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MECHANISM DESIGN AS A RESPONSE TO THE PROBLEM OF CLIMATE CHANGE

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ABSTRACT

This paper explores the applicability of the theory of 'mechanism design' to the analysis of business interaction. We present a case study involving a large multinational energy company faced with the opportunity to respond proactively to the inclusion of the aviation industry within the European Emissions Trading Scheme as of 2012. Based on empirical findings, we demonstrate that mechanism design theory is a good set of conceptual tools for the design of economically sound mechanisms, aligning individual incentives with collective goals. Mechanism design theory, however, tends to advocate the design of optimal ways for 'application' of mechanisms, assuming a fairly passive set of organisations. The empirical evidence suggests that actors will not optimise responses to the rules of the game as isolated decisions. Instead, companies will respond to mechanisms as viewed within their wider business network which demonstrates socially embedded clues for coordination that impact on the design of the rules of game.

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1. INTRODUCTION

Climate change is a serious and contemporary challenge and it is widely acknowledged that without effective collaboration there will not be an effective response on the global scale required. Yet for policy makers the challenge of responding to the problem of climate change is how to design mechanisms, so that when organizations or individuals interact in a self-interested manner, collaborative outcomes are still possible. Actors often fail to collaborate, even when there is a well intended ambition to do so (Arrow et al., 1995). This may be attributed to the multiplicity of ways to frame existing problems (Kahneman & Tversky, 1979), the lack of 'incentive compatibility' among actors (Myerson, 1979) as well as the struggle among actors to build or defend a dominant position in a specific sector or industry (Levy & Egan, 2003).

An answer to the question of how to respond to the problem of climate change might be given by investigating the underlying rules of the game or the 'mechanism design' that governs business interactions (Hurwicz, 1973; McKibbin & Wilcoxon, 2002; Myerson, 1986). In theoretical terms, designing mechanisms takes the form of arranging an interaction system in which participants send messages to each other; then a pre-defined agreement of rules assigns an outcome for each received message (Hurwicz, 1973). Consider the initial lack of 'mechanisms design' for pricing scarce environmental resources such as clean air or water and then the gradual impact of new legal rules on environment-friendly action. Notwithstanding the general debate about climate change, hitherto corporations have not been legally required to internalize (pay the cost of) all externalities which result from their corporate actions. With the introduction of new legal rules such as carbon taxes or restrictions, however, companies are starting to disclose carbon emission levels and to incorporate emissions in their books. New environmental rules can be seen as a 'mechanisms design' that re-frames complicated interaction systems among organisations and individuals.

More formally, legislation acts an integral part of humanly devised mechanisms which potentially redefine the rules of the game; and, thereby, encourage corporations to re-arrange their business interactions in such a way that desirable outcomes are achieved. Apart from legal rules, 'mechanism design' may include rules regarding *auctions*, *markets* or even rules regarding consensual collective decision-making through majority or unanimous voting. Within the European Union, for example, there is currently a cap and trade mechanism which sets a ceiling on CO₂ emissions and within certain constraints lets the market decide upon best modes of compliance. Heavy CO₂ emitters who miss their targets can either 'make' emission reductions to meet their new emissions cap, or 'buy' emissions reductions achieved by other actors. A cap and trade scheme is designed to be more efficient in terms of cost, since the actors with the cheapest CO₂ reduction options should make the bulk of reductions and then sell them to those with more expensive CO₂ reduction options.

While the study of various market or auction forms have become an established paradigm within the

field of organisational economics, questions have arisen over the nature of norms, rules, conventions and systems of beliefs that are shared between actors and their efficacy on the realisation of exchanges (Casson, 1982; Choi, 1993; Loasby, 2000, Mouzas and Ford, 2007). Consider for example industry standards or legal and non-legal rules and regulations regarding trade practices. While previous work recognizes the tremendous impact of rules of the game on interactions, there are few detailed discussions accounting for what actually happens in these interactions and how conversely existing business interactions shape the creation and establishment of new rules of the game. This rather surprising considering it is not only the legislators but also the companies in all sorts of industries who pro-actively try influence and shape the rules in their business networks. Two missing links might explain this research gap. First, we know very little about how pre-defined agreements of rules come to exist and how they act as clues for coordination that guide actors helping them understand what to expect and what is expected from them. Second, environmental resources such as clean air are non-excludable and non-rival public goods; they are available for everyone and their consumption by one actor does not prevent others from using them as well (Cornes and Sandler, 1986). Therefore, public goods are prone to 'free riding' because it is often in individual actors' interests to find ways to let other actors carry the costs of provision of the public good, while still enjoying the collective benefits from the provision of these public goods.

In our study of 'mechanisms design', we investigate the re-arrangement of interactions by 'NRG', a large multinational energy company in the aviation industry which is confronted with new environmental rules that result from the inclusion of the industry in the European Emissions Trading Scheme as of 2012. Our research objective is to examine the impact of these new environmental rules on the company's interaction with other organizations. What can we learn from new environmental rules as focal points that guide coordination? What is the role of incentive compatibility? What are the implications for research and policy?

The structure of the present paper is as follows. This first section provides an introduction to the importance of mechanisms design in responding to the problem of climate change. The second section briefly describes previous research and provides us with a theoretical foundation. Section 3 explains the methods applied to answer the research questions. Section 4 refers to a case from the aviation industry. Section 5 confronts the key findings from the case with a set of theoretical tools and section 6 discusses conclusions and implications.

