ASSESSING EXTRAORDINARY CLAIMS: ACTUARIAL SCIENCE AND THE SEARCH FOR TRUTH

Professor Michael R. Powers

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Webinar

Tuesday, 07 September 2021, 10:00 BST

A Word From Today's Chairman

Professor Michael Mainelli

Executive Chairman

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Today's Agenda

- 10:00 – 10:05 Chairman's Introduction
- 10:05 – 10:25 Keynote Presentation – Professor Michael R. Powers
- 10:25 – 10:45 Question & Answer

Today's Speaker

Professor Michael R. Powers

Zurich Insurance Group Chair Professor

Tsinghua University's School of Economics and Management

Assessing Extraordinary Claims: Actuarial Science and the Search for Truth

Michael R. Powers
School of Economics and Management
Schwarzman College
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FS Club Z/Yen Webinar
September 7, 2021

Sagan Standard

“Extraordinary claims require extraordinary evidence.” (Carl Sagan, 1980)

“Extraordinary claims require extraordinary evidence.” (Philip Abelson, 1978)

“An extraordinary claim requires extraordinary proof.” (Marcello Truzzi, 1978)

Abelson

“[T]he weight of evidence for an extraordinary claim must be proportioned to its strangeness.” (Théodore Flournoy, 1899)

“[W]e ought to examine [seemingly inexplicable phenomena] with an attention all the more scrupulous as it appears more difficult to admit them.” (Pierre-Simon de Laplace, 1814)

“A thousand phenomena present themselves daily which we cannot explain, but where facts are suggested, bearing no analogy with the laws of nature as yet known to us, their verity needs proofs proportioned to their difficulty.” (Thomas Jefferson, 1808)

Occam's Razor

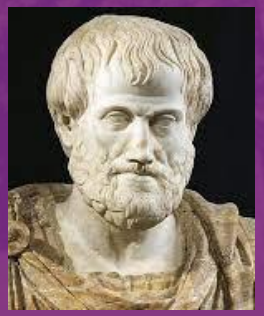
"We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances." (Isaac Newton, 1687)

"Nature does not multiply things unnecessarily; that she makes use of the easiest and simplest means for producing her effects; that she does nothing in vain, and the like." (Galileo Galilei, 1632)

"Entities are not to be multiplied without necessity." (William of Ockham, c. 1287-1347; quoted by John Punch, 1639)

"If a thing can be done adequately by means of one, it is superfluous to do it by means of several; for we observe that nature does not employ two instruments where one suffices." (Thomas Aquinas, 1225-1274)

"We may assume the superiority, other things being equal, of the demonstration which derives from fewer postulates or hypotheses." (Aristotle, 384-322 BC)



Aristotle

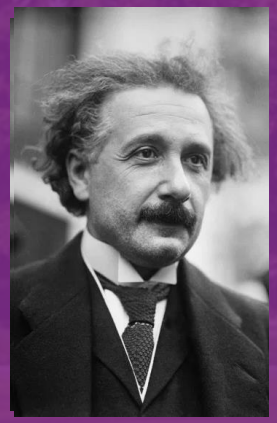
What Is an Extraordinary Claim / Event?

An extraordinary claim is the assertion that an extraordinary event has occurred or will occur; where an extraordinary event is characterized by two properties:

(1) It must have an *a priori* probability of 1/1,000,000 or less (following Littlewood's "Law of Miracles"); and

(2) It must be particularly conspicuous (usually because it was predicted before its occurrence, either through pure prophecy or as an alternative hypothesis in scientific analysis).

Nostradamus



Einstein

Extraordinary Coin Tosses

Suppose I draw a fair coin from my pocket and toss: H T T T H T H H T H H H H T H H H H T T (where H = Heads and T = Tails). Although the *a priori* probability of that sequence is less than 1/1,000,000, the event is not extraordinary because there is nothing conspicuous about it.

