our conceptual argument about speculation as a form of resonance by reference to the experience of shale development in Poland and the UK. We read the curtailed histories of shale in the two countries together (rather than comparatively), to consider how in both settings uncertainties linked to the quality of the resource infiltrated economic and political realms. We highlight how, both in Poland and the UK, geological knowledge about shale and its economic and political possibilities came together to create a distinctive speculative orientation towards the future based on the uncertain qualities of the underground. We draw on documentary sources and fieldwork, although our objective of this section is not to present a comprehensive account of shale development in the two countries. Instead, we have organised our exploratory account to identify how speculation about and through shale originated in the spatial (volumetric) limits of geological knowledge, but quickly became amplified by the economic and political possibilities of uncertainty.

[2] Szolucha refers to 'science', although we think it important to acknowledge a wider epistemic community associated with geological understandings of the underground that also encompasses industry, government and some civil society organizations.

3.1. Known unknowns – speculative knowledge production

The existence of organic-rich, sedimentary shale rock formations around the world has been known to geologists and industry experts for decades (e.g., McCabe, 1998; Rogner, 1997). These so-called "unconventional" pockets of organic matter are less sparsely scattered and potentially much larger than conventional reservoirs of hydrocarbons. Whether organic matter trapped in shale rocks can be unlocked and turned into a potent – and commercially attractive - flow of gas remains unknown, without many test drillings that need to be performed in (often large) areas identified as prospective. When geologists and industry experts speculate on the future potentiality and extractability of these subsurface 'known unknowns' (Kuchler, 2017), they label them as 'undiscovered' and 'sub-economic' resources that wait patiently underground for a future equipped with more suitable technologies and better economic circumstances (e.g., the "McKelvey Box", see in McKelvey, 1972). Such hypothetical resource potential is sustained by a high degree of uncertainty, creating a field of multiple future possibilities for extractive industries and policy makers alike. In this way, incomplete geological knowledge has speculative possibilities – i.e. an immanent potential for alignment with political-economic goals - that resonates across economic and political spheres. As McKelvey (1972) noted, "even incomplete and provisional estimates are better than none at all, and if they differentiate known, undiscovered, and presently uneconomic resources they will help to define the supply problem and provide a basis for policy decisions relating to it" (p. 34). In short, unconventional resources have an excess of speculative potential that can be put to work politically: most obviously, they can be rendered as a storehouse-in-waiting in relation to security of supply or economic development.[3] However, this speculative potential - which rests on uncertainties about the 'qualities of territory' – produces an orientation or disposition towards the future characterised by hope, chance and risk that can be harnessed for wider political-economic objectives.

The shale gas boom in the United States (U.S.), that kicked-off with full force in the early 2000s, was enabled by two key technological novelties: horizontal drilling and hydraulic fracturing. Both techniques were essential for opening and harnessing the potential of organic-rich matter (both gas and oil) locked in American shales. This is because, contrary to conventional hydrocarbons extracted by tapping a vertical well into an underground reservoir, unconventional resources trapped in shale deposits can only be released by manipulating the subsurface rock structure and creating a reservoir to allow flow to the surface (Kama & Kuchler, 2019; Kuchler, 2017). Unsurprisingly, the U.S. shale revolution prompted massive interest around the possibility of developing "home-grown" shale gas resources in other parts of the world, particularly in Europe increasingly dependent upon natural gas imports from Russia.

What followed was a proliferation of shale gas resource estimates for regions and countries outside the U.S. (McGlade et al., 2013). Europe's subsurface rapidly became a site of intense geological and geopolitical speculations as to whether and to what extent American success could be replicated (Kama & Kuchler, 2019). Since 2009, diverse public-private constellations of consulting firms and research organizations circulated their assessments of the potential shale gas availability in Europe (e.g., ARI, 2009; CERA, 2009; Wood, 2009; EIA/ARI, 2011, 2013). Amid a rapidly increasing international interest that quickly permeated through to the public in several European countries, national geological surveys in the UK and Poland were also mobilised to make assessments of domestic shale gas resource potential (e.g., Andrews, 2013, 2014; DECC, 2010; PGI, 2012).

