



Profesor

Malay Ghosh

DOKTOR HONORIS CAUSA

**Uniwersytetu Ekonomicznego
w Katowicach**

Professor

Malay Ghosh

DEGREE HONORIS CAUSA

**of the University of Economics
in Katowice**

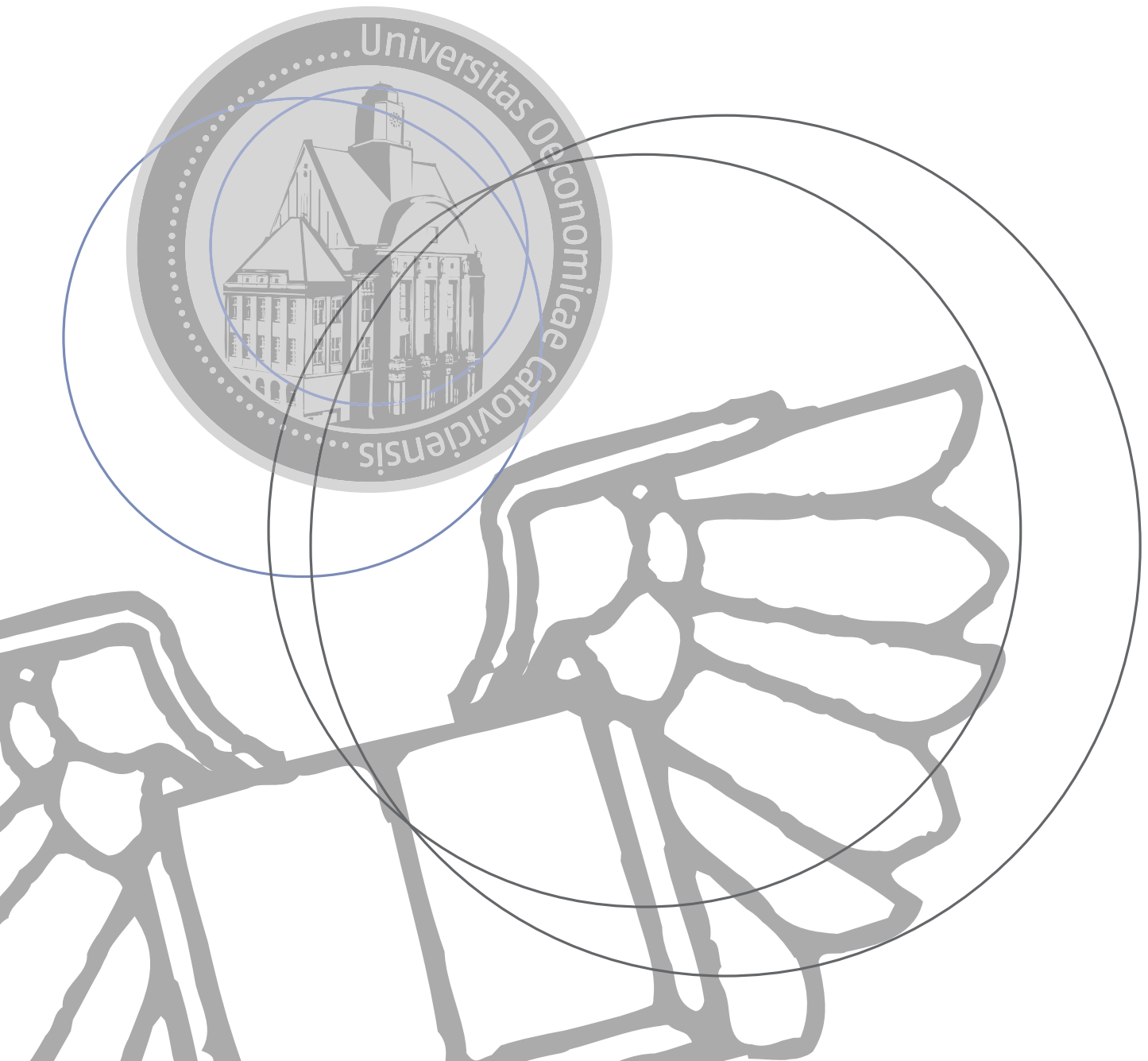


Uroczystość nadania
Profesorowi
Malayowi Ghoshowi
tytułu
doktora *honoris causa*
Uniwersytetu Ekonomicznego
w Katowicach

Ceremony of conferring upon
Professor
Malay Ghosh
the doctor *honoris causa* degree
of the University of Economics
in Katowice

Katowice
14 maja 2021 roku / 14 May 2021





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Słowo wstępne

Introduction

Szanowni Państwo,

Przed współczesnym Uniwersytetem stoją wyzwania prowadzenia badań naukowych na światowym poziomie, rozwijania współpracy międzynarodowej i popularyzacji nauki. Aby sprostać tym wyzwaniom, należy obserwować i doceniać w tym zakresie najlepsze praktyki uniwersytetów na świecie i pracujących tam badaczy.