2. INTELLECTUAL ORIGINS AND PREVIOUS RESEARCH

The view of markets as networks of exchange relationships is based on the observation that actors are individually significant and they often rely on the resources and capabilities of other actors (Easton and Håkansson; 1996, Gnyawali and Madhavan, 2001). These interdependencies result in continuing and frequently complex interactions designed to perform exchanges which create joint gains. Interactions are often constrained or enabled by a set of explicit or implicit rules ranging from informal cultural customs to binding laws (Mouzas and Ford, 2007). Empirical evidence suggests that rules usually draw upon pre-existing bases of agreement among related actors to articulate an order of shared conventions (Choi, 1993, Young, 1993). Thus, rules comprise customary, expected, legal, and often non-legal standards and principles. Their validity and legitimacy is continuously challenged and redefined through the evolution of consent over time among related actors (Barnett, 2003; Barnett, 1986).

Building on the insight that interaction does not occur in a vacuum, Schelling (1963) proposed the idea of focal points which captures the essence of social conventions (Sugden, 1995). Focal points are clues for coordination which help different parties to understand what is expected from themselves and others (Schelling, 1963). A focal point guides and channels the actions of parties towards particular bargaining or coordination outcome(s). Effective focal points are usually prominent, easy to recognise, and unique (ob. cit.). Furthermore, a focal point is strengthened when it is simple, supported by historical precedents and non-arbitrary, i.e. backed up by a supporting rationale. In his examination of Schelling's influential theory, Myerson argues that Schelling's avoidance of 'methodological determinism' allows him to make contributions to the understanding of the empirical observation that, contrary to the suggestions of traditional economic theory, there are

multiple equilibria / many possible outcomes from interactions (Myerson, 2006b). As such, focal points can be the basis of rational decisions which are socially determined by efforts to coordinate, rather than purely economically and rationally determined (ob. cit.).

One excellent treatment of Schelling's work looks to operationalise focal points for use in analysis of interaction (Janssen, 2006). It is noted that focal points are based upon a supporting logic, rather than incremental bartering, thus changes agreed will tend to be greater than the smallest increment possible. Because of this, focal points are best sought through modal, rather than average responses. This is because decisions taken using focal points will tend to represent a number of discrete possibilities, rather than a continuum which would be better measured using a mean / average. For example, when negotiating an amount, the focal points encouraged by trade norms can influence the decision taken. Knowing the average purchased amount was 67kg would be less informative than knowing the modal order was 75kg. Knowledge of this mode would encourage the researcher to seek focal points to explain it, for example if the traded product was available in increments of 25kg and perhaps 75kg represented a week's supply.

Instead of taking the economic system as given, mechanism design examines the effects of the design of the economic system upon the outcome(s) it generates (Hurwicz, 1973). At the core of the theory is the principle that any institution's main challenge in setting structures and incentives is to gather truthful information from participants (Myerson, 2006a). Mechanism design theory introduces the concept of 'incentive compatibility' that is linked to the challenge of structuring individual incentives so that the desired collective action is possible and encouraged. Mechanisms are incentive compatible when they incentivise the supply of truthful information (Myerson, 1979). For example in our case study we see that by swapping from free to auctioned CO2 permit allocation, the European legislators removed the incentive to apply for a generous allocation of permits. Furthermore, mechanism design theory proposes the so called 'revelation principle' which is a methodological tool designed to help with practical applications of mechanism design (KVA, 2007). This tool advocates that the solution to a problem can first be optimised through the application of a set of direct mechanisms. These guide the formation of the fundamentals of the mechanism design. For example, a direct mechanism might be a mathematical model or calculation scheme. Building upon these foundations, a more realistic mechanism for real world application is then designed. The revelation principle is an acknowledgement that a purely economic treatment of a problem will not suffice for successful real world application. An example is given in Figure 2, which shows the economic logic behind the structure of the European Emissions Trading Scheme.

Environmental resources such as clean air can be regarded as public goods. In theoretical terms, public goods are considered as non-excludable and non-rival; it is not possible to restrict access to them, and consumption by one party does not prevent consumption by another (Barrett, 2007). Climate change mitigation is an example of an effort to provide a public good, that of a world where the costs of climate change are avoided. By their nature, public goods are prone to 'free riding', since it is often in individual actors' interests to find ways to let others carry the costs of provision of the public good, while still enjoying the collective benefits from the provision of the public good. Groves and Ledyard (1977) define a free rider as a party which understates their preferences in order to avoid their share of the burden of provision. Public goods are linked to the 'tragedy of the commons' which flags the existence of incentives for individuals to exploit a commons. This is because their individual cost in protecting the commons cannot be justified against the anticipated diluted / shared benefits (Hardin, 1968).

The goal of discouraging free riders provides a link back to mechanism design. In designing a mechanism for cooperation around climate change mitigation, proponents of mechanism design encourage legislators to aim for achieve incentive compatibility, whereby truthful reporting of private information on the valuation of climate change mitigation would result in the optimal amount of expenditure to provide a solution (KVA, 2007). We explore a case where legislators are attempting to introduce the 'corrective actions' that Hardin calls for in order to preserve incentive compatibility.

3. RESEARCH METHODS

Our research investigates the re-arrangement of interactions by 'NRG', a large multinational energy

company. NRG is confronted with a new mechanism design- the inclusion of the aviation industry within the European Emissions Trading Scheme as of 2012. Investigating the response to the climate change as a contemporary phenomenon in its real life context can most suitably be achieved through the case study research method (Alexander and Bennett, 2005; Halinen and Torrnoos, 2005; Perry, 1998, Yin, 2003). Our choice of case was guided by the desire to directly examine the target of new environmental rules, by including NRG and EUTA in the case we covered two key organisations affected by the new legislation. Through their members EUTA also spoke on behalf of a larger section of the aviation industry than we could hope to cover on an individual basis. Access to the legislator was partly through material disclosed during the public process of consultation, and partly through NRG's and EUTA's direct relationship and interactions with the legislators.

