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Developing Glasgow Accord for COP-26 Using Game Theory

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Abstract: The UNFCCC hosted its 25th convention, known as COP25, which cannot be considered to be a success among the climate change conferences due to the failure of 175 nations to agree upon the final details of the Paris Agreement proposed in 2015. The aim was to bring together nations across the globe and reduce the global temperature rise to 2°C, which was expected to be around 4.5°C to 6°C. The justifications for the incompetence can be attributed to a variety of aspects, including their inability to implement the intended nationally determined contributions (INDC). Since there is no overall governing body that can ensure strong implementation of the accords, the system needs to be self-regulatory without any vulnerability to international politics. This study develops a series of factors that can be considered for decision making, benefiting and rewarding to assure complete self-governance of these nations on the said climate accord, without making it vulnerable to the political relations among nations. This study uses pre-defined elements of Game Theory in order to achieve the required equilibrium, as a base for understanding decision making and proposing a possible system to create an acceptable result for the member nations.

Keywords: Climate change; Game theory; Non-cooperative; Decision making; COP 26; UNFCCC.

Introduction

The United Nations Framework Conventions on Climate Change (UNFCCC) is a convention that intends to negotiate and bring together nations to address the pressing concerns of climate change. The UNFCCC strives to keep greenhouse gas levels in the environment stable at a rate that discourages detrimental anthropogenic climate change debates (NATIONS, 1992). The goal is to attain the target level of greenhouse gas (GHG) emissions in a rational quantity of time to enable natural systems to adjust to the changing environment. The COP or Conference of Parties is the Convention's main decision-making entity, whose main duty is to examine the Parties' national correspondence and pollution inventories. This is done through predetermined intended nationally determined contributions or INDC that aim to address pollution and climate change through different interventions. These INDC's are mutually agreed upon by the member nations.

The UNFCCC was composed of 154 nations during the United Nations Conference on Environment and Development (UNCED), often referred to as the Earth Summit, held in Rio de Janeiro from June 3 to 14, 1992. In 2016, during the 21st Conference of Parties, 196 nations committed to restrict global temperature rise to 2°C and undertake action to minimize the rise to 1.5°C. The key feature of the treaty ensures that the actions of all nations are reviewed after every 5 years requiring the parties to develop new pledges to assure that we are working in the right direction to achieve our goals.

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Though the agreement had very ambitious goals for the members it did not succeed to develop a detailed method that could justifiably assess the actions and impacts of different nations on the global temperature. After the recommendations of the United States of America, the developed nations also took up the responsibility of raising 100 billion USD for the cause of addressing the concerns of climate change. The parties failed to identify any effective mechanism of contribution or distribution of the financial resources altogether. The agreement was expected to come to action in 2020. In case the parties fail to develop a suitable mechanism, the UNFCCC could potentially descent into a series of Conferences before an alternate method is developed. Hence, a suitable mechanism must be developed that assures proper functioning and helping nations achieve their goals.

This study, hereafter, assesses the potential of using game theory as a tool for identifying critical factors that may be incorporated in the mechanism. This study aims to recognise a system that would potentially lead the nations or parties to achieve their goals while also preventing the mechanism to be sabotaged due to failure of achieving goals by a few parties. This study assesses the conference as a regime against any nation that may or may not achieve its goals and the potential outcomes of it. Game theory allows one to compare such outcomes and hence create a system where the outcomes are suitable to the regime and the individual parties.

Game Theory

The principles of game theory provide a shared vocabulary for formulating, structuring, analysing, and ultimately comprehending various strategical cases. Game theory, in its broadest definition, investigates conflicting events, the interplay of actors, and associated judgments. In the framework of game theory, gaming is considered as a collection of (typically limited) participants that engage according to pre-set norms. Individuals, parties, businesses, and partnerships are all examples of players. Such encounters will have an impact on each of the individuals and also the entire society, meaning that these interventions have been interdependently reliant.

Furthermore, a game is characterised by a set of participants and overall capacity to follow the regulations i.e., their set of tactics. The theory may also be construed in a way that the topic of game theory is circumstantial in which the outcome for a party depends not just on their actions, but also on the conduct of the other parties.

