Dialectical Interactions in Intelligence Analysis

William G. Foote and Andrew W. Foote

5/19/2021

The ongoing issue

Analysts can discover how current insights and decisions can influence the array of future and emerging insights and decisions. They discover not the actual, but rather the probable paths by which various decision makers might interact, all conditional on the current state of information. The fundamental principle of dialectical analysis is the existence of a concrete unity of otherwise opposed decisions, decision makers, interactions among decisions and decision makers, and so on. Without a possible unity, there would never be a resolution, or a result, or a way forward.

Unity can only exist when the bias of a decision and the shared biases of multiple decision makers and their army of analysts can be overcome by some higher viewpoint. In the absence of a unity we simply expect decay and destruction, until a higher viewpoint on the matter takes hold and sweeps away the general bias in favor of a resolution. Thus a dialectical analysis[1] that begins by excavating oppositions, must in the end resolve the oppositions with a plan that transcends oppositions. New biases will generate more oppositions, and so the process continues.

The purpose of this paper is several fold.

1. We build on existing and evolving methodologies in intelligence analysis that explicitly attempt to reduce and potentially eliminate analyst annd decision maker bias. Two biases are immediately relevant: framing and anchoring (see Heuer (1999)], Gilovich (2002)).[2]

2. Continuing the discussion in Foote (2018), Bruce (2014), and Collier (2005) we detail the linkage among ways of thinking (dialectic), of decision analysis (horizon analysis), and analytical implementation (interactive decision making). We introduce game theory (see Smit and Trigeorgis (2004) and the classic Robert Dorfman (1958)) to forge the linkages through the nexus of interactive decisions.[3]

3. We offer a practical example, simplistic enough to fit within the confines of this short excursus, yet insightful in its ability to elucidate the dialectical-horizon-analytical implementation linkages. These linkages show how decisions and oppositions can potentially be unified into a higher viewpoint. An example of a higher viewpoint is the replacement of opposition with coordination and compromise.[4]

---

[1]The term dialectic has been used is a variety of contexts. For Plato it is the art of dialogue of opposing arguments. For Aristotle dialectic helps to discover truth by scrutinizing the opinions of others. Marx inverts Hegel's thesis-antithesis-synthesis as a materialistic and mechanical historical process. Lonergan (1970) conceives of dialectic as a combination of an aggregate of events, any event traceable to one or more opposing yet related causes, all modified by subsequent events. Dolan (2018) applies dialectical analysis to frame healthcare policy. He makes the important point that dialects transcends space and time. For our purposes dialectical analysis includes techniques, criteria, products and process, and a methodology that seeks to discover and present concrete, linked, but opposed decisions and reasons for why decisions might change.

[2]In the context of framing, the exclusion of data from analysts' and policy makers' curtails analyst and policy maker horizons alike. WIth limited horizons, analysis and its product can miss the point, instruct resources to move the wrong way, at the wrong time, in the wrong place, and also for the wrong reasons. Each of these negative outcomes can have significant repercussions on subsequent policies and their likely impact. Anchoring biases analysis in the direction of starting at the same or similar place every time. Overconfidence in estimates results quite reliably.

[3]Game theory has been used in a variety of settings including strategic investment, evoluti(onary biology, and in the economics of war, peace, negotiation, and, yes, terrorism (see Sandler (2014) for a survey, Bandyopadhyay, Sandler, and Younas (2013) for an application to foreign direct investment and aid. The classic reference close in time to the establishment of the basics of game theory is Robert Dorfman (1958)).

[4]This example derives from a now standard game theoretic model of interactive decision making. Our analytical frame and

4. Finally, we suggest some practical pathways along the lines of Heuer and Pherson (2010) and Bruce (2014) to enhance the intelligence analysts structured analytics toolkit.

The next section summarizes the important role that decision maker's, analysts', and policy-makers' horizons play in the relentless unfolding of concrete events that are opposed, yet linked.

Dialectics and horizon

Dialectics analyzes the interactions of opposed decision makers. Central to dialectics are the decision makers' horizons in any number of useful dimensions. In fact the analyst is as much subject to a dialectic inherent in the interaction of analysts with other analysts, with assets, and with policy-makers. All of these actors possess both overlapping and disjoint sets of attributes in various dimensions related to time, content, techniques, priorities, and beliefs.

Foote (2018) proposes steps in a horizon analysis that the analyst might deploy.

1. Map actors's horizons and use an associative matrix to vizualize the interaction of horizons. Dimensions such as timing, geography, technology, socio-economics, finances, environment, people, and politics can help delineate the segmentation of horizons.

2. Use a linked analysis to develop a rating scale that describes the degree and direction of strength of similarity of horizons across actors. An ordinal rating scale helps to make logical an array of unorganized themes and opinions.

3. Use Delphi (oracle) experts, devil's (multiple too) advocates, low probability / high impact and other challenge analyses along with the horizon linkages to formulate scenarios around potential outcomes. Decision sequences can be compared on an outcomes basis using scenario ratings.

4. Given a scenario, use horizon linkages to generate competing hypotheses. Analyze using techniques such as Analysis of Competing Hythotheses (ACH in Heuer and Pherson (2010)).

5. Use other structured analytics as needed to excavate the known unknowns of the complex interaction of various actors in the case. Build an outcomes, likelihood, priority table linked to changes in horizon attributes to sensitize decision makers to various permutations of decision possibilities. This is where this paper will indicate a reasonable use of the analysis of interactive decisions.

Horizon analysis is at the pinnacle of analysis because the analytical judgments start with and ultimately can only be accepted by a decision maker conditional on analyst and policy maker horizons. When the analyst has established various horizons, the next step is to find sequences of decisions that might dominate an intelligence estimate. Game theory provides a way to characterize potential moves by decision makers.

Dialetics and games

A **game** is any set of decisions, also called strategies, where at least two agents, also known as players, interact according to a set of possible outcomes, beliefs about themselves, markets, or each other, and rules of engagement. In other words, the game framework maps directly to the dialectics dictate to analyze horizons. We will use the techniques of game theory to implement a dialectical analysis of the strategic interaction of several players.