Data drawn on in this paper were collected and analysed during participant observation at NRG over a period of six months. During the research, participant observation was possible at all times. The work was at Vice-President and Executive-Vice-President level, focusing upon CO2 management and strategy at corporate level. Case material typically included representative policy responses, strategy documents, project / joint venture documentation and interactions with industry associations, legislators and NGOs. Observations and data sources were logged daily in a research diary and a library of case documents was created to record / capture relevant material. Data analysis required creation of a hierarchy of categories and then sorting material to fit this (Bennett and Elman, 2006; Numagami, 1998). Triangulation of data was achieved through comparison of empirical findings gained in different groups and through different media / data sources (Yin, 2003). Instead of looking across the full range of responses and actors, we followed the logic that focal points are best developed from modal responses (Janssen, 2006; Schelling, 1963).

There were several cycles whereby we moved between theoretical tools such as focal points, rules, or incentive compatibility and empirical data on interaction episodes. This interplay between theoretical tools and empirical data differs from one-way deductive or inductive methods. In our analysis, the observed response to climate change is an open system, events do not follow a determined pattern, instead they are subject to social mechanisms (Hedstrom and Swedberg, 1998). For this reason, we needed to engage in analytical experimentation to identify the generality of mechanisms that produced the events which were experienced. However, we distinguish generality from recurrent regularities. Our generality is ascribed to the 'operation' of mechanisms which produced the observed events. Mechanisms may "act in their normal way even when expected regularities do not occur" (Tsoukas, 1989 p.551). As the relationship between mechanisms and their outcomes is not fixed but contingent, our analysis includes a critical examination of the 'contextual conditioning of mechanisms which turns, or fails to turn, causal potentials into a causal outcomes' (Pawson and Tilley 1997, p.69).

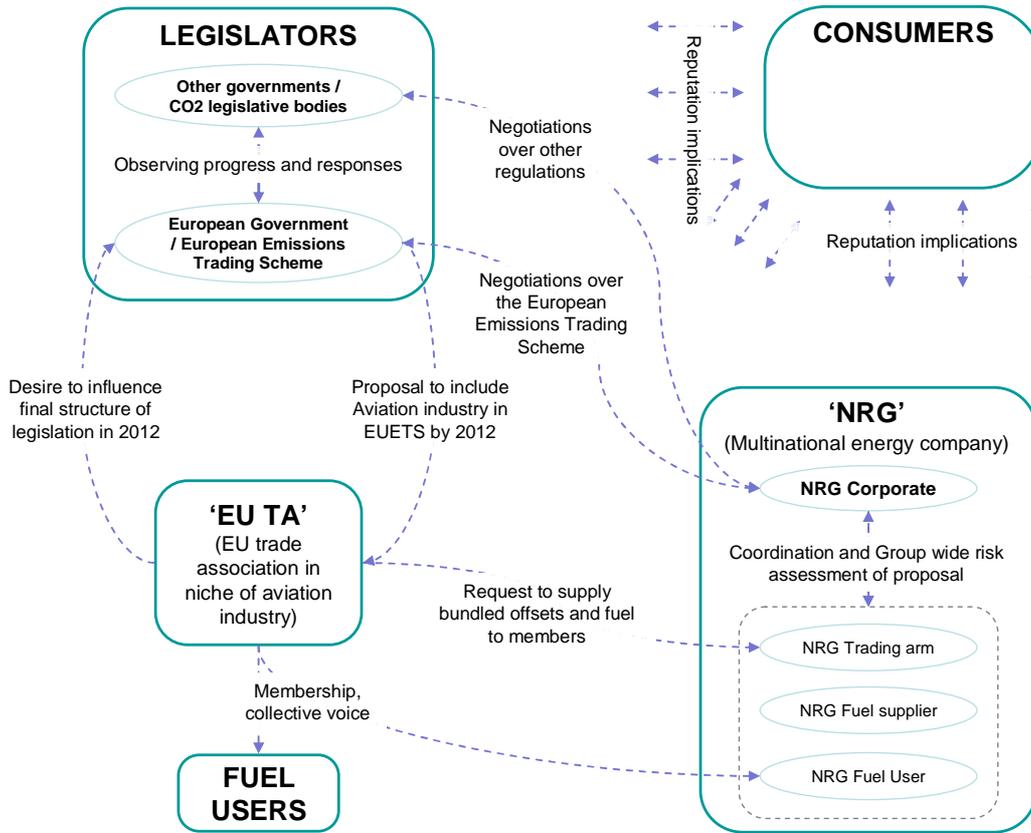
4. EMPIRICAL CASE STUDY

This case study describes network interactions by 'NRG', a large multinational energy company faced with the opportunity to respond proactively to future CO2 legislation. The core announcement triggering the events described in the case was the inclusion of the aviation industry within the European Emissions Trading Scheme as of 2012. As well as the deadline for inclusion of the aviation industry, the EU announced that early action in the years leading up to 2012 would potentially be recognised by the final structure of the legislation.

