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Playing games around climate change – new ways of working to develop climate change resilience

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This paper uses game theory to examine the efforts of public sector actors in the UK to integrate climate change interventions within development processes. Drawing on desk-based analysis and interviews, we identify instances where private-sector developers act strategically to exploit public-sector imperatives to deliver economic growth and housing. We find these imperatives constrained the agency of planners to effectively reconcile climate mitigation/adaptation objectives within wider priorities of economic growth. Yet, we identify instances whereby strategic planning frameworks, informal networks and bespoke development frameworks were effective means to build trust between actors and foster co-operation, better enabling development which meets climate change mitigation/adaptation objectives. In doing so, we illustrate the practical and theoretical value of game theory, whilst highlighting how careful use of strategic planning can support achieving climate change mitigation/adaptation objectives at a local scale.

Keywords: climate change adaptation; climate change mitigation; strategic planning; game theory; environmental planning

1. Introduction

There is a rich literature exploring the innovative actions taken by or on behalf of governments to address climate change at every scale from the community to the international, and all points between (see, for example, amongst very many others Kern and Bulkeley 2009; Nolon 2009; North, Nurse, and Barker 2017). As many of these studies have found, putting in place effective policies to plan for climate change mitigation and adaptation is complex, and analyzing what works and what does not is often equally so. Taking an institutional approach to understanding climate mitigation and/or adaptation activity is an increasingly common method (Aylett 2013), for example by exploring the effects of changes to "rules-in-use" and "institutional arrangements" on "governance dilemmas" such as climate change (Patterson and Huitema 2019, 384).

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What is less common is a focus on the actions of key actors working in and for those institutions in addressing climate change – perhaps inevitably, as an institutional approach emphasizes the interactions between agency and structure, a detailed exploration of what "agents" do might be seen to neglect the structural elements of governance. However, in Britain, a context of "rapid policy experimentation" in relation to urban governance (Sturzaker and Nurse 2020, 150), where structures can come and go seemingly with the wind, a renewed focus on agency might be appropriate. Such a focus is one contribution of this paper, making use of game theory to "conceptualise the interactions that occur between planning and other market actors in the development process" (Lord and O'Brien 2017, 218).

A second contribution is to take an unfashionably positive approach to the analysis of planners, who in recent years have often been "simultaneously criticized for being too neoliberal (by academics) and not neoliberal enough (by politicians)" (Sturzaker and Lord 2018, 365). In this paper, we identify examples of public sector planners who are challenging the primacy of the private sector development industry and playing leading roles in relation to climate change. In contrast to a wider perceived de-professionalisation of planning activity (Clifford 2016), we show how "planners can be agents for change and proponents of empowerment" (Vigar 2012, 373).

This paper, then, brings to bear the field of game theory to explore the attempts of planners and related professionals to address climate change, through a series of case studies of urban governance within Great Britain. In what follows, we reflect on the role of local government officers on devising and implementing policy, and the tiered "games" of influence that are played at a range of scales. Through this analysis the activities of significant "players" and the positions they take within the process of integrating development and climate change adaptation and mitigation can be better appreciated and analyzed.

In the subsequent sections of this paper we first briefly summarize recent literature on policy and practice seeking to address climate change, before outlining our own analytical approach – that of game theory. We then detail our empirical methods, before presenting our results and analysis. In our conclusion we identify a clear set of findings in relation to the theory and practice of environmental planning.

2. Situating climate change policy and practice

The growing policy attention on climate change across the UK and internationally has been a critical factor promoting engagement with issues of flooding, pollution, climatic variation and recently health and well-being, by actors in the planning and environment sectors. Reactions to climate change by policy-makers emerged in the 1960s and accelerated from the late-1980s onwards following the establishment of sustainable development as a global imperative (Hulme and Turnpenny 2004; Gupta 2010). A series of subsequent global protocols have been used to develop, ratify and deliver adaptive practice, for example the 1997 Kyoto Protocol. These are then followed through with further international agreements such as the Paris Accord, and transposed into (trans)national law and policy through, such tools as the EU's European Climate Change programme and the Climate Act 2008 in the UK.

Studies of these higher level frameworks successfully demonstrate the importance of strong institutions promoting multi-level action, the influence of a robust evidence base, and a process of integrated knowledge exchange between decision-makers and market actors (van den Hove 2000; Nieminen, Salomaa, and Juhola 2021). Researchers also

acknowledge the transactional costs of creating and implementing climate-centric policy (McCann 2013). Evidence further suggests that climate change policy is most effective when it incorporates "catalysts" such as climate events or the categorization of climate change as a wicked problem, enabling weak policy frameworks to transition into stronger ones (Meadowcroft 2002; Clement 2021). This has been facilitated by the growing awareness of the added-value to society of addressing climate change, the integration of evidence within policy, and subsequent delivery and monitoring (Dhar and Khirfan 2017).