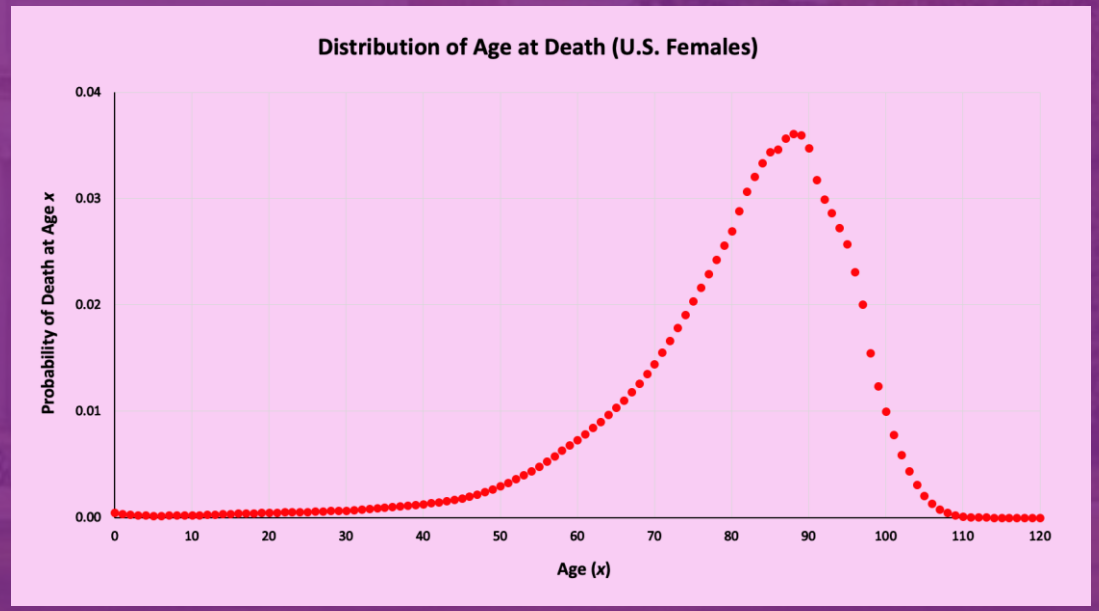
However, if I announce I will toss H T T T H T H H T H H H H T H H H H T and proceed to do so, then both my claim and the subsequent event would be extraordinary because I had predicted something rare before it occurred.

The “Most Important” Open Question in Actuarial Science?

One obvious candidate: What is the maximum possible human lifespan?

Currently, there is no general agreement on the upper bound of the distribution of human lifespans; or even whether a finite upper bound exists.

For today, we will assume such a bound (ω) does exist – although it may change over time.



Relevant Data

The Gerontology Research Group maintains a list of all verified supercentenarians (i.e., human beings confirmed to have attained an age of at least 110). Currently, this database includes about 1700 individuals.

The 101 longest recorded lifespans are associated with people born within the historical period 1870-1907. For simplicity, we will assume this period included 300 million births, and these longest lifespans constitute the 101 largest order statistics from a random sample.

Jeanne Calment, France
(122 years, 164 days)

Sarah Knauss, USA
(119 years, 97 days)