This affected NRG in a number of ways. Firstly it supplied fuel to the aviation industry. Secondly NRG operated a number of private aircraft which would have to comply with the forthcoming legislation. Thirdly, one of the potential compliance options for fuel users was through the purchase of CO2 offsets, meaning that 'NRG Trading Arm' saw a potential new market open up. 'NRG Corporate' had a coordinating role and was responsible for managing potential impacts in other relationships, legislation and markets. An important third party in the network was the 'EUTA' which was one of the trade associations that was active in the European aviation industry. This body had existing relationships with NRG Fuel user and most other actors within their niche in the EU's

Aviation Industry. Figure 1 below shows the industrial network and the interactions taking place.

Figure 1: NRG within their network

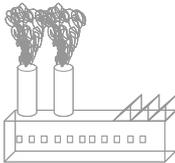


Context: CO2 regulatory mechanisms and the European emissions trading scheme

At the highest level, the guiding principle for the design of CO2 legislation is to minimise the costs of reducing emissions, achieving compliance at the minimum cost to the economy and society. To this end, two key design criteria are the avoidance of unnecessary regulatory burdens, and seeking flexibility that allows businesses as much freedom as possible in modes of compliance (DEFRA, 2007).

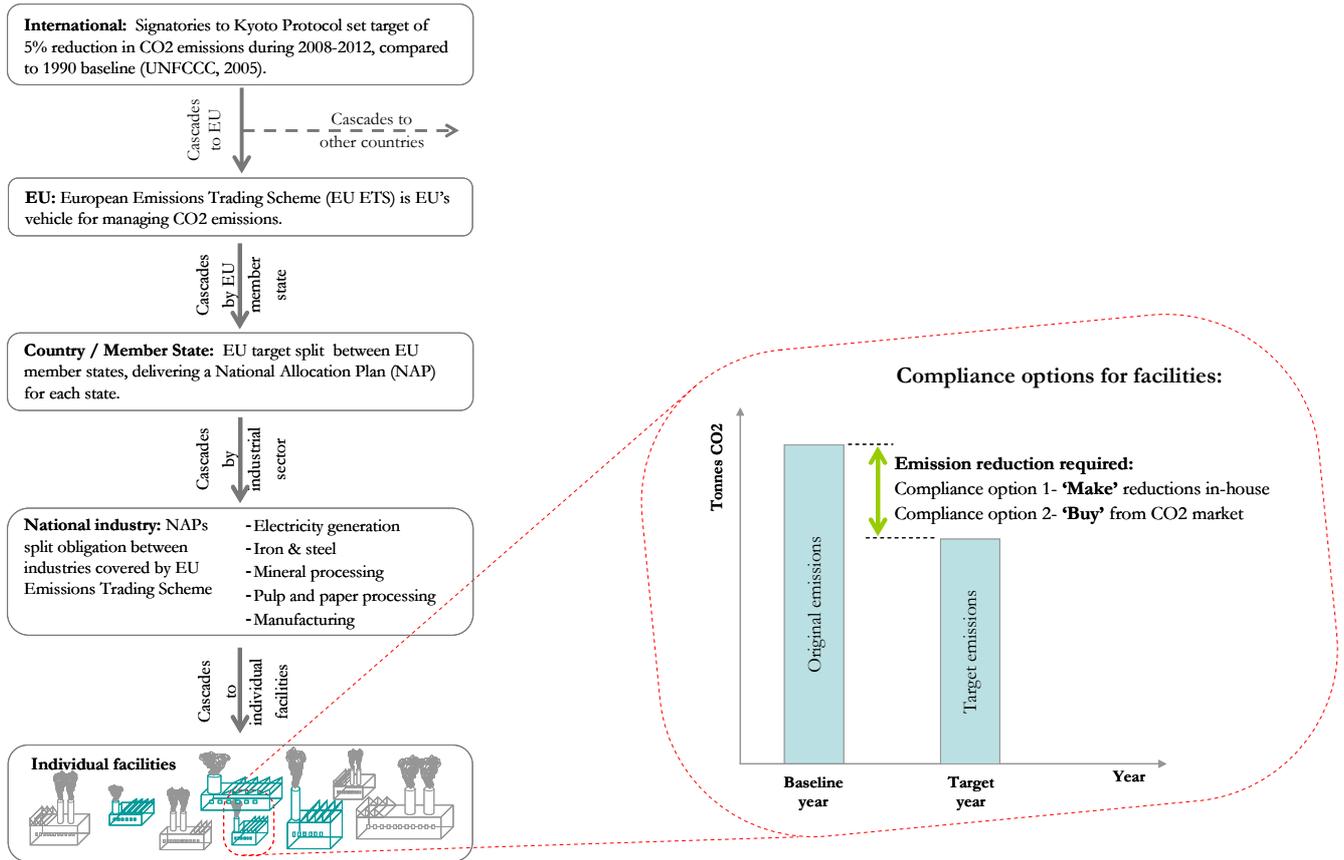
The European Emissions Trading Scheme is a market based response designed to be more effective than a straight tax or mandate. Figure 2 illustrates the main three potential mechanisms for regulation of CO2; namely tax, mandate, or emissions trading. A straight tax on CO2 faces the criticism that at the outset it is not possible to predict the level of CO2 savings a tax will generate. A tax also fails to introduce any flexibility for compliance, neglecting the different costs of CO2 abatement faced by actors. The second option for CO2 regulation, a mandate, equally shares a CO2 reduction target across each facility in the industry. This does set a predictable cut in CO2 emissions; however the total cost across the industry is not minimised since there is no flexibility to trade emissions reductions across facilities. Finally, 'emissions trading' is a system which sets an industry wide CO2 reduction target and provides a market for CO2 savings. CO2 savings achieved beyond the emissions cap at one facility can be sold into the market as emissions permits to be purchased by facilities with a CO2 reduction cost higher than the market price. In this example, Factory B makes all the CO2 reductions required and sells the excess to factory A. Within the emissions trading model, the scale of emission cuts is predictable and the cost of compliance is minimised since emission reductions are pushed to the facilities with the cheapest reduction options.