Enduring questions around the effectiveness of climate change policy include how to rationalize local needs within strategic decision-making to ensure that adaptation/mitigation measures can transcend a single policy scale, and whether it is possible to map sub-national or city-scale action onto higher level policy initiatives (Heidrich *et al*. 2016). The perceived distance between international/national policy and local action is an issue this paper addresses in due course.

Although institutions can act as drivers of policy change they require a level of flexibility, as well as having supportive political and economic structures, if they are to provide a continuity of information exchange between actors, decision-makers and strategic/local actions. In many instances, the ongoing range of sectoral approaches lead to variation in delivery and a lack of continuity in climate policy and action (Aguiar *et al*. 2018). It is therefore important to understand the context of policy formation and implementation of climate change action within institutions to appreciate where blockages exist. Moreover, an understanding of scale, the complexity of environmental change, political and institutional uncertainty, and the long-term impacts of development on urban systems are needed to understand the fluidity of stakeholder agency, knowledge exchange and advocacy in practice (van den Hove 2000).

To address the complexity of climate change policy requires an appreciation that no single policy can hold a political primacy over others. Where climate change "competes" with economic development, housing and transport infrastructure for space in the policy arena we can identify weaker targets, commitments and actions. As a consequence, it is important to consider how a nesting of policy can be utilized to aid the transference/translation of knowledge between institutions, actors and scales to promote a diffusion of knowledge within the distributive spheres of policy-making and delivery (Bulkeley *et al*. 2003).

It is in the interconnectedness of practice and the interaction of institutions where there may be opportunities to share best practice and formulate effective praxis at a number of scales. Where weak policy structures exist, and/or if they are employed with a lack of knowledge and institutional capacity or the use of inappropriate evidence to frame development, the focus of climate change action can be undermined due to a lack of political buy-in (Oberthür 2009).

Addressing the disruptive nature of policy via increased agency of advocates aids the shaping of policy/practice. Where a continuity and stability of approach and collaboration between partners is visible there is a greater focus on climate change action (Oberthür 2009). The delivery of long-term improvements in climate change policy should therefore align strategic partnerships and development objectives with an assessment of short-term (and localized) needs (Averchenkova, Fankhauser, and Finnegan 2021). Furthermore, multi-level government, aided by a strong advocacy arena, provides a level of understanding of the issues surrounding climate change allowing consideration of future-proofing options to made (Paavola, Gouldson, and Kluvánková-Oravská 2009), helps to identify a responsible body (for example via the

Climate Change Act and the Committee on Climate Change in the UK), and support policy formation at the local government scale. Thus, some have argued that there needs to be a virtuous cycle of policy formation, rationalization, and evaluation supportive of praxis that develops via multi-partner agreements and robust evidence (Newig and Koontz 2014). This helps to create a level of stability within government that is responsive to shifts in the political framing of climate within policy (Rietig and Laing 2017; Busch and Jörgens 2005).

In the next section we present and justify our theoretical approach – that of game theory, an analytical tool as yet under-used in relation to environmental planning.

3. Game theory and environmental planning

Game theory originated as a branch of mathematics, used to analysis the potential strategy of economic agents, and examine the interdependent nature of strategies, which result in varied pay-off and outcomes (Binmore 2007). Latterly, the insights of behavioral economics have led to the application of game theory as a behavioral theory of decision-making (e.g. Camerer and Lowenstein 2004). Game theory can be applied in non-cooperative and co-operative scenarios. It provides an understanding of how strategy, context and information can result in varied pay-offs for different players (who typically represent individuals or organizations). By using "toy-games" we can make predictions on outcomes and understand how different "rules of the game" can affect outcomes. In co-operative scenarios a key focus is upon the division of collective pay-off amongst a coalition (Binmore 2007).

It began to be applied within urban planning in the late 1970s, where Batty (1977) used a co-operative game to highlight the distinction between optimality (in public-welfare terms) and stability in bargaining strength. A game-theoretical approach was advocated by Ball, Lizieri, and MacGregor (1998), given the necessity for many stakeholders to co-operate within urban planning and the conflict which can emerge from this requirement. The "players" within this process typically have contrasting aspirations, interests and motives, while the strategies taken by each player can be highly dependent on, and influenced by, the strategy taken by others (Samsura, van der Krabben, and van Deemen 2010). Given that strategic interaction is a common focus for both game theory (Binmore 2007) and planning, this approach has seen increasing academic interest within planning research, yet as Lord and O'Brien (2017, 220) note it remains a "nascent" field, with significant potential for further application.