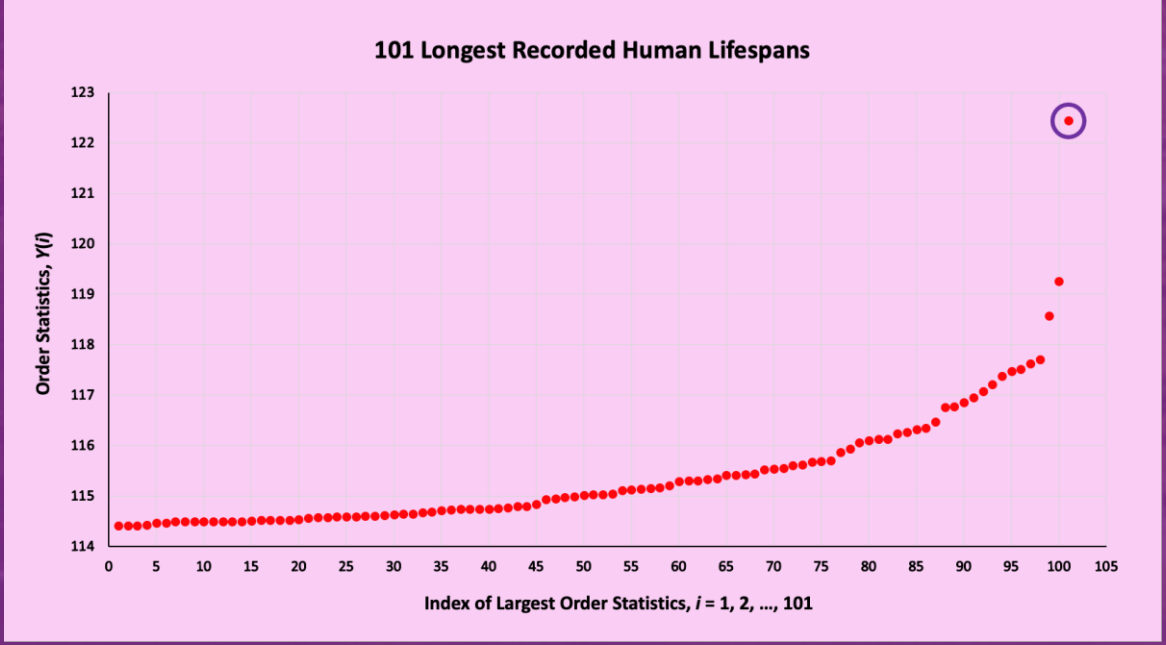
Ten Longest Recorded Human Lifespans

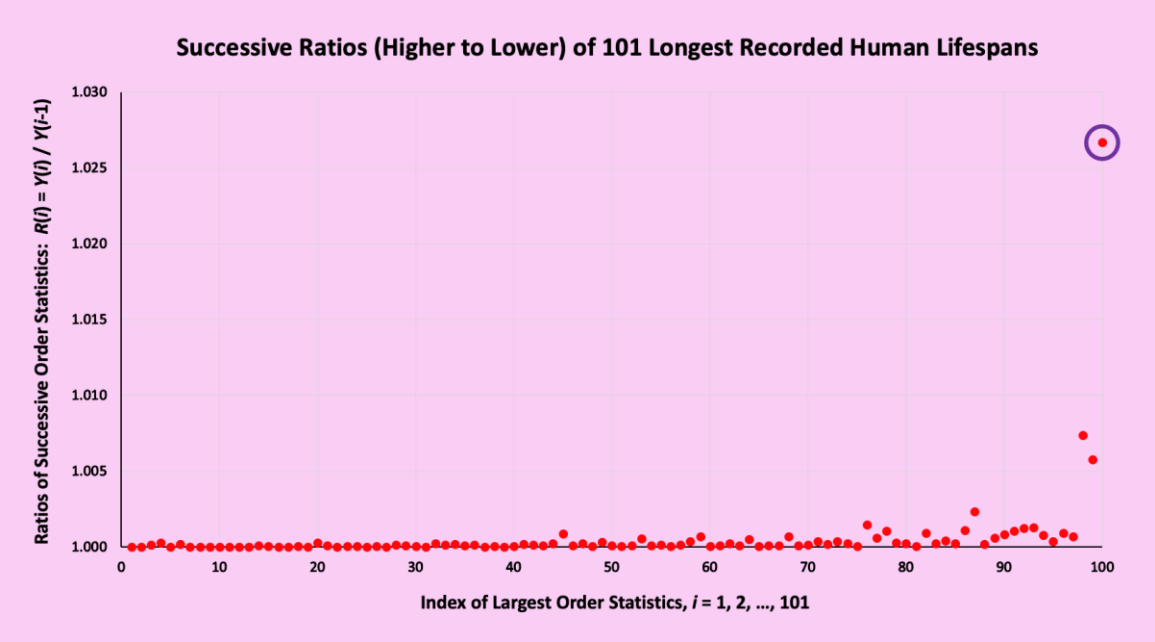
Rank	Name	Date of Birth	Date of Death	Age Attained	Nationality
1	Jeanne Calment	Feb. 21, 1875	Aug. 4, 1997	122 y, 164 d	France
2	Sarah Knauss	Sep. 24, 1880	Dec. 30, 1999	119 y, 97 d	USA
3	Kana Tanaka	Jan. 2, 1903	*Still Living*	118 y, 248 d	Japan
4	Nabi Tajima	Aug. 4, 1900	Apr. 21, 2018	117 y, 260 d	Japan
5	Marie-Louise Meilleur	Aug. 29, 1880	Apr. 16, 1998	117 y, 230 d	Canada
6	Violet Brown	Mar. 10, 1900	Sep. 15, 2017	117 y, 189 d	Jamaica
7	Lucile Randon	Feb. 11, 1904	*Still Living*	117 y, 208 d	France
8	Emma Morano	Nov. 29, 1899	Apr. 15, 2017	117 y, 137 d	Italy
9	Chiyo Miyako	May 2, 1901	Jul. 22, 2018	117 y, 81 d	Japan
10	Misao Okawa	Mar. 5, 1898	Apr. 1, 2015	117 y, 27 d	Japan

