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# A Conversation with Tze Leung Lai

**Ying Lu, Dylan S. Small and Zhiliang Ying**

*Abstract.* This conversation began in June 2015 in the Department of Statistics at Columbia University during Lai's visit to his alma mater where he celebrated his seventieth birthday. It continued in the subsequent years at Columbia and Stanford. Lai was born on June 28, 1945, in Hong Kong, where he grew up and attended The University of Hong Kong, receiving his B.A. degree (First Class Honors) in Mathematics in 1967. He went to Columbia University in 1968 for graduate study in statistics and received his Ph.D. degree in 1971. He stayed on the faculty at Columbia and was appointed Higgins Professor of Mathematical Statistics in 1986. A year later he moved to Stanford, where he is currently Ray Lyman Wilbur Professor of Statistics, and by courtesy, also of Biomedical Data Science and Computational and Mathematical Engineering. He is a fellow of the Institute of Mathematical Statistics, the American Statistical Association and an elected member of Academia Sinica in Taiwan. He was the third recipient of the COPSS Award which he won in 1983. He has been married to Letitia Chow since 1975, and they have two sons and two grandchildren.

*Key words and phrases:* Hong Kong, Columbia University, Stanford University, statistics, biostatistics, sequential experimentation, mathematical finance.

## 1. FROM CHILDHOOD TO COLUMBIA YEARS

**Zhiliang:** You were born and grew up in Hong Kong. Would you like to tell us about your childhood and your primary and secondary education there? How did the Hong Kong education system work at that time?

**Tze:** Hong Kong is very much in the news now following the ongoing large-scale protests against the Extradition Law Amendment Bill that began on June 12. I was born in another momentous epoch in the history of Hong Kong—June 1945, 2 months before Japan, which had invaded Hong Kong since December 1941, surrendered and returned Hong Kong to Britain. The Second World War was followed by the Civil War in China and the Korean War, which resulted in difficult times for Hong Kong. I spent most of my childhood living in overcrowded Wan Chai and playing with my neighbors' kids until I entered the North Point Government Primary School in the fifth grade when I first experienced the pressure of school work and competitive examinations. My family moved to North Point (in the news these days as a hot spot of violent clashes between anti- and pro-government demonstrations) for more spacious accommodation. I was the youngest in my class because I skipped kindergarten and had to work extra hard to catch up with my classmates, many of whom repeated the fifth grade to get into a government school; there were few government schools (which had well-trained teachers and yet inexpensive tuition) in those days. Although I barely made the cut to get into North Point Government Primary School, my studies there prepared me for the Secondary School Entrance Examination in the sixth grade. I did well enough in that examination to enter the prestigious Queen's College, which had Sun Yat-Sen as our most distinguished alumnus. Concerning my secondary education, it followed the British system: Form 1 to Form 5 and then the competitive Hong Kong Certificate of Education Examination to select a cohort to enter Form 6 (Lower 6 and Upper 6), followed by the Matriculation Examination, which was the entrance examination for The University of Hong Kong (HKU), the only university recognized by the British Hong Kong government in those days. Sam Wong had written about my secondary school education in Shen, Tsang and Wong (2016), so I will not repeat his points here.

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FIG. 1. *Tze at age* 1.5 *years.*

**Zhiliang:** I have heard that you did not major mathematics at The University of Hong Kong. What was your major, and minor if you had one? In retrospect, how do you feel about your college education? What about college life?

**Tze:** Yes, when I entered HKU, I planned to major in economics. In fact, mathematics was too hard for me as I self-studied just enough mathematics in Form Upper 6 to pass the Mathematics Matriculation Examination. I chose Economics, Statistics, Mathematics, Number Theory and History of Mathematics as the four "papers" (i.e., subjects) for my first-year examination, after which I had planned to take nine papers in Economics in the third-year examination. Following the British system, we only studied three years to receive our bachelor's degree. A month after I entered HKU, I changed this plan to major in Mathematics instead, taking all nine papers in Mathematics (including one in Statistics) in my final year, as explained in Part I of Leong (2019). Hence, the answer to your question is that I started to major in Economics, but switched to be a Math major with some trepidation. In retrospect, I was extremely lucky to have made that switch because I would not have envisioned the 1967 leftist riots in Hong Kong, which turned out to be much more violent than the current anti-government protests. I am always grateful to HKU's Mathematics Department not only for the excellent education I received there but also for offering me a position as Demonstrator of Mathematics during that tumultuous period when I had serious reservations about joining civil service for which I had prepared my career.