The discretionary nature of the British planning system means that negotiations, particularly at the project implementation stage, can play a central role in development outcomes (Claydon 1998). This leads Lord (2012) to note that this is an area in which game theory is especially useful. In this space, formal and informal rules, norms, framing as well as culture can play an important role in outcomes (Claydon 1998; Ernste 2012; Dunning *et al*. 2019). Collectively such an approach can help practitioners and researchers alike understand how the "rules of the game" are interpreted (Ennis 1997) thereby developing our knowledge of environmental and urban management.

While engagement with game theory within planning research remains limited, it has been more widely applied in the context of environmental management, with two topics of significant attention being international climate negotiations and water management agreements. One approach is evolutionary game theory, which uses multi-agent based modeling environments e.g. NetLogo to model the dynamic and evolving

process of strategic interaction (Wilensky 2002). This approach uses decision-rules to understand the effect of changing key variables upon the result of ongoing interaction such as the level rewards for defection from cooperation (Patt and Siebenhüner 2005). For example, following this approach to examine international climate agreements Caleiro, de Sousa, and de Oliveira (2019) found that a high defection reward rapidly leads to a disastrous scenario of total defection from agreement, while Santos *et al*. (2012) found a greater understanding of the risk of defection amongst nations increases the chance of reaching cooperation.

Another common approach, taken in this study, is the utilization of "toy-games" to identify factors which support, or prevent co-operation in "real-world" environmental management scenarios. For example, Ostrom (1998, 2000, 2008) developed an important body of work to identify how institutional contexts can help overcome collective-action problems. In particular, she identified the importance of social norms, reciprocity, and reputation in fostering cooperation, leading Cárdenas and Ostrom (2004, 310) to argue that "studying the context of a game is crucial because institutions affect individual's decision to cooperate." Many strategies to manage climate risk can be framed as collective-action problems, for example the management of water resources (Hoegh-Guldberg *et al*. 2019). Supalla *et al*. (2002) and Loaiciga and Leipnik (2000) apply the prisoner's dilemma to highlight the risk of parties "defecting" from water use agreements to secure short-term profits over long-term sustainability, illustrating the need for credible and enforceable penalties for noncompliance (Loáiciga 2004).

Other less prominent "toy-games" such as the Stag-Hunt and Chicken can be useful in understanding why cooperation fails to occur in such collective-action problems. For example, Lord (2012) highlights the potential of alternative "toy-games" including the "Stag Hunt" in understanding the necessity of building trust between parties to resolve a range of collective-action within planning and environment management through the use of shared rulebooks. Madani (2010) uses the game of Chicken to illustrate how aggressive signaling by one party in a collapsed water sharing agreement encourages the other party to "chicken out" and invest to restore shared water supply infrastructure. DeCanio and Fremstad (2013) use a series of "toy-games" to illustrate how differences in the perception of risk influence a nation's decision to "defect" within international climate negotiations.

Wang, Fang, and Hipel (2011) apply co-operative game theory to examine co-operation of multiple players in the process of brownfield development; like Asami (1988) they find an "essential player" (typically the land owner) has significant power in the distribution of pay-offs. Lord and O'Brien (2017) apply a series of principles drawn from game theory, through their illustration of planning's "market-making" role. This includes an analysis of the mechanisms used to overcome first-mover problems and to foster coalition-building; both are of paramount importance to development. The latter issue is also of particular relevance within this paper, which examines the role of (re)introduced institutions of planning within emerging city-regions within the United Kingdom (Sturzaker and Nurse 2020).

4. Methods

The purpose of this research was to explore approaches to addressing climate change in the UK through planning at a strategic (larger than local authority/municipality) scale. We were particularly interested in statutory planning, i.e. planning policy which

Table 1. Our interviews.

No.	Area of job focus (anonymised to protect confidentiality)	Date
1	Clyde Valley strategic planning	25 July 2019
2	Clyde Valley climate change	25 July 2019
3	Greater Manchester climate change	13 June 2019
4	Greater Manchester planning	28 June 2019
5	Greater London climate change	29 July 2019
6	Birmingham City climate change	5 July 2019
7	Birmingham City planning	15 July 2019
8	Bristol City climate change and planning (joint interview with two team members)	3 July 2019

forms part of the "development plan," which is the document(s) against which development proposals (planning applications) are determined in the UK.

