



## GAMBLING FOR THE SAKE OF SCIENCE THOMAS PFEIFFER

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Thomas Pfeiffer is an evolutionary biologist at Massey University in Auckland, New Zealand. He received a diploma in Biophysics from the Humboldt University Berlin and a doctoral degree in Environmental Sciences from the ETH Zurich. After a short period of postdoctoral research at ETH Zurich, Thomas Pfeiffer received the prestigious Branco Weiss Fellowship and moved to Harvard University. Since 2012, Thomas Pfeiffer has been Professor for Biochemistry and Computational Biology at Massey University, where he directs an interdisciplinary degree programme, the Bachelor of Natural Sciences. His research interests include metabolic modelling, game theory and decision making. – Address: New Zealand Institute for Advanced Study, Massey University, Private Bag 102904, North Shore Mail Centre, 0745 Albany, Auckland, New Zealand.

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I had visited the Wiko on two previous occasions: once as a guest of Iruka Okeke (Fellow 2010/11), with whom I worked on a piece of research on the shortcomings in the diagnosis of febrile diseases in Africa, and once for an annual meeting of the foundation “Society in Science / The Branco Weiss Fellowship” that supported much of my postdoctoral research. Although of short duration, both visits had an impact. The work on the diagnosis of fevers turned out to be quite relevant in the context of the 2014 Ebola outbreak in West Africa; and it was the work I started as a Branco Weiss Fellow that unexpectedly prevented me from focussing much on the topic I originally intended to work on.

During my three-month stay as a Fellow in 2015, I was part of the Focus Group “Gene regulation and organismal diversity” and intended to concentrate mainly on my biological

research programme that combines metabolic biochemistry and game theory. More specifically, I planned to develop approaches that could help reveal intricacies in microbial metabolic “decision making”. Are microbes capable of sensing each other’s presence? Do they change their metabolic strategies when sensing the presence of a potential friend, competitor or foe? Despite being important for developing a better understanding of interactions within microbial communities, such questions have not yet been investigated very well.

Considerable time was dedicated to this topic. We had fruitful conversations within the focus group and also with the local research community that has shared our interest in the topic. Activities included a meeting with Birgitta Whaley (Fellow 2012/2013) on the potential role of quantum effects in biological regulation and catalysis, a meeting with Wolfram Liebermeister (Charité Berlin) on metabolic modelling and a mini-workshop organized by Orkun Soyer (Fellow 2014/2015) and Ralf Steuer (HU Berlin) on the topic “Evolution and optimality in cellular systems”. Other Fellows contributed tremendously – I was particularly excited to meet Jannie Hofmeyr (Fellow 2014/2015), one of the pioneers of metabolic modelling.

It was, however, a different topic that maintained a strong grip on my research activities at the Wiko. Starting in 2005 with John Ioannidis’ paper “Why most published research findings are false”, a vibrant discussion of the reliability of published research had attracted increasing attention and motivated a number of studies on that topic. One of these studies, the “Reproducibility Project: Psychology”, was concluded during my stay at the Wiko. This study in turn is closely linked to a project I am involved in on the use of prediction markets in science.

As a Branco Weiss Fellow (2005–2010), I had started a research programme of my own on the reliability of science, publication bias and “fashions” in science. As part of this programme, I collaborated with a group of economists around Anna Dreber and Magnus Johannesson (Stockholm School of Economics) to organize prediction markets in the context of science. This work followed ideas outlined by the economist Robin Hanson in an essay from 1995, entitled “Could gambling save science?”

While fascinating, Hanson’s ideas on using prediction markets in science did not trigger many applications, and we aimed to fill that gap. “The Reproducibility Project: Psychology” offered an excellent opportunity to explore practical applications of prediction markets in science. With dozens of studies being scheduled under transparent criteria for replication, and the replications being described in great detail, we set up prediction

markets on replicability. In these markets, participants could trade “bets” about which of the studies would replicate and which ones would not. Through the prices of these bets, participants create forecasts about the replicability of each study. The motivation for this project is to investigate whether knowledge of the reliability of published findings is present in the community and whether prediction markets can aggregate this information. The prediction markets indeed gave excellent forecasts of reproducibility; we also showed how the markets can be used to analyse the temporal dynamics of testing in a research field and the appropriateness of testing procedures. The Wiko provided an excellent environment to work on this project and the research programme behind it: the interdisciplinary spirit of the Wiko goes together very well with this research; and while promoting interactions with the other Fellows, the setting also allows one to “withdraw” for more intense periods of analysis and writing. Moreover, I had the opportunity to invite one of my collaborators from Stockholm, Eskil Forsell, to review and refine important steps in the interpretation of market prices, and to prepare using prediction markets as “decision markets”.

While prediction markets generate forecasts that can be useful to optimize decision making, a problem that often arises in this context is that decisions may influence which outcomes can be observed. Imagine, for instance, a soccer coach who has to choose which of his two top scorers to put on the field in an upcoming game. Ideally, he would like to predict the outcome of the game for both options and then select the more promising one. But can prediction markets be set up in a meaningful way, when the outcome of only one option can be observed? Conceptual work and theoretical treatment of such questions have emerged over the last few years. With Eskil, I discussed lab experiments to pave the way towards applications of decision markets in practice. In the context of published research findings, this means that decision markets could be not only used to forecast replicability, but also to help select the most interesting or controversial findings for replication.

The idea to use “gambling” to make decisions that typically fall into the domain of science policy cannot be expected to meet unanimous agreement. However, as long as problems with the replicability of published research persist, a somewhat disruptive approach seems justified. Clearly, such a complex problem deserves to be approached with a wide range of methods, including unconventional ones such as prediction markets.

Of course a Fellowship at the Wiko offers opportunities that go far beyond the work on research projects. Especially to a German now based in New Zealand, it is a great

chance to catch up with colleagues, family and friends; take the family to some of the favourite vacation spots in Europe; and get the kids to learn some German. All of this made for a successful and enjoyable stay, and I'd like to thank the Wiko for making this possible.

Publications related to the Fellowship:

- Munafo, M. R., T. Pfeiffer, A. Altmejd, E. Heikensten, J. Almenberg, A. Bird, Y. Chen, B. Wilson, M. Johannesson, and A. Dreber. "Using prediction markets to forecast research evaluations." *Royal Society Open Science* 2 (2015).
- Dreber, A., T. Pfeiffer, J. Almenberg, S. Isaksson, B. Wilson, Y. Chen, B. A. Nosek, and M. Johannesson. "Using prediction markets to estimate the reproducibility of scientific research." *PNAS* (2015) Early Edition.