**Zhiliang:** Upon graduating from college, what did people usually do at that time? What are the things that prompted you to apply to a Ph.D. program in the US? Any particular reason for choosing Columbia and Statistics?

**Tze:** I have already given a detailed answer to this question in Part I of Leong (2019).

**Zhiliang:** What did the Statistics Department look like when you came to Columbia from Hong Kong? Was it located in the Mathematics Building? I heard the Department had moved a few times.

**Tze:** When I arrived at Columbia in mid-September of 1968, the university had just experienced turmoil. In late March, the Columbia administration placed on probation six student activists who demonstrated inside Low Library (the administration building) to protest Columbia's affiliation with IDA (Institute for Defense Analysis); the university said the protest violated its ban on indoor demonstrations. In response to the Columbia administration's attempts to suppress anti-IDA student protest and its plans for building a gymnasium in the city-owned Morningside Park against community opposition, student activists from Columbia's SDS (Students for a Democratic Society) and SAS (Student Afro Society) held large scale demonstrations on campus and in Morningside Park and eventually took over Hamilton Hall. The assassination of Martin Luther King Jr. on April 8 led to the separation of SAS and SDS along racial lines, and the white student activists of SDS eventually left Hamilton Hall and occupied the President's office in Low Library and three other academic buildings. The protests ended on April 30 when the New York Police Department quashed the demonstrations with tear gas. President Grayson Kirk, who succeeded Eisenhower in 1953 after the latter became President of the US, stayed away from Commencement and announced his retirement. Therefore, when I arrived at Columbia, the university was beginning its healing process under interim president Andrew Cordier, Dean of SIA (School of International Affairs), who listened and responded to student concerns and spoke out against the Vietnam War. The trustees appointed him President in 1969, and he accepted on condition of continuing the search for a new president.

Concerning the Statistics Department (called "Department of Mathematical Statistics" in those days), it was also undergoing a similar recovery process (from depletion of tenured faculty) when I arrived. It was a small department that used to have Ted Anderson, Herbert Robbins and Howard Levene as tenured full professors, and a number of visiting professors and assistant professors. First, Anderson left in 1965 to visit Imperial College of University of London and eventually moved to Stanford in 1967. Then Robbins left in 1966 for University of Michigan as Professor of Mathematics, and he remarried that year. His new wife Carol had lived and worked in New York, which she preferred to Ann Arbor. Therefore, Robbins decided to move back to Columbia in 1968 and bring in his "team" as tenured faculty, consisting of Y. S. Chow as full professor and David Siegmund as associate professor. Hence when I arrived in 1968, both Chow and Robbins were there, and Siegmund joined a year later

(from Stanford). Levene was still the chairman, and Alvin Baranchik, Raoul LePage, John Rolph and Burton Singer were the assistant professors. The department was in Fayerweather Hall, which was one of the buildings occupied by students earlier that year and which also housed the Departments of Economics and Sociology. On the other hand, Robbins negotiated with the administration for additional space in the basement of the Mathematics Building so that the cubicles there for graduate students could be assigned to Math Stat Ph.D. students as well. I got a cubicle, which was where I worked as my dormitory room was very small, with a bed, a desk and a small toilet.

**Zhiliang:** Could you describe to us about your life at Columbia as a Ph.D. student?

**Tze:** This was described by Sam Wong using the information from my good friend and former HKU classmate Man Keung Siu, who was a Ph.D. student in Math and went to Columbia a year ahead of me (Shen, Tsang and Wong, 2016). Another change that Robbins brought to the department was to have an oral (instead of written) qualifying examination, to be taken before the end of the second year of study. The idea was to let students start their research early so that the qualifying examination could dwell more deeply on the individual student's research area. However, many students "freaked out" during the oral exams, so it was switched back to written examination after that year. I also almost freaked out because all buildings, including the Math Building, were barricaded by student demonstrators protesting against Nixon's sending troops to Cambodia, yet my oral exam still took place even though I had not studied for the past 10 days when I spent all my time in my dormitory room listening to the radio for updates of events in Cambodia and Vietnam. Despite my initial panic when I arrived at the examination room, I managed to stay calm and was the only one who passed the oral qualifying exam without having to retake it; see Milan Shen's part of Shen, Tsang and Wong (2016).