Understanding COP in Context of Game theory

The notion of creating an international regime on climate change was initially suggested during the Rio summit in 1992. The plan did not provide the desired results owing to its failure at COP-6 in November 2000 and in 2001, when the U.S.A. disobeyed the Kyoto Protocol. In the jargon of game theory, following the norms and procedures of the convention will be known as ‘conformance’, whereas failing to do so, whether purposefully or unwittingly, will be described as ‘deterrence’. The fundamental issue in adopting a global climate change agreement is to create an effective mechanism for tracking, confirming, and executing the parameters it establishes.

On the ‘conformity problem’ at the meeting of participants, there is a massive amount of study and literature available. Certain scholars have also suggested ways to improve the characteristics of obligated party competence and the change in the global climate system. (Bodansky, 2001; Grubb, 1999; Oberthür and Ott, 1999; Hargrave et al., 1999; Heister et al., 1997).

However, no systematic attempt has been undertaken to determine the parameters under which a climate regime compliance system is likely to be effective. In the construction of such a system, the idea of equilibrium is critical. In this study, we apply non-cooperative game theory, which exists under the absence of external authority, to address the inadequacies in the present framework. The goal is to discover the variety of accessible stable situations that exist in the system and then examine the actual system to determine the degree to which these conditions help in achieving the identified equilibrium.

Nash Equilibrium

It is not an overstatement to suggest that Nash equilibria are a fundamental idea in game theory. The concept of Nash equilibrium begins with the premise that each participant picks its approach in the absence of knowledge about the opposing participants’ tactics. The Nash equilibria establish a bare minimum for stabilization. If a contract incorporates clauses that create conformity as a Nash equilibrium, then no signatories can gain from disobedience considering the tactics of all the remaining participants.

Furthermore, a particular learning from Nash equilibria is that imposing harsh sentences is the most effective way to prevent disobedience. Indeed, the harsher the punishment, greater probability it is that conformity will be maintained as a Nash balance analyse a small version in Figure 1 to understand why.

The compliance game is depicted in Figure 1 as one among a specific group (here called to as Party j) at one side and the climatic regime at another. It may well be helpful to conceive of "the system" as the Compliant Commission's enforcement division as a result, we are working with an instance of what we formerly referred to as centralized execution. The compensations might be regarded as expenses and advantages in comparison to the case when Party j agrees. T represents the increased reward earned by Party j if it decides to not cooperate, and C represents the expenses incurred by Party j if penalised. Lastly, L covers the value enforced on the system if Party j refuses to fulfil, whereas P represents the price borne by j.

In case the Party j complies, either of the regime's policies is indeed the optimal response. The explanation for this is because if Party j agrees, the system is unable to intervene, implying that the government's policy has no bearing on that result. As a result, the criterion for the upper left unit to be a Nash Equilibrium is mere that T ≤ C. At first glance, this finding appears to counter the Heister et al. (1995) contention that a regime of exact ratio among penalty and reward is preferable.

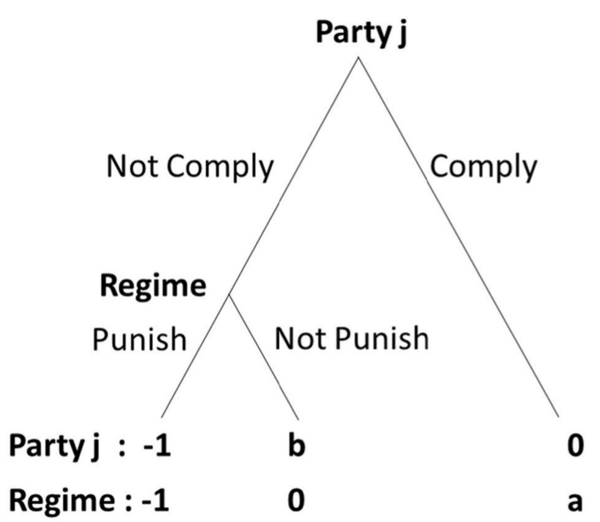

Figure 1: Flow chart for consequences of different cases of compliance and determent.

Moreover, the benefits from deterring (i.e., a regime in which T=C) would've been insufficient to dissuade disobedience. Nevertheless, if there is a tiny gap between a violation and the administration of the sentence, and forthcoming compensations are undervalued, Heister's conclusions remain accurate even when T = C. To put it another way, the Nash equilibrium recommends that the punishment rate ought to be higher than proportionate. In addition, all else being similar, the harsher the sentence (the bigger C), the more probable it is that conformity will be maintained as a Nash equilibrium.