Uniwersytet Ekonomiczny w Katowicach podejmując zadanie rozwoju naukowego, postanowił wyróżnić dokonania osoby, która będąc wybitnym naukowcem i niestrudzonym popularyzatorem nauki, jednocześnie współpracuje z naszą *Alma Mater*.

Osobą, która otrzymuje najwyższą godność akademicką – doktorat *honoris causa* – jest Pan Profesor Malay Ghosh, *Distinguished Professor* z University of Florida, światowy autorytet w zakresie teorii statystyki oraz jej zastosowań m. in. w naukach ekonomicznych i społecznych.

Pan Profesor Malay Ghosh jest nam szczególnie bliski ze względu na współpracę z Katedrą Statystyki, Ekonometrii i Matematyki w Kolegium Zarządzania.

Ladies and Gentlemen,

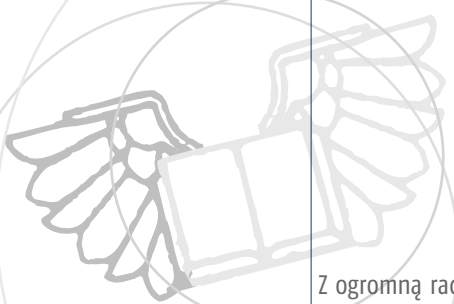
Today's university faces the challenge of conducting world-class scientific research, fostering international cooperation and disseminating scientific developments. With this end in view it is necessary to follow and acknowledge the best practices adopted by universities and their researchers across the world.

The University of Economics in Katowice, committed to the pursuit of scientific excellence, has resolved to recognise the achievements of an eminent scientist indefatigably involved in the popularisation of science, who works closely with our *Alma Mater*.

The person to be awarded the highest academic honour – the doctor *honoris causa* degree – is Professor Malay Ghosh, *Distinguished Professor* at the University of Florida, a world authority in the field of statistical theory and its applications in, *inter alia*, economic and social sciences.

Professor Malay Ghosh is our highly valued partner, who has been cooperating with the Department of Statistics, Econometrics and Mathematics at the College





Z ogromną radością przyjmujemy fakt, że Pan Profesor dostrzegł dokonania zespołu z Katowic, zaś wspólne pola zainteresowań naukowych przekładają się na konkretne inicjatywy, m. in. wykłady gościnne, międzynarodowe seminaria i publikacje.

Prof. Malay Ghosh tym samym stał się ambasadorem naszej Uczelni na świecie, dlatego z największym szacunkiem i ogromną radością nadajemy godność doktora *honoris causa*, włączając Pana Profesora w społeczność Uniwersytetu Ekonomicznego w Katowicach.

Vivat Academia, Vivant Professores!

Rektor Uniwersytetu Ekonomicznego w Katowicach
prof. dr hab. inż. Celina M. Olszak

Przewodniczący Kolegium Zarządzania
prof. dr hab. Wojciech Dyduch

Słowo wstępne/Introduction

of Management. We wholeheartedly welcome the fact that the accomplishments of the Katowice research team have caught Professor's attention, and that our shared scientific interests translate into specific initiatives, such as visiting lectures, international seminars and publications.

Professor Malay Ghosh has thereby become our University's global ambassador. It is, therefore, a great honour and pleasure to confer the degree of doctor *honoris causa* on Professor Ghosh and thus admit him into the community of the University of Economics in Katowice.

Vivat Academia, Vivant Professores!

Rector of the University of Economics in Katowice
Prof. Celina M. Olszak, Ph.D., D.Sc.

Head of the College of Management
Prof. Wojciech Dyduch, Ph.D.



Q.F.F



F.Q.S

SUMMIS AUSPICIIS
SERENISSIMAE REI PUBLICAE POLONORUM

NOS

RECTRIX MAGNIFICA UNIVERSITATIS OECONOMICAЕ CATOVICIENSIS
CAELIA M. OLSZAK
PROFESSOR DOCTOR HABILITATA INGENIARIUS SCIENTIARUM OECONOMICARUM

CATHEDRAE ARTIS STATISTICAЕ, OECONOMETRIAE ET MATHEMATICAE PRAEPOSITUS
UNIVERSITATIS OECONOMICAЕ CATOVICIENSIS
IANUSSIUS WYWIAŁ
PROFESSOR DOCTOR HABILITATUS SCIENTIARUM OECONOMICARUM
PROMOTOR RITE CONSTITUTUS