**Zhiliang:** How about your research interests and work you did as a Ph.D. student?

**Tze:** I started working with Siegmund on my thesis shortly after he came to Columbia in August 1969. My thesis topic was based on Robbins' Wald Lectures at the annual meeting of the Institute of Mathematical Statistics, held that year in New York City. The problems I subsequently worked on are related to (a) mixtures of likelihood ratio martingales, (b) power-one tests and (c) confidence sequences, and are described in Section 2.3 of my article on the history of martingales in statistical modeling (Lai, 2009). I basically finished most of my research by the end of January 1971, when I summoned the courage to ask Siegmund whether he felt that was enough for a Ph.D. thesis. After he replied yes and told me to write it up, I was emboldened to ask if he would help me find a teaching job. He told me to come back a week later, at which time he offered me several possibilities including an assistant professor position at Columbia. Without any hesitation, I replied that Columbia was my choice and thanked him for giving me this opportunity.

**Zhiliang:** Your papers with Siegmund (Lai and Siegmund, 1977, 1979) on nonlinear renewal theory are a milestone in sequential analysis. Could you tell us about how the project evolved?

**Tze:** Actually this started with a course that I took from Siegmund in the fall semester of 1970, on advanced probability in which he covered certain chapters in William Feller's classic *An Introduction to Probability Theory and Its Applications, Volume 2* (Feller, 1971), in particular Chapter 11 on renewal theory. After I joined the faculty, I participated in Y. S. Chow's seminar series on random walks and Blackwell's renewal theorem. We worked on the extension of renewal theory to nonlinear boundary crossing problems during the academic year 1974–1975, and wrote up the results for publication in the following year when I was away from Columbia.

**Zhiliang:** I heard you spent an entire sabbatical year at the University of Illinois at Urbana-Champaign. How was it? Are there other places you spent your sabbatical?

**Tze:** I spent the 1975–1976 academic year visiting UIUC's Mathematics Department. I had spent my relatively young academic life entirely at Columbia, first as a Ph.D. student and then as a faculty member. Although I already received tenure as associate professor at that time, I was not eligible for sabbatical leave because of Columbia's "six-year rule"—the first sabbatical I might take was in the 1977–1978 academic year since my appointment at Columbia started on July 1, 1971. My work on martingales and sequential analysis caught the attention of UIUC's probability group, which had been at the center stage of martingale theory led by Doob and Burkholder. In March of 1975, I received an invitation from UIUC's Mathematics Department to visit for a year, and accepted immediately after getting the approval of the department chair at Columbia. It was a very enjoyable year and I learned a lot from the seminars, several in a week, and started collaborations with Bill Stout and Bob Wijsman. Columbia also had a "two-year rule" for taking leaves. Hence, after my visit to UIUC, the earliest time I could ask for another leave was in the 1978–1979 academic year, and I planned to take my sabbatical leave to visit Stanford during that year. However, my wife found a good job in New York after receiving her MBA from Columbia. Therefore, the plan changed from sabbatical leave to spending the winter and spring quarters at Stanford where I had been assigned two courses to teach to cover half of my salary for the originally planned sabbatical. The first (and only) sabbatical leave I took from Columbia was the winter semester of 1981, to babysit at home after the birth of my son Peter in December 1980.

**Zhiliang:** In the early 80s, you and Herbert Robbins wrote a number of landmark papers (e.g., Lai and Robbins, 1979, Lai and Robbins, 1985) on the multiarmed bandit problem and the stochastic approximation. Any thought on your work and interesting stories behind your collaborations with Robbins?

**Tze:** After I returned to Columbia from UIUC in August 1976, Siegmund had already left Columbia for Stanford and I moved to his office because the one that I had used before was taken by Andre Tchen who joined the department when I was away, after receiving his Ph.D. from Stanford. Therefore, my "new" office was next to that of Robbins, who liked to drop by in the morning to talk about ideas that had occurred to him the night before. This is the background of the series of papers I wrote with him during the period 1976–1986. The papers on adaptive stochastic approximation and multiarmed bandits turned out to be the most influential in that series, and the areas of research they initiated are still vibrant today after over 40 years of multidisciplinary development. I benefitted immensely from being his "neighbor" in those 10 years.

**Zhiliang:** Besides Robbins, Chow and Siegmund, did you also work with other colleagues and Ph.D. students in the department? I read your papers with C.-Z. Wei. Of course, Minggao (Gu) and I, as your students, worked extensively with you and benefited greatly from your guidance.