Every game has the following horizons:

1. The set of players. These are the decision makers. At least two players can make a game. If there is one player, then there is always the *deus ex machina* player of fate, nature, the roll of a die, the draw of a card in solitaire to fulfill this requirement.

2. A set of strategies and information sets. The work strategy derives from the Greek noun for army leader, *strategos*, and the verb to lead an army, *strategein*. The verb is a compound of *stratos*, something spread

---

interpretations borrow from models built by Slantchev (2014) and applied to coercion in national security settings. The model will have three actors. One of the actors simply makes decisions with the roll of a die, another will be informed about the roll, and a third will only be able to observe the actions of the second actor. This is a game of incomplete information.

---

out like an army, and *agein*, to act, drive or move. Strategies are sets of decisions that marshall a player's resources to drive desired, valued and prioritized outcomes. Information sets are common or private bodies of knowledge that a player has relative to other players. Decisions might be pre-committed if they are all or nothing moves, for example an oil company's rigs already built and producing oil. They might also be optional in nature such as the decision to build or delay building a rig.

3. Timing and order of decisions. This dimension delineates the way in which decisions interact among the players. Decisions might be simultaneous or sequential, and with or without complete or perfect information.

4. A set of outcomes for each strategy. If a strategy is a sequence or simultaneous set of decisions, then each strategy's outcome will represent a player's valuation of the set of decisions, given the other players' decisions, and given information available to the player. Valuation may be in currency, such as USD of net present value, or ordinal scales, such as ratings of satisfaction gained (or lost).

We focus on games of strategic interaction among at most three agents:

- Commercial natural resource explorer, producer, and trader

- Government natural resource concessionaire

- Terrorist disruptor

Decisions align with agents and include:

- Grant or refuse concession

- Invest or abandon concession

- Disrupt concession or remain dormant

For example, let's look at this highly stylized game, really an interactive set of decisions, among three agents to begin our search for an approach that links otherwise opposed forces among the stakeholders in an analytical estimate.

1. A government oil lease concession agency (concessionaire) that licenses commercial oil companies to explore, prove, produce, and ship crude oil according to a production sharing agreement (PSA). The concessionaire has the option to continue to honor the PSA as well as the option, in the breach, to annul the PSA and nationalize the oil platform.

2. A commercial oil company (OILco) that purchases a license, that is, an option, to explore, prove, product, and ship crude oil leased through the government concession agency. We assume that OILco has purchased the license, already signed a PSA, has proven reserves, and is pumping and shipping crude oil to the world markets.

3. A terrorist organization (terror cell) that can disrupt the crude oil supply chain seemingly at will.

The header describes two terror cell actions. These are the choices a terror cell might make to disrupt OILco or the concessionaire. The left margin describes two government choices: continue to honor the PSA with OILco or nationalize OILco's operations. Each cell has two outcomes, one for OILco, and one for the Government. We assume that whatever happens, the terror cell may have a range of satisfactions with outcomes, but in the end its mission of disruption will have succeeded.

	Terror cell masquerading as a legitimate government agent blocks an oil shipment (false positive)	Terror cell masquerading as a legitimate commercial producer (OILco) spills a partial shipment of oil (false negative)
Concessionaire continues to honor the production sharing agreement	OILco: USD10K reschedules. Government: 5 votes on non-critical bill lost to the opposition + inconvenience, embarrassment.	OILco: USD4mm clean up. Government: more leverage over OILco.
Concessionaire nationalizes the oil platform	OILco: USDmillions and millions lost investment and future margins. Government: gets into the oil business for pennies on the USD, but has the expense of running a business it does not understand.	OILco: USD4mm clean up and offers to help run the oil platform. Government: gets into the oil business for pennies on the USD.

The most stable interaction cell in this table for OILco and Government is where the terror cell blocks and oil shipment and the government continues to honor the PSA. In this case, OILco would experience relatively small financial losses and the Government has at most a more difficult time in parliament getting bills passed, *ceteris paribus*. All other cells have some larger onerous cost for either or both OILco and Government. Again, terror cells seem to win, from their point of view, no matter the disruption.

Slantchev (2014) indicates in another context three reasons for dominant strategies such as these:

- Nationalizing can not eliminate or even mitigate the root cause: terror cells. If the government nationalizes OILco's operations, it effectively creates a National Oil Company. This is fine if it knows how to run such an operation. But governments might be able, at least at first.

- In the nationalization process, government would probably need to find and procure a third party platform services provider, engage third-party shippers and traders, and secure working capital financing. These are all time and experience intensive activities with large and persistent investments to absorb the many risks of running an operation in the extractive industries.

- OILco has no reason to conduct its business much differently than before. It can hire mercenaries to defend its platforms, install counter-measures and early warning arrangements and equipment, insure against financial losses, and hedge market price risk of commodities extracted and shipped from the production sites.

Game strategies could transform into other outcomes, for example, by sterilizing the threat, making it far less effective. OILco and the government could use the existing PSA, modify its roles, responsibilities, timing, schedules to hedge what otherwise appears as indiscriminate, and rarely occurring, terrorist disruption. Government can try to co-opt the terrorist through financial and political means. The same could be said of natural disasters that would produce similar effects. Another game-changer is increased volatility in the demand, and price, of crude oil.

Why are games so dialectical?

Dialetic involves oppositions that are somehow linked. A long list of oppositions includes decisions, beliefs, priorities, inclusion or exclusion of data, and analytical techniques as well as oppositions among these categories. The key note of opposition is interaction. Analytical techniques that rely explicitly on interaction are game-theoretic, or at least look like networks. All games include more than one player. Viewed in this way we can always model a single actor game with a hidden, latent, implicit actor in the wings. This implicit actor might be nature, fate, the odds, or whatever myth suffices. Explicitly recognizing opposing agents and

their possibly intersecting and evolving horizons reveals a first level of dialectical decision making. More levels can be considering through the oppositions of analytical authenticity and the community in which analysis resides. By itself authenticity is a virtue of an analytical community that seeks to eliminate, or at the least ameliorate, individual, group, and even community manifestations of bias.

Authenticity of analysis and subsequently of analytical product stems from three dialectical dimensions found in any community, including the one defined by the three agents in our highly stylized example. The intelligence analyst stands outside of this community, but has her own community with which to interact. The agents as a group form a community that is itself a dialectical reality in their opposing actions and reactions to one another, in the expansion and contraction of normal modes of operation and conventional wisdom, and in their preferences for anticipating right and wrong actions and horizons. Each of these oppositions can be thought of as horizons. These horizons can be further refined.