Figure 2: An illustration of potential regulatory mechanisms for CO2

Regulatory options	Factory A: Cost of reducing CO2 emissions through changes to plant = \$50/tonne 	Factory B: Cost of reducing CO2 emissions through changes to plant = \$10/tonne 	Cost borne by industry	Tonnes CO2 saved
	1) Tax: Fixed cost of XX\$/tonne CO2 emitted.	Factory A makes CO2 reductions based upon individual economics and priorities.	Factory B makes CO2 reductions based upon individual economics and priorities.	> min possible Industry costs are not pushed to cheapest reduction options
2) Mandate: Fixed reduction of CO2 mandated across industry. E.g. 20 tonnes split evenly between factories A and B.	10 tonnes CO2 saved in house at a cost of \$500	10 tonnes CO2 saved in house at a cost of \$100	> min possible (\$600)	fixed by legislation (20 tonnes)
3) Emissions trading: Emission reduction target set for whole industry (e.g. 20tonnes). Market decides best mode of compliance.	High cost of CO2 reductions at factory A means compliance comes through buying 10 tonnes CO2 from the carbon market (in this case bought from Factory B).	Low cost of abatement justifies 20 tonnes CO2 saved in house at a cost of \$200. 10 tonnes used for compliance. 10 tonnes sold to carbon market (bought by factory A).	min possible (\$200)	fixed by legislation (20 tonnes)

The European Emissions Trading Scheme cascades from the Kyoto Protocol, which is administered the United Nations and represents the main international response to climate change. The protocol sets a target to reduce greenhouse gas emissions to more than 5% below 1990 levels between 2008 and 2012 (UNFCCC, 2005, UNFCCC, 2006). The EU has signed the protocol as a region and its emissions reduction target cascades down to individual facilities as shown in Figure 3. Within the EU each member state has a National Allocation Plan. At the national level the industries covered by the European Emissions Trading Scheme are each assigned their share of the reduction target. Next these cascade to individual facilities which then face the choice to either ‘make’ the reductions in-house or ‘buy’ the savings required from the CO2 market.

Figure 3: Cascade of the Kyoto protocol to individual facilities within the European Emissions Trading Scheme



The Kyoto Protocol came into force in 2008 and is set to run until 2012, with the European Emissions Trading Scheme mirroring this time frame. Initially the European Emissions Trading Scheme included the electricity, iron and steel, mineral processing, pulp and paper and manufacturing industries.

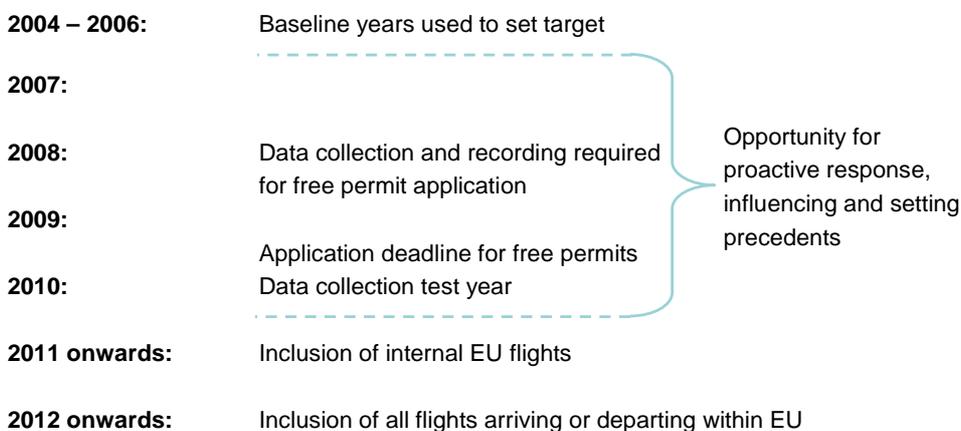
The European legislator's initial proposal

Once the Kyoto Protocol finishes in 2012 there is uncertainty over whether there will be another global CO2 regime and if so what form it will take. The EU is active in these debates and has also put forward a plan to extend the European Emissions Trading Scheme post 2012. This will go ahead regardless of progress in international negotiations. One element of the proposed updates is the inclusion of the aviation industry. Aviation is a fast growing sector and is politically charged with regards climate change. Legislators are looking to include the aviation industry post 2012, but are keen to incentivise early action. The EU government has made it clear that the final legislation may recognise early action.

One of the core debates is over how to allocate CO2 permits to industry players. Previously they were allocated for free, their value being created through their scarcity and the fact that they can either be sold in the CO2 market, or surrendered to achieve compliance. There are now proposals that some or all permits will be auctioned, rather than allocated for free. This proposal comes from experience gained in the first phase of the European emissions trading scheme which ran until 2008. Permits were allocated for free during phase I, based upon applications made by individual sites / organisations. Since the permits were allocated for free, there was an incentive to apply for a generous allocation. In such a situation individual incentives encouraged gaming of the system. The aim of auctioning allocations was that facilities would no longer have an incentive to game the system- permits were no longer free. The mechanism was also designed to encourage truthful reporting of data. One of the key incentives for early action was that organisations in the aviation industry which collected and submitted their CO2 performance data early would be rewarded through being given the chance to apply for free emission permits. This could represent significant financial savings to the companies that adhere to the early implementation framework illustrated in Figure 4 below.