**Tze:** When I first joined the faculty, I worked with my previous fellow Ph.D. students, including Gordon Lan (with whom I published a paper in 1976), Tom Louis and Murad Taqqu. After I returned from my visit at UIUC in 1976, I worked with junior colleagues who recently joined the department, including Jack Cuzick and Bruce Levin, with whom I published papers in *Trans. Amer. Math. Soc.* and *Proc. Natl. Acad. Sci.*, respectively. Since 1979, I also worked with the Pediatric Pulmonary Group on a program project of the NIH that led to over ten publications, all of which involved a junior colleague Gabriel Haddad with whom I worked closely. When I moved to Stanford, Haddad also left Columbia for Yale where his research in respiratory physiology and medicine gained wide international recognition. Ten years ago, I received an email from him saying that he had moved to UC San Diego as the chair of the Department of Pediatrics and physician-in-chief and chief scientific officer of Rady Children's Hospital in San Diego. He invited me to visit him and explore possible collaboration now that he moved to California. I flew down to La Jolla to visit his laboratory and was greatly fascinated by his research breakthroughs in hypoxia, ischemia and genetic and molecular mechanisms of cell death and cell survival in oxygen deprivation. A year later he was awarded a $10 million Program Project Grant by the NHLBI (National Heart, Lung and Blood Institute). Because I was tied up with other projects at Stanford, I was not able to resume our collaboration in this exciting research frontier. However, such possibility finally emerged this year. I met his colleague Ronghui (Lily) Xu in the Department of Family Medicine and Public Health last year in a workshop at Fudan that you organized. She expressed strong interest in working with Haddad and me, and invited me to visit UC San Diego to discuss possible projects for collaboration. I flew to San Diego this February to meet with her and Haddad and mapped out some projects and collaboration plans.

My work with you, Minggao, and earlier with Zukang Zheng who received his Ph.D. in 1984 and returned to China where he rose quickly through the academic ranks and became a Dean and later a Vice President of Fudan University, was actually also related to NHLBI. In 1981, the Beta Blocker Heart Attack Trial (BHAT), sponsored by NHLBI to test whether administration of the beta-blocker propranolol to patients who had at least one documented myocardial infarction would result in significant reduction in mortality from all causes during the follow-up period, stopped early during interim analysis in favor of propranolol. This caught the immediate attention of the pharmaceutical companies in the New York–New Jersey area, which called me for consultation in designing similar trials for regulatory approval of their new drugs. I was a recognized expert in sequential experimentation and analysis, but I never learned survival analysis myself and I realized that what was really needed was time-sequential survival analysis that nobody seemed to have worked on before. I therefore asked Zukang to take the survival analysis course taught by John van Ryzin and to read widely on the subject. This eventually led to his thesis that significantly extended the approach of Koul, Susarla and Van Ryzin (1981), which Zukang later further developed with you and me in our paper (Lai, Ying and Zheng, 1995). The publication of BHAT (1982) in *JAMA* cites a paper of Tsiatis (1981) on the asymptotic distribution of time-sequential logrank statistics. Dan Anbar of Abbott Laboratories approached me to apply to the NSF for a university-industry grant for the development of these time-sequential methods with Tsiatis and Gordon Lan who had worked on BHAT after he joined NHLBI. The grant proposal was funded, and I recruited you and Minggao to work on the project as graduate research assistants, capitalizing on the frequent visits of Lan and Tsiatis to Columbia and the periodic workshops from which you, Minggao and I learned a lot.

My work with Ching-Zong Wei began when I asked him to join me in extending my work with Robbins on adaptive stochastic approximation to the multivariate case. This led to his thesis in 1980 and papers with me and Robbins (Lai, Robbins and Wei, 1978, 1979) together

with his papers with me (Chen, Lai and Wei, 1981, Lai and Wei, 1982a, 1983a, 1982b, 1983b, 1985). He joined the faculty at University of Maryland (College Park) upon graduation and became my close collaborator in further developing our ideas for stochastic adaptive control of linear stochastic systems, leading to our series of papers (Lai and Wei, 1982c, 1986a, 1986b). After he left Maryland for Taipei to become Director of the Institute of Statistical Science of Academic Sinica, his interest moved to other areas and I recruited you to complete that line of research with me when you were on the faculty of UIUC, culminating in our two papers (Lai and Ying, 1991a, 1991b).