PRAECLARO VIRO

Malayo Ghosh

INSIGNI PROFESSORI UNIVERSITATIS FLORIDENSIS

EXCELLENTI DOCTO DE AUCTORITATE MUNDANA

RO MERITIS EIUS

ILLUSTRIBUS EFFECTIBUS SCIENTIFICIS IN DISCIPLINA ARTIS STATISTICAЕ EIUSQUE APPLICATIONUM,
ACTIVA DIVULGATIONE SCIENTIAE ATQUE PROMOVENDA INTERNATIONALI COOPERATIONE
SCIENTIFICA CUM UNIVERSITATE OECONOMICA CATOVICIENSI

SENATUS CONSULTO UNIVERSITATIS OECONOMICAЕ CATOVICIENSIS
EX DIE XXX MENSIS IANUARIИ ANNO MMXX

TRIBUIMUS TITULUM HONORIFICUM, IURA OMNIAQUE PRIVILEGIA

DOCTORIS HONORIS CAUSA
UNIVERSITATIS OECONOMICAЕ CATOVICIENSIS



CATOVICIAE DIE XIV MENSIS MAII ANNO MMXXI

PROF. DR HAB. IANUSSIUS WYWIAŁ
PROMOTOR RITE CONSTITUTUS

PROF. DR HAB. ING. CAELIA M. OLSZAK
H.T. RECTRIX MAGNIFICA

Dyplom

Diploma

Kalendarium

Schedule of events

28.11.2019

Senat Uniwersytetu Ekonomicznego w Katowicach postanawia wsząć postępowanie w sprawie nadania tytułu doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach Profesorowi Malayowi Ghoshowi oraz wyznaczyć:

1. Profesora dra hab. Janusza Wywiąła (Uniwersytet Ekonomiczny w Katowicach) na promotora,
2. Profesora Yvesa Bergera (Uniwersytet w Southampton) na recenzenta,
3. Profesora Ralfa Münnicha (Uniwersytet w Trewirze) na recenzenta

dorobku naukowego i osiągnięć Profesora Malaya Ghosha w postępowaniu w sprawie nadania mu tytułu doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach.

30.01.2020

Po zapoznaniu się z recenzjami Senat Uniwersytetu Ekonomicznego w Katowicach podejmuje uchwałę o nadaniu Panu Profesorowi Malayowi Ghoshowi tytułu doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach.

14.05.2021

Następuje uroczyste nadanie Panu Profesorowi Malayowi Ghoshowi doktoratu *honoris causa* Uniwersytetu Ekonomicznego w Katowicach.

The Senate of the University of Economics in Katowice resolves to initiate the proceedings aimed at conferring the degree of doctor *honoris causa* of the University of Economics in Katowice upon Professor Malay Ghosh. The Senate appoints:

1. Professor Janusz Wywiął (University of Economics in Katowice) as a supervisor,
2. Professor Yvesa Berger (University of Southampton) as a reviewer,
3. Professor Ralf Münnich (University of Trier) as a reviewer

of Prof. Malay Ghosh's scientific output and achievements in the said proceedings.

Having read the reviews, the Senate of the University of Economics in Katowice adopts a resolution to confer the degree of doctor *honoris causa* of the University of Economics in Katowice upon Professor Malay Ghosh.

The ceremony of the conferment of the degree of doctor *honoris causa* of the University of Economics in Katowice upon Professor Malay Ghosh takes place.





Malay Ghosh

Biografia

Biography

Dane osobowe:

- **Imię i nazwisko:**
Malay Ghosh
- **Data urodzenia:**
15.04.1944
- **Miejsce urodzin:**
Kalkuta, Indie
- **Stan cywilny:**
żonaty, dwoje dzieci
- **Obywatelstwo:**
amerykańskie
- **Adres służbowy:**
Department of Statistics
University of Florida
223 Griffin-Floyd Hall
P.O. Box 8545
Gainesville, FL 32611-8545

Wykształcenie:

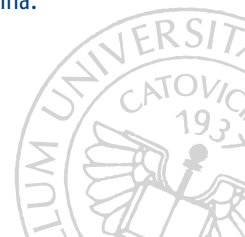
- Stopień licencjata w dziedzinie statystyki (z wyróżnieniem), 1962, Calcutta University; First Class First, Gold Medalist.
- Stopień magistra w dziedzinie statystyki, 1964, Calcutta University; First Class First, Gold Medalist.
- Stopień doktora nauk statystycznych, 1969, University of North Carolina, North Carolina.