A difficulty with the Nash equilibrium would be that a technique might dictate illogical conduct for certain portions of a play (certain subgames) whilst also belonging to a Nash equilibrium for that play. A Nash equilibrium, for instance, could be maintained by a threat that is vacant in the view that this would not be independently reasonable for the threatened to follow it out when the necessary violation occurred. But, prior knowledge with other global accords implies that considerably quite moderate replies may not have been plausible too. Global commodities treaties, for instance, sometimes call for response employ, the suspension of the voting rights as a possible reaction to violation (Werksman, 1998, p. 27). Likewise, (Chayes and Chayes, 1995) observe that, while termination of participation and other rights is described exactly as a possibility in several global agreements it is normally used only in rare situations. This appears to show that a shortage of reliability is a pervasive issue for global law enforcers

This is not improbable for the same would be true for the global climate system. For example, one of the repercussions accessible to the implementation department under the Marrakesh Accords is the termination of qualification for carbon trade. If a group's

Table 1: Consequences compiled as per compliance of Parties and Regime

		Regime	
		Punish if Party j does not comply	Not punish if Party j does not comply
Party j	Comply	0,0	0,0
	Not comply	T-C,-L-P	T,-L

power to trade quotas is stopped, this is expected to have an impact on third parties through the quotas and energy sectors (Hagem, Mstad and Westskog, forthcoming). The effects will be more severe if the concerned nation is a big player in the allocation markets. In contrast, if Russia — a key provider of quotas – had its right to do business halted, there might very certainly be a considerable cost hike. By implication, there'd be a contradiction among net purchasers and net dealers of quota over whether Russia's ability to deal must be terminated. As a result, it is evident that the risk of suspending will be genuine.

Backward induction makes it simple to identify the requirements for compliance to be maintained as a subgame perfect equilibrium in the game shown in Table 1. The first requirement is that the regime must be justified in punishing Party j if it fails to comply. All things considered, penalising a party that does not cooperate must result in a net benefit for the regime. This necessitates that $-L-P>-L$, implying that P is negative. The second condition is $0 \geq T-C$, often known as $C \geq T$. The latter criterion, as we've shown, is required for compliance to be perpetuated as a Nash equilibrium.

Here, we do not intend to identify the type of penalties most likely to fulfil the subgame excellence requirement. Rather, we'll use a basic illustration (involving decentralized enforcement). Assume the parties have agreed that the Paris Agreement will be instantly cancelled if any of them decides to commit a (severe) breach. This type of response is generally described in the concept of recurrent games by the Grim Trigger technique.

Grim Trigger directs a person to cooperate at all phases of the process till a defeat happens, after which the gamer is free to desert endlessly. In many other terms, if a defect occurs, collaboration comes to an end once for all. It is generally recognised that the employment of Grim Trigger both by (or all) sides is a Nash equilibrium in the infinitely recurring Prisoners' Dilemma — a paradigm that was widely utilized to examine enforceability concerns. (Friedman, 1971)

However, terminating a whole pact in reaction to one breach does not seem feasible. One clear reason seems to be that terminating the deal would endanger the worldwide ecology. Furthermore, no participant can be supposed to enter a contract freely until it regards oneself as being well off as a result of doing just that. Even though a breach is only meant to result in a temporary suspension of the treaty, it is still true that the parties are better off collectively resuming cooperation immediately rather than enduring the delay created by the suspension. As a result, treaty suspension mitigates but not eliminates the difficulty produced by treaty termination. We'll have to go elsewhere to do this. Renegotiation proofs is the result of this. However, if an agreement benefits all signatories, then the sides suffer a group disadvantage if the agreement is terminated. However, the risk of agreement cancellation is expected to fulfil the needs of independent rational suggested by the concept of subgame excellence, its implementation will not be jointly reasonable.

