# Nested Causal Modelling and Game Theory: A Ternary Enclosure Experiment in Strategic Prediction

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## Abstract

This paper performs a nested causal modelling of the relationship between game theory and Nested Causal Modelling (NCM). It uses the ternary enclosure function to test three constructions.

First, it models NCM as enclosed within game theory, translating as much of the NCM method as possible into a game-theoretic form. This produces an enclosure game in which players do not merely choose strategies inside a fixed payoff matrix, but move across nested scales, alter the effective game, and seek escape from zero-sum enclosures.

Second, it models game theory and NCM as parallel enclosures inside a larger simulation-and-prediction problem field. In this construction, game theory and NCM are not rivals. They are adjacent analytical systems with different departures from the same reference condition. Game theory models strategic choice among actors. NCM models causal descent through enclosures.

Third, it models game theory as enclosed within a modified NCM through an interstitial game-formation enclosure. NCM does not directly swallow game theory. It first encloses the conditions under which a game becomes well formed: players, strategies, payoffs, information, rules, scope, and boundary validity. This construction suggests that game theory can materially enhance NCM by sharpening actor incentives, while NCM can materially enhance game theory by adding nested depth, dynamic enclosure switching, and an explicit account of the boundary conditions under which a game is valid.

The experiment concludes by populating the middle position of the ternary relation with a clearer account of how the two methods differ in their departure from Zero Infinity. Game theory begins from conflict or choice within a defined game. NCM begins from departure inside an enclosure. The two methods meet where a strategic game is recognized as one nested causal enclosure among others.

## 1. Purpose

The purpose of this paper is not to declare that Nested Causal Modelling replaces game theory.

It does not.

Game theory is one of the most successful formal languages for strategic interaction. It has strong tools for incentives, payoffs, equilibria, information asymmetry, repeated interaction, commitment, signaling, bargaining, and defection.

The purpose is different.

This paper asks whether the relationship between game theory and NCM can itself be modelled as a nested causal structure.

The experiment has three questions:

1. What happens when NCM is enclosed inside game theory?
2. What happens when game theory and NCM are treated as parallel enclosures inside a larger simulation field?
3. What happens when game theory is enclosed inside NCM?

The answer may improve both methods.

Game theory may gain scale-depth, dynamic enclosure switching, and boundary awareness.

NCM may gain a sharper account of actors, incentives, strategic response, and equilibrium.

The deeper possibility is that their relation reveals a new middle position: an enclosure-aware strategic modelling framework that can simulate not only choices inside games, but changes in the enclosing conditions that make games what they are.

## 2. The Ternary Enclosure Function

The basic ternary enclosure function is:

```
E = [E_left | D_middle | E_right]
```

Where:

- `E_left` is the enclosing condition or outer field;
- `D_middle` is the active departure, relation, or carried enclosure;
- `E_right` is the enclosed condition or inner field.

In full NCM, the first and third positions may themselves contain valid enclosure functions. The middle position may carry a departure or may carry another enclosure when the departure itself has internal nesting.

This makes the function recursive:

```
E = [[... ] | D | [... ]]
```

The purpose of this paper is to use that structure to model the relation between game theory and NCM.

The key modelling question is:

```
What changes when one method is placed in the enclosing position,
the other in the enclosed position, and their difference in the middle?
```

## 3. Reference Condition: Zero Infinity

Zero Infinity functions here as the reference state from which the two methods depart.

In this paper, Zero Infinity does not need to be treated as a physical claim. It can be treated as the balanced analytic reference condition:

```
No player has yet been defined.
No game has yet been bounded.
No enclosure has yet been selected.
No departure has yet been named.
No payoff has yet been assigned.
No causal descent has yet been followed.
```

From this reference state, game theory and NCM depart differently.

Game theory departs by defining players, strategies, payoffs, information, and solution concepts.

NCM departs by defining reference condition, departure, enclosure, causal flow, boundary, and intervention.

Both are lawful departures.

Neither is identical to the reference.

The middle position of the present experiment is the difference between these two departures.

## 4. Construction One: NCM Enclosed Within Game Theory

The first construction places game theory in the enclosing position and NCM in the enclosed position:

```
[Game Theory | translation | NCM]
```

This asks:

Can NCM be expressed as a game?

The answer is yes, partially.

NCM can be translated into a game-theoretic construction when:

- actors can be defined as players;
- enclosure positions can be defined as game states;
- departures can be defined as state changes;
- intervention can be defined as strategy;
- volatile outcomes can be defined as terminal states;
- nonvolatile support conditions can be defined as controllable parameters;
- payoffs can be assigned to remaining inside, escaping, escalating, or transforming a game.