Personal Information:

- **Name:**
Malay Ghosh
- **Date of birth:**
April 15, 1944
- **Place of birth:**
Calcutta, India
- **Marital status:**
Married with two children
- **Citizenship:**
American
- **Office address:**
Department of Statistics
University of Florida
223 Griffin-Floyd Hall
P.O. Box 8545
Gainesville, FL 32611-8545

Educational Qualifications:

- Graduated (B.A.) with Statistics (Honors) in 1962 from the Calcutta University, Calcutta; First Class First, Gold Medalist.
- Graduated (M.A.) in Statistics in 1964 from the Calcutta University, Calcutta; First Class First, Gold Medalist.
- Graduated (Ph.D.) in Statistics in 1969 from the University of North Carolina, North Carolina.





Doświadczenie zawodowe:

1. Lecturer in Statistics, Presidency College, Calcutta (kwiecień – sierpień 1966).
2. Research Assistant, Department of Statistics, UNC, Chapel Hill, NC (wrzesień – maj 1967).
3. Business Mathematician, Corporate Headquarters, IBM, Armonk, NY (czerwiec – sierpień 1967).
4. Research Assistant, Department of Statistics, UNC, Chapel Hill, NC (wrzesień 1967 – maj 1968).
5. Research Assistant, Department of Biostatistics, UNC Chapel Hill, NC (czerwiec 1968 – sierpień 1969).
6. Post Doctoral Fellow, Department of Biostatistics, UNC, Chapel Hill, NC (wrzesień 1969 – sierpień 1970).
7. Systems Engineer, IBM World Trade Corporation, Calcutta, India (listopad 1970 – styczeń 1971).
8. Associate Professor, Indian Statistical Institute, Calcutta, India (luty 1971 – październik 1977).
9. Visiting Associate Professor, Department of Biostatistics, UNC, Chapel Hill, NC (czerwiec 1974 – sierpień 1974).
10. Visiting Associate Professor, Department of Statistics, Iowa State University, Ames, IA (wrzesień 1974 – maj 1977).
11. Professor, Indian Statistical Institute, Calcutta, India (listopad 1977 – luty 1978).
12. Professor, Department of Statistics, Iowa State University, Ames, IA (marzec 1978 – lipiec 1982).
13. Professor, Department of Statistics, University of Florida, Gainesville, FL (sierpień 1982 – lipiec 1998).
14. Distinguished Professor, Department of Statistics, University of Florida, Gainesville, FL (sierpień 1998 – teraz).

Professional Experience:

1. Lecturer in Statistics, Presidency College, Calcutta (April – August 1966).
2. Research Assistant, Department of Statistics, UNC, Chapel Hill, NC (September – May 1967).
3. Business Mathematician, Corporate Headquarters, IBM, Armonk, NY (June – August 1967).
4. Research Assistant, Department of Statistics, UNC, Chapel Hill, NC (September 1967 – May 1968).
5. Research Assistant, Department of Biostatistics, UNC Chapel Hill, NC (June 1968 – August 1969).
6. Post Doctoral Fellow, Department of Biostatistics, UNC, Chapel Hill, NC (September 1969 – August 1970).
7. Systems Engineer, IBM World Trade Corporation, Calcutta, India (November 1970 – January 1971).
8. Associate Professor, Indian Statistical Institute, Calcutta, India (February 1971 – October 1977).
9. Visiting Associate Professor, Department of Biostatistics, UNC, Chapel Hill, NC (June 1974 – August 1974).
10. Visiting Associate Professor, Department of Statistics, Iowa State University, Ames, IA (September 1974 – May 1977).
11. Professor, Indian Statistical Institute, Calcutta, India (November 1977 – February 1978).
12. Professor, Department of Statistics, Iowa State University, Ames, IA (March 1978 – July 1982).
13. Professor, Department of Statistics, University of Florida, Gainesville, FL (August 1982 – July 1998).
14. Distinguished Professor, Department of Statistics, University of Florida, Gainesville, FL (August 1998 – thus far).

15. ASA Senior Research Fellow (styczeń 15, 1990 – lipiec 15, 1990): 50% at the Bureau of the Census; 50% at the Bureau of Labor Statistics.
 16. Eugene Lukacs Distinguished Visiting Professor of Statistics at the Bowling Green State University (jesień, 1993).
 17. Visiting Professor of Biostatistics, University of Minnesota (marzec – maj, 1994).
 18. ASA/NSF/Census Research Fellow (sierpień – grudzień, 2001).
 19. Visiting Professor, Texas A & M University (styczeń – kwiecień, 2002).
 20. Visiting Professor, Australian National University, Canberra, Australia (luty, 2006).
 21. ASA/NSF/Census Research Fellow (sierpień – grudzień, 2008).
 22. Visiting Professor, National University of Singapore (styczeń – kwiecień, 2009).
 23. Visiting Fellow, SAMSI (styczeń – kwiecień, 2014).
 24. Visiting Professor, University of Technology, Sydney (kwiecień, 2016).
15. ASA Senior Research Fellow (January 15, 1990 – July 15, 1990): 50% at the Bureau of the Census; 50% at the Bureau of Labor Statistics.
 16. Eugene Lukacs Distinguished Visiting Professor of Statistics at the Bowling Green State University (Fall, 1993).
 17. Visiting Professor of Biostatistics, University of Minnesota (March – May, 1994).
 18. ASA/NSF/Census Research Fellow (August – December, 2001).
 19. Visiting Professor, Texas A & M University (January – April, 2002).
 20. Visiting Professor, Australian National University, Canberra, Australia (February, 2006).
 21. ASA/NSF/Census Research Fellow (August – December, 2008).
 22. Visiting Professor, National University of Singapore (January – April, 2009).
 23. Visiting Fellow, SAMSI (January – April, 2014).
 24. Visiting Professor, University of Technology, Sydney (April, 2016).