**Zhiliang:** There is your photo around 1980 in China. Where did you go and whom you did you meet during your first trip to mainland China. I remember that you went on a second trip to China to teach a summer school at Nankai University in 1985 when I was a student at Columbia. Where did you go besides Tianjin during that trip and how was the summer school?

**Tze:** My first trip to mainland China was arranged the year before during my visit to Stanford when I got to know Kai Lai Chung well. We used to go on long walks during weekends. During one of those walks after he came back from a visit to the Chinese Academy of Sciences with a delegation of probabilists, he asked me if I would be interested in visiting the Academy during the following year to give lectures on statistics. I answered yes and told him my availability in May 1980 after finishing my classes at Columbia. He made the arrangements that paved the way for my first visit to China, beginning with Guangzhou, then Hangzhou, Shanghai and finally Beijing. I had to fly (round trip) to Hong Kong from JFK International Airport in those days and took the train to Guangzhou.

Concerning my second trip, I met SS Chern in the summer of 1983 at MSRI (Mathematical Sciences Research Institute) at Berkeley, of which Chern was the founding director. That year featured a program in statistics in MSRI and I spent one month there. Besides the faculty from UC Berkeley's Statistics Department, I also met Herman Chernoff, David Cox and Peter Huber, who were also visiting MSRI at that time. I got to know Chern well that summer, and he called me a year later when he was developing a similar research institute, namely the Nankai Institute of Mathematics in Tianjin (now renamed the Chern Institute of Mathematics, which is one of the four national centers of mathematical sciences in China). He invited me to visit Nankai and to teach a summer program in Statistics in 1985. After finishing the teaching and grading at Columbia in May, I began my trip and visited Hong Kong, Shanghai, Guilin, Chongqing, Xian and Beijing before finally arriving at Tianjin to teach the summer program in Statistics. Other visiting professors in the summer program included Shiu Yuen Cheng of UCLA for

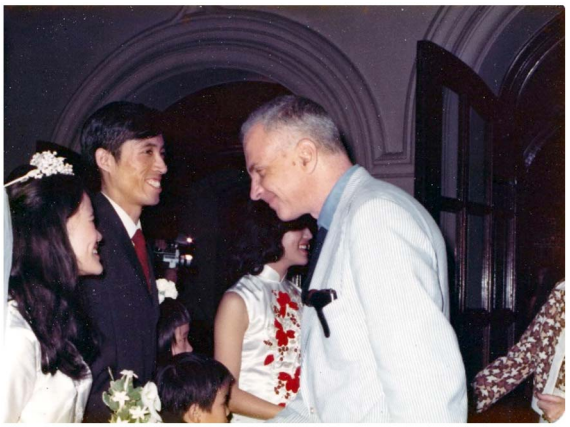

FIG. 2. *Herbert Robbins at Tze's wedding.*

partial differential equations, Henry Helson of UC Berkeley for harmonic analysis, Wu-Chung Hsiang of Princeton for differential topology and Din-Yu Hsieh of Brown for applied mathematics. I had an amazing group of students who already knew the basic material that I had prepared to teach, hence I had to switch to contemporary research topics and prepared new lectures on the spot. Several students including Xuming He, Jiayang Sun and Bin Yu, have become leaders in the field. Another one in the class was an electrical engineering student Tom Luo, who was on his way to MIT and who is the Vice President of The Chinese University of Hong Kong in Shenzhen (CUHKSZ). I saw him again 30 years later in an Advisory Board meeting of CUHKSZ in 2015.

## 2. THE FIRST SEVENTEEN YEARS AT STANFORD

**Dylan:** How did your move to Stanford in 1987 work out for you and your family?

**Tze:** It worked out very well. After receiving the Stanford offer, it took me some time to move to Stanford with

FIG. 3. *Tze at the Great Wall of China*, 1980.