This produces an enclosure game.

## 5. The Enclosure Game

In a standard game, players choose strategies inside a defined game.

In the enclosure game, players may also attempt to alter the enclosure of the game itself.

The game state is:

```
G_n = game at enclosure depth n
```

Players may choose:

- remain inside `G_n`;
- escalate to `G_{n+1}`;
- de-escalate to `G_{n-1}`;
- redefine the payoff boundary;
- expose hidden support conditions;
- compact opposing departures;
- or exit the current game by entering a larger enclosure.

A zero-sum game at one level may become non-zero-sum at another level:

```
G_n: payoff(A) = -payoff(B)
G_{n+1}: payoff(A) + payoff(B) < shared_loss_avoided
```

This is the first enhancement NCM can bring to game theory.

It gives game theory a structured way to model scale changes without treating the game boundary as fixed.

## 6. Infinite Depth and Scale in a Game-Compatible Form

Game theory can already model extensive-form games, repeated games, stochastic games, evolutionary games, and games of incomplete information.

But many games still begin by accepting a bounded game space.

NCM adds recursive enclosure depth.

In game-compatible language, this means that a game can contain nested games, and those nested games can contain further nested games without a predefined terminal descriptive limit:

```
G = [G_outer | strategic departure | G_inner]
```

This does not mean every simulation must run infinitely.

It means the model is allowed to represent unbounded descriptive depth while halting computation at a stated boundary.

In practical terms:

- a supply-chain game can contain supplier games, regulatory games, labor games, logistics games, capital games, and political games;
- an alliance game can contain procurement games, intelligence games, technology games, industrial games, and public-trust games;
- a conflict game can contain identity games, resource games, audience games, status games, and survival games.

The game becomes richer because its boundary is no longer assumed to be the natural boundary of the problem.

## 7. Construction Two: Parallel Enclosures

The second construction places game theory and NCM in parallel enclosures inside a larger modelling problem:

```
[
  Simulation and Prediction Field
  |
  method comparison
  |
  [Game Theory || NCM]
]
```

Here the two methods are not nested inside each other.

They are adjacent.

The enclosing field is the human need to simulate and predict complex behavior.

Inside that field, game theory and NCM specialize differently.

Game theory asks:

```
Given actors, strategies, payoffs, and information,
what choices become rational?
```

NCM asks:

```
Given an enclosing condition, active departure, and nested causal path,
what lower conditions become activated?
```

The methods are parallel because both improve prediction, but they observe different aspects of the problem field.

## 8. Comparative Capacity

Game theory is strongest when:

- actors are identifiable;
- strategies can be specified;
- payoffs can be approximated;
- information conditions can be stated;
- equilibrium concepts are useful;
- strategic interaction is the central problem.

NCM is strongest when:

- the active system is nested;
- the problem recurs across scale;
- the boundary of the model is unclear;
- actors are shaped by enclosing conditions;
- a high-order state change activates lower risk;
- intervention must occur before volatile causality becomes active.

In the NDAA Section 219 case, game theory identified why defection may become attractive under breakdown conditions. NCM identified how the same integration pathway changes meaning when the enclosing state shifts from alliance to adversarial breakdown.

Game theory saw the incentive.

NCM saw the causal descent.

The parallel model suggests that both are needed.

## 9. Construction Three: Game Theory Enclosed Within NCM

The third construction places NCM in the enclosing position and game theory in the enclosed position, but not directly.

There is an interstitial enclosure between them.

That interstitial enclosure is the game-formation layer: the layer where actors are identified as players, available actions become strategies, consequences become payoffs, uncertainty becomes information structure, and the boundary of the game is declared.

```
[NCM | Game-Formation Enclosure | Game Theory]
```

This asks:

Can NCM enclose game theory and extend it?

The answer appears to be yes.

Game theory can be understood as a powerful local model inside a broader NCM field. But before game theory can operate, a prior enclosure must make the game legible.

The game-formation enclosure asks:

- Who counts as a player?
- What actions count as strategies?
- What consequences count as payoffs?
- What information is visible, hidden, private, or common?
- What time horizon defines the game?
- What costs are excluded from the payoff structure?
- What boundary tells the analyst that this is one game and not another?

Only after those questions have been answered does game theory receive a well-formed game.

NCM then asks:

- What outer enclosure formed the game-formation layer?
- Who or what defined the players?
- What enclosure made those strategies available as strategies?
- What reference condition made the payoff meaningful?
- What is excluded from the payoff matrix?
- What lower enclosures absorb uncounted costs?
- What upper enclosure could change the game?
- What Final Frontier marks the limit of this game's authority?