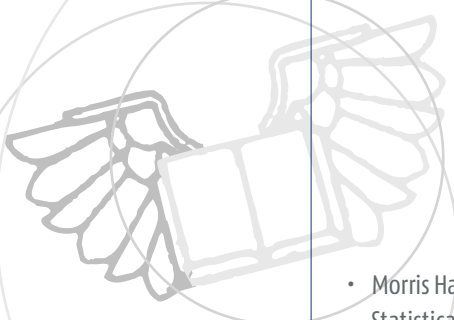
Wyróżnienia zawodowe:

- Elected Fellow of the American Statistical Association.
- Elected Fellow of the Institute of Mathematical Statistics.
- Elected Member of the International Statistical Institute.
- Elected Fellow of the International Society for Bayesian Analysis.

Professional Honor:

- Elected Fellow of the American Statistical Association.
- Elected Fellow of the Institute of Mathematical Statistics.
- Elected Member of the International Statistical Institute.
- Elected Fellow of the International Society for Bayesian Analysis.





- Morris Hansen Lecture organized by the Washington Statistical Society in 2018.

Nagrody:

- T.I.P., 1994.
- P.E.P., 1996.
- Medal im. Jerzego Sława-Neymana w 100. rocznicę Polskiego Towarzystwa Statystycznego, kwiecień 2012.
- Lifetime Achievement Award przyznana przez International Indian Statistical Association, grudzień 2017.
- Small Area Estimation Award 2019.
- Samuel S. Wilks Award from the American Statistical Association in 2020.

Doświadczenie redakcyjne:

1. Member of the Editorial Board of "Journal of Statistical Research".
2. Member of the Editorial Board of "Statistics in Transition".
3. Member of the Editorial Board of "Brazilian Journal of Statistics".
4. Editor of the „Sankhya B" (lipiec 2007 – grudzień 2011).
5. Editor of the "Sequential Analysis" (styczeń 1996 – grudzień 2003).
6. Editorial Secretary of the "Sankhya" (sierpień 1972 – lipiec 1974).
7. Member, Journal Committee of "Sankhya" A and B (sierpień 1976 – grudzień 1999).

- Morris Hansen Lecture organized by the Washington Statistical Society in 2018.

Awards:

- Recipient of T.I.P., 1994.
- Recipient of P.E.P., 1996.
- Jerzy Sława-Neyman Medal at the 100th Anniversary of the Polish Statistical Society, April 2012.
- Lifetime Achievement Award from the International Indian Statistical Association, December 2017.
- Small Area Estimation Award 2019.
- Samuel S. Wilks Award from the American Statistical Association in 2020.

Editorial Experience:

1. Member of the Editorial Board of "Journal of Statistical Research".
2. Member of the Editorial Board of "Statistics in Transition".
3. Member of the Editorial Board of "Brazilian Journal of Statistics".
4. Editor of the "The Indian Journal of Statistics – Official Journal of Indian Statistical Institute. Sankhya B" (July, 2007 – December, 2011).
5. Editor of the "Sequential Analysis: Design Methods and Applications" (January, 1996 – December, 2003).
6. Editorial Secretary of the "Sankhya" (August 1972 – July 1974).
7. Member of the "Journal Committee of Sankhya A and B" (August 1976 – December, 1999).