- Decisions may be based on simple actions and their reactions among the three decision makers. At this primal level, the agents are superannuated versions of insect colonies, prides of lions, and packs of dogs. They pursue one goal after another in action or reaction to others's similar pursuits. At this level along with the mapping of the potential moves of each agent as they interact with one according to their own preferences.

- Opposed to simple action-reaction is the compendium of practical insights a whole tradition of decision makers have melded into conventional wisdom. This dimension corresponds to Bruce (2014)'s "habit of thought" form of epistemology, perhaps with a sprinkling of "authority." But conventional wisdom cannot progress, as it is, by definition, the current convention to which everyone in the community adheres, sometimes, for dear life. This is the existing business model of the private oil producer, the political party system that instructs the NOC executive to take or not take action, the world financial market that even the government's and OILco bankers cannot usually supersede. What breaks the mode of conventional wisdom, goes beyond the existing horizons that would otherwise confine decisions and agents, are break throughs of new insights. Growth opportunities arise and align with evolving agents' horizons.

- Finally opposed to action-reaction and conventional wisdom are the values that ground why a community, and specifically, a key decision maker in that community, should or should not act in a particular way. This constitutes a moral dimension of right and wrong that provides a prioritization of actions with consequences. This dimension reaches beyond what is correct or incorrect to include the possibility of grasping at new opportunities and being rid of those opportunities that no longer can be favored in the new environment caused by expanding horizons. The private oil company executive, if U.S. based, and listed as an SEC registrant, must abide by U.S. laws, including disclosure of material conditions that affect investments like oil rigs in potentially high security risk environments. A culture of risk aversion might attend such decisions so that the executive might avoid funding from parties possibly known for terrorist associations. OILco would have an incentive to disclose grounded in its franchise to operate.

Here the analyst needs to use the notion of dialectic to understand how these three decision makers as a community is a system on the move cycling through progress and decline, the concrete resultant of the mutual conditioning of these three opposing forces:

- When action-reaction dominates a community, its decision makers often do not have the luxury of considering options, developing resources, or perform any action that takes time, and money. This dominance, if it becomes embedded in the normal course of analytic work flow, will ultimately allow anyone to justify anything through arguments such as exigent circumstance. Analysts would thus relegate an OILco's decisions to all or nothing investment, and government's decisions to the negotiation of a once and for all time production sharing agreement.

- When conventional wisdom chooses to ignore the action-reaction dynamics of a group, or the values that hold a community together, a community can devolve into a reliance on rules in spite of fresh sources of the data of sense and consciousness. These rules may indeed have emanated from breakthroughs and the progress over the decline of human communities. But they stagnate and result in oligarchies that protect their current power base.

- Where the calculus and rules of pleasure and pain dominate values, analysis is biased, and deeper human needs will be ignored. As deeper needs are ignored, common sense becomes overwhelmed, progress turns into decline, and the guiding like of shared values gives way to a knee-jerk reactionary culture.

Communities move, pushed and pulled by these principles, now converging toward, now diverting away from genuine progress. In the very concrete of specific factors, timing, force levels, trajectories, trends, and estimaate it is these push-pull dialectics that the analyst must understand and project into analytic judgments of fact and value. The analyst is then in the role of prognosticating possible and then probable outcomes of various mutual encounters and resulting decline or progress.

The implications for practical analysis that attempts to improve the quality of analysis across these levels of authenticity include the following horizon sets.

Actors. Here we account for the key actors. More importantly we will view them as decision makers. Suppose we include three principal actors: a nation with existing resource development facilities with yet to be developed, and as yet unproven, resource reserves, a resource development company that satisfies shareholder desire for more wealth, and an insurgent that desires to rule the nation.

Decisions. For each decision maker determine their key decisions. Fashion these as distinct choices that are mutually exclusive. For example, a nation with existing national mining or oil facilities may decide to build or don't build existing production of the natural resource. The resource developer might decide to explore and develop or not. The insurgent might attack or not.

Information. We can think of the insurgent actor in a very simplistic way as a probability that the insurgent will attack or not. Then given this probability, known far better to the nation than to the resource developer, perhaps due to experience and a mole inside the insurgent organization that is credible, the nation then decides to build or not. Here is where decisions become contingent on information. If the nation builds and the insurgent attacks, then costs of building will be higher than if the insurgent does not attack. For the resource developer, at this very early stage of analysis, we could say that the costs of exploration and development are the same whether an insurgent attacks or not.

Interactions. We can then use all of the actors, their decisions, and the actor dependent information to frame the various interactions. There are many interaction paths that can be visualized extensively in a decision tree, or in a table. We can use simultaneous or sequential moves by any of the actors.

The actors may not know two aspects of the interactions when they decide to act: (a) they may not know what actions the other actors have taken, or (b) they may not know the payoffs of the other actors. When all actors observe all actions related to their information sets, the game, the interaction, is one of perfect information. When all actors know all the other actors' payoffs, interaction occurs with complete information. We can transform interactions among actors with incomplete information about the other actors into a set of interactions with imperfect information using one actor in the role of Nature. In our highly stylized example, the Insurgent is the force of nature.

Now that we have firmly established many grounds for dialectical linkages among horizons, we start to build a practical representation of an analysis. This is where game theoretic tools come into play.

On to a model?

Any model is an abstraction from reality. Unfortunately the bad reputation of some models paints the whole modeling enterprise with the same brush. Models are not the full unadulterated panoply of all the possible thinggs, reactions, actions, places, times, people we might observe. A model is an aggregation and abstraction from all the data that is possibly existent. A model has a meaning only in its purpose. The purpose of a dialectical model, and thus of a game, is to shed light on the interactions of opposing forces, in our case, at least two decision makers.

If dialectical analysis teaches us anything at all it is *retorquendo*: when one says they have do not like another's model, they indeed to have one in mind, at least as subject to the same criticism. Taking data to a model and back to the data, often producing more data of facts and values will always start with the simplest representation of a reality in which we have questions both for facts and values. We can only hope

we pose the right questions for the situation at hand. That all being said we start to formalize our rendering with some decisions. We will build a model that was presented and analyzed by Harsanyi (1967) as applied to the intelligence tasks at hand.