all the things that needed to be done, including paperwork and taking care of my obligations at Columbia. I moved to Stanford in January 1987 and my mother, wife and sons stayed in New York for a while. I put in a bid for a house on campus for $5000 less than the asking price, but I lost the bid to Steven Chu, who was moving from Bell Labs to Stanford at that time and who later won the Nobel Prize in physics in 1997. He paid full price (laughs). I then looked at the house that we currently live in, but didn't like it enough to put in a bid. Shortly after my wife took a week of vacation to visit Stanford, and fell in love with the garden and the fruit trees after taking a look at the house. She put in a bid for $10,000 less than the asking price and the owner accepted. There were a few more days of her vacation left and she went for an interview at Wells Fargo; she had been working in New York City at Chemical Bank (which later merged into J.P. Morgan). She got the offer from Wells Fargo, at a much lower rank and salary than her position at Chemical Bank. She took the job, while complaining about how much she had to give up, but the good thing was that after a year, she got back to the same rank that she was at before. I said: congratulations and no more complaints (laughs). The move worked out very well for our sons, particularly for our younger son, David, because of the excellent Bing Nursery School on campus that I managed to enroll him in. On the other hand, my research definitely slowed down at that time and I was basically banking on the ideas I had before and working with outstanding former students such as Zhiliang. That was what kept me going. I was also attending classes and seminars at Stanford to pick up new skills and collaborations, as described in Part II of Leong (2019).

**Dylan:** One of your legacies is your tremendous number of students. We have all been amazed and grateful for how much time you have found for all of us. What is your approach to advising students?

**Tze:** Actually, I feel very lucky to have my students. In a number of cases, my interests in an area started from talking to and working with them. You may not realize how much I have learned from them, and you in particular. Do you remember that when you started working with me, I suggested some change-point problems in finance since you told me that you would be interested in innovative statistical methods and applications in economics? I didn't realize that you were actually interested in economic policies (about which I didn't know much at that time) instead of financial economics. Fortunately, during that year I was a Fellow at Stanford's Center for Advanced Study in the Behavioral Sciences (CASBS), where I met the distinguished economist Alan Krueger from Princeton, who was also a CASBS Fellow that year and who gave a talk related to his seminal work on natural experiments to study the effect of education on earnings. I found his talk fascinating and told you about it when we met later that week. You said that you had already been studying that work and also Krueger's work with the MIT economist Joshua Angrist on instrumental variables and their econometric applications. I brought you to CASBS the following week to meet Alan, with whom you got on well and met regularly. After Alan returned to Princeton, you changed your thesis topic from change-point problems in finance to inference and model selection for instrumental variables, which you finished in two years. We have been collaborating in this area of research—instrumental variables, natural experiments, causal inference—since then, in economics, biostatistics, drug safety and epidemiology.

**Dylan:** How was your time as chair of the department from 2011 to 2014?

**Tze:** There was a hiring freeze, yet we managed to hire Wing Wong from Harvard, which I regard as a highlight of my experience as department chair. My three-year term as department chair was during that dot-com crash and began with the September 11, 2001, terrorist attacks. Before I started my term, Jun Liu who had just been promoted to associate professor with tenure at Stanford got an offer as full professor from Harvard where tenure is only given to full professors. As it was not possible for us to match Harvard's offer, Jun left for Harvard, taking a one-year leave from Stanford before deciding whether he would return to Stanford. I called him about his decision during my second year as chair, and he replied that he would return if Stanford would promote him to full professor and give him space at the new Bio-X Center (also called the Clark Center as it was built on a donation by James Clark, a computer scientist and entrepreneur who has founded Silicon Graphics, Netscape and Healtheon). I talked to other senior faculty of the department and they authorized me to convince the Dean's Office that Jun would be a valuable addition to the Bio-X program. Hence we got an "extra" tenure line because of Jun, besides space at Clark Center. Jun's promotion to full professor also went smoothly through the Appointments and Promotion Committee, but his return to Stanford fell apart in the late summer because he had a "two-body problem"; his wife was not able to get a job in Silicon Valley, in the midst of the dot-com crash, comparable to what she had in Boston. It was a disappointing setback, but with the silver lining that the Dean's Office had agreed to the extra tenure line for Statistics in the Bio-X program and space allocation in Clark Center. Still hopeful that the Dean's Office might agree to give Statistics an extra tenure line with the Bio-X connection and space in Clark Center if we could come up with an outstanding candidate, I met with colleagues who had worked with me on Jun's case to discuss the best way forward. We came up with two new joint appointments for me to propose to the Dean of Humanities and Sciences: a full professor position, joint with Biostatistics in Health Research and Policy, for the Bio-X program and lab space

