

# Game theory in Business: Implications for professional practices

By:

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## The Nature of this Talk

**Caveat – research background and the nature of  
this Presentation**

**This presentation adopts:**

- ▶ a global and humanistic approach
- ▶ a rigorous secular scientific perspective
- ▶ a multi-disciplinary analysis

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## Outline of Talk

- Part 1: Analysing Game Theory Models
- (Game Theory Mechanics)
  - Game theory basics
  - Different forms
  - Elements of game theory
  - Different dimensions of game theory
  - Some well known games
  - Basic solution methods
  - Game theory: Similar areas for applied research and practices

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## Outline of Talk: Continue

- Part 2: Designing Games
- (Mechanism Design, Choosing a Game Form/ Model, Contract Theory Models)
  - Strategies for solving the problems of Systems
  - Research and Professional practices: Different many disciplines
  - Functional areas of research and professional practices
  - Designing games: efficient mechanisms, Institutions, rules, strategies, etc.
  - Mechanism design – optimisation models

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## Outline of Talk: Continued

- Part 3: Game Theory – Miscellaneous Issues
  - Empirical Research and Evidence
  - Different Issues in mechanism design : A Summary
  - Game theory and moral philosophy : The last words
  - Conclusion
  - Sources and References

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## Game theory: basics

- A game: scheme, strategies, diplomacy, actions, plan, trick, etc.
- Game theory is the (mathematical) study of strategic interdependent interactions (negotiation, conflict, cooperation, etc.) in a multi-agent system for optimal decision-making and strategy formulation;

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## GT: basics

- ▶ **Uses of game theory for business practices for:**
- ▶ **Decision making; strategy formulation; negotiations; for cooperation formation; conflict resolution; for coordination; for relationship development - altruism, reciprocity; managing risks; developing contracts, incentives & organisations, etc.**

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## In business practices

- ▶ **In business practices:**
- ▶ **different areas such as business strategy, accounting, auditing, finance, supply chain management, IT, business laws, economic issues, marketing, franchising, etc.**
- ▶ **Application areas:**
- ▶ **In the areas of business, economics, engineering, law, computer science, politics, psychology, sociology, biology, war, finance, etc.**

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## Different forms

- ▶ **Different forms of Game Theory Models: cooperative and non-cooperative, normal and extensive, 2 and n person, stochastic, dynamic, evolutionary, behavioural, etc.**

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## Elements of game theory

- ▶ Game theory: Multi-agent systems, distributed systems:
- ▶ Different Agents; Interdependent Strategies
- ▶ Rules of games; Payoffs; Values
- ▶ Interactive and Rational Decisions
- ▶ Solutions: Outcomes

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## Multi-agent systems : Issues

- ▶ **Elements of multi-agent systems:**
- ▶ **information, incentives: Conflicts of interests, agency problems, information asymmetry, institutions, culture, etc.**
- ▶ **Principal and agent relationships in many areas of business and other disciplines**
- ▶ **Pioneers: Hurwicz, Stiglitz, et al.**

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## Different dimensions of game theory

- ▶ **Mathematics and intuition**
- ▶ **Theory and applications**
- ▶ **Academic work and Professional practices**
- ▶ **Analysing games and designing games**

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## Some well known games

- ▶ Prisoners dilemma
- ▶ Zero sum game
- ▶ Non-zero sum game
- ▶ cooperative and non-cooperative,
- ▶ normal and extensive,
- ▶ 2 and n person,
- ▶ stochastic, dynamic, evolutionary, behavioural, etc.

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## Example: 2 person zero sum game: Payoff matrix

- ▶ Payoff Matrix

Minimax solution

			min row =
	B1	B2	
A1	(10)	16	(10)
A2	7	17	7
A3	8	13	8
max column	(10)	17	

$\min(\max \text{ col}) = v = \max(\min \text{ row}) = 10$

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## Prisoner's dilemma

- 2 prisoners – decision problem:  
Confess or not
- If both confess, each gets 10 years sentence
- If one does confess, and the other does not: First will get free and other will get for 15 years
- If both denies: both get 2 years.
- Shows conflict of interests and reasons for selfish behaviour.
- Common in many situations and environments.