Is Madame Calment's Age an Extraordinary Event?

The fact that Mme. Calment lived more than 122 years certainly is remarkable, with an *a priori* probability much less than 1/1,000,000.

However, *somebody* out of the 300 million people born between 1870 and 1907 had to be the oldest. Therefore, to be truly extraordinary, her lifespan must be a statistical outlier (which it is).





Accusation of Fraud

Given that Mme. Calment's age is a statistical outlier, is it reasonable to suspect intentional misrepresentation?

"No single subject is more obscured by vanity, deceit, falsehood and deliberate fraud than the extremes of human longevity." (Norris McWhirter, 1986, Editor, *Guinness Book of World Records*)

Among alleged supercentenarian deaths recorded (by the US Social Security Death Index) between 1980 and 2009, only about 20% had valid ages. (Young, Desjardins, et al., 2010, *Current Geront. & Ger. Res.*)

In 2018, Russian gerontologist Valery Novoselov and mathematician Nikolay Zak popularized an (already existing) theory that Jeanne Calment died in 1934, and her daughter (Yvonne, born in 1898) assumed her official identity. This would reduce Mme. Calment's attained age to 99.

The Evidence

Several scholarly papers have been published on the topic, most in *Rejuv. Res.* (e.g., Zak, 2019; Robine, Allard, et al., 2019; Zak and Gibbs, 2020; Robin-Champigneul, 2020; and Young, 2020). Also, the story has been covered extensively by news media and Internet bloggers.

Most commenters agree that: (1) Mme. Calment's age is a statistical outlier; and (2) many reports of supercentenarian lifespans are false.

Differences of opinion arise over:

- The Calment family's financial incentive to switch identities.
- The plausibility of an identity switch unnoticed by friends, neighbors, et al.
- Photographic evidence comparing the physical features of Jeanne and Yvonne.
- Changes in Mme. Calment's signature over time.
- Mme. Calment's ability to recall early events in her life.
- Comments by insurance company personnel.
- The role played by Mme. Calment's celebrity status in France.
- The failure of French researchers to perform dispositive DNA tests.

The Scientific Consensus

Currently, the gerontological research community generally supports the original claim of Jeanne Calment's age; and some are particularly outraged by Zak's assertions.

Robine, Allard, et al. (2019) wrote: "[W]e would like to stress the unacceptability of publishing an article with such unfounded accusations …. … [W]e call for a retraction of Zak's article."

(NB: The two lead authors (Robine and Allard) were members of a scientific team that extensively investigated – and supported verification of – Mme. Calment's claim.)