Sub-Game Efficiency

The concept of subgame excellence ensures that balance conduct is compatible with individualized reasonableness mandates. Nevertheless, there is a small issue with the concept of subgame excellence in the setting of implementation. Even though adherence is compatible with subgame excellence, it may be undercut by a communal motivation to try and negotiate following a breach. It may just be in everyone's best interests to let bygones be bygones and start collaboration as soon as possible. However, if a player can predict this, deterrence will not be effective, even if it meets the condition of subgame excellence. As a result, the incentives to cooperate in the first instance are diminished. A side may mislead solely as it believes that an offer to renegotiate would be welcomed just after the event. This is entirely the issue with such a regime that seeks to prevent disobedience by threatening agreement cancellation or interruption, as we've seen in the preceding part.

The restructuring may be accommodated in the system by making it obvious to potential defectors that renegotiation is not an option. Judgment must consequently have a motive to rely on punishment for breaches. As a result, a major point for compliance from the concept of renegotiating proneness is to eliminate hindrances that, if implemented, would be damaging to all participants.

The concept of coalition-proof Nash equilibrium incorporates an additional theory involving communal logic. The main premise of this notion is that disobedience can often be induced by nations operating together (i.e., as a coalition) instead of separately. In other terms, two or more people may plot to exploit all others. An efficient regulatory system must inhibit such conspiracies.

Considering a circumstance in which a huge number of nations should determine if or not to abide by a certain pact, like the Paris Agreement. If no one side may benefit from unilateral defection, a Nash equilibrium occurs in which all nations cooperate. However, this Nash equilibrium is not overly good, because it would imply that no subgroup of nations may get a superior result by departing simultaneously, assuming that all nations not even in the subgroup obey.

The possibility that two or many nations may collude to cheat together is undoubtedly significant. The powerful Nash equilibrium, on the other hand, has a severe flaw.

Assume that nations 1, 2..., k all would gain from deviating from a treaty with N participants (kN). These parties will not unite, since resultant conspiracies are not an equilibrium in and of itself. Provided that the other individuals of the subgroup depart from the plot, it may well be preferable for a specific person (or a body of persons) to depart from the conspirators. The robust Nash equilibrium is not a particularly convincing resolution idea since it does not discriminate among variations that are itself equilibria and those that are not.

Bernheim et al., 1987 developed the notion of coalition-proof Nash equilibrium to address this issue. In comparison to Aumann's approach, the coalition-proof Nash equilibrium is much more in accordance with personal logic because only self-enforcing collaborative departures are viewed as possible dangers to an agreement's viability. What's novel is that each alliance or sub-group is assessed using the identical criteria as the entire collection of players. When coping with the prospect of plotting sub-coalitions, the coalition-proof Nash equilibrium becomes a more persuasive answer. It'd be naïve not to contemplate the prospect of additional infiltration while creating a coalition to deceive together.

We may derive a relatively gloomy and one more positive consequence for the implementation of relevant provisions from the idea of coalition-proof Nash equilibrium. On the down hand, we can anticipate a global climate change system to meet the condition of alliance proof to a restricted degree. More clearly if the progressive alliance of all member states decides to withdraw from the Paris Agreement jointly, there is likely to be nothing that any practical implementation system can do over it. On the other extreme, the formation of such a coalition is difficult to conceive since, if the signatories believe the agreement is so irrational that it allows group defect, modifying it would be a better alternative.

In order to understand the behaviour of the parties, we shall assume them to be classified as "resilient" and "compliant". Regardless of the regime's reaction, a resilient party will never submit. A complying party, on the other hand, chooses to comply only if the regime punishes non-compliance. However, it is common knowledge that each partner, independently of the others, is resilient with probability q. A complying party receives a payoff of 0 if it conforms, but the regime receives a payoff of a>0 if party j complies. A compliant Party j receives a payoff of b>0 if the regime does not penalise, whereas the regime receives a payoff of zero. If the regime punishes, however, both the obedient Party j and the regime receive a -1 payoff. Even if Party j does not cooperate, the government prefers not to penalise (at least in the short term). As a result, if the game is only played once, the threat of punishment is ineffective. As a result, the game's answer is for Party j to fail to comply (regardless of its kind), while the regime fails to choose to punish.