We can sequence the following decisions for the Nation (N) and the Resource Developer (R) by beginning with the Insurgent (I) as

$$I = \{a = attack, \ \sim a = stay\ quiet, \ \varnothing = dissolve\}$$

with probability p of attack a and $1 - p$ of staying quiet $\sim a$. These two actions, opposed to one another dialectically (imagine the discussion!), form the complete set of strategies, as decisions, for the Insurgent.

We might even say that the payoff to the Insurgent is the simplest possible for either action: the numeral one. This payoff is the way we will normalize the payoffs of the Nation and Resource Developer. A positive payoff is a net gain of something of highly valued importance to an actor. A negative payoff is a net loss. For the Insurgent there is a 1 unit level of positive satisfaction. More importantly the value of the Insurgent's action is really now aligned with the probability of an attack.

Given an attack a or not $\sim a$, the Nation (N) could on the one hand build B with attack or not build $\sim B$. On the other hand Nation could build b if no attack, or not $\sim b$. Each of these pairs of choices carry with them very different project plans with consequences in cost of human, physical, and financial wealth and gain.[5]

$$N = \{B = build\ if\ attack, b = build\ if\ no\ attack, \ \sim B = don't\ build\ if\ attack, \sim b = don't\ build\ if\ no\ attack\}$$

Whether there is an attack or not, the actions by the Resource Developer will always be develop or wait. Wait is an option, develop is more of a commmitment.

$$R = \{D = develop, W = wait\}$$

The decision set for the Resource Developer (R) is as simple as it looks. In our thought experiment we will suppose that R does not observe the action by N, and therefore cannot condition its behavior on that. Thus there is only one contingency in this game of imperfect information and it arises when R decides to explore and develop N's natural resources without knowing that N has or has not built under the aegis of an Insurgent attack B or not $\sim B$.

Incomplete information complicates the structure number of interactions actors have and must consider. The Resource Developer must consider sixteen possibilities for pure strategies and that's only with two actions by another actor (N) in two contingencies fomented by a third actor (I) with probability of attack p. Here is an *extensive form* representation of the game of strategic interaction we are modeling.[6]

---

[5]We use the convention that an uppercase decision, for example, B, is associated with a positive state, for example a an attack. A lower case decision, for example b, would associate with the complementary negative state, for example $\sim a$, no attack. The symbols $\sim X$ indicate *not - X*.

[6]Harsanyi (1967) managed to convert a game where all players have incomplete information into an equivalent game with complete information. He did so by letting a force of nature decide which type of player would act next, whereupon other players, knowing the probability of a force of nature action, would also act.
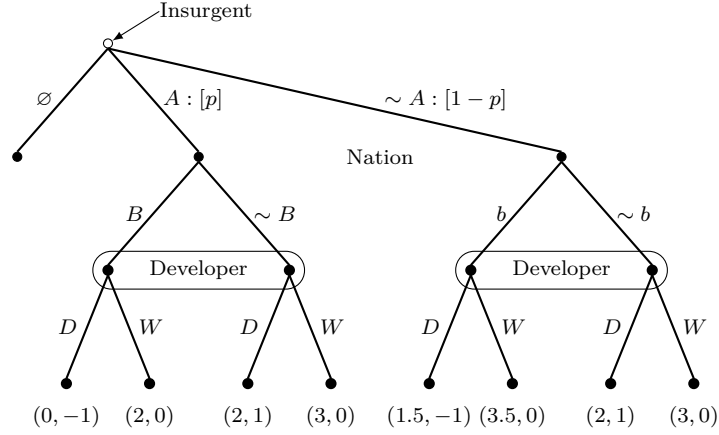
Insurgent moves first and chooses Nation's *type*. The term *type* refers to a mode of operation that conditions a player's current and subsequent actions. With probability p the type is *attack* and with probability $1-p$ the type is *no attack*. We will also lay in a *null* $\varnothing$ leg to keep in mind that the insurgent might simply go away however likely or not that event might be.

We will assume that Nation and Resource Developer have the same prior beliefs about the probability distribution of Insurgent's moves. With the restrictive information set around Resource Developer's choices, Nation observes its own type (*i.e.*, Nation learns what the move by Insurgent is) but Resource Developer does not.

After Nation learns its type, it has private information: all Resource Developer knows is the probability p of Nation being of one type or another. When Nation is of type *attack* its build / don't build decision is very different from the situation when type is *no attack*. For example, given an insurgency attack, building would be at a much higher cost, funding would be more limited, security would be more highly compromised.

Resource Developer's beliefs are common knowledge. That is, Nation knows what it believes its type to be, and it knows that Resource Developer knows, with probability, and so on. Nation will be optimizing its decision paths given what it thinks Resource Developer will do, and Nation's behavior depends on these beliefs.

We have now realized several steps in the dialectic-horizon analysis:

1. We identified several horizon sets including decision makers, decisions, information, interactions.

2. We have been able to detail the many possible interactions among elements of the horizon sets.

3. We now have viable scenarios against which we can begin to hypothesize courses of probable action.

A solution?

We can lay out the scenarios in a table, called the *strategic form* of the game. This is where we introduce beliefs about an Insurgent attack with probability p or not, with probability $1-p$. The Resource Developer's pure strategies are just $R = \{D, W\}$. But the Nation must take into account whether there is an attack or not and thus has four pure strategie $N = \{Bb, B \sim b, \sim Bb, \sim B \sim b\}$ to consider. This is all because of the configuration of the information set. The strategy of Bb has a expected payoff of $p(0) + (1-p)(1.5) = 1.5 - 1.5p$. We find this by traveling down the B and b legs first through D to the first (Nation) values in the pairs to get 0 and -1.5. Simiilarly for Resource Developer we find for its E strategy $p(-1) + (1-p)(-1) = -1$ and thus irrespective of beliefs.

Similarly we move through the B and b legs first through W to the first (Nation) values in the pairs to get 2 and 3.5. Thus the payoff for Nation wheh Developer waits (W) is $p(2) + (1-p)(3.5) = 3.5 - 1.5p$. We strike another corner of the horizon analysis, not only by specifying payoffs, but by linking payoffs with beliefs.