Aside from these formalised opportunities to gain recognition for early action, actors within the European Aviation industry also saw the potential to proactively influence the emerging regulation design. Actors sought to take early action to demonstrate potential modes of compliance in hope of influencing the final legislation design.

Figure 4: Timeline for inclusion of aviation within European Emissions Trading Scheme



Offsetting- the minefield

Before moving further, a key term must be defined. ‘Offsetting’ is the process whereby individuals or organisations not covered by a legally binding trading scheme purchase CO2 permits and destroy them. Through doing this, organisations may claim to have offset a tonne of CO2. Offsetting can thus be defined as the purchase and destruction of CO2 permits outside of a legally binding emissions trading scheme.

Offsetting brings a number of complications not faced by those covered by the European Emissions Trading Scheme. Firstly, as offsetters are not bound by legislation, there is no legal requirement for the strict verification processes used within the European Emissions Trading Scheme. Secondly, as off-setters are not able to sell any CO2 reductions made in-house back into the CO2 market, the capital efficiency of emissions trading does not apply to offsetting. Off-setters are routinely only able to choose the ‘buy’ option given in Figure 3. Reductions in-house, the ‘make’ option, do not enable off-setters to monetise their CO2 savings, since they do not have formal access to sell into the CO2 market. Given its lack of verification, plus the fact that offsetting can short-circuit the market mechanism at the heart of the capital efficiency of emissions trading; offsetting is often met by stakeholders with scepticism and accusations of ‘green-wash’. Offsetting often faces claims that it is a cheap way of tabling green claims, without taking any action to ‘make’ emissions savings / manage CO2 emissions in-house.

It is important to recognise that in this case, early action by the aviation industry would be offsetting, i.e. the purchase of CO2 permits outside of legally binding legislation. This was unavoidable, since it was not possible to engage in emissions trading until the scheme became legally binding in 2012. As we will see, NRG’s corporate policy team had to provide steer to help avoid the potential pitfalls of offsetting.

EU TA’s Initial proposal to NRG

The case starts when EUTA, a trade association active in a niche of the European Aviation Industry, approached NRG with a proposal to form a partnership and supply offsets to EUTA members. Specifically, the proposal was to develop a new fuel offering based upon bundling the aviation fuel and CO2 offset together. This would provide a potential compliance method for aviation customers covered by the European Emissions Trading Scheme, one built into the fuel purchase itself. As a member of EUTA, this proposal was also presented to ‘NRG Fuel User’. The initial intention of the approach was that ‘NRG Fuel User’ would eventually purchase the offering, rather than be directly involved in its development / delivery.

As mentioned previously, the legislative changes impacted a number of areas of NRG's business. These areas overlapped and in some ways caused conflicts of interest within the company. 'NRG Fuel Supplier' and 'NRG Trading Arm' saw the proposal as a potentially attractive business opportunity. They gave 'NRG Fuel User' strong feedback to steer the EUTA proposal towards using 'NRG Fuel Supplier' and 'NRG Trading Arm' to supply the fuel and offsets respectively. Next the proposal for a partnership between NRG and EUTA was put forward to NRG corporate. NRG were to supply fuel and offsets, whilst EUTA would bring economies of scale by acting to aggregate the demand of its members. EUTA members would benefit from a unified approach to compliance that would bring increased influence on the legislator to adopt their 'bundled fuel and offset' method as a compliance option once the legislation was enacted in 2012. 'NRG Fuel User' also saw the proposal as a response to external pressures from CO2 interest groups.

With the broad proposal / structure outlined, NRG Corporate had the responsibility to coordinate and oversee the actions taken by 'NRG Fuel User', 'NRG Trading Arm' and 'NRG Fuel Supplier'. CO2, offsetting, and the emissions of the aviation industry were all high profile issues. The main responsibilities of NRG Corporate were to manage the risk of setting difficult precedents with other customers or legislators and to avoid damage to NRG's reputation, by ensuring the environmental validity of the proposal. The key tensions experienced by 'NRG Corporate' and the resulting interactions are now examined in turn.

Make or Buy? (The CO2 conundrum)

'Make' or 'Buy' is one of the main discussion points within the wider CO2 community. It is a result of the structure of CO2 legislation which is a cap and trade system, see Figure 2. When faced with the option to put forward a proactive response to the inclusion of the aviation industry in the European Emissions Trading Scheme by 2012, NRG had to decide whether to 'Make or Buy'. In other words they had to choose whether to 'make' the CO2 reductions required in-house, or 'buy' the reductions permits from other parties / the CO2 market. This was the first point of discussion within the different groups of NRG. NRG Trading Arm, Fuel Supplier and Fuel User felt that a 'buy' response through purchasing CO2 reductions (offsets) was the most appropriate option. This preference was inline with initiatives taken by competitors who had previously offered the chance for customers to supplement their flight ticket with an offsetting option. This offering had allowed passengers to offset the emissions generated during the flight by buying reduction certificates from the CO2 market. Along these lines, NRG Trading Arm saw the opportunity to extend its CO2 trading operations to a new area. NRG Fuel Supplier saw the partnership with EUTA as presenting an opportunity to achieve increased market share. NRG Fuel User saw the offering as being the least cost and most convenient option to comply with the forthcoming legislation. NRG Corporate, however, saw the proposal as potentially damaging in a wide range of other areas in NRG's wider network.