[3] 'Storehouse' here brings to mind Heidegger's (1977) notion of the 'standing reserve' and references the way technologies (like hydraulic fracturing) enframe materials as exploitable objects defined by their readiness for human use (see, for example, Johnson et al., 2014).

However, shale accumulations across Europe – including in Poland and the UK – had been largely unexplored and were poorly understood in terms of unconventional resource extraction (Hadro, 2010; Harvey et al., 2018; Kama & Kuchler, 2019). Hence, all new estimates of unconventional gas potential were based on vintage and scanty data obtained via insufficient geological surveys dating from the second half of the 20th century. Yet, for speculation on shale's potential, this incomplete and highly uncertain geological knowledge was not considered a problem but an asset. In place of multiple boreholes serving as direct points of access into underground hydrocarbon landscapes, speculation became the necessary means through which shale gas potential could be made imaginable. A lack of credible geological data, and total absence of commercial production in Europe, meant it was only through speculation that interpretations of the Earth's deep-time organic content stored in the subsurface could be bridged with anticipations of future resource extraction potential. In other words, the uncertainty surrounding shale gas potential generated speculation, which in turn, thrived upon and sustained uncertainty. Shale's *future potential* – rather than shale itself - became the key resource.

In this context, historic and low spatial resolution geological data on the subsurface in Poland and the UK were repeatedly reinterpreted and reproduced using different approaches, resulting in dramatically different levels of spatially delineated volumetric appraisals (Kama & Kuchler, 2019; Kuchler, 2017). The anticipation of shale here did not produce a politics of pre-emption and risk-reduction geared towards managing future probabilities but instead fuelled a politics of possibility. Organic-rich shale accumulations were presumed to be continuous, imagined to have potential for yielding gas in the future, and were subdivided into vast prospective areas (or basins), usually more than several thousand square km in extent. The subsurface "content" of these prospective basins was then visualised by reference to often large gas-in-place (GIP) volumetric numbers. The absence of shale gas production in Europe meant that U.S. shale plays (e.g., the potent Barnett Shale in Texas, or the less productive Antrim Shale in Michigan) were employed as analogues for the productivity of Polish and British shale occurrences and their capacity to yield gas, notwithstanding their different geologies (DECC, 2010; PGI, 2012). The larger the GIP estimated, the higher the technically recoverable volume. These analogues and estimates offered potent geo-imaginaries that, in Weszkalnys's (2017, p. 293) phrase, served as an "indeterminate yet sustaining force" of shale's possibility.

Through this propagation of uncertainty, speculation thrived and intensified around a wide range of estimates that brought within themselves different future imaginaries suspended between abundance and scarcity. For example, an assessment conducted by consulting firm Advanced Resources International (ARI) for the U.S. Energy Information Administration (EIA) in 2011 estimated technically recoverable shale gas resources to be an impressive 5300 bcm in Poland and scarcely 10% of that (566 bcm) in the UK (EIA/ARI, 2011). A year earlier, the British Geological Survey (BGS) – commissioned by the Department of Energy and Climate Change (DECC) to assess the country's shale gas potential – tentatively projected that the productivity of UK shales could be 150 bcm (DECC, 2010). In 2012, the U.S. Geological Survey (USGS, 2012) indicated that Poland's recoverable potential could reach a maximum of 116 bcm. The same year, by applying the USGS methodology, the Polish Geological Institute (PGI) arrived at the optimal level of recoverability in the amount of 768 bcm (PGI, 2012). Both the PGI and BGS volumetric appraisals ware met with criticism for possibly underestimating future resource recoverability and, as a result, potentially discouraging industries and investors from engaging in shale gas developments in Poland and the UK (Kama & Kuchler, 2019).

In 2012, Poland took the lead in Europe's shale gas "revolution" with a record number of 111 valid concessions (Wachtmeister et al., 2021). However, by late 2017, the number of active concessions had dramatically declined to a mere 20. To date, from 72 test wells drilled in Poland between 2010 and 2016, only 25 hydraulic fracturing and nine