	D	W
Bb	$(1.5 - 1.5p, -1)$	$(3.5???1.5p, 0)$
$B \sim b$	$(2 - 2p, 1)$	$(3 - p, 1)$
$\sim Bb$	$(1.5 + 0.5p, 2p - 1)$	$(3.5 - 0.5p, 0)$
$\sim B \sim b$	$(2, 1)$	$(3, 0)$

Again we realize that given the information set that constrains Resource Developer means that life and payoffs are simple. For example while the Nation has to factor the probability of attack p into its decision making, Resource Developer does not. In the case of a Bb scenario $D = -1$ and $W = 0$ for the Resource Developer. The interactions constrain Resource Developer with an incomplete and thus narrow information set, so its strategy will only have one component: what to do at this information set, namely the possible revelation of one of two potential events. But Nation has a wider set of information than does Resource Developer, so Nation's strategy must specify what to do if its type is attack and what to do if its type is no-attack. Nation's strategy has to specify what to do in both cases. Once Nation learns its type, Nation does not care what it would have done if it is of another type vice-versa for the other type.

Nation's strategy will specify action plans for both types of Insurgent possible actions. For each situation Nation's optimal action depends on what Resource Developer will do, which in turn depends on what Nation would have done at information sets even if these are never reached optimally. Nation knows its cost which is, say, conditioned by a no insurgent attack. So why should it bother to formulate a strategy for the (non-existent) case where its cost may be high due to an insurgent attack? The answer is that to decide what is optimal, Nation has to predict what Resource Developer will do. Resource Developer does not know its true cost or benefits, so it will decide to delay or develop based on its expectations about what a insurgent attack Nation would optimally do and what a no insurgent attach Nation would optimally do. In other words, the strategy of the attacked Nation conditions Resource Developer's expectations.

The last two scenarios dominate the others.

	D	W
$\sim Bb$	$(1.5 + 0.5p, 2p - 1)$	$(3.5 - 0.5p, 0)$
$\sim B \sim b$	$(2, 1)$	$(3, 0)$

Let's solve Nation's problem with these dominant strategies: play row $1 :\sim Bb$ with probability r_1 or row $2 :\sim B \sim b$ with probability r_2. Each row will then fire a response from Resource Developer who plays column $1 : D$ with probability c_1 or column $2 : W$ with probability c_2.

Nation maximizes its expected payoffs in probability p as well as probabilities r and c, subject to the constraints that probabilities add up to one and are all greater than or equal to zero.

$$\max_{r_1, r_2} r_1(c_1(1.5 + 0.5p) + c_2(3.5 - 0.5p)) + r_2(c_1(2) + c_2(3))$$

subject to

$$r_1 + r_2 = 1$$

and

$$r_1, \ r_2 \geq 0$$

Our solution uses an optimization subject to constraints found for example throughout Varian (1992). The

analysis begins with the formation of an objective funcction[7] followed by marginal conditions.[8]. We solve the marginal conditions for an optimal set of mixing probbilities.

At a given probability of attack p by Insurgent we use the implicit constraint that $c_1 + c_2 = 1$ and with r_1 and $r_2 \geq 0$ we have complementary slackness to set $\mu_1 = \mu_2 = 0$. We then arrive at this solution for the probability c_1 that Nation will move in the D direction or c_2 in the W direction.

$$c_1^* = c_2^* = 0.5$$

We can interpret c_1^* as the degree to which or even the likelihood Nation would think that Resource Developer would mix the develop (D) and wait (W) strategies. In our case here it is optimal in the sense of the mix that maximizes Nation's expectation of how its strategies meld with its view of Resource Developer's. It is interesting to note that beliefs about attack or not do not seem to matter.

A similar analysis maximizes Resource Developer's expected value of its develop or wait moves in terms of what Nation might do. In that case it turns out that Resource Developer would think that Nation would mix its two strategies $\sim Bb$ and $\sim B \sim b$. The mixing probabilities are in this case r_1 and r_2, that by definition add up to one and must be greater than or equal to zero. We then arrive at this solution for the probability r_1 that Resource Developer will move in the $\sim Bb$ direction or r_2 in the $\sim B \sim b$ direction.

$$r_1^* = \frac{1}{2(1-p)} r_2^* = 1 - r_1^*$$

This time beliefs about attack do matter. If $p = 0$, then we would be certain there would be no attack. Then Nation would seem to mix their two strategies evenly since $r_1 = r_2 = 0.5$. THere is a degenerate solution when $p = 1$. In this case r is simply not defined (denominator is zero). This makes sense since both dominant strategies for Nation involve no attack! We then go back to one of the other two strategies that assume an attack for guidance.

If $p > 1/2$ then there is a belief that Insurgent will likely attack. In this case, the mixing probability $r_1 < 0.5$ and indeed leans in the direction of not building in the no attack mode with the $\sim B \sim b$ strategy. If $p < 1/2$ then Nation and Resource Developer believe that Insurgent's attack is less likely. In this case the mixing probability is still $r_1 \leq 0.5$. So we have the same result that strategies lean in the direction of Nation not building in the case of no attack. This means that the model endogenizes its decisions through the updating caused by an estimate of the probability of Insurgent attack p or not $1 - p$.

We can see from the tree model and optimizing behavior that the attack-type Nation never builds, and this deters Resource Developer's commitment. Commercial development can only be viable through the no attack-type Nation's (credible) threat to build. If Nation expects Resource Developer to commit, rather than delay, for certainty, then even the no attack-Nation type would prefer not to build, which in turn rationalizes Resource Developer's decision to develop with certainty. This result is independent of Resource Developer's prior beliefs about Insurgent's attack patterns.

Simulate until morale improves!