According to Young (2020): "The paper evidence, family and local history context, and great assembly of >30 documents, combined with no evidence against, make the Jeanne Calment case the best paper-and-testimonies-validated case of all time. In addition … Jean-Marie Robine …, Michel Allard, James Vaupel …, …Guinness World Records …. Case closed."

(NB: Young is a senior gerontological consultant for Guinness World Records, which validated Mme. Calment's claim.)

Are the Research Standards Reasonable?

The basis for Young's conclusion seems to be:

- A broadly held (yet subjective) belief, based on the quantity and quality of evidence, that Jeanne Calment's claim is valid with a high degree of confidence.
- An unabashed appeal to authority.

Even for one who strongly believes (subjectively) that the identity-switch scenario is highly unlikely, these standards appear very weak, and far from common conceptions of scientific "proof".

It seems rather peremptory to say "Case closed." based on only a high degree of subjective belief, especially when dispositive DNA tests are feasible.

How Should We Handle Subjective Beliefs?

Ask professional actuaries!

Because of frequent data limitations for making forecasts of insurance and pension payments, actuaries have been some of the earliest and most prolific users of Bayesian (subjective/judgmental) statistical methods.

One common actuarial framework for combining data from two sources, one of which is somewhat subjective, is credibility estimation. To estimate some unknown parameter θ:

$$C_\theta = z\hat{\theta}_{\text{Ordinary}} + (1-z)\hat{\theta}_{\text{Subjective}} \text{ ,}$$

where z and $1-z$ are credibility weights given by the actuary's (subjective) assessment of the relative accuracy of the two estimators.

Subjective Credibility Estimate of Maximum Human Lifespan

For the case at hand, we can calculate a credibility estimate of the unknown parameter ω as follows:

$$C_\omega = z(p)\hat{\omega}_{\text{Knauss}} + [1 - z(p)]\hat{\omega}_{\text{Calment}} \ ,$$

where

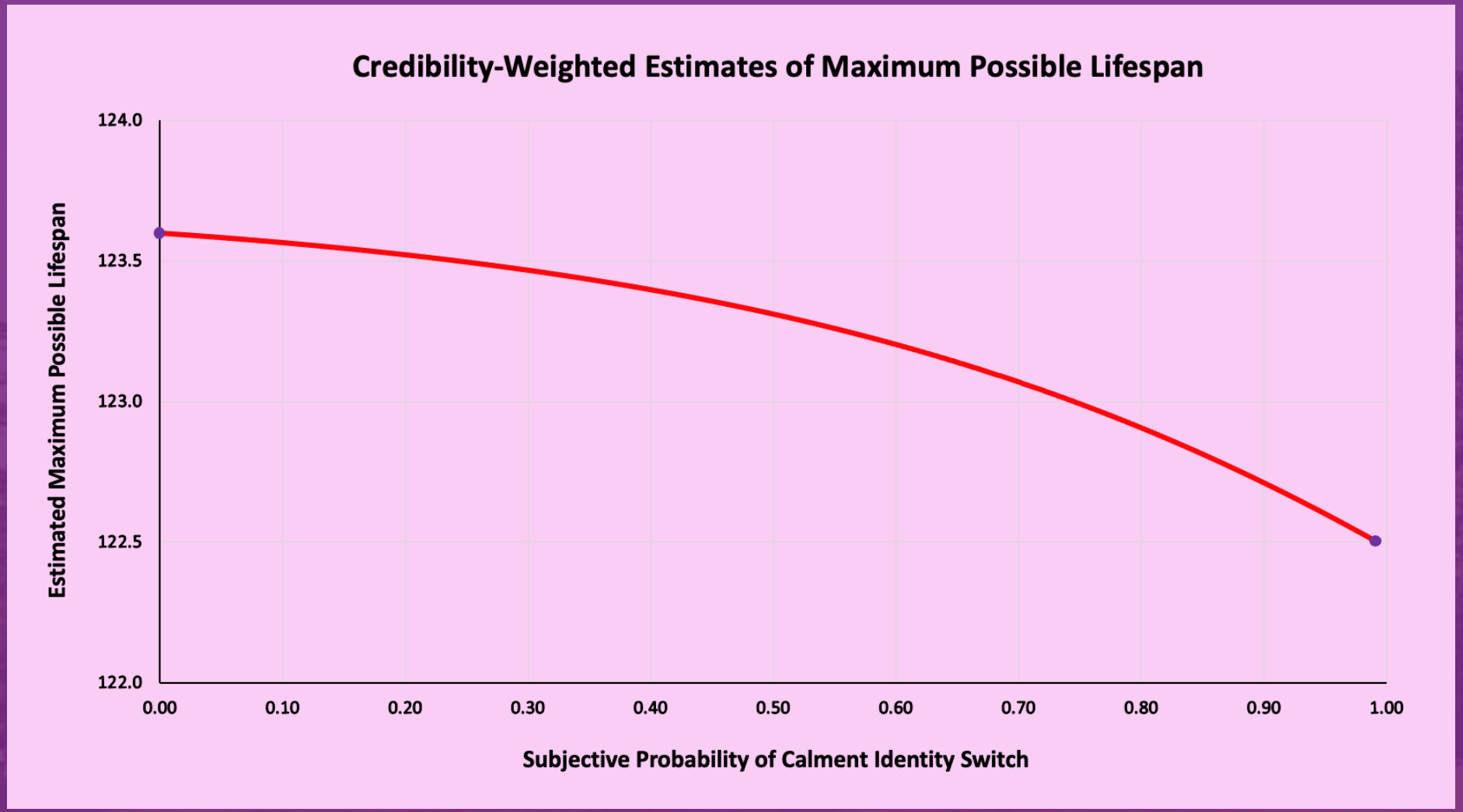
$$\hat{\omega}_{\text{Knauss}} = \hat{\omega}(\text{Knauss Age}, p) \ ,$$