micro-fracturing treatments were performed (MŚ, 2016). In the UK, 8 test wells have been completed across an area of nearly 13,000 km^2 held under onshore petroleum licences, of which three have been partially fracked (Fishman, 2016; Fletcher & Bradshaw, 2023; Harvey et al., 2018). In early 2023, there were 117 active onshore petroleum licences covering shale plays in England although, absent any activity, these are likely to expire in the next couple of years.[4] Setbacks and withdrawals of planning applications mean that, at the time of writing, no site in the UK has permission to drill shale gas wells (Fletcher & Bradshaw, 2023). Both countries, therefore, have found themselves sitting on something akin to a phantom Eldorado – a future imaginary of resource abundance within reach, but with nothing (yet) to reach for. Moreover, the lack of credible data meant it was not possible to deem any estimate incorrect – any assessment could be credible – so that conventional approaches to handling indeterminacy (via the use of probabilities, for example) were superseded. The assessments provided different future imaginaries of resource potential trapped in the subsurface, signalling a multitude of future possibilities. The political-economic value of shale gas, then, lay not in the resource itself but in the sustained geological uncertainties upon which speculation thrived. From this perspective, speculative appraisals of future potential (and the possibilities to which they gave rise) were less about helping policy makers prepare for future development, and more about harnessing uncertainties in ways that made the future actionable in the present.

3.2. Speculative flows and economies of appearance

The uncertainties surrounding incomplete geological knowledge of shale sustained speculative flows of capital into shale development in Poland and the UK. Geological uncertainties enabled 'economies of appearance' (Tsing, 2000) to take hold, in which speculation about the qualities of the underground (originating in the spatial limits of geological knowledge) resonated with speculative practices in the economic sphere that fold uncertainty about the future into profit making. Combined, these turned the subsurface into a virtual entity that could be owned and held on the ground via state-issued drilling concessions. Concessions parcelled up the subsurface into containers of future potential (via the imaginary of shale gas abundance) that could be acted on in the present, regardless of whether a resource was found or not. In these classic economies of appearance, capital accumulation could be achieved without extracting gas from the subsurface but by capitalising on the uncertainties associated with underground potential.

Exploration in Poland and the UK identified a total prospective area for unconventional gas that was very large. Poland's total prospective area was estimated at over 56,000 square km and included three shale basins stretching from the Polish coastline in the north to the country's border with Ukraine in the south-east; while the prospective area of the UK's Bowland Basin alone covered over 25,000 square km (EIA/ARI, 2011). This vast underground space containing a massively uncertain volume of gas in place was further divided into concessions on the ground. As a result, each parcel of land designated for exploration covered a much larger area than would ultimately be fracked. For example, Cuadrilla's Petroleum Exploration and Development Licence (PEDL 165) in Lancashire in northwest England, where the now (in) famous test well Preese Hall-1 was drilled in 2011 causing local tremors, covers an area of more than 1000 square km. Likewise, many concessions for prospecting and exploration of unconventional gas in Poland covered more than one thousand square km each.

Such a prospective area becomes a virtual subsurface – a container of hopes and dreams sutured around a multiplicity of future possibilities – and (re)imagined through conjectural volumetric appraisals of resource potential. It then easily becomes a site of potent speculative activities involving different actors ranging from large international corporations and national companies to small family firms and the so-called wildcats. Speculation both sustains and thrives on the massive uncertainty of gas-in-place which brings a multitude of possible futures. Because value does not lie in the resource itself, but in the speculative potential of future value, concessions become financial assets that are swiftly transferred, swapped, joint-ventured or farmed-in by different players for a quick profit or to boost stocks. In some cases, they can also become subject to corruption and criminal activities, such as bribery (Reuters, 2012).

Concessions became the point of entry for different sources of capital that then circulated within complex business arrangements. Lured by large (yet highly uncertain) speculative volumetric estimates concealed beneath them, concessions offered a way for financial actors to "buy into indeterminate futures" (Bryant & Knight, 2019, p. 99), a chip with which to gamble. In this sense, every license owner could become a winner (or loser) in the unconventional gas roulette. Betting on shale gas was worth the gamble as profits could be made via different speculative arrangements, e.g., boosting company stocks by performing a test well or acquiring a "promising" licence; selling concessions as assets; swapping, farming-in and joint ventures. The capital flowing into shale in Poland and the UK came through multiple international channels: of the total of 27 blocks awarded in the UK's 14th licensing round, 12 were acquired by companies based abroad or with majority ownership located overseas (Ottery, 2015); many Polish prospecting and exploration (P + E) concessions were similarly acquired by companies with foreign-based capital (MŚ, 2016).