8. Associate Editor of the Book Reviews Section of the "Journal of the American Statistical Association" (listopad 1980 – luty 1983).
 9. Member of the Editorial Board of "Sequential Analysis" (styczeń 1981 – grudzień 1995).
 10. Member of the Advisory Board of "Statistics and Decisions" (listopad 1980 – grudzień 1988).
 11. Member of the Editorial Board of "Statistics and Decisions" (styczeń 1989 – grudzień 2001).
 12. Co-Editor of the Special Issue of "Communications in Statistics" entitled: "Stein-Type Multivariate Estimation" (1986).
 13. Member of the Editorial Board of "Communications in Statistics, Theory and Methods" (październik 1987 – grudzień 1994).
 14. Associate Editor of the "Journal of Nonparametric Statistics" (styczeń 1990 – grudzień 1992).
 15. Associate Editor of the "Journal of Statistical Planning and Inference" (styczeń 1992 – grudzień 1994).
 16. Adjunct Associate Editor of the "Annals of Statistics" (1994).
 17. Member of the Editorial Board of "Statistics" (lipiec 1994 – grudzień 2000).
 18. Co-Editor of the „Sankhya" (styczeń 2000 – grudzień 2007).
 19. Associate Editor of the "American Statistician" (styczeń 2000 – grudzień 2008).
 20. Associate Editor of the "Metron" (styczeń 2003 – grudzień 2006).
8. Associate Editor of the Book Reviews Section of the "Journal of the American Statistical Association" (November 1980 – February 1983).
 9. Member of the Editorial Board of "Sequential Analysis" (January 1981 – December, 1995).
 10. Member of the Advisory Board of "Statistics and Decisions" (November 1980 – December 1988).
 11. Member of the Editorial Board of "Statistics and Decisions" (January 1989 – December, 2001).
 12. Co-Editor of the Special Issue of "Communications in Statistics", entitled: "Stein-Type Multivariate Estimation" (1986).
 13. Member of the Editorial Board of "Communications in Statistics – Theory and Methods" (October 1987 – December, 1994).
 14. Associate Editor of the "Journal of Nonparametric Statistics" (January 1990 – December 1992).
 15. Associate Editor of the "Journal of Statistical Planning and Inference" (January 1992 – December, 1994).
 16. Adjunct Associate Editor of the "Annals of Statistics" (1994).
 17. Member of the Editorial Board of Statistics (July, 1994 – December, 2000).
 18. Co-Editor of the "Sankhya" (January, 2000 – December, 2007).
 19. Associate Editor of the "The American Statistician" (January, 2000 – December, 2008).
 20. Associate Editor of the "Metron" (January, 2003 – December, 2006).





Monografie:

- *Sequential Estimation* (with N. Mukhopadhyay and P.K. Sen). John Wiley and Sons, New York 1997.
- *Bayesian Methods for Finite Population Sampling* (with G. Meeden). Chapman and Hall, New York 1997.
- *Current Issues in Statistical Inference: Essays in Honor of D. Basu* (Co-Edited with P.K. Pathak). IMS Lectures Notes Monograph Series Number 17, Cambridge, MA 1992.

Wybrane artykuły (spośród 306 publikacji):

- *On Bounded Length Sequential Confidence Intervals Based on One-Sample Rank-Order Statistics* (with P.K. Sen) [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 189–203.
- *On a Class of Rank Order Tests for Regression with Partially Informed Stochastic Predictors* (with P.K. Sen) [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 650–661.
- *On the Wald Optimality of Rank-Order Tests for Paired Comparisons* [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 1970–1976.
- *Nonparametric Methods in Longitudinal Studies* (with J.E. Grizzle and P.K. Sen) [1973], "Journal of the American Statistical Association", Vol. 68, pp. 29–36.
- *A Law of Iterated Logarithm for One Sample Rank Order Statistics and an Application* (with P.K. Sen) [1973], "The Annals of Statistics", Vol. 1, pp. 568–576.
- *Nonparametric Selection Procedures for Symmetric*

Monographs:

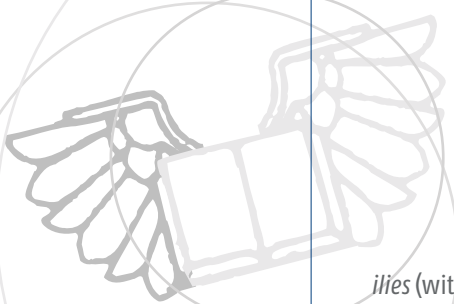
- *Sequential Estimation* (with N. Mukhopadhyay and P.K. Sen). John Wiley and Sons, New York 1997.
- *Bayesian Methods for Finite Population Sampling* (with G. Meeden). Chapman and Hall, New York 1997.
- *Current Issues in Statistical Inference: Essays in Honor of D. Basu* (Co-Edited with P.K. Pathak). IMS Lectures Notes Monograph Series Number 17, Cambridge, MA 1992.

