# Problems, paradoxes and probability

The main theme of the course is to present basic concepts in probability theory and relate them to their history and arrive at an understanding how these are used to make decisions. Problem or a paradox and then resolve it through some concept, either from philosophy or probability theory. The goals will be to give students the tools to think critically about how to make decisions. Additionally, some of the areas I will be presenting will represent cutting edge research avenues which are open to be understood from mathematical, economic, sociological, philosophical, and even theological frameworks. This content is relatively difficult but it is a fast track for understanding cutting edge material in the academic world. The goal will be to give an expansive view of the problems involved when trying to construct confidence about events in the worlds.

The first few sessions will aim at a comprehension of basic tools of probability theory. Each class will involve examples of the concepts, and will have brief assignments on the material. Most of the material will simply be presented on a blackboard/whiteboard but depending on the class some PowerPoint or handouts may complement it. Problems can be assigned every week or biweekly, the textbooks can be used or the site http://www.cut-the-knot.org/ for more advanced students.

1. What is industrial organization

**Cabral’s four questions:**

1. Is there market power?
2. How do firms acquire and maintain market power?
3. What are the implications of market power?
4. Is there a role for public policy regarding market power?

**Definition**: Market power is the ability set prices above cost. Note that one definition of power is the ability to acquire goods below their market price.

It is worth emphasizing that all costs are generated through a subjective process. Whether the cost to consume something is 1 dollar or 10 dollars depends on whether the process to create or extract that good is something people want to do or not. This explains why actors/writers often get paid less, their work is more enjoyable.

**Formal market power: r = (R-C)/C and if costs proportional to output then: r = (P-UC)/UC**

Static studies find low market power, dynamic studies find high market power. Problems with static: Salary inflation hides it. Problem with dynamic studies: Doesn’t measure at the individual level.

**Sources of market power:** Patents, Regulation, Barriers to entry or exit.

**Implications of market power.**

For firms, more profits, more value

For policy makers: Transfer from consumers to firms

**Types kinds of efficiencies:**

*Against monopoly:*

Allocative (people who have a high value, get the value)

Productive efficiency (low costs)

Rent Seeking(unrproductive uses of resources, such as influencing politicians)

*Pro monopoly:*

Investment efficiency. (less stuff was made than otherwise)

Approach: Give market structure, such as buyers and sellers, differentiation. What is the causal model we can have here? Either that the environment causes the behavior, or the behavior causes the environment. The latter option is more controversial. Of course, the market structure is often not a sufficient explanation of behavior. \*

Most of economics is about what CANNOT be asserted. Examples: Supply and demand, we cannot reason from a price change. Price competition, we cannot infer competition from the number of players. Compare this to a grandfather clock.

The origin of the tradition is from the empirical tradition.

**Homework**: selected problems from the textbooks

1. Conditional probability: Bayes, Chapter 4-7 Ian Peterson, Chapter 4, Chapter 6 and 10

Present the [Monty Hall problem;](https://en.wikipedia.org/wiki/Monty_Hall_problem) and [Boy or Girl paradox](https://en.wikipedia.org/wiki/Boy_or_Girl_paradox) work, explain how it works from a Bayesian point of view.

**Homework**: Selected problems OR Assignment

Assignment: Watch this [video](https://www.youtube.com/watch?v=5Cqbf86jTro) and read the [Wikipedia](https://en.wikipedia.org/wiki/Sleeping_Beauty_problem) article, explain the main issues with the Sleeping beauty problem.

1. [St Petersburg paradox](https://en.wikipedia.org/wiki/St._Petersburg_paradox) and it’s solution([Kelly](https://en.wikipedia.org/wiki/Proebsting%27s_paradox) vs ergodic vs utility), Ian,Chapter 8-9, Peterson, Chapter 4

Explain what expected value is by giving intuitive examples. Read the [wager passage](https://en.wikipedia.org/wiki/Pascal%27s_wager#:~:text=for%20practical%20purposes.-,Explanation,has%20no%20affinity%20to%20us.&text=A%20game%20is%20being%20played%20at%20the%20extremity%20of%20this,or%20tails%20will%20turn%20up.) of Pascal and explain the argument. Give some objections and some answers to the objections. After explaining the St Petersburg paradox I will discuss how it can be solved by a change in the optimand.

[Reference for optimal gambling](file:///C:\Users\DavidEttinger02\Documents\Mendeley%20Desktop\Verkes\Verkes_2016.pdf), [Chapter 2 of Ergodic economics](https://ergodicityeconomics.files.wordpress.com/2018/06/ergodicity_economics.pdf)

1. Ambiguity: [Ellsberg](https://en.wikipedia.org/wiki/Ellsberg_paradox#:~:text=The%20Ellsberg%20paradox%20is%20a,be%20evidence%20for%20ambiguity%20aversion.) and [Allais](https://en.wikipedia.org/wiki/Allais_paradox#:~:text=The%20Allais%20paradox%20is%20a,predictions%20of%20expected%20utility%20theory.). Chapter 10 from IAN. Chapter 4 from Peterson

What is the difference between Risk and Uncertainty? What is a [Dutch book](https://en.wikipedia.org/wiki/Dutch_book#:~:text=In%20gambling%2C%20a%20Dutch%20book,coherent%2C%20namely%20are%20being%20skewed.) explanation? Explain how the two paradoxes relate to betting and subjective probability theory.

Assignment: An essay question about the differences between Classical vs Frequentist VS Bayesian.

1. Independence and Association, Pearl 2009 Chapter 2&3 Peterson Chapter 9

What is independence? Correlation vs causation, examples

Explain what association and correlation is, introduce the concept of a collider and talk a little bit about causality. Explain why Fischer was not convinced about smoking and cancer and explain how the backdoor criterion is insufficient to prove smoking causes cancer whilst the front door criterion works.

1. Risk seeking and research: (optional session, this session is more technical so only if the rest have proceeded as planned). Dubins and Savage

Give an [example](https://www.cut-the-knot.org/Curriculum/Probability/ChessTournament.shtml#solution) in detail.

Explain how it links to [Savage’s](https://www.goodreads.com/en/book/show/19484230) treatment of decision theory under constraints.

Give some more examples of Bayesian decision theory, including some cutting edge work in economics.

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| **Main textbooks:** |
| Probability: Hacking, Ian, and Hacking Ian. *An introduction to probability and inductive logic*. Cambridge university press, 2001. |

Decision theory: Peterson, Martin. *An introduction to decision theory*. Cambridge University Press, 2017.

Pearl, Judea, and Dana Mackenzie. [Book of why](file:///C:\Users\DavidEttinger02\Documents\Mendeley%20Desktop\Pearl,%20Mackenzie\Pearl,%20Mackenzie_Unknown.pdf)*: the new science of cause and effect*. Basic Books, 2018.

**Secondary books:**

Resnik, Michael D. *Choices: An introduction to decision theory*. U of Minnesota Press, 1987.

Pearl, Judea. "[Causal inference in statistics](file:///C:\Users\DavidEttinger02\Documents\Mendeley%20Desktop\Pearl\Pearl_Unknown.pdf): An overview." *Statistics surveys* 3 (2009): 96-146.

Dubins, Lester E., et al. *How to gamble if you must: Inequalities for stochastic processes*. Courier Corporation, 2014.