For example, in 2009, a Polish family firm Mazovia Energy Resources acquired seven licences for P + E of unconventional gas resources in Poland (MŚ, 2009). With no previous experience in P + E, drilling services or resource extraction, the company's sole objective was to acquire specific concessions only to gain financial benefit by selling them as assets to other companies that hoped to develop unconventional resources in the country. Among others, three concessions were bought by San Leon for USD 1 million in cash and shares (World Oil, 2011). Of all concessions for prospecting and exploration granted by the Polish government between 2007 and 2016, more than half were sold, transferred, joint-ventured or farmed-in. The UK's 14th licensing round (2015) also saw a variety of different actors granted concessions, including small companies with limited capitalisation drawn by the speculative possibilities of holding virtual subsurface assets whose value would rise if shale was developed elsewhere in the UK, and that could be sold on or offered as a farm-in to larger players.

Test well drilling became closely akin to, what Tsing (2000) calls, the "economy of appearances" aimed at boosting a company's portfolio or its stocks, and to attract public attention and further investments. The more spectacular "discovery" the better, as its volumetric imaginary of abundance attracted and sustained attention from investors, decision-makers, media outlets and the public. Due to the massive uncertainty of multiple resource estimates, any finding on-ground could be deemed triumphant. After drilling one test well at the Preese Hall site in Lancashire in 2011, Cuadrilla Resources (owned by Australian company A.J. Lucas and Anglo-American equity firm Riverstone Holdings) announced an impressive "discovery" of 200 Tcf (5663 bcm) of GIP in the Bowland shale (Oil & Gas Journal, 2011). Following this sensational announcement which, at that time, strongly contradicted the BGS's tentative findings (DECC, 2010), the company also argued that "should a fraction of this be extracted at a commercial rate, there is every chance that Cuadrilla's presence in the Lancashire area would lead to an 'Aberdeen Effect', where the region becomes the 'hub' for natural gas from shale operations in the UK and Europe" (Cuadrilla, 2013). Other companies rushed to make similar spectacular discoveries, consequently adding to the confusion about what shale gas potential was credibly trapped underground. In 2013, IGas Energy reported GIP in its northwest England licences to "most likely" be 102Tcf (2888 Bcm) (Reuters, 2014). A year later and after drilling one test well (Irlam-1/1Z), the

[4] As Fletcher and Bradshaw (2023: 8) explain, new shale licences in the UK "are effectively provisional: their first term lasts for 6 years, at which point the company either shows proof of agreed activity, or surrenders the licence."

company increased its GIP estimates to 192 Tcf (5436 Bcm) (Kavanagh, 2014). In 2014, Australian firm Eden Energy announced that there could be 34.2 Tcf (968 Bcm) of shale gas across seven of its licences in South Wales, covering an area of around 806 square km (Fishman, 2016). Similarly, in Poland, the highly optimistic estimates of shale gas resources where soon followed by the announcements of "spectacular" discoveries and assessments involving specific concessions. For example, in 2011, a small exploration enterprise 3Legs Resources announced an estimate of up to 170 Tcf of gas-in-place across the company's six licences in the Baltic Basin and outlined the plan to unlock "very significant upside potential" of its Polish assets (Natural Gas World, 2011). Similarly, a year later, the Canadian-based LNG Energy estimated the total resource volume for its three concessions in northern Poland ranging from 4.5 Tcf (126 Bcm) to 13.2 Tcf (370 Bcm) (Natural Gas World, 2012).

Moreover, shale gas developments were perceived as a way for allied industrial sectors to expand capital and generate new sources of revenue, particularly in the chemical and construction industries. For example, the global chemical company INEOS has been keen on exploring the UK's unconventional gas potential to gain access to gas feedstock for the company's UK refinery and expansion of chemical products and services. The former chairman of Poland's largest oil refiner and petrol retailer, PKN Orlen, compared Poland's shale gas frenzy to the economic effect created by the UEFA Euro Championships in 2012 that substantially spurred and increased various infrastructural developments in the country (Kowalczyk, 2012). In other words, the speculative shale gas promise resonated through and sutured a wide range of capital interests, including the energy industry, chemical manufacturing, construction, services, and so on. The future promise of shale gas – or what we will refer to as the shale gas derivative (see Section 4) – became the key resource that a wide array of companies and businesses bet on and acted upon in the present.