Selected papers (out of 306 publications):

- *On Bounded Length Sequential Confidence Intervals Based on One-Sample Rank-Order Statistics* (with P.K. Sen) [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 189–203.
- *On a Class of Rank Order Tests for Regression with Partially Informed Stochastic Predictors* (with P.K. Sen) [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 650–661.
- *On the Wald Optimality of Rank-Order Tests for Paired Comparisons* [1971], "The Annals of Mathematical Statistics", Vol. 42, pp. 1970–1976.
- *Nonparametric Methods in Longitudinal Studies* (with J.E. Grizzle and P.K. Sen) [1973], "Journal of the American Statistical Association", Vol. 68, pp. 29–36.
- *A Law of Iterated Logarithm for One Sample Rank Order Statistics and an Application* (with P.K. Sen) [1973], "The Annals of Statistics", Vol. 1, pp. 568–576.
- *Nonparametric Selection Procedures for Symmetric*

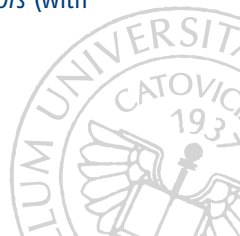
- Location Parameter Populations* [1973], "The Annals of Statistics", Vol. 1, pp. 773–779.
- *Sequential Rank Tests for Location* (with P.K. Sen) [1974], "The Annals of Statistics", Vol. 2, pp. 540–552.
 - *Admissibility of Minimality of Some Maximum Likelihood Estimators When the Parameter Space Is Restricted to Integers* [1975], "Journal of the Royal Statistical Society", Series B, Vol. 37, pp. 264–271.
 - *On the Nonattainability of Chebyshev Bounds* (with G. Meeden) [1977], "The American Statistician", Vol. 31, pp. 35–36.
 - *Probability of Moderate Deviations for Stationary Mixing Processes* (with G. Jogesh Babu) [1977], "The Annals of Probability", Vol. 5, pp. 222–234.
 - *Admissibility of Linear Estimators in the One-Parameter Exponential Family* (with G. Meeden) [1977], "The Annals of Statistics", Vol. 5, pp. 772–778.
 - *Sequential Point Estimation of the Difference of Two Normal Means* (with N. Mukhopadhyay) [1980], "The Annals of Statistics", Vol. 8, pp. 221–225.
 - *Admissibility in Finite Problems* (with G. Meeden) [1981], "Annals of Statistics", Vol. 9, pp. 846–852.
 - *A Note of Strong Unimodality of Order Statistics* (with J. Huang) [1982], "Journal of the American Statistical Association", Vol. 77, pp. 929–930.
 - *Choosing between Experiments: Applications in Finite Population Sampling* (with G. Meeden) [1983], "The Annals of Statistics", Vol. 11, pp. 296–305.
 - *Construction of Improved Estimators for Multiparameter Estimation in Discrete Exponential Fam-*
- Location Parameter Populations* [1973], "The Annals of Statistics", Vol. 1, pp. 773–779.
- *Sequential Rank Tests for Location* (with P.K. Sen) [1974], "The Annals of Statistics", Vol. 2, pp. 540–552.
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 - *Probability of Moderate Deviations for Stationary Mixing Processes* (with G. Jogesh Babu) [1977], "The Annals of Probability", Vol. 5, pp. 222–234.
 - *Admissibility of Linear Estimators in the One-Parameter Exponential Family* (with G. Meeden) [1977], "The Annals of Statistics", Vol. 5, pp. 772–778.
 - *Sequential Point Estimation of the Difference of Two Normal Means* (with N. Mukhopadhyay) [1980], "The Annals of Statistics", Vol. 8, pp. 221–225.
 - *Admissibility in Finite Problems* (with G. Meeden) [1981], "Annals of Statistics", Vol. 9, pp. 846–852.
 - *A Note of Strong Unimodality of Order Statistics* (with J. Huang) [1982], "Journal of the American Statistical Association", Vol. 77, pp. 929–930.
 - *Choosing between Experiments: Applications in Finite Population Sampling* (with G. Meeden) [1983], "The Annals of Statistics", Vol. 11, pp. 296–305.
 - *Construction of Improved Estimators for Multiparameter Estimation in Discrete Exponential Fami-*