If dialectical horizon analysis teaches us anything it directs us to question about assumptions and ultimately the horizon boundaries themselves. In the model of multiple agents' optimizing behavior just discussed, we

---

[7]We form the Lagrangian function L. We compose the Lagrangian with expected value of the outcomes of Nation's potential strategies (rows) subject to whether Resource Developer develops or waits (columns). We then penalize the expected value for violating any of the constraints.

$$L = r_1(c_1(1.5 + 0.5p) + c_2(3.5 - 0.5p)) + r_2(c_1(2) + c_2(3)) - \lambda(r_1 + r_2 - 1) - \mu_1 r_1 - \mu_2 r_2$$

[8]First order conditions are the first derivatives of the Lagrangian function with respect to each of the probabilities (rates of change of the objective with respect to a very small move in r_1 and r_2). The derivatives are set equal to zero because at this value of the probabilities there can be no marginal improvement or detriment to the value of the Lagrangian objective function. We now solve these equations simultaneously for Nation's mixing probability across Resource Developer's choices (c_1, c_2).

$$c_1(1.5 + 0.5p) + c_2(3.5 - 0.5p) - \lambda - \mu_1 = 0, \; and \; 2c_1 + 3c_2 - \lambda - \mu_2 = 0$$

---

formulated only one point estimate of how behaviors might play out in the incomplete information game. It behooves us to ask what is the range of mixing probabilities that Nation or Resource Developer might use given the possibility that the two agents are somewhat entangled in their commitments. Examples of such entanglements might be joint sunk costs, shared interests in development, legal constraints, and existing contracts.

We suppose that the analyst estimates that there is a high degree of correlation in the outcomes of Nation and Resource Developer. There is also a high, but smaller, degree of correlation between the outcomes of Insurgent and Nation. Between Resource Developer and Insurgent there is a high negative correlation relating their outcomes. We can parameterize this using assumptions from probability and statistics to illustrate the range of impact of innovations, otherwise known as news, on each actor, as well as between them. Using Monte Carlo techniques we start with a sampling of potential raw news outcomes unshaped by analyst's estimates of averages, except for the correlation among the actors.
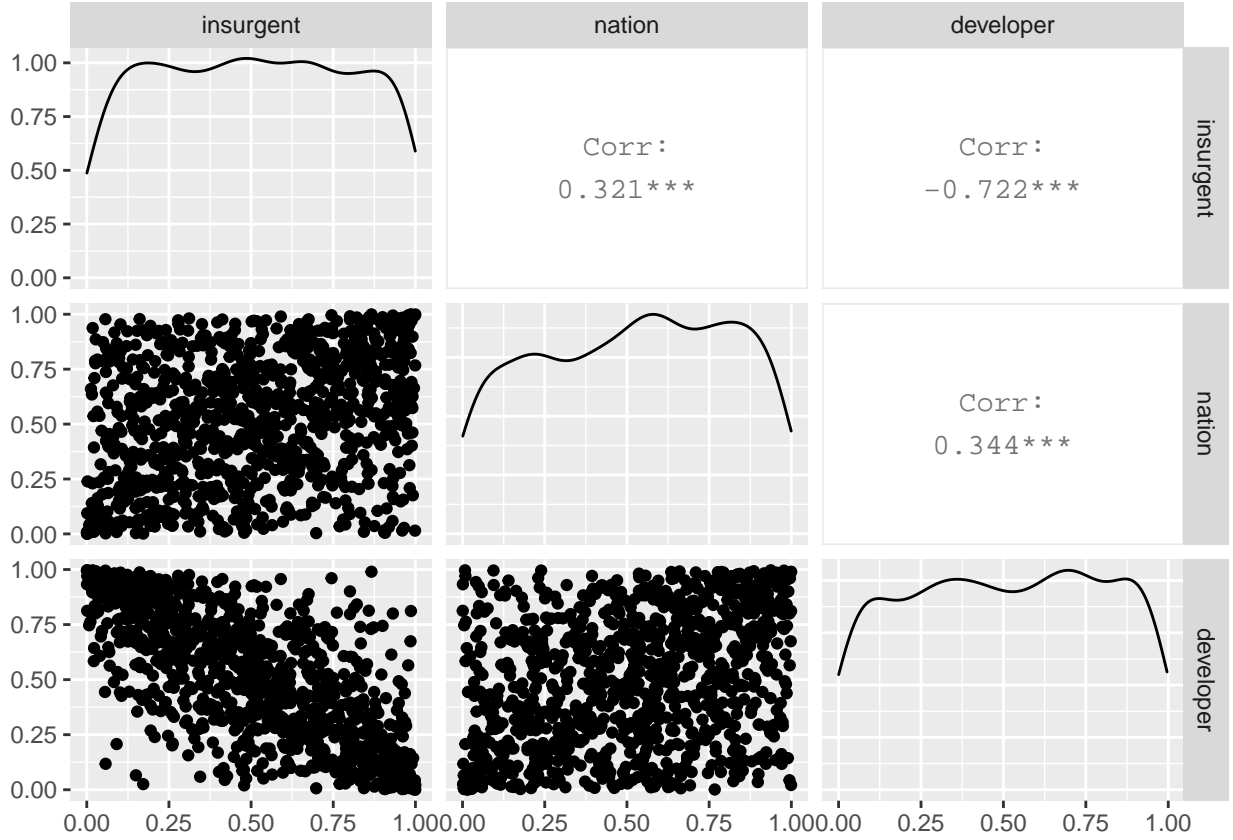

The scatter matrix depicts *noise*, that is news or innovations: one variate is about as likely as another. There is some structure imposed on the noise: how the actors are related to one another. The analyst captures the degree of relationship through a correlation parameter. The analyst builds on this foundation to shape the news into outcomes for each actor.

Whether the Insurgent will attack or not is a literal flip of a coin. But analysts estimate that the coin is loaded against attack, and so assign a probability of attack of 0.30 (3 attacks for every 10 scenarios). The simulation takes this into account by generating 1000 potential scenarios.