The Polish and UK shale cases show how a virtual (sub)surface was able to spin the industrial and economic wheel of fortune in the present, regardless of whether the underground shale resource would prove to be abundant or not. The exploration of prospective areas mobilised a broad spectrum of (often entangled) industry and service subcontractors with many types of national and international actors involved, including third-party services (e.g., basin modelling and geological data analysts, seismic services, corporate and permitting services, environmental services, construction of roads, human resources), drilling services (e.g., casing and cementing, drill bits and fluid systems, pipe supply, waste management, well pad construction, mud logging), and completions (e.g., pressure pumping, equipment supply, proppant supply, water management). To take one example, the Polish state-controlled PGNiG had only a limited number of concessions and performed only a few test wells, but was involved in several other test drillings where its subsidiary subcontractors (e.g., Geofizyka Toruń) were designated to provide geological data or drilling equipment, set up a well-pad and/or drill a well for other firms.

3.3. Political gamble

As Amoore (2013) points out, when a sovereign power is unable to control or curb unpredictable future trajectories, it turns to speculation that, feeding on uncertainty, converts economic profitability into political possibility. The massive uncertainty surrounding estimates of shale gas resource potential in Poland and the UK not only prompted but also empowered policy-makers in both countries to "gamble": that is, to encourage, enable and intervene in risky ventures by basing energy policy visions, objectives and strategies on betting and/or hoping that a considerable volume of shale gas potential could be harnessed in the future. In this sense, the shale gas developments in Poland and the UK illustrate that the political incumbencies were not interested in predicting or controlling the future, but rather benefited from - and sought to sustain - the existing conditions of uncertainty. This speculative resonance has been amplified through the political sphere in two distinct ways.

First, it is the "gambling" character of the state power – the risky betting on shale gas as a future chance, even "the last chance at fossil fuels" (House of Commons, 2011) – that opens a myriad of possibilities, ranging from national energy security to export capacity and societal wealth as well as a boost in local economic development. Like gamblers, the incumbents actively participate in the unconventional gas "roulette" by betting on different future geoimaginaries encapsulated in the promise of yet another (or perhaps the final) fossil fuel bonanza. Speaking about shale gas at the Utility Week Energy Summit in mid-2016, the former UK Minister of State for Energy, Andrea Leadsom, stated that, "our job is not to predict the future but to create the conditions for innovation. That will give us the best chance of ensuring that a system of secure, affordable and clean energy is our lasting legacy" (GOV.UK, 2016). By declaring that the UK government was "going all out for shale" (Watt, 2014), the then Prime Minister David Cameron indicated the political intention to bet all the chips on the chance of harnessing the potential of "home-grown" unconventional gas. In an opinion piece published in the Telegraph in 2013, Cameron argued that the UK "cannot afford to miss out on fracking" because "… for centuries, Britain has led the way in technological endeavour: an industrial revolution ahead of its time …" and "fracking is part of this tradition, so let's seize it" (Cameron, 2013). In 2014, the House of Lords' Economic Affairs Committee expressed the full support for the UK government's decision to "go all out for shale" (MacGregor, 2014). In the report on *The Economic Impact on UK Energy Policy of Shale Gas and Oil* (House of Lords, 2014), the Committee argued that "the UK should seize the opportunity offered by its shale gas resource" and that "The UK is exceptionally fortunate to have substantial shale gas and oil resources" (House of Lords, 2014, p. 87). Although Lord Browne (then Chairman of Cuadrilla Resources) referred to unconventional gas as a "source of competitive advantage" for the British nation and promised to invest "whatever it takes" (Harvey, 2013), six years later he admitted that "fracking in the UK doesn't make much sense. I think it was a test to see if it worked. We probably don't need to do it" (Vidal, 2019).