The first stage of the research consisted of a desk-based search for relevant case studies, in which the limited number of examples of statutory strategic climate planning policy in the UK quickly became apparent. This is largely due to the abolition of regional planning in England in 2010 – a decision which, when coupled with the abolition of County Structure Plans in a previous round of "reforms" in 2004, means there is no comprehensive form of strategic planning in England (Sturzaker and Nurse 2020). One of our cases, discussed below is from Scotland, which did, at the time this research was carried out, still have formal city-regional strategic planning (this being replaced in 2019 by non-statutory regional planning) but the significantly smaller populations of Scotland, Wales and Northern Ireland means that strategic planning policy is reasonably easy to deliver at the national scale, in contrast to England.

The policy search was therefore expanded to local plans, and to emerging, rather than adopted, strategic plans. Through this search five areas were identified for narrative studies. Interviews were arranged with relevant local and strategic-scale individuals in planning or climate resilience teams, and were undertaken during summer 2019 (see Table 1). These interviews primarily focused on the practical challenges and key lessons in relation to developing and implementing climate policy at a resilience scale, including institutional barriers and local political contexts.

The (re)-introduction of strategic planning in England has not been straightforward, and two of the case studies (the West of England and Greater Manchester) saw their strategic plans delayed, although in the first instance the recommendation of examiners of the Joint Spatial Plan; and the latter political contention over the Greater Manchester Spatial Framework. This does not negate the value of studying the development of these plans or, particularly, the context surrounding them and the tactics adopted by key actors in these areas.

4.1. A brief introduction to our cases

Our first case study is the Clyde Valley, home to *Clydeplan*, the "operating name for the Glasgow and Clyde Valley Strategic Development Planning Authority Joint Committee" (Clydeplan 2020), the planning authority for the city-region of the Glasgow metropolitan area. The Clydeplan Strategic Development Plan, adopted in 2017, the *Clyde Valley Green Network Partnership*, and the activities of *Climate*

Ready Clyde, a "cross-sector initiative funded by the Scottish Government and 12 member organisations" (Climate Ready Clyde 2020) were all investigated by the research team.

Our second case study is the *Greater Manchester Combined Authority* (GMCA). The GMCA has been working for several years on the *Greater Manchester Spatial Framework*, a city-region wide plan which, it is hoped, will be both a "joint Development Plan Document," a plan owned by the ten constituent local authorities in Greater Manchester, and a Spatial Development Strategy on behalf of the Mayor of Greater Manchester. At the time of writing, the future of the GMSF is unclear, after Stockport Borough Council pulled out of the plan due to controversy over its plans for homes in the green belt, amongst other issues. As noted above, the processes which planners and others are implementing in Greater Manchester to address climate change are interesting in themselves, so we spoke to officers from the planning and climate resilience teams at GMCA.

Our third case study is Greater London, and the role of the *London Plan*. The *Greater London Authority* (GLA) has had statutory planning powers since its creation in 2000, making London the only city-region in England with statutory strategic planning for most of the last 20 years. There have been several iterations of the London Plan, the most recent adopted in March 2021. The long history of joint working over climate change between the GLA, its constituent local authorities and other partners was the focus of our interviews here.

Our fourth case study is the Birmingham city-region. Birmingham is at the core of the *West Midlands Combined Authority*, which as with Manchester and London has its own mayor. Unlike in those two cases, however, there has been little progress with a strategic plan. Our interviews instead focused on the role of Birmingham City Council, the largest local authority in England by population, in leading activity in relation to climate change.

Our fifth case study is the *West of England Combined Authority* (WECA), their *West of England Joint Spatial Plan,* and Bristol City Council. WECA is the city-region encompassing Bristol, and comprises just three local authorities – Bristol, Bath and North East Somerset, and South Gloucestershire. Different in context to our other case studies, this is a smaller area in spatial and population terms. It had progressed its Joint Spatial Plan to the point of independent examination, but the plan was rejected by the UK Government's Planning Inspectorate in early 2020, and we have also explored activities led by Bristol City Council in this area, given the long history of such activity (Brownlie 2011).

In each of these case study locations we interviewed at least one, and in most cases two, individuals who we identified as playing important roles in the development and implementation of planning policy related to climate change. The nature of the roles varied, as did the organizations they worked for. To protect the anonymity of these individuals, we have anonymised them in Table 1 below.

Each interview was undertaken in a semi-structured format, with the broad areas of focus being upon any (particularly strategic) policies which had been adopted to address climate change; how these were developed; the range of stakeholders involved; the level of political "buy-in" for such approaches; the practical challenges faced by those involved in the development of plans and policies in the area. Interviews were recorded and transcribed, and the transcripts then analyzed by coding each contribution using NVivo. These were subsequently synthesized into a series of themes which

summarized the issues surrounding the implementation of climate mitigation/adaptation policy across our eight interviews.