Nation and Resource Developer are assessed to have average outcomes as reported in the 2x2 table of outcomes of dominating strategies.

|		D	W
$\sim Bb$		$(1.5 + 0.5p, 2p - 1)$	$(3.5 - 0.5p, 0)$
$\sim B \sim b$		$(2, 1)$	$(3, 0)$

The analysts estimate standard deviations of outcomes, a measure of estimation variability, a relatiely tight 0.10 for Nation and more uncertain 0.25 for Resource Developer. How the analysts arrive at these estimates would be the subject of several more chapters in Heuer and Pherson (2010). Here we depict the distributions of potential outcomes for Nation only for a probability of Insurgent attack of $p = 0.30$. Each of the simulated outcomes along the diagonal of the scatter matrix is built on the relatedness of Insurgent to Nation to Resource Developer.
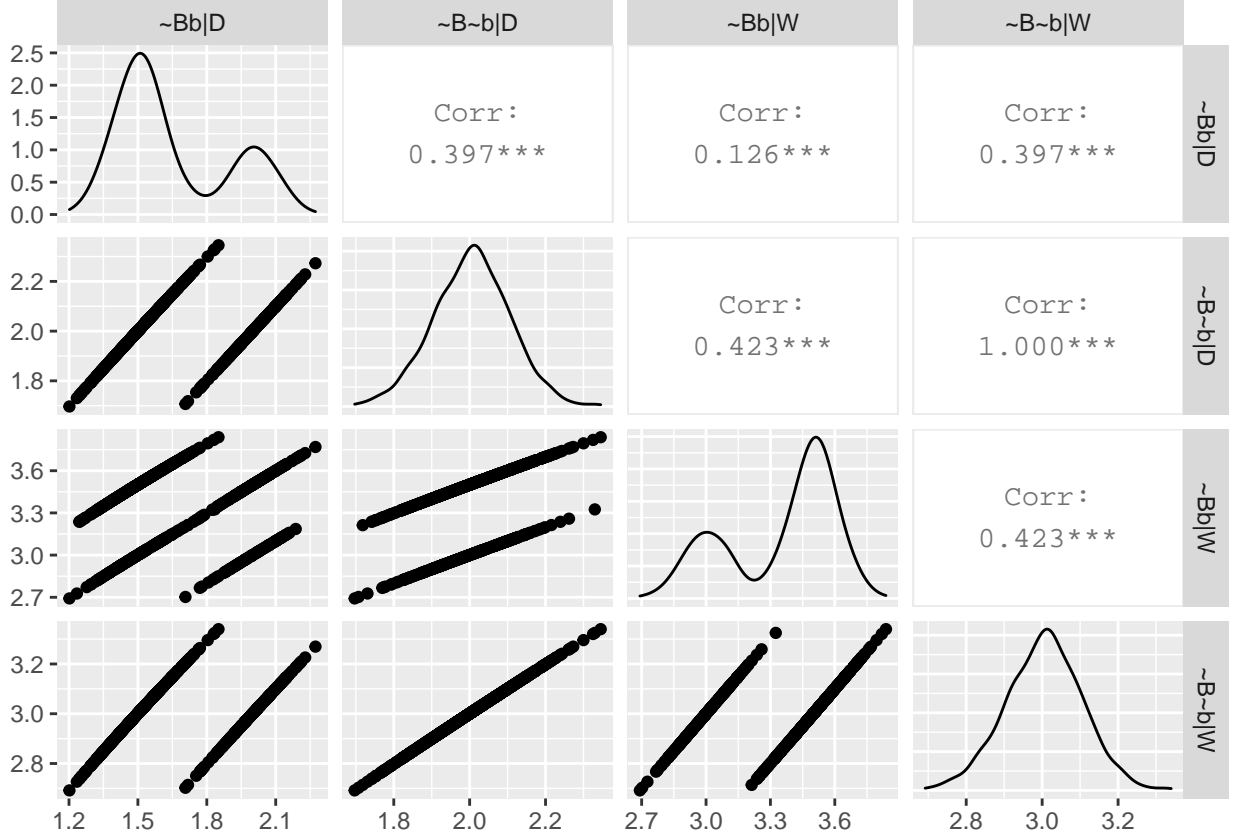
Outcomes are symmetrical for Nation strategies B $b|D$ and B $b|W$ (Nation does not build under any circumstance and Resource Developer either develops or waits and sees). More interesting they are perfectly correlated and thus nearly the same strategy in terms of risk. They are clearly not mutually exclusive.

On the other hand outcomes for Nation strategies $Bb|D$ and $Bb|W$ (Nation does not build if attacked but does if not and Resource Developer either develops or waits and sees) are exactly anti-symmetrical as they are mirror images. These strategies have little to do with one another and are nearly independent and possibly mutually exclusive.

For Resource Developer we can also simulate outcomes again using the average outcomes but estimated with greater uncertainty. The probability of Insurgent attack is maintained at $p = 0.30$.
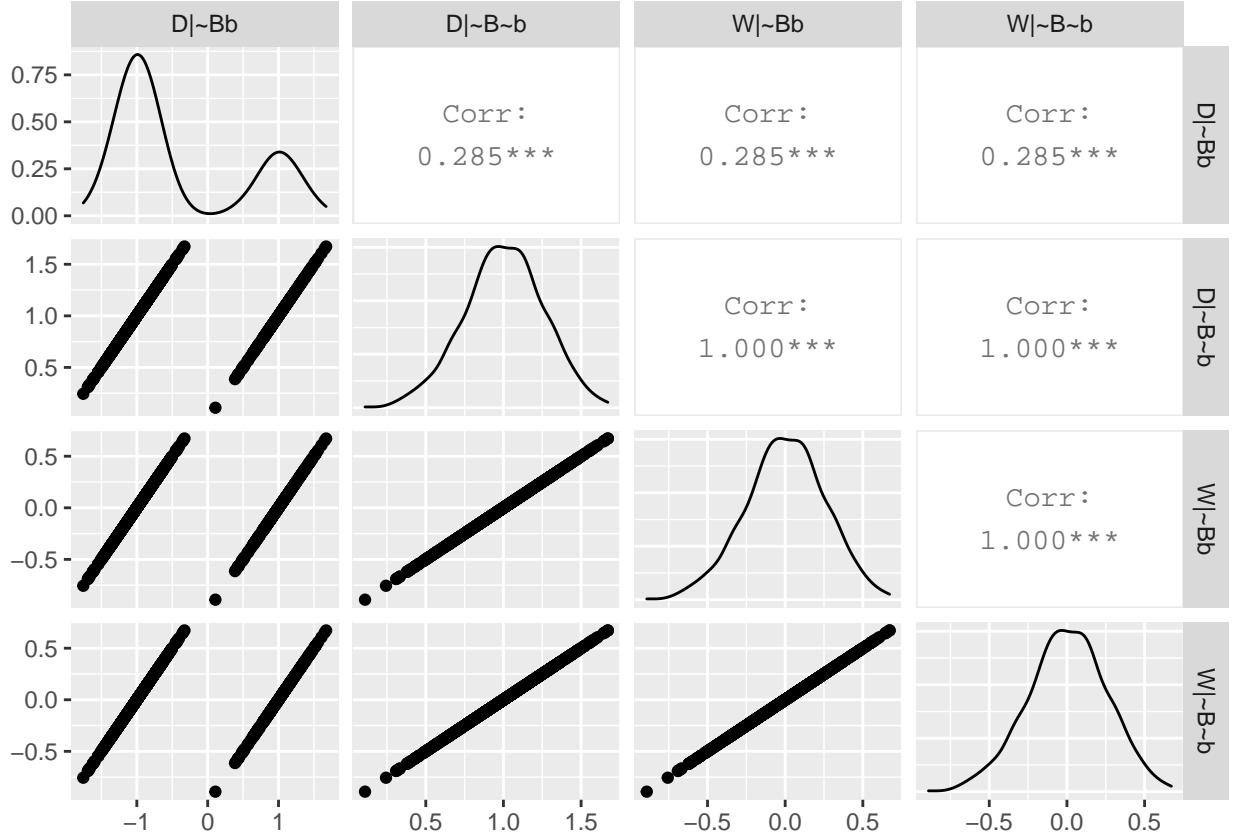
Resource Developer's strategy outcomes are nearly the same except for developing when Nation poses a credible threat of building when it knows that Insurgent is not attacking but has a view that the Insurgent will attack with $p = 0.30$.