Similarly, in Poland, political leaders perceived shale gas predominantly through the lens of the "great chance" and sprouted a myriad of visions, including gas/energy independence and economic wealth based on the production of this fossil fuel (Lis & Stankiewicz, 2016). In 2010, the former Minister of Foreign Affairs, Władysław Sikorski, claimed that the production of shale gas in Poland would offer a chance for the country to become a second Norway within just 10–15 years (Gazeta, 2010). In 2011, former Prime Minister Donald Tusk assured Polish citizens that commercial exploitation of shale gas could start in 2014 and that Poland could become independent in gas supplies by 2035 (Sowula, 2011). The PM also declared that the revenues from gas exploitation would contribute to a special fund (similar to the Norwegian and Canadian funds) which would be used to guarantee the security of Polish pensions in the future. In 2012, former Deputy Minister of State Assets, Mikołaj Budzanowski, asserted that the production of gas from domestic shales would allow Poland to export LNG to other countries in Europe, thus copying the gas success of Qatar (Berenda, 2012).

Moreover, shale gas exploration wells and industry activities surrounding resource exploration became sites for political spectacles. In 2011, Donald Tusk's televised press conference – in which he claimed Poland's great chance for gas independence – had striking optics as the

PM stood holding a shale rock in his hand with a burning gas flare from the "Lubocino-1" test well in the background. In 2010, the opposition leader Jarosław Kaczyński, visited another test well in northern Poland where he declared in front of the journalists that "shale gas is a great opportunity not only for Pomerania, but also for Poland" (Nasze Miasto, 2010).[5] As Kuchler and Höök (2020, p. 6) argue, national enthusiasm surrounding shale gas estimates in Poland placed considerable pressure on Polish politicians, especially prior to the 2011 parliamentary elections, but the uncertainty embedded in the volumetric appraisals empowered them to speculate and thus make political capital by betting on possible futures ranging from national energy security to local economic development.

Second, political activity in speculative practices surrounding shale gas developments has been intimately entangled with (inter)national business and industry. Johnstone et al. (2017) observe how various positions within the British state apparatus have been occupied by people who have connections with fracking and other relevant extractive industries. An examplar of this sort of interplay is John Browne, member of the House of Lords while simultaneously Chairman of Cuadrilla Resources and partner in Riverstone Holdings, co-owner of Cuadrilla. Both Lord Howell (former UK energy minister) and Lord Green (former director of chemical giant BASF) were members of the Windsor Energy Group (WEG) sponsored by, among others, BP, Shell and British Gas. The Polish oil company LOTOS, active in Poland's shale gas developments, joined the WEG in 2009. Similarly, Poland's political elites have been (traditionally) entangled with the industry, especially those that are state-controlled. People coming directly from government institutions (such as the influential Ministry of State Treasury) have been appointed to leading positions in key extractive industries and vice-versa. However, government policy visions are not always in line with industry and business objectives. This is particularly evident in the case of smaller players that secure concessions for a quick financial benefit, or small-scale companies that speculate around their test well results. The large involvement of foreign capital in the Polish and British fracking developments (investments from the U.S. and Australia in particular) also undermine the fragile construction of shale gas exploration (and/or exploitation) as a "national resource" or a resource developed for a "national" benefit or wealth.

4. Concluding discussion: speculating on shale – shale as a derivative

Subterranean natural resources offer certain affordances for speculation, and none more so than the post-conventional energy futures that attach to resources like shale. In shale, subsurface imaginaries, geological frontiers and technological capacities combine to produce multiple contingent possibilities, as Kama (2022) has shown. Consequently, the potentiality (i.e., volume and value) of subterranean shale resources are uncommonly uncertain, as illustrated by the startling gap between enormous estimates of gas in place and actual yield from wells. Our point here, however, is not to argue for the special place of natural resources for speculative activity but to highlight what the uncertainties associated with resource potential make possible. It is this 'politics of possibility' associated with multiple uncertainties – and their reciprocal amplification – that we have sought to understand through the case of shale. In doing so, we have outlined a more expansive understanding of speculation than that most often associated with resource potential, which focuses narrowly on the calculative and financial. We have developed an understanding of speculation as resonance, as mutually reinforcing connections across epistemic, economic and political spheres that amplify and reinforce a speculative orientation. The result of this resonance, as we have shown, is that it becomes possible for leading politicians to describe state strategy as 'gambling' on the underground.