$$\hat{\omega}_{\text{Calment}} = \hat{\omega}(\text{Calment Age}, p) \ ,$$

$$z(p) \approx \frac{1}{3-3p+p^2} \ ,$$

and p is the subjective probability of the Calment identity switch.

Subjective Credibility Estimate as a Function of *p*



Is Subjective Credibility Acceptable in Scientific Research?

Although Bayesian methods are becoming more popular in empirical research, they rarely employ truly subjective probabilities in the context of small sample sizes.

Conventionally, “science” is viewed as a collective undertaking, in which one cannot use personalized probabilities (or other parameters). However:

- Actuarial forecasting (for commercial purposes) is also a collective undertaking.
- The arguments of Young (2020) and others clearly are based on subjective beliefs.

In the case of actuarial forecasting, reasonableness presumably is ensured by market forces.

In the case of observational-data-based science, reasonableness presumably is ensured by scholarly peer pressure.

Which is more dependable?

How about Prediction Markets?

Scholarly peer pressure often is very weak; and market forces are rather weak in the case of estimating ω.

However, market forces can be strengthened considerably through formal prediction markets.

In fact, prediction-market methods have been shown to provide "better-than-chance" ability to forecast scientific outcomes (see, e.g., Dreber, Pfeiffer, et al., 2015, *Proc. Natl. Acad. Sci.*).

Consider a prediction market in which one could place a True/False bet on the conditional statement: "Given that French scientists conduct DNA tests on Mme. Calment's blood samples, they will confirm there was no identity switch."

If such a market existed, …

… How Would You Bet?

Jeanne Calment

Yvonne Calment

Madame Calment

[Photo montages downloadable from Madame Calment Wiki site at calment.fandom.com.]

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Tsinghua University

长命百岁!

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(Chinese Symbol of Longevity)

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- Tue, 14 Sep (15:00-15:45) Share Schemes For Non-Employees & The Gig Economy
- Wed, 15 Sep (15:00-15:45) Deforestation-Linked Sovereign Bonds – A Nature-Based Solution?
- Thu, 16 Sep (09:00-09:45) All Party Parliamentary Groups: What Purpose Do They Serve?

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