This analysis completes the circle begun with the identification of horizons. A dialectic[9] poses interactions among three decision makers. The analyst delineates decision paths, information sets, outcomes, and beliefs. The elimination of analytic bias can proceed through the collaborative operations of systematization, challenge, and transparency all housed in an evolving methodology. Importantly ranges of outcomes of various strategies can be simulated for further insights into what might evolve in this decision arena.

Next steps

This paper develops several analytical linkages. They start from a dialectical optic of opposing forces and their interactions. Given these oppositions the analysis leads us through the maze of interlocking (or not) decision maker, decision, timing, information, and interaction horizons. Horizons are put into play with optimizing behaviors of each decision maker in a game theoretic approach.

There are several directions for intelligence analysts to take:

1. We can validate various models of incomplete information with behavioral experiments. Subjects would be presented with various analytical situations. Given their responses, alterations to opposition and challenge analytics, horizon identification and relationships, and game theoretic optimization by decision makers could be proposed and inventoried.

---

[9]Here, and somewhat succintly, three opposing forces, an insurgent, a nation-state, and a commercial developer, are linked through sometimes intersecting objectives through their joint and several decisions. As they decide, they evolve new events and information, as well as new outcomes. The dialectic progresses. The simulation helps us relate strategies under various conditions and estimation environments.

2. We can also validate models of interactive decision making using discrete choice estimations from the data of actual decisions. Similarly a variety of interactive decision model structures and decision maker responses could be inventoried for scenario and hypothesis generation.

3. Taking a different tack, we can expand the decision maker outcome estimation process by introducing real options of interaction among opposing and partially opposing (*i.e.,* coordinating, collaborating, and colluding) decision makers. Examples of real options include options to grow, spawn, abandon, idle, default, defer, or any other useful decision trigger informed by particular analytical situations.

Whatever representations of reality analysts' pose, the use of dialectic is not a substitute for all of the analysis that undergirds the interactions among decision makers. The use of game theoretic models does employ and expand the use of many of the Heuer and Pherson (2010) analytical techniques.

References

Bandyopadhyay, Subhayu, Todd Sandler, and Javed Younas. 2013. "Foreign direct investment, aid, and terrorism." *Oxford Economic Papers* 66 (1): 25–50. https://doi.org/10.1093/oep/gpt026.

Bruce, James B. 2014. "Making Analysis More Reliable: Why Epistemology Matters to Intelligence." In *Analyzing Intelligence: National Security Practitioners Perspectives*, edited by Jan Fagerberg, David C. Mowery, and Richard R. Nelson. Georgetown University Press.

Collier, Michael W. 2005. "A Pragmatic Approach to Developing Intelligence Analysis." *Defense Intelligence Journal* 14 (3): 17–35.

Dolan, Timothy E. 2018. "Framing Indeterminacy: Dialectical Analysis and Futures Studies." *World Futures Review* 10 (1): 83–94. https://doi.org/10.1177/1946756717739628.

Foote, William G. 2018. "Dialectical Intelligence Analysis: A New Optic."

Gilovich, Kahneman, Griffin. 2002. *Heuristics and Biases: The Psychology of Intuitive Judgment.* Cambridge University Press. https://doi.org/10.1017/CBO9780511808098.

Harsanyi, John C. 1967. "Games with Incomplete Information Played by "Bayesian" Players, I." *Management Science*, no. 3: 159–82.

Heuer, Richards J. 1999. *Psychology of Intelligence Analysis.* Center for the Study of Intelligence. https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/books-and-monographs/psychology-of-intelligence-analysis/PsychofIntelNew.pdf.

Heuer, Richards J., Jr., and Randolph H. Pherson. 2010. *Structured Analytic Techniques for Intelligence Analysis.* CQ Press.

Lonergan, Bernard J. F. 1970. *Insight: A Study of Human Understanding.* Philosophical Library.

Robert Dorfman, Robert M. Solow, Paul A. Samuelson. 1958. *Linear Programming and Economic Analysis.* McGraw-Hill.

Sandler, Todd. 2014. "Terrorism and counterterrorism: an overview." *Oxford Economic Papers* 67 (1): 1–20.

Slantchev, Branislav L. 2014. "National Security Strategy: Games and Information." *Department of Political Science, University of California at San Diego.* http://slantchev.ucsd.edu/courses/ps142j/lectures/games-and-information.pdf.

Smit, Han, and Lenos Trigeorgis. 2004. *Strategic Investment: Real Options and Games.* Princeton University Press.

Varian, H. R. 1992. *Microeconomic Analysis.* Norton.