Hence, it is important to remember that irrespective of how frequently the regime punishes, it will not be able to dissuade disobedience by resistant nations. As a result, the projected, recurring payoff of punishment becomes (1-q)a+q (-1). For all the system to penalise, this reward must be greater than the zero payoff it receives when it does not penalize. As a result, the likelihood q of a specific participant becoming resistant meets the condition $q < \underline{a}$. It is worth noting that the higher a the higher the given cut-off for q. As a result, as one might assume, the greater the system respects compliance, the more probable it is to punish non-compliance.

A secondary need for a successful deterrent is that the administration's intention to penalize is legitimate, which means the short-term expense of carrying out the threat must be balanced against the long-term benefit of deterring other countries from defecting in the future. In other words, for the threats to be legitimate, the administration's discount element Delta should be near to 1.

If either of those requirements is met, an ideal equilibrium is established in which all resistant members are discouraged from violation. In this scenario, the system fines each incidence of disobedience, as long because it has never failed to punish the defiance before. But on the contrary, side, if the regime has previously abstained from punishing at minimum once, it just never charges anymore. A complying party conforms if the system has never before refused to penalize disobedience, while does not conform if the system has been unable to penalize at least once.

Conclusion

A compliance system that incorporates all of the preceding insights would most certainly get near to decreasing (deliberate) disobedience. This study has looked at a variety of non-cooperative game theory insights that are important to enforcing present and future climate accords. These experiences imply that establishing a system of "hard" enforcement that successfully deters non-compliance is a difficult undertaking, one that the Paris agreement mechanism is only setting out partially. The concept of Nash equilibrium highlights the fact that in order to prevent non-compliance, rather severe consequences may be required. The penalty, in particular, should be set at a higher than proportionate rate. If a violation occurs, the sub-game perfect equilibrium points out that the punishments must not only be harsh but also individually reasonable to apply. According to the coalition proof equilibrium, a climate change regime must limit to not only individuals but also collective (subgroup). The adaptable mechanisms open up some possibilities for potentially profitable collective cheating, but they also place some restrictions on it. The concept of perfect Bayesian equilibrium implies that the regime may use private information to deter non-compliance. A fully transparent enforcement regime, in particular, could be detrimental to compliance levels. The renegotiation proof equilibrium states that punishing a party proven to be in non-compliance must be collectively reasonable.

Nevertheless, the climate regime's conformance system is the result of a complicated process in which the necessity to check disobedience was closely evaluated against varied other reasons, along with the wish to fulfil the standards of due process. The Glasgow Accord may not contain every one of the aforementioned principles from non-cooperative game theory, nonetheless it may not be a fatal flaw as it could still improve the chances of success of the agreement. Considering that the Glasgow accord might be one of the most crucial attempts to take timely measures, it is important to consider all probable aspects and assure success.

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Conflict of Interest

None of the authors have any financial interest or benefit, arising from the direct applications of this research.

References

Adger, W.M., 1995. "Compliance with the Climate Change Convention", *Atmospheric Environment*, **29:** 1905-1915.

Al-Raweshidy, H. and Dr. Omar Raoof, 2010. Theory of Games: An Introduction. In *Game Theory.* West London, United Kingdom, Burnel University.

Aumann, R., 1959. "Acceptable Points in General Cooperative N-Person Games", in A.W. Tucker etal., Contributions to the Theory of Games IV. Princeton: Princeton University Press.

Axelrod, R. and Hamilton, W.D., 1984. The Evolution of Cooperation. New York: Basic Books, **211:** 1390-1396.

Barrett, S., 1994. "Self-enforcing International Environmental Agreements", Oxford Economic Papers 46, 878-894.

Barrett, S., 1999. "A theory of full international cooperation". *Journal of Theoretical Politics*, **11:** 519-541.

Bernheim, B.D., Peleg, B. and Whinston, M., 1987. "Coalition-Proof Nash Equilibria I: Concepts". *Journal of Economic Theory*, **42:** 1-12.

Bodansky, D., 2001. "International Law and the Design of a Climate Change Regime", in U. Luterbacher and D.F. Sprinz (eds.), International Relations and Global Climate Change. Cambridge, Mass.: MIT Press.

Brams, S. J., n.d. Game Theory and Politics. Mineola, New York, New York University, Dover Publications, Inc.

Carraro, C. and Siniscalco, D., 1993. "Strategies for the International Protection of the Environment". *Journal of Public Economics*, **52:** 309-328.