As mentioned above, aviation competitors had previously offered offsets as an optional product for purchase by consumers. However, if they bundled the offset and fuel together and used it to influence proposed legislation, NRG was setting a new precedent in the aviation industry. At the same time, it was noted that competitors would most likely be considering the same idea and so while the fear of setting a precedent was real, there was also the desire not to miss a potential opportunity. NRG Corporate continued to work with the other areas of the business to come up with a group policy on offsetting. There were two key dimensions to the issue: who provided the offsets, and what type of offset was used. The first was quickly closed off, it was decided that any offsets purchased by NRG would come from their trading arm, rather than a third party. It was felt that this would maximise the business opportunities for NRG, whilst at the same time avoiding the risk of dealing with a 3rd party in a potentially controversial market. The second question over what type of offset to offer was around whether to use voluntary or compliance based offsets. It was quickly decided that although voluntary offsets were the least-cost solution they would not be used. This was due to their lack of transparency and the low level of consumer trust of offsetting in general. The decision was taken that offsetting would be done using emission reduction permits supplied by either the United Nations' Kyoto Protocol, or by the EU Government's European Emission Trading Scheme. The external verification of compliance-based offsets by such authorities was seen as justifying the extra cost over voluntary offsets.

The Issue of Precedent Setting

At the time of the announcement of aviation's inclusion in the European Emissions Trading Scheme, there was a wide range of CO₂ legislation in consultation. NRG Corporate was acutely aware that different legislators were closely interacting and that a precedent set in one region / industry could easily spread to others. For example Californian legislators were known to be working with Chinese and European legislators, and the Stern team which published the influential Stern Review were known to be working upon a similar report to guide legislation in the developing countries. The existing relationships and interactions between legislators meant precedents set by supporting one piece of legislation in a particular region / industry would quickly influence other pending legislation. This made it essential that any proactive response to one piece of legislation was viewed within the wider legislative context. NRG Corporate had a role of helping NRG Trading, NRG Fuel Supplier and NRG Fuel User in understanding the wider implications of their proposals for a proactive response to the aviation legislation. As experts in CO₂ legislation, NRG Corporate also played a part in explaining the different potential compliance options, their environmental robustness and capital efficiency. As with many energy companies at the time, NRG publicly supported the European emissions trading scheme and was broadly calling for more legislation on CO₂ in order to create a level playing field and the ability to assign a monetary value to CO₂ reductions.

NRG Corporate's interactions with other areas of NRG and also in its engagement with EU TA performed two functions. Firstly NRG Corporate steered the proposal through careful treatment of CO₂ offsetting, secondly they acted as advisors on the technical validity of proposals in terms of environmental soundness and legislative acceptability. While precedents had already been set externally on offsetting within the aviation industry and other sectors with equally public profiles, no one had yet offered the fuel and offset as a bundled product. NRG corporate was nervous that in setting the precedent it could have unintended circumstances in other future legislation and that in this case 'first mover advantage' could come with a sting in the tail. Another major concern that NRG Corporate felt was over consumer attitudes towards offsetting. Whilst consumer interest in climate change was at an all time high and it was felt that consumers valued low CO₂ offerings, it was also recognised that consumers viewed offsetting with more than a hint of scepticism. This scepticism was magnified by critical press articles and material released by CO₂ interest groups.

NRG' Final Response

After assessing the reputation risks, observing the offsetting precedents in the aviation industry and weighing up the likelihood of setting a precedent that would spread to other environmental rules; NRG finally went ahead with the proposal given two criteria. Firstly, to maximise the business opportunity and minimise exposure to risk through third parties, NRG Trading Arm would be the sole supplier of offsets and likewise NRG Fuel Supplier with regards fuel. This would ensure the supply of robust offsets and give full transparency as to their sourcing and treatment. Secondly it was considered that it was acceptable to meet external demand for such offerings by using compliance based offsets, but that NRG would make further efficiency efforts in house. IE, as a risk mitigation approach, due to the external opinions of offsetting, NRG Fuel user preferred to take a mix of both 'make' and 'buy' actions to manage emissions. NRG Fuel User would join the project and 'buy' offsets, whilst at the same time 'making' significant emissions reductions in-house through energy efficiency measures. This decision was partly due to external network pressures, and partly to align with NRG's group wide drive for efficiency improvements across the company. It was also considered that NRG Fuel user would supply emissions data inline with the timeframe illustrated in Figure 4, this was due to the incentive that doing so would enable the application for free emissions permits in 2012.

4. ANALYSIS OF EMPIRICAL RESULTS

We now analyse the empirical findings using the analytical tools described previously. First, we give a treatment of mechanism design and its influence upon interactions. Building upon this, we expand the analysis to include social dimensions through application of the theory of focal points.

Mechanism design's relevance to our empirical observations is now discussed. First we examine the revelation principle, a theoretical tool aimed at operationalising mechanism design. It recommends a two-stage approach of (1) defining the economically optimal mechanism and (2) adapting it for real world practicalities. This was found to be inline with empirical observations of the design and revision of the European Emissions Trading Scheme. We saw that a mechanism of emissions trading was chosen since it was economically optimal when compared to the alternatives of a tax or mandate. A tax was neither able to achieve optimal economic efficiency, or to fix the anticipated reduction of CO₂ at the outset. Whilst a mandate was able to fix the CO₂ reduction anticipated, it was still economically suboptimal, see Figure 2 for more detail. Thus the first stage of the approach recommended by the revelation principle, to select an economically optimal mechanism as a basis for new environmental rules, is inline with the design process used for the European Emissions Trading Scheme. Second, the revelation principle recommends taking the optimal economic mechanism and adapting it to allow for real-world considerations. Such modifications were observed in the first phase of the European Emissions Trading Scheme. For example, the case flags that in phase I, emission permits were allocated for free. Phase 1 was a trial period, ahead of phase II which mirrors the Kyoto Protocol compliance period of 2008 to 2012. The free allocations were seen by many as the least politically challenging method of implication, whilst still allowing early testing of the system prior to its compliance period in phase II. Thus, it can be seen that, inline with the revelation principle, regulation on CO₂ followed a base ambition of economic efficiency whilst recognising the need for real world simplicity and political acceptability.