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## Basic Solution methods

- **Maximin**
- **Nash equilibrium**
- **Dominant strategies**
- **Joint optimisation models**

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## Computer Programs

- **Some useful programs for computational organizational design are:**

**GAMBIT, GAMUT, NECTAR,  
EXCEL, GAMS,  
MATLAB, MATHEMATICA,  
MINOS, SAS.**

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Game theory: Similar Areas for applied research and practices for designing efficient systems, rules, etc.

- ▶ **Systems, Networks and Organisations: Examples – Economy, corporations, governmental bodies, charitable organisations, Supply Chain, etc.**
- ▶ **Objectives of Designing Multi Agent Systems :**  
Efficiency, fairness, incentives, information symmetry, cooperation, coordination, etc.

**Strategies: Negations, cooperation, conflict, coordination, altruism, reciprocity, etc**

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## Strategies for solving the problems of Systems

- ▶ **Strategies for solving the problems of organisations:**
- ▶ **Designing games/ Mechanism design**
- ▶ **A mechanism is a set of actions for achieving some outcomes**
- ▶ **Incentives**

**Incentive system – ownership, remuneration, non-economic incentives: Cooperative behaviour; Coordination**

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## Professional practices: Different many disciplines

- ▶ **Game theory gives strategies, information and models for many professional practices in different areas of business: corporate management and governance, economics, finance, and business strategies, relationship management, etc.**

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## As game theory is useful

- ▶ As game theory is useful for managing all aspects of our life, game theory has been extensively used in different areas of life (personal, research, teaching, professional, social, etc.).
- ▶ There are many books, websites, YouTube videos, etc. for applications of game theory in different areas of life.
- ▶ We can search the Internet for finding these materials for different uses as these uses can be useful managing all aspects of our life – from academic research to legal settlement.

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## Game theory is useful

- ▶ Examples of Applications in Business Strategies and Practices:
- ▶ Dixit, Avinash (2008), *The Art Of Strategy : Game Theorist's Guide To Success In Business & Life*, New York : W.W. Norton & Company, 2008
- ▶ McMillan, J, (1996), *Games, strategies, and managers*, New York : Oxford University Press.
- ▶ Many books, websites, YouTube videos, etc. in different areas of life (personal, professional, social, etc.)

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## Functional areas of research and professional practices 1

- 
- 1. efficient multi-agent system design
- 2. mechanism design (intuitional design, policy design, incentive design, etc.)
- 3. organisational design
- 4. risk management (very important)
- 5. Strategy formulation
- 6. conflict resolution, peace making, arbitration, mediation
- 7. cooperation, competition,
- 8. legal research and practices – litigation, settlement, moves, etc.

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## Areas of research and professional practices 2

- 9. industrial engineering – designing and managing operations (supply chain, production planning etc.)
- 10. computer science – algorithm, network design, computing, machine learning, artificial learning, etc.
- 11. politics: voting, coalition formation, etc.
- 12. social and cultural engineering
- 13. corporate governance, compliance, regulations
- 14. financial trading, investment planning, etc.
- 15. war, diplomacy, international organisations – operations and management
- 16. etc.

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## Applications: Mechanism Design: Designing Games

- **Mechanism Design Approaches and Models.**
- **Different OR Models:**  
**Game Theory Models: Joint optimisation models**

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## Designing games: efficient mechanisms, Institutions, rules, strategies, etc

- ▶ The need for designing an efficient mechanism: to achieve objectives of systems, corporations.
- ▶ Through solving the problems in designing an efficient mechanism: Information and interest asymmetry, agency issues, culture, bounded rationality, emotional dissonance, alienation, etc. by different mechanisms.
- ▶ So the need for mechanisms that can overcome the above problems and can provide efficient, social welfare enhancing organisational /economic performance: mechanism design (Hurwicz, Stiglitz, et al.).