This does not weaken game theory.

It places game theory inside its lawful boundary by identifying the interstitial enclosure that makes the game possible in the first place.

In expanded ternary form:

```
[
  NCM
  |
  [players | strategies/payoffs/information | game boundary]
  |
```

```
  Game Theory
]
```

The middle position is therefore not an empty bridge. It is the game-formation enclosure.

## 10. Enclosing Game Theory Without Erasing It

The strongest version of NCM does not discard game theory.

It encloses it.

Game theory remains valid where strategic actors are meaningfully defined and where choices can be modelled as strategies under payoff and information constraints.

NCM extends the analysis by asking whether the game itself is the right enclosure.

If the game is too small, players may appear irrational because their actual payoff belongs to a larger enclosure.

If the game is too large, local incentives may disappear into abstraction.

If the game excludes an outer boundary condition, equilibrium may be misidentified.

If the game excludes an inner enclosure, hidden costs may be displaced into actors or systems that are not counted.

Thus NCM adds a boundary audit to game theory.

## 11. The Middle Position: Difference in Departure

The most important part of the ternary experiment is the middle position.

When game theory and NCM are placed on either side of the ternary function, what belongs in the center?

One answer is:

```
[Game Theory | difference in departure | NCM]
```

Game theory departs from Zero Infinity by defining a game.

NCM departs from Zero Infinity by defining an enclosure.

Game theory asks what happens after the game is bounded.

NCM asks what boundary made the game appear.

Game theory takes the player seriously.

NCM takes the enclosure of the player seriously.

Game theory solves for rational action inside the game.

NCM asks whether the game is the right level of reality.

The middle position is therefore not conflict.

It is boundary selection.

## 12. Toward an Enclosure-Aware Game Theory

The experiment suggests a possible hybrid:

```
Enclosure-Aware Game Theory
```

This hybrid would retain game theory's strengths:

- players;
- strategies;
- payoffs;
- equilibrium;
- information;
- repeated interaction;
- signaling;
- bargaining;
- defection.

But it would add NCM's strengths:

- nested game boundaries;
- reference conditions;
- departures;
- top-down causal activation;
- volatile and nonvolatile causality;
- boundary audits;
- enclosure switching;
- intervention points;
- Final Frontier limits of model authority.

The result would not merely ask:

```
What should the player do?
```

It would also ask:

```
What game is the player trapped inside?
What larger enclosure makes that game solvable?
What lower enclosure carries the cost?
What boundary condition makes the equilibrium unstable?
```

## 13. Possible Discovery

This experiment may reveal something important for the NCM book.

The backward-compatible form of NCM should not be framed only as a critical-path method. In strategic settings, it may also be framed as an enclosure-aware game method.

That would allow NCM to enter existing analytical fields without first asking readers to accept the full metaphysical structure.

For skeptics:

`NCM is a way to audit the boundary of the game.`

For game theorists:

`NCM adds recursive enclosure depth and dynamic boundary switching.`

For NCM practitioners:

```
Game theory sharpens the actor-incentive layer inside the causal
enclosure.
```

The interstitial game-formation enclosure should also be added:

```
NCM does not enclose game theory directly. It encloses the conditions
that make a game well formed, and game theory operates inside that
formed game.
```

This suggests a revision to the book:

NCM should be described as having at least two backward-compatible interfaces:

1. a critical-path / steady-state support interface for operational systems;
2. an enclosure-aware game interface for strategic systems.

## 14. Conclusion

Game theory and NCM are not enemies.

They are different departures from the same reference problem: how to simulate and predict behavior inside bounded reality.

Game theory begins by defining the game.

NCM begins by asking what encloses the game.

When NCM is enclosed inside game theory, it becomes an enclosure game that allows players to move across scale and escape zero-sum traps.

When game theory and NCM are placed in parallel, they reveal different forms of predictive capacity: incentive prediction and causal-descent prediction.

When game theory is enclosed inside NCM, the enclosure is mediated by a game-formation layer. NCM first models the conditions that make a game legible: players, strategies, payoffs, information, time horizon, and boundary. Game theory then becomes a powerful local model whose boundary conditions can be audited, extended, and repaired.

The middle position is the difference in departure from Zero Infinity.

Game theory defines strategic choice.

NCM defines the enclosure in which strategic choice becomes meaningful.

The result is not the victory of one method over the other.

It is a better map.

We begin.