5. Results and analysis

Through a series of reforms, largely since 2010, the British planning system has increased its dependence upon market-led regeneration and development to achieve local priorities (Ferm and Tomaney 2018). These reforms have occurred within the climate of financial austerity, with local government receiving a 49.1% cut in real terms from 2011–2018, leading to an overall reduction of 52% in the funding of planning departments (National Audit Office 2019) leading a loss of vital expertise.

Throughout our discussions it was clear the reforms and funding challenges represented a fundamental constraint to planners' agency, with common with previous studies examining English climate change planning e.g. Young and Essex (2020). For climate adaptation and mitigation it means that even where additional measures have been successfully secured through a planning application, there can be an implementation gap - as described by Interviewee 1 there is "a big challenge enforcing things [i.e. compliance with the permission] and it goes back to lack of resources." These funding challenges create difficult tradeoffs for local authorities, as expressed by several participants "the actual adaptation function within local government has not been even a remotely statutory requirement." Resources tend to be prioritized toward statutory [legally required] functions, leading to other priorities being neglected.

This situation is compounded by the perceived ambiguity of the imperatives and strategies for climate adaptation and mitigation at the national scale. This contrasts with other high-level policy-drivers such as the delivery of new homes, with centrally set housebuilding targets carrying clear consequence for failure of delivery (Ministry of Housing and Local Government (MHCLG) 2021). Collectively this creates a context whereby the delivery of housing and local economic growth is favored over other concerns, including climate adaptation and mitigation. This situation therefore creates significant complexity and ambiguity in prioritizing climate change objectives.

A specific example found in our work was a fear, or experience of "call-in" of a policy or development decision, where Interviewee 7 describes "the very confused position around the government position […] each area is faced with the same uncertainty about how would the Planning Inspector respond and what is the interpretation of national policy?" Participants also linked this to ambiguity in the interpretation of policy by developers and planning committees. It was seen that guidance on climate change adaptation measures e.g. green infrastructure, remained as "somewhat indicative of what we want to see rather than mandating" echoing analysis by Rydin (2013).

Despite these challenges there was evidence that changing perceptions of climate change across the private and public sectors, alongside broader shifts on the part of the public had increasingly led to a more conducive environment for climate mitigation and adaptation policy (Interview 6). The increasing public awareness of climate risks and appetite for greater levels of action by local and national governments were noted by participants in our research. In particular, participants cited Extinction Rebellion and the School Strikes movement as pivotal in this shift. Interviewee 5 remarked that "politicians at the local borough level are primed to hear solutions right now" with Interviewee 8 suggesting that political space was opening for more radical solutions, which would previously have been deemed politically unfeasible. Participants describe

Table 2. The Stag Hunt.

LPA 1	LPA 2	
	Hare / Defect	Stag / Co-operate
Hare / Defect	2 2	0 4
Stag / Co-operate	4 0	5 5

a similar shift in attitudes within parts of the private sector, something that we explore later in our findings.

A contrasting view of the effects of enforced restructuring and budget cuts did also emerge from our discussions with participants, with Interviewee 6 describing how this meant that senior leadership within authorities were increasing perceiving climate adaptation and mitigation programs as "a key linkage point, strategically and policy-wise to all those issues and health and well-being and people's quality of life is the natural environment." There was, therefore, a view expressed by Interviewee 6 that such an agenda could represent a cost-effective approach, meaning it could be utilized to "sell" the agenda to political leadership given it "[…] speaks to politicians in a great way but also has a link through climate change as well" who saw the agenda as not only cost-efficient but also useful to "[…] break-down silos."

5.1. Dilemmas and defection

The first section of our findings illustrated that it is a compelling moment for climate action within the UK, not least due to the impending need to adapt and mitigate to avoid catastrophic impacts (Kovats and Osborn 2016), but also due to the interplay between factors which constrain and enable the necessary change. Local planning authorities (LPAs) are faced with significant dilemmas, with commitments and aspirations to meet environmental objectives, in the face of strong imperatives to deliver housing and economic growth.

Whilst bearing in the mind the heterogeneity of the development industry, our discussions suggested that although developers might nominally support a climate adaptation and mitigation agenda, the commitments and aspirations of LPAs can often be at odds with those of private-sector developers. This creates an adversarial context in which discussions and formal negotiations take place. The remainder of our findings will therefore adopt a game-theoretical approach, first exploring how developers skillfully employ strategies to exploit LPAs dilemmas, and outline the tactics employed by planners to counter this.

