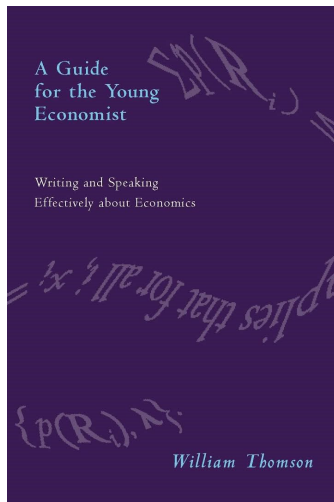# A guides for the graduate student and introduction of fair allocation mechanisms

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Useful toolbook

Research experience

- Exercises in core courses: (To do, or not to do). It is not a question.

- Knowledge of mathematics: (advanced calculus in analytical but computational (ex. Principle of mathematical analysis), stochastic differential equations, functional analysis, real analysis, topology, differential geometry, ...*etc.*) Le dernier theoreme de Fermat (1637): there is no $x \in \mathbb{Z}, y \in \mathbb{Z}, z \in \mathbb{Z}$ with $x, y, z \neq 0$ for solving the equation $x^n + y^n = z^n$, where $n > 2$. The statement has been verified by Andrew John Wiles and Richard Taylor (1995). To prove the result, the authors introduce subfields of mathematics: algebraic geometry and group ring for the symmetric group. Simplicity is beauty.

- Cultivate "good" taste during reading: (being a professional gourmet in academic) Journals you can target.

- Digging literatures: (deeply?) 8 ways to prove Arrow Impossibility Theorem

Research experience

- Writing papers from angle of someone else (referees, editor or associate editor, and readers): (naming concepts or notation, one sentence with one clear message, paragraphs, sections, writing exposition and proofs logically, title, keywords and JEL classification numbers, acknowledgement)

- Writing referee reports: taste, subjective judgement with clear justification

- Taking and answering comments: (from someone in the street and at the conferences)

- Reading referee reports: carefully no matter whether it is positive or negative

- Writing replies to comments by referees, associate editor, and editor carefully

- Presenting your paper or being professional on job market: one sentence, or 10-minute summary, reminder: job talk

Research agenda

Fairness

- Internet Magazine "Adbusters" initiates a movement Occupy Wall Street in New York (2011/09/17)
- Against wealth inequality, 99 percent versus 1 percent
- spread over San Francisco, Los Angeles, Chicago, Boston,...*etc.*
- spread over South America, Europe, Asia, Africa,...*etc.*
- Kenichi Ohmae published a book entitled "M shape society" in 2006.
- Thomas Piketty publishes a book entitled "Capital in the Twenty-First Century" in 2013.

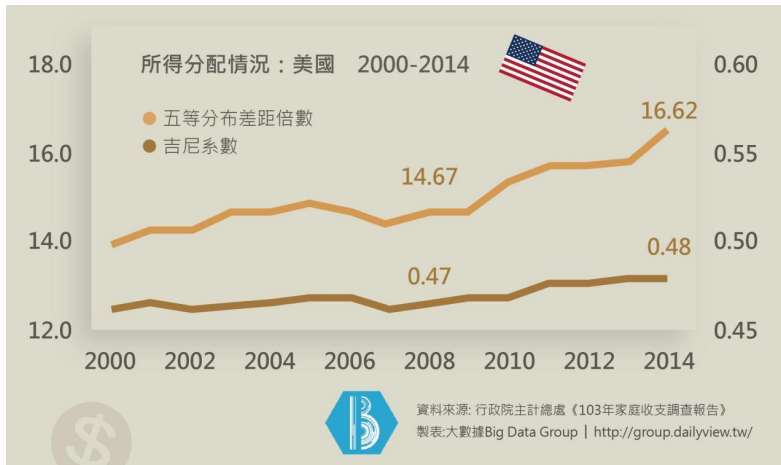**Fairness**

Introduction of fair allocation mechanisms

Fairness

Introduction of fair allocation mechanisms

Fairness

所得分配比：台灣 1964-2014

五等分位差距倍數

吉尼係數

資料來源: 行政院主計總處《103年家庭收支調查報告》
製表:大數據Big Data Group | http://group.dailyview.tw/
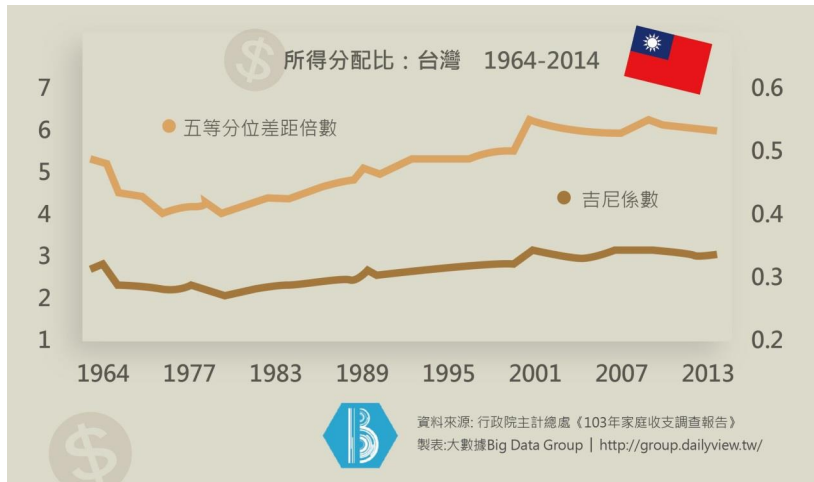
Introduction of fair allocation mechanisms