To build our account we have drawn on existing research on resource-making, located in the fertile borderlands of resource geography and political geography, but it has also been necessary to look beyond this work to consider contributions in political geography to the politics of governance (Amoore, 2013; Massumi, 2009). A key insight from this work is the way uncertainty and indeterminacy are constitutive and generative of forms of socio-political order, rather than merely a residual or excessive element evading efforts at control. Moreover, speculation in the face of this uncertainty is not about predicting or (even less) controlling the future, but about sustaining forms of uncertainty and rendering them as possible futures (no matter how improbable). As Thrift (2005, p. vi) observed some time ago, this very uncertainty "is increasingly being taken up and worked with by capitalism in ways which are productive of new kinds of aggregation and ordering." While our account is not about the nature of capitalism and, instead, is situated in the everyday politics of resource-making, we share this interest in the generative possibilities of uncertainty (as they relate to underground resources) and their significance for social ordering. We have drawn attention to the economic and political value of the uncertainties attached to shale, and how shale's value as a potential resource lies primarily in the multitude of possible future imaginaries it sustains that can be acted upon in the present. Old and sparse geological data in Poland and the UK were repeatedly reinterpreted, leading to many different volumetric shale gas appraisals that further propagated uncertainty. Speculative assessment thrived on these diverse estimates which promised different futures suspended between abundance and scarcity. In this way, prospective shale gas areas became more or less "indiscriminate potential" (Massumi, 2009, p. 162), containers of hopes, chances and opportunities through which a multiplicity of different actors engaged in "spectacular" performances of potential (Tsing, 2000). Incumbent governments in Poland and the UK sought to benefit from the uncertainties surrounding shale gas, "gambling" on its potential and the myriad possible futures to which it could give rise, from national energy security (home-grown gas) to local economic development and addressing inter-regional inequalities.

Engaging work in political geography has helped us move from a narrowly economic understanding of speculation with regard to imaginaries of resource potential, to a fuller account of the political orders that are produced alongside and through speculative resources. By developing a more expansive notion of speculation and applying it as our conceptual lens we have, in effect, interpreted the potentiality of shale gas in the UK and Poland as a type of *derivative* (Arnoldi, 2004; see also Büscher, 2010; Amoore, 2013; de Goede et al., 2014). As Arnoldi (2004, p. 23) observes, derivatives exploit uncertainties of possible futures as a resource "by virtualizing it". In other words, derivatives transform the future horizon from a range of non-existent possibilities to something that – although it does not really exist – can exist "in practice" and can be acted upon in the present (Arnoldi, 2004, p. 24). In this sense, the potentiality of shale gas is a virtual asset – it is through this potentiality, and the multitude of different futures that are possible, that the resource can be acted upon in the present. Shale gas is thus akin to a virtual entity – raw potentiality, latent (and multiple) possibilities – that may be bought and sold, shared and swapped, traded, gambled, and politicized in the present.

Significantly, the capacity to act on this potential is - following Amoore (2013) - made feasible by "what is not known." Uncertainty, then, underpins the politics of possibility that cohere around the potential of shale. The value of shale does not lie in specific physical properties of the resource itself but in its uncertain potentiality – what it might be, what it could become - and the possibilities triggered and

[5] The former UK Prime Minister, David Cameron, used the industrial optics of a fracking site near Gainsborough, Lincolnshire in January 2014 to announce that local councils could keep 100% of the business rates from fracking operations, in a bid to convince local communities to accept shale gas development and back up the government's statement about 'going all out' for shale. His visit was timed to coincide with Total's confirmation that it would invest in the Gainsborough project, the first major firm to commit to UK shale.

sustained by this uncertainty. In a broader sense, this derivative or virtual character of shale gas' potentiality shares the affective rationality of the gamble – of taking a chance - with a number of other 'post--conventional' resource projects which are similarly "aware of the virtually given contingency and open future(s)" (Arnoldi, 2004). It is the openness of the future in these contexts – i.e., a multitude of possible futures – that is being exploited, rather than the resource itself. The plurality of possibilities, however, means divergent and frequently contradictory temporalities are in play – things could be at different rates and times – which require various strategies (e.g., epistemic, political, economic) and speeds of action. It is through the derivative or virtual character of potentiality that this complexity and multiplicity can be conceived in a meaningful way (Arnoldi, 2004), and spill-overs and resonances made possible across scientific, market and political domains.

Declaration of competing interest

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

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