Chakravorty, A., 2019, December 17. *COP25 climate summit: A massive failure of leadership?* Retrieved from The Indian Express: https://indianexpress.com/article/world/cop25-climate-summit-a-massive-failure-of-leadership/

Chayes, A. and Chayes, A.H., 1993. "On Compliance", International Organization 47, 175-205.

Chayes, A. and Chayes, A.H., 1995. The New Sovereignty. Compliance with International Regulatory Agreements. Cambridge, Mass.: Harvard University Press.

COP-6 (2000), "Note by the President of COP6, 23 November 2000". extracted from https://unfccc.int/process-and-meetings/conferences/past-conferences/the-hague-climate-conference-november-2000/cop-6/cop-6-documents

Downs, G.W., Rocke, D.M. and Barsoom, P.N., 1996. "Is the Good News about Compliance Good News about Cooperation?", International Organization 50, 379ff.

Farrell, J. and Maskin, E., 1989. "Renegotiation in repeated games". *Games and Economic Behaviour*, **1:** 327-360.

Fearon, J., 1995. "Rationalist Explanations for War". *International Organization*, **49:** 379-414.

Finus, M., 2001. Game Theory and International Environmental Cooperation. Cheltenham: Edward Elgar. Friedman, J. 1971. "A Non-Cooperative Equilibrium for Supergames", *Review of Economic Studies*, **38:** 1-12.

Fudenberg, D. and Tirole, J., 1994. Game Theory. Cambridge, Mass.: MIT Press. Gartzke, E. 1999. "War is in the Error Term", *International Organization,* **53:** 567-587.

Gibbons, R. 1992. A Primer in Game Theory. New York: Harvester Wheatsheaf.

Gopalakrishnan, T., 2019, December 16. *Climate Emergency CoP 25: A failure on key deliverables*. Retrieved from Down to Earth: https://www.downtoearth.org.in/news/climate-change/climate-emergency-cop-25-a-failure-on-key-deliverables-68448

Greenberg, J., 1989. "Deriving strong and coalition-proof nash equilibria from abstract system". *Journal of Economic Theory*, **49:** 195-202.

Griffin, C., James, F. and Kesidis, G., 2011. *Game Theory: Penn State Math 486 Lecture Notes.*

Grubb, M., Vrolijk, C. and Brack, D., 1999. The Kyoto Protocol. A Guide and Assessment. London: The Royal Institute of International Affairs.

Gul, F., 1997. "A Nobel Prize for Game Theorists: The Contributions of Harsanyi, Nash and Selten". *Journal of Economic Perspectives*, **11(3):** 159-174.

Hagem, C., Maestad, O. and Westskog, H., forthcoming. "Effective Enforcement and Imprecise Deterrents: Impacts of Punishment on Punishers via the Markets for Permits and Energy", *In:* J. Hovi, O.S. Stokke & G. Ulfstein, eds., Compliance with climate commitments: Conditions and mechanisms.

Hargrave, T., Helme, N., Kerr, S. and Denne, T., 1999. Defining Kyoto Protocol Non-Compliance Procedures and Mechanisms. Leiden: Center for Clean Air Policy.

Harsanyi, J.C., 1967-68. "Games With Incomplete Information Played by 'Bayesian' Players. Part I: The Basic Model", *Management Science*, **14:** 159-182; "Part II: Bayesian Equilibrium Points", *Management Science*, **14:** 320-334; "Part III: The Basic Probability Distribution of the Game", *Management Science*, **14:** 486-502.

Heister, J., Mohr, E., Stähler, F., Stoll, P.-T. and Wolfrum, R., 1997. "Strategies to enforce compliance with an international CO treaty", *International Environmental Affairs*, **9:** 22-53.

Hotz, H., 2006. A short introduction to game theory. extracted from https://www.theorie.physik.uni-muenchen.de/lsfrey/teaching/archiv/sose_06/softmatter/talks/Heiko_Hotz-Spieltheorie-Vortrag.pdf

Hovi, J., 1998. Games, threats and treaties. Understanding Commitments in International Relations, London: Pinter.

Hunt, C., 2012, November 16. *Kyoto Protocol fails: get ready for a hotter world*. Retrieved from The Conversation: https://theconversation.com/kyoto-protocol-fails-get-ready-for-a-hotter-world 10742#:~:text=The%20Protocol%20was%20in%20fact,USA%20failed%20to%20sign%20up.&text=The%20world%20economy%20will%20continue%20to%20grow.