Resource Allocation Problems

- Toys resolution problem
- School choice problem
- Organ transplant problem
- Matching problem
- Queueing problem
- Dividend (Profits) allocation problem
- Estate division problem
- Bankruptcy problem (originated from two puzzles in Jewish document, the so-called "Talmud")

Contest Garment Problem

Worth of the garment	Claimant 1	Claimant 2
	100	200
200	50	150

Research agenda

Estate Division Problem

Estate of the man	Wife 1	Wife 2	Wife 3
	100	200	300
100	$\frac{100}{3}$	$\frac{100}{3}$	$\frac{100}{3}$
200	50	75	75
300	50	100	150

Research agenda

- King Solomon's problem
- Cake division (pie-cutting) problem
- Nuclear power plant (or refuse burner) location problem
- Metro station location problem
- Social choice problem
- Power distribution (apportionment) problem
- Gerrymandering problem (redistricting problem)
- *etc.*

Gerrymandering problem

傑利蠑螈
維基百科，自由的百科全書

傑利蠑螈（Gerrymander）乃指選區劃分之方式是專為某方選舉利益而設計的。這個字詞從美國馬薩諸塞州州長埃爾布里奇·格里（Elbridge Thomas Gerry）的名字，及當時劃分後的選區形狀貌似蠑螈（salamander）此兩者而來。

傑利蠑螈這詞的原文「Gerrymander」在其語言的使用方法中，可同時作動詞和名詞使用。作動詞時，指將選區劃分成對特定某方有利；作名詞時，指專對特定某方利益設計劃分後的選區。其發音方面，原麻州州長蓋利（Gerry）裡的「G」是發音成硬G/g/，但在傑利蠑螈（gerrymander）裡，因為顎化的關係而發音成軟G。

目錄

來源

在1812年時，當時美國馬薩諸塞州州長埃爾布里奇·格里（Elbridge Thomas Gerry，1744年－1814年），為確保民主共和黨在州議會選舉贏得更多議席，所以成立一項法案，刻意將馬薩諸塞州的州議會選區重劃，讓敵對的聯邦人黨票源集中在少數選區，保障民主共和黨候選人不成比例地當選。

當時重劃的選區中，有一選區形狀相當怪異，狀似蠑螈（salamander），一種長得蜥蜴的兩棲動物，亦有說法是指是傳說中長得像蜥蜴的一種怪物，尾巴長長的，還有短腳的樣子。於是政敵便將埃爾布里奇·格里（Gerry）的姓氏與蠑螈的字尾（mander）組合而成「gerrymandering」（傑利蠑螈），用來影射為照顧黨派利益，不公平劃分選區的方式。

Gerrymandering problem

聶為民主共和黨贏得該州議員選舉，但格里本人卻輸掉州長選舉，但他成為詹姆斯·麥迪遜的副總統，最後於1814年死在任內。

例子

1812年馬薩諸塞州選區劃分

上圖為一虛構例子。A至C均有6票紅色、9票黑色，A至C的總票數各為15，同時均被劃分為三小區。因應不同的選區劃分，雙方取得的席位數目截然不同。在A中黑組全取3席、紅組0席；在B中，黑組優勢被削弱，取得2席，紅組取得1席；而在C中，紅組卻可取得2席，比黑組還要多1席。

手段

集中選票和分散選票

在傑利蠑螈的過程中有兩大基本策略主軸：其一就是盡可能極大化己方票源的有效使用，其二就是盡可能極小化對方票源的有效使用。是故，「集中選票」（packing）和「分散選票」（cracking）為傑利蠑螈的主要手段。

集中選票為盡可能將對方陣營支持者集中劃入己方鐵票區域，以消耗降低這些選票在其他區域的作用力。分散選票則指盡可能將對方陣營的鐵票區域劃分成數個選區，以達到稀釋對方鐵票區域的作用力。

Dame Shirley Porter 案例

為達到傑利蠑螈的結果，除了集中選票和分散選票這兩個主要手段之外，還有個不尋常卻實際上發生了的方法，就是將己方支持者大量遷進這個選區。這案例發生在英國西敏市，當時為保守黨執政該地方政府，市議會主席Dame Shirley Porter和其他市議員策劃並且執行了個政策，將該市的公共房屋出售給有意支持該黨的人民以支援保守黨的邊緣選區。

影響

Research agenda

- Each solution (rule) represents a core value system.
- Logical relations between core value and "fairness" criteria.
- A core value can be represented or equivalent to the implications of various combinations of fairness criteria.
- What makes one solution (core value) different from others.

Research approaches

1. Definition: simplicity and intuition.

2. Axiomatic approach: The departure point of the approach is the fairness properties. These properties are formally used to compare solutions. The ultimate object of the axiomatic study is to understand the implications of various combinations of different fairness properties. It is a centralized system.

Research approaches

3. Strategic approach: The socially desirable outcome recommended by the solution (or the core value) that is justified by axiomatic approach can be achieved through designing a non-cooperative game in which agents behave based on their own interests. It is a decentralized system. The axiomatic and strategic approaches are complement to each other. The departure point of the approach is to bridge the gap between the two counterparts (namely, cooperative and non-cooperative) of game theory.