Our first "toy-game," the Stag Hunt, uses the analogy of hunting a Stag versus a Hare to highlight the contrasts between co-operative and individualistic strategies. In our version of game the players are LPAs, a Stag represents a development outcome whereby climatic risk is minimized via greater mitigation/adaptation measures, reflected by a greater pay-off for both LPAs. The "Hare" reflects development occurring, though with weaker environmental measures. When a single player plays "Hare" the pay-offs from this investment are greater, though if both do so the investment is split, reflected in the shared pay-off. In Table 2 these outcomes are summarized by a pay-off table, where the four potential outcomes are represented with the respective

pay-offs. The figure in the bottom left corresponds to the pay-off following the "game" received by LPA 1, the top right by LPA 2.

Co-operation and defection are important in our study as they are central to our findings. LPAs are under pressure to attract finite investment and development, meaning that not only are developers and LPAs engaged in adversarial negotiations but that different LPAs are also engaged in competition. The issues was neatly described by Interviewee 2 "I think that there is huge pressure for housing development, houses in some officers and politicians' minds equals progress and economic success […] do we really want to refuse on this ground or are we prepared to accept something to go through. Developers are completely aware of all those arguments." Here, and within the other interviews, it was clear that developers were able to exploit this situation.

The first strategy employed by developers was a willingness to play LPAs off against each other. Interviewee 1 remarked that "You don't want to see them moving to the next authority area […] It goes back to the governments to give us the power to do things and enforce things, but it needs to be standard across the borders." This cuts to the heart of the matter, with the interviewee expressing the fear that, in the parlance of game theory, that a neighboring authority will "defect" leading to the loss of a pay-off, both in terms of environmental benefit, but also new housing and economic investment. In contrast, it may be possible for the developer to extract a greater profit from a proposal. Here, there is the risk of a vicious circle occurring whereby LPAs continually "defect" in each round of the "Stag Hunt," gradually eroding regulatory requirements in a bid to attract development. Interviewee 2 felt the result of this "game" were already evident, "we do need houses, but we don't want to create these awful, very poor developments."

There was an indication from our interviewees that these issues are shaped, at least in part, by the underlying strength of the development market in the region: "In some parts of the country there may be development values much higher than in Liverpool, Manchester or Leeds, you might get slightly less pushback" (Interviewee 3). This issue has clear parallels with the wider delivery of infrastructure via planning gain, where Lord *et al*. (2019) described vicious (in lower value) and virtuous (in higher value) circles of investment.

A second tactic deployed by developers draws on the contrasting position of LPAs and private developers, again the contrasting effects of this strategy was dependent on the strength of the local development market and the financial resources of the local authority. Developers were willing to use their greater resources to produce evidence to avoid policy requirements, thereby reducing build costs, this might be technical evidence "technical consultants using every argument under the sun not to do something" (Interviewee 7), or the now familiar "viability charade" (e.g. Crosby 2019; Lord *et al*. 2019). Again we can draw from game theory to help understand the role of such evidence, this time using the toy-game of "Chicken." The formal role of this evidence is to prove development is policy-compliant or to exempt from additional regulatory requirements. However, we conceive another, informal role of this strategy.

As illustrated by the pay-offs within Table 3, when playing "Chicken" there is a significant incentive for both players to signal their "type" (Binmore 2007), since an indication that you are "tough" shows you are unlikely to "swerve." Translating this analogy to planning would mean that developers might invest significant sums on technical evidence to signal their intension to "continue," thereby indicating their unwillingness to accept greater costs. An LPAs failure to commission evidence to challenge

Table 3. Chicken.

LPA	Developer	
	Continue	Swerve
Continue	−3 −3	0 2
Swerve	2 0	1 1

this can be read as a signal of their weakness, and therefore a signal they may be likely to eventually "swerve," thereby permitting a non-policy compliant proposal.

5.2. Co-operation between local authorities

Despite these difficulties, there remains evidence of planners successfully implementing strategies which effectively supported an LPA's response to climatic risk. There was testimony that where established, strategic authorities and policy played a key role in doing so with informal structures and relationships playing a complementary role.

We again use the "Stag Hunt" to illustrate the importance of trust between players. As set out previously, there are a variety of pay-offs for each player, which depends upon the strategy played by the opposing player. In particular, the game highlights the importance of trust, since both LPAs trust the other sufficiently they can be confident in co-operating (playing "Stag"), representing an outcome with development with greater climate adaptation and mitigation measures.

As highlighted by Lord (2012) an enforceable planning rulebook can offer the means to provide trust for mutual co-operation. This is especially relevant in the context of our findings whereby a strategic planning framework can set a "level playing field" across multiple authorities. This means the strategic behavior of developers, as outlined in the previous section, can be countered by strategic behavior on the part of LPAs.