IISD, 2000. "Summary of the Workshop on Compliance Under the Kyoto Protocol", Earth Negotiation Bulletin 12, No. 124. http://www.iisd.ca/vol12/enb12124e.html

Keohane, R.O., 1984. After Hegemony: Cooperation and Discord in the World Political Economy. Princeton, New Jersey.: Princeton University Press.

Kerr, S., 1998. "Enforcing Compliance: The Allocation of liability in International GHG Emissions Trading and the Clean Development Mechanism", RFF Climate Issue Brief #15 (Internet edition). http://www.rff.org/issue_briefs/PDF_files/ccbrf15.pdf

Kreps, D. and Wilson, R., 1982. "Reputation and Imperfect Information", *Journal of Economic Theory*, **27:** 253-279.

McGillingray, F. and Smith, A., 2000. "Trust and cooperation through agent-specific punishments". *International Organization*, **54:** 809-824.

Milgrom, P. and Roberts, J., 1982. "Predation, reputation and entry deterrence". *Journal of Economic Theory*, **27:** 280-312.

Mitchell, R., 2001. "Institutional Aspects of Implementation, Compliance, and Effectiveness", ch. 11 in U. Luterbacher and D.F. Sprinz (eds.), International Relations and Global Climate Change. Cambridge, Mass.: MIT Press.

Nash, J.F., 1951. "Non-cooperative Games". *Annals of Mathematics*, **54:** 286-295.

Nations, U., 1992. United Nations Framework Convention On Climate Change. *Conference Of Parties* (Pp. 1-33). United Nations.

Oberthür, S. and Ott, H.E., 1999. The Kyoto Protocol. International Climate Policy for the 21st Century. Berlin: Springer Verlag.

OECD, 1998. Ensuring compliance with a global climate change agreement. Paris: OECD Information Paper.

Oye, K.A., ed., 1986. Cooperation under Anarchy. Princeton, N.J.: Princeton University Press. Pew Center on Global Climate Change (2001), "Climate Talks in Bonn: News and Information". http://www.pewclimate.or/bonn/daily.cfm?m

PTI. (2019, December 26). *Five reasons why COP25 climate talks failed*. Retrieved from Economic Times: https://energy.economictimes.indiatimes.com/news/renewable/five-reasons-why-cop25-climate-talks-failed/72973661

Rasmusen, E., 1989. Games and information. An introduction to game theory. Oxford: Basil Blackwell, Fourth Edition.

Selten, R., 1965. "Spieltheoretische Behandlung eines Oligopolmodells mit Nachfrageträgheit". *Zeitschrift für die gesamte Staatswissenschaft*, **12:** 301-324.

Selten, R., 1975. “Re-Examination of the perfectness concept for equilibrium points in extensive games”. *International Journal of Game Theory*, **4:** 25-55.

Shubik, M., 1970. “Game theory, behavior, and the paradox of the prisoner’s dilemma”. *Journal of Conflict Resolution*, **14:** 181-193.

Sprinz, D. and Helm, C., 1999. “The effect of global environmental regimes: A measurement concept”. *International Political Science Review*, **20:** 359-369.

Stranlund, J.K., 1995. “Public mechanisms to support compliance to an environmental norm”. *Journal of Environmental Economics and Management*, **28:** 205-222.

Taylor, M., 1976. Anarchy and cooperation. London: John Wiley and Sons, Pp viii,151.

Taylor, M., 1987. The possibility of cooperation. Cambridge: Cambridge University Press.

UNFCCC, 2000. “Procedures and mechanisms relating to compliance under the Kyoto Protocol.”

Text proposed by the Co-Chairmen of the Joint Working Group on Compliance to the COP-6. van Damme, E. (1991), Stability and Perfection of Nash Equilibria. Berlin: Springer-Verlag.

UNFCCC, 2021, March 18. *WHO: Climate Change and Human Health*. Retrieved from World Health Organisation: https:/www.who.int/globalchange/climate/unfccc/en/

Werksman, J., 1998. Responding to non-compliance under the climate change regime. Paris: OECD Information Paper.