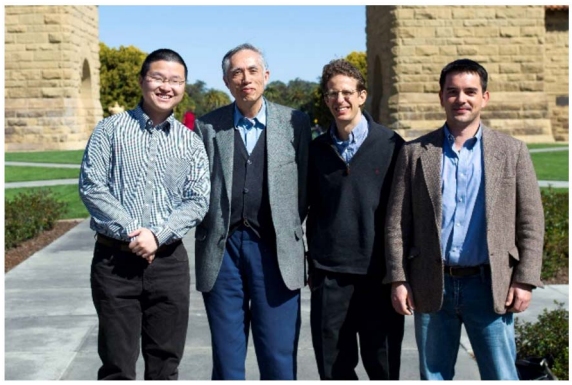

FIG. 4. *Yong Su*, *Tze*, *Dylan and Mike Baiocchi*, *Stanford* 2013.

in Clark Center, and an assistant professor position, joint with Electrical Engineering. The Dean agreed and the full professorship went to Wing Wong before my term as chair ended, while the assistant professorship went to Andrea Montanari in 2006, who won the NSF CAREER award in 2008 and became a full professor in 2015.

## 3. THE PAST FIFTEEN YEARS AT STANFORD

**Ying:** When I first met you in the ICSA meetings 15 years ago, I was still working at UCSF and you gave talks on time series and financial econometrics. After I moved to the VA Cooperative Studies Program Palo Alto Coordinating Center at Palo Alto Health Care System and the Biostatistics group of the Department of Health Research and Policy (HRP) at Stanford University School of Medicine 10 years ago, I found that you held a courtesy appointment at HRP and just co-founded with Phil Lavori the Center for Innovative Study Design, while also being the director of the Financial Mathematics program and teaching a full load of statistics and financial mathematics courses. How did you split your time among these major tasks and what were your long-term goals behind them?

**Tze:** George Papanicolaou of the Mathematics Department and I co-founded the Financial Mathematics (FinMath) program at Stanford in 1999 when George served as the program's founding director. Not only did I assume new responsibilities such as curriculum development and student placement in the financial industry, but I also re-oriented my research toward time series and financial econometrics so that I could teach effectively the course Statistical Methods in Finance, a core course of the program for which I was responsible. I became director of the program in 2005 and served three consecutive three-year terms as director until 2014 when FinMath transitioned to the Institute of Computational and Mathematical Engineering (ICME) and was renamed Mathematical and Computational Finance (MCF), with me and Kay Giesecke as co-chairs of the Steering Committee. How FinMath "survived" the Financial Crisis of 2007–2008 and the subsequent Great Recession and then flourished with the FinTech revolution is described in the section "Financial Mathematics, Trilogy in Statistical Finance, and FARM" of Shen, Tsang and Wong (2016). FARM—the acronym of Financial and Risk Modeling Institute—is an interschool and interdisciplinary research institute, of which I am the director, established in 2012.

Part II of Leong (2019) describes the background of my courtesy appointment in Biostatistics at HRP (now at BDS). Fifteen years ago, our School of Medicine (SoM) planned a Cancer Center application to the National Cancer Institute (NCI) and asked me to be interim director of the Biostatistics Shared Resource in the application. A year later, SoM received the Cancer Center award and recruited Phil, who was Director of the VA Cooperative Studies Program in Palo Alto, to be Director of the Biostatistics Shared Resource and Chair of HRP. Phil asked me to stay at the Cancer Center as Co-director of the Biostatistics Shared Resource and to join HRP as courtesy faculty. This started our close collaboration on innovations in design and analysis of clinical trials for the development of new therapies and for comparative effectiveness research of approved treatments, paving the way for the approval of our proposed Center for Innovative Study Design (CISD) in 2009 by the Dean of SoM and a very favorable review of the Stanford Cancer Center by the NCI

FIG. 5. *Tze at Stanford Commencement in* 2014 *as department chair.*

FIG. 6. *Ying*, *Tze*, *Phil Lavori and Kevin Grimes*, 2019.

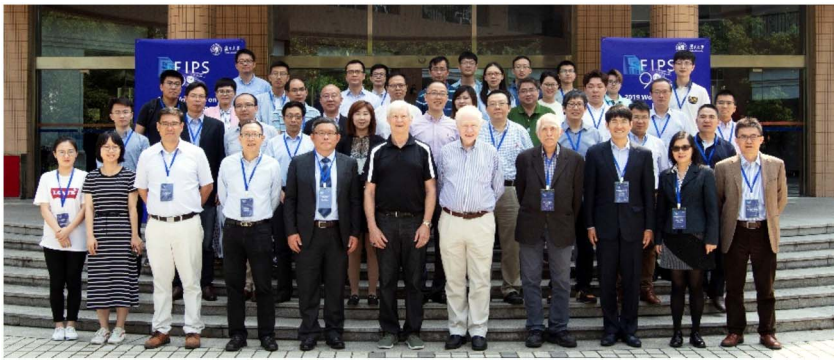

FIG. 7. *Tze*, *Per Mykland*, *Robert Engle*, *Shiyi Chen* (*Vice Dean of Fudan School of Economics*) *at* 2019 *FIPS*.