Taking the arguments above further, we now analyse the incentives embedded in the original mechanism and the proposed updates for inclusion of aviation post 2012. These demonstrate the importance of achieving incentive compatibility in mechanism design. While the original free allocation of permits worked well during phase I, offering the 'path of least resistance' to implementation and the opportunity to learn ahead of the compliance period of phase II, there were significant limitations to the mechanism design. As examined below, these led to gaming of the system and incentives to free ride by applying for generous allowances. As described in the case study, the allocation of permits for free during phase I was based upon applications made by individual sites / organisations. This introduced incentives encouraging gaming of the system. Since they were free, it was in the interest of each site to apply for as many permits as possible. The problem was confirmed at the end of phase I, when the price of permits plummeted due to over allocation. Luckily, the legislators had anticipated such problems and had built in a 'system reset'. A new allocation was required at the start of phase II, and phase I permits could not be carried over to phase II. Accordingly, on the first day of phase II, the price of the permits recovered. Further to this, the design of the mechanism for phase III / post 2012 was much more inline with ambition of incentive compatibility. Auctioning permits post 2012 removed the incentive for individual facilities to game the system. Since emission permits were no longer free, auctioning removed the incentive to apply for a generous allocation, meaning individual incentives were aligned with the collective goal.

As discussed, the fundamental principle of mechanism design is to encourage truthful reporting of data by all participants. This ambition was relevant, since it was embedded in the opportunity to respond proactively to the legislation. One of the key incentives for early action was that organisations in the aviation industry which collect and submit their CO₂ performance data early will be rewarded through being given the chance to apply for free emission permits. This could represent significant financial savings to the companies that adhere to the early implementation framework illustrated in Figure 4. Thus, the lessons learned during phase I informed a design that was incentive compatible and encouraged early and truthful reporting of data ahead of enactment in 2012.

Next we examine the relevance of focal points as clues for coordination that shape the social process of interaction. In our case, it was found that new environmental rules focussed primarily upon economic aspects, such as cost minimisation through the avoidance of unnecessary regulatory burdens and giving flexibility in compliance modes. In contrast, although NRG and EUTA shared these economic concerns, they had also to consider non-economic points of reference. NRG and EUTA shared concerns for precedent setting in other relationships and future legislation,

plus recognition of consumer concerns on offsetting and 'green-wash' accusations. The theory of focal points thus flags that in order for legislators to understand or anticipate the response of organisations to inclusion of aviation within the European Emissions Trading Scheme, they will have to deal with the non-economic focal points held by organisations. In our case, the final response by NRG was not economically optimised. Instead, the response was designed to protect against accusations of green-wash and to manage the setting of precedents in other relationships and future legislation.

5. CONCLUSIONS AND IMPLICATIONS

This paper discussed empirical findings regarding responses to the problem of climate change. Focusing on new environmental rules within the EU, we provide insights regarding the applicability of mechanism design for complex, cross border business networks dealing with both techno-economic as well as socio-cultural issues.

Mechanism design theory tends to advocate the design of optimal mechanisms for 'application' on what is implied to be a fairly passive set of organisations. We argue that instead of seeing the process of mechanism design as being unilateral, there is value in recognising the importance of interaction with the anticipated recipients of the rules of the game, giving way to a more dialectic process. Our empirical evidence suggests that actors will not optimise responses as isolated decisions. Instead, they will respond to mechanisms as viewed within their wider network implications and within historic and future relationships. Our case has shown that mechanism design is an effective tool for the development of economically sound mechanisms, aligning individual incentives with collective goals. We suggest that the theory of focal points can bring extra insight to the process of mechanism design by acknowledging socially embedded clues for coordination that will influence the final outcome of interactions regarding mechanism design. This is inline with the observation that in order to fully understand NRG's and EUTA's response to aviation's inclusion in the European Emissions Trading Scheme, it was necessary to understand the focal points of 'management of precedent setting' and 'avoidance of accusations of green-wash'. These were significant points of reference which were at least given as much consideration as the economic concerns relevant to the particular mechanism under negotiation.

The present study of mechanism design as a response to the problem of climate change may stimulate further research in two interrelated areas. Firstly, the concept of focal points offers the opportunity to incorporate social and cultural elements into the investigation of actors' interaction. From previous research, we know that actors achieve a much better co-ordination when they rely on focal points, but we know very little about how these focal points are established and how they evolve over time. If focal points are built upon bases of agreements that pre-exist in webs of exchange relationships, then we need to learn more about the collective process of achievement of agreement. Second, the concept of incentive compatibility invites us to look at actors' underlying interests and motivations as triggers of business interaction and connect them with the institutional structure of exchange relationships. Previous research on how actors frame problems may provide analytical tools that could help us understand actors' inter-temporal trade-offs, as well as their deeply ingrained biases and errors. Future research in this area would deliver a better understanding of a multiplicity of possibilities to respond to the problem of climate change.

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