An example cited by Interviewee 5 was the implementation of an Urban Greening Factor (UGF), which sets out a minimum acceptable standard of Green Infrastructure that must be implemented across different types of development. The LPA's position in negotiations was therefore strengthened since the developer's ability to play neighboring LPAs off is weakened, since all LPAs had adopted the UGF within their respective planning policy framework. In the terms of the "Stag Hunt," each player can be confident in playing "Stag" since the shared framework provides the trust that the other player will also play "Stag."

It was also evident that trust could be further developed through informal networks. These actions were seen to be important in developing a shared understanding of the purpose of the policy in question. For example, Interviewee 5 described how "There was a lot of discussion about that [the UGF] but informally through the existing groups and the green groups […] I think they really in a sense sort of recognise that it is helping them rather than making it more difficult for them."

These informal networks were seen as vital to sustaining action by Interviewee 8, as they explained how strong personal relationships between individuals meant that even when political control of authorities changed or when restructuring occurred there remained continuity, and trust between the authorities in question. The previous

success of an authority was also seen to play an important factor in the willingness to co-operate between LPAs, with Interviewee 5 indicating that a long history of successful and widely influencing work upon resilience and environmental sustainability did translate into more effective interventions.

Interviewee 4 sets out what such an approach means "from a planning perspective they have all agreed on the headlines of principals and they can disagree on the matter of detail." The agreement's principles ensures the consistency required to maintain trust between LPAs, whilst a localized policy can continue to offer the flexibility and agency for planners, allowing the tailoring of an approach to a localized context. Given that governance arrangements within the emerging combined authorities within the UK typically require consensus agreement amongst constituent authorities (Sturzaker and Nurse 2020) this quality is clearly of value.

Furthermore, there was an awareness across our participants that "Of course the [local authority] boundaries are irrelevant in nature, so it is a strong selling point." (Interviewee 6). One such example is overheating, since the urban heat island effect depends on the land use of the whole built-up area, which is more likely to align to a sub-regional scale of strategic planning policy.

5.3. Co-operation between public and private sector

Changing attitudes within some areas of the private sector (as set out earlier in the findings) was identified as an important opportunity to advance an authority's climate mitigation/adaptation strategy. Interviewee 6 illustrated this, "they [developers] want to be doing something that directly addressed the effect of climate change, sustainability and the long-term climate resilience […] saying to their investors is we are future-proofing your investment."

The same interviewee set out an example, illustrating how planners would seek out private-sector actors whose objectives aligned with the LPAs aspirations, expressed via what is known as a *Supplementary Planning Document* oriented around the concept of natural capital. The work led to the development of a bespoke development framework via a partnership involving a range of public, private and third sector organizations. This contained 10 core sustainability criteria which could be used to assess development proposals. These criteria were then used to assess tenders for a strategically important city-centre development site owned by the local authority. The interviewee was clear that this provided the city with an opportunity to illustrate the holistic benefits of high-quality development, and provided an important place-branding opportunity for the city. They indicated that it also helped shift attitudes within the private sector and within the local authority itself, "[it] helped shift the fact that what they thought of as a local [name redacted] development project suddenly became, no this is a global opportunity. Therefore, it this whole agenda of climate change resilience urban development that is now a global agenda of interest."

In understanding how coalitions of actors might co-operate to achieve shared objectives we turn to co-operative game theory. In the aforementioned example, the authority was able to develop a mechanism to ensure that actors who were joining the coalition had no opportunity to "defect" (and reduce their climate mitigation/adaptation measures). If private sector actors choose to "defect" they would be left with no payoff, and the mechanism meant that once the coalition was formed there was an enforceable contract to ensure it was stable over the duration of the development

project. McCain (2010) finds that to keep a coalition stable there must be a mechanism that provides a credible threat.

What makes this situation distinct from the less encouraging accounts set out earlier is that the local authority owned the development land. In game theory terms they are an essential player, since without their involvement there could be no coalition and no pay-off from development. This then meant that the involvement of the local authority within the coalition could be conditional upon a greater pay-off for themselves, which like in the previous section was securing development with additional climate mitigation and adaptation measures.

This case illustrates the ingenuity of planners, amongst others in a local authority in developing an effective mechanism to secure a stronger position in negotiations and therefore to receive a greater pay-off, perhaps even leading to a wider cultural change within the local development market. However, in this case, and within discussions with other interviewees there was evidence that under the current planning framework such an approach was only feasible via private-public development projects or through tendering processes of development upon council-owned land. This case therefore also provides a warning that, at present, the formal structures of planning constrain the agency, and strategic choice of planners, placing them at a significant disadvantage in this version of the "planning game."