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## Mechanism design optimisation models

- **Optimisation models for mechanism design:**

- ▶ **A mechanism design model:**

- ▶ **Max: welfare /objective**

**Subject to:**

- ▶ **1) resource allocation constraints**

**2) incentive-compatible and individual  
rationality constraints**

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## A formal model

Mechanism design for the principal involves finding the contract  $(a_1, a_2)$  to solve the following optimisation problem:

$$\max_{a_1, a_2, e} p_1(e)(X_1 - a_1) + p_2(e)(X_2 - a_2)$$

Subject to

$$\begin{aligned} p_1(e)u(a_1) + p_2(e)u(a_2) - ce &= k, \\ p_1(1)u(a_1) + p_2(1)u(a_2) - c &\geq p_1(0)u(a_1) + p_2(0)u(a_2) \end{aligned}$$

(Source: Eeckhoudt, Gollier, and Schlesinger 2005)

The first constraint: individual-rationality constraint. The second constraint: incentive-compatibility constraint.

This designs an efficient organisation by controlling agency problems leading to an improved organisation.

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### Mechanism design as a game theory problem

- ▶ Game theory presentation of the mechanism design model for strategic interactions of multi-agent systems:
- ▶ Organisation design involves designing a game form  $(S, g)$ , where  $S = S_1 \times \dots \times S_n$ ,  $S_i$  = set of agent  $i$ 's strategies,  $g$  = organisational outcome/design,  $g: S$  is a mapping from  $S$  to  $A$   
(Marschak, 1989).
- ▶ Game theory and the agency theory: Different forms of game, game theory and organisational behaviour
- ▶ Cooperative game design for mechanism design
- ▶ Cooperative game theory – modelling and implementation – subgame perfect equilibrium, repeated game, Folk theorem, cooperation – altruism, fairness, equity, reciprocity, etc.
- ▶ Behavioural game theory models are necessary.

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### Computational Mechanism Design or Game Theory

- ▶ For real-life applied applications: Computation, programming, data, implications
- ▶ Computational Methods and Algorithms for Mechanism Design
- ▶ Different Computational Methods and Algorithms for:
  - ▶ Game theory models and optimisation models
- ▶ Computation and Complexity:
  - NP Hard Problem
- ▶ Important Reference: Mount, K., and Reiter, S., 2002, Computation and Complexity in Economic Behaviour and Organization, Cambridge University Press.

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## Empirical Research and Evidence

- ▶ Information necessary for effectiveness of games, incentives, mechanisms, contracts, etc.
- ▶ Empirical research for this:  
Experimental economics, behavioural game theory

Econometrics and statistics applications

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## Models and Computer Programs for Professional Practices

- Models as discussed before
- Some useful programs for practical applications: computational mechanism or organizational design, etc are:  
GAMBIT, GAMUT, NECTAR, EXCEL, GAMS,  
MATLAB, MATHEMATICA, MINOS, SAS,  
STATA.

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## Different Issues in mechanism design : A Summary

- ▶ Issues in theory of mechanism design:  
Revelation principles, dominant strategy, theorem of non-existence  
  
Game theory based analysis but optimisation version possible
- ▶ Different mechanisms:  
Moral hazard, adverse selection, Vickery-Grove-Clarke, Pivot, etc.  
Game theory implications – reverse game theory – all types of games can be developed for mechanism design.

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## An Area of Special Application: Risk Management

- ▶ Different forms of Risks:
- ▶ Strategic, relational, conflicts, environmental, institutional, etc.
- ▶ Game theory can be used very well for managing risks and uncertainty.

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## Conclusions

- ▶ Multi-agent systems, Agency relationships, game theory and mechanism design theory are real life phenomenon.
- ▶ For doctoral research,
  - ▶ develop and analyse:
  - ▶ Mechanism design issues and models: cooperative game theory models, general optimisation models (including mechanism design constraints).
- ▶ For post-doctoral practices:
  - ▶ Apply the above

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## Conclusions (cont.)

- ▶ **Behavioural game theory models (theoretical and computational) in cooperative game form or joint optimisation model form are specially useful for this for academic research and formulation of strategies for professional practices.**

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Game theory and moral philosophy :  
The last words

- ▶ **Again: Above matters - in business practices, different areas such as business strategy, accounting, finance, supply chain management, IT, business laws, economic issues, marketing, franchising, etc.**
- ▶ **Game theory and moral philosophy: self interest, ethics, cooperative culture and society.**

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## Sources

- ▶ **Books, journals**
- ▶ **Internet Websites**  
▶ **(search for game theory)**
- ▶ **YouTube Videos**  
▶ **(search for game theory)**

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**END**

**Thank you for your attention**