that granted the "Comprehensive Cancer Institute" designation to the Center in 2016. Concerning your question of how I managed to split time among my major tasks, I worked closely with Phil for the Cancer Center and CISD projects, and co-directors of FARM for the quantitative finance research projects, together with my graduate students (RAs and TAs), postdocs and visiting collaborators, toward the short-term goal of sustained growth of both centers and the long-term goal of achieving major impact and breakthroughs. More important was the critical mass for CISD to expand after you moved over from the VA Cooperative Studies Program to join the new Biomedical Data Science Department as full-time faculty in 2016 and to co-lead CISD; see Figure 6 on one of our leadership meetings. We finally were able to outreach to the FDA and the pharmaceutical and health care industries, capitalizing on the UCSF-Stanford Center for Excellence in Regulatory Science and Innovation (CERSI) and joining forces with the University of Maryland CERSI through annual workshops at Stanford or University of Maryland in Baltimore County.

**Ying:** You have published a number of books on a variety of topics after I became your colleague. In addition, you are on the advisory committees of a number of overseas research centers. How did you find time to write the books and travel overseas to meetings in the midst of your very busy schedule at Stanford?

**Tze:** Yes, I currently have a full teaching load of 3 courses per year plus administrative duties on committees besides advising students (undergraduates, master's-level and Ph.D.-level). Therefore, the time I can travel overseas to attend advisory meetings is quite limited and I have to bundle the trips so that I only take a few intercontinental flights on a yearly basis. I also incorporate book writing into these trips, during which I give lectures on certain topics of the books that I am writing up at that time. I also use some of the trips to host some of the professional meetings for which I am responsible. An example is the 2019 FIPS Workshop (on June 15–16) at Fudan University; see Figure 7. I chair the Finance, Insurance, Probability and Statistics (FIPS) section of the Institute of Mathematical Statistics (IMS) and the section has been holding an annual workshop since 2011. The ninth one this June was held as a satellite workshop of the annual conference of the Society of Financial Econometrics (SoFiE) that was held at Fudan on June 11–14. Accordingly, we were able to invite the 2003 Nobel laureate

FIG. 8. *Panelists and moderator in a panel discussion of the* 2019 *SCPKU Workshop*.

FIG. 9. *Zhiliang*, *Tze*, *Weijie Su*, *Hang Zhang*, *Ronghui Xu* (*from right to left*) *at Fudan*, 2018.

in economics Robert Engle and the SoFiE president Per Mykland as keynote speakers who attracted a large audience. I was in Beijing on June 6–12 to attend a CISD conference at Stanford Center at Peking University (SCPKU; see Figure 8) and then the ICCM (International Congress of Chinese Mathematicians) hosted by the Yau Center for Mathematical Sciences, of which I am a member on the international advisory committee. Related workshops in collaboration with the Fudan Institute for Big Data were also organized; see Figure 9.

**Dylan:** Your work with Ying and Phil Lavori at CISD has been catching wave after wave in translational medicine and regulatory science in the last decade, particularly in the past two years. What are some of the emerging trends in these fields that you are working on?

**Tze:** Actually, many of the waves you refer to were either started, or actively engaged in the development, by our medical colleagues at Stanford. They recognized the need for innovative study designs and analysis and approached us to work with them to fill the need. Our team had worked out very well with them, especially after Ying moved over in 2016 from the VA to co-lead the effort. Ying's move is very timely as Stanford School of Medicine has launched in the past two years new centers and institutes, including the Wu Tsai Neurosciences Institute, Center for Precision Mental Health and Wellness, Center for Innovation in Global Health, Center for Population Health Sciences and the Woods Institute for the Environment, in which I am a faculty affiliate and have begun working with Ying and other CISD members on these emerging trends and exciting new collaborations in translational neuroscience and psychiatry, evidence-based health interventions and management, health insurance analytics and technology.

**Zhiliang, Dylan and Ying:** Thank you so much for the time talking to us.

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