6. Conclusions

This paper has illustrated the challenging position that a combination of market-led planning reforms and financial pressures have created for planners trying to introduce and implement policies to mitigate and adapt to climate change. We find a series of factors produce a constrained space for action, though we identify accounts of proactive action by illustrating how planners and other public sector actors interact, to resolve conflict and to reach an agreement that is deliverable and acceptable for all parties. In doing so we make recommendations for planning practice and future research.

One significant contribution of this paper is its use of game theory to explore the outcomes of environmental planning activity. The "toy games" used within this paper illustrate that the use of such seemingly abstract tools can provide new analytical insights into the activity of planners and other significant actors. There are two ways in which our approach was effective in uncovering the "rules of the game," answering the call of Lord and O'Brien (2017). Firstly, it provides a clear account of how developers effectively exploit the dilemmas faced by local authorities in pursuit of a greater pay-off. Secondly, conflict was evident within a parallel "game" where local authorities compete for limited opportunities, and our use of game theory suggests how planners can be strategic in operationalizing tactics to counter those used by developers.

In common with Palm and Lazoroska (2021) our work underlines the importance of building trust to foster co-operation and mutual understanding to successfully implement climate change policy objectives. This was seen by planners informally framing opportunities and policy, building personal relationships and educating actors. In this suggestion, we draw parallels to the call of Adams and Tiesdell (2010) for planners to recognize their role in framing and shaping markets, by calling on planners to shape markets to maximize the opportunity to meet climate change objectives. Second, there are formal means to build trust, such as through the adoption of shared planning rule-

books. Hence, despite the ongoing procedural and political challenges surrounding the development of strategic planning frameworks within England, our analysis advocates for the completion of such plans within existing City-Regions and beyond. The "toy-games" were effective in illustrating how such frameworks can be a mechanism to provide trust, thereby providing the constituent local authorities with a strategic advantage. Not only that, but a strategic scale is likely to be more appropriate to tackle many pressing environmental challenges including flood risk, the urban heat island, and biodiversity loss. Indeed, such measures are relatively uncontroversial, when compared to the contentious issues of housing allocation and greenbelt de-designations (Sturzaker and Mell 2016), so may provide a good prospect of agreement across political divides.

National governments are often ostensibly committed to action on climate change (e.g. the UK's commitment to reach a zero-carbon economy by 2040 [BEIS 2019]), however such rhetorical and even legal commitments are not always translated into action. Our analysis illustrates this in relation to national planning policy in the UK, which we find conflicts with adaptation and the broader low-carbon agenda. In particular, our participants cite centrally imposed targets for housing delivery, which were seen as overriding concerns surrounding, enabling developers to operationalize an argument weakening measures based on a financialised logic of viability and deliverability. Like Ferm and Raco (2020) we find that the context of austerity means that local authorities' pressures to deliver new housing, regeneration and economic growth are intensified. Simultaneously, it was apparent that the current planning framework weakens the position of local planning authorities, who instead pursued other means, including public-private partnership and bespoke tenders to foster long-term co-operation between actors.

Another implication of our findings relates to the variable ability of authorities to extract additional value from development, either via planning gain or by ensuring that development includes the appropriate climate change mitigation/adaptation measures. Our work suggests that the ability to do so is related to underlying land values, and the strength of the development market, in line with suggestions of path dependencies in development markets (Lord *et al*. 2019). Following this, there is a risk of replicating and exacerbating existing regional inequalities (UK2070 Commission 2020). There are two consequences of this. The first is that a failure to invest sufficiently in adaptation measures risks exposing areas with an existing economic weakness to increased environmental shocks and stresses. Dunning and Lord (2020) note this is likely to begin to translate into declining market values and investor confidence thereby inducing vicious circles, further compromising the ability to act upon climatic risks. Secondly, there are important implications for climate justice, since those in areas of greater deprivation tend to have a lower per capita contribution to the net greenhouse gas emissions (Büchs and Schnepf 2013), yet are most likely to be impacted by increased climatic risk and are least able to adapt to and cope with additional risk (Preston *et al*. 2014). Our findings suggest that a continued reliance upon the private sector to deliver climate adaptation and mitigation measures, without reforms to effectively share costs nationally will intensify climate injustice within the UK.

The remit of this study was limited to the approach, and perceptions of, public sector actors in the implementation of climatic change adaptation and mitigation strategies. We advocate for further research which explores how actors in the private sector approach these issues, particularly in examining the tactics employed within

negotiations to achieve their objectives. This would add to our findings and provide another perspective on these processes, improving our understanding of development negotiations and thus the outcomes observed.

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