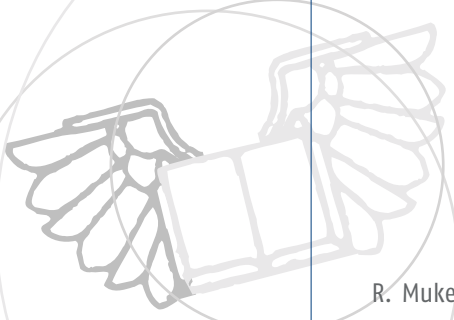




- ilies* (with J.T. Hwang and K.W. Tsui) (with discussion) [1983], "The Annals of Statistics", Vol. 11, pp. 351–376.
- *A Note on Bootstrapping the Median* (with W.C. Parr, K. Singh and G.J. Babu) [1984], "The Annals of Statistics", Vol. 12, pp. 1130–1135.
 - *A New Bayesian Analysis of a Random Effects Model* (with G. Meeden) [1984], "Journal of the Royal Statistical Society", Series B, Vol. 46, pp. 474–482.
 - *Some Admissible Nonparametric and Finite Population Sampling Estimators* (with G. Meeden and S. Vardeman) [1985], "The Annals of Statistics", Vol. 13, pp. 811–817.
 - *Empirical Bayes Estimation in Finite Population Sampling* (with G. Meeden) [1986], "Journal of the American Statistical Association", Vol. 81, pp. 1058–1062.
 - Discussion: *Jackknife, Bootstrap and Other Resampling Schemes* by C.F.J. Wu, [1986], "The Annals of Statistics", Vol. 14, pp. 1308–1310.
 - *Sequential Shrinkage Estimation* (with D.M. Nickerson and P.K. Sen) [1987], "The Annals of Statistics", Vol. 15, pp. 817–829.
 - *Robust Empirical Bayes Estimation of Means from Stratified Samples* (with P. Lahiri), [1987], "Journal of the American Statistical Association", Vol. 82, pp. 1153–1162.
 - *Simultaneous Estimation of Poisson Means under Entropy Loss* (with M.C. Yang), [1988], "The Annals of Statistics", Vol. 16, pp. 278–291.
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 - *Simultaneous Estimation of Poisson Means under Entropy Loss* (with M.C. Yang), [1988], "The Annals of Statistics", Vol. 16, pp. 278–291.

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 - *Median Unbiasedness and Pitman Closeness* (with P.K. Sen) [1989], "Journal of the American Statistical Association", Vol. 84, pp. 1089–1091.
 - *Bayesian Prediction in Linear Models: Applications to Small Area Estimation* (with G.S. Datta) [1991]. "The Annals of Statistics", Vol. 19, pp. 1148–1170.
 - *Constrained Bayes Estimation with Applications* [1992]. "Journal of the American Statistical Association", Vol. 87, pp. 533–540.
 - *Some Remarks on Noninformative Priors* (with G.S. Datta) [1995]. "Journal of the American Statistical Association", Vol. 90, pp. 1157–1163.
 - *On the Invariance of Noninformative Priors* (with G.S. Datta) [1996]. "The Annals of Statistics", Vol. 24, pp. 141–159.
 - *Wishart Distribution via Induction* [1996]. "The American Statistician", 50, 243–246.
 - *Estimation of Median Income of Four–Person Families: A Bayesian Time Series Approach* (with N. Nangia and D. Kim) [1996]. "Journal of the American Statistical Association", Vol. 91, pp. 1423–1431.
 - *Second Order Probability Matching Priors* (with
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 - *Bayesian Prediction in Linear Models: Applications to Small Area Estimation* (with G.S. Datta) [1991]. "The Annals of Statistics", Vol. 19, pp. 1148–1170.
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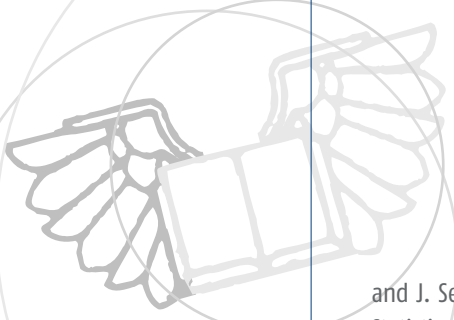




- R. Mukerjee) [1997]. "Biometrika", Vol. 84, pp. 970–975.
- *Noninformative Priors for Dispersion Models* (with C. Garvan) [1997]. "Biometrika", Vol. 84, pp. 976–982.
 - *Generalized Linear Models for Small Area Estimation* (with K. Natarajan, T.W.F. Stroud and B. Carlin) [1998]. "Journal of the American Statistical Association", Vol. 93, pp. 273–282.
 - *Bayesian Prediction with Approximate Frequentist Validity* (with G.S. Datta, R. Mukerjee and T. Sweeting) [2000]. "The Annals of Statistics", Vol. 28, pp. 1414–1426.
 - *An Elementary Derivation of the Wishart Distribution* (with B.K. Sinha) [2002]. "The American Statistician", Vol. 56, pp. 132–133.
 - *On an Exact Probability Matching Property of Right-Invariant Priors* (with T. Severini and R. Mukherjee) [2002]. "Biometrika", Vol. 89, pp. 952–957.
 - *Small Area Estimation Based on NEF-QVF Models and Survey Weights* (with T. Maiti) [2004]. "Biometrika", Vol. 91, pp. 95–112.
 - *Hierarchical Bayesian Neural Networks: An Application to Prostate Cancer Study* (with T. Maiti, D. Kim and A. Tiwari) [2004]. "Journal of the American Statistical Association", Vol. 99, pp. 601–608.
 - *Bayesian Classification of Tumors using Gene Expression Data* (with B.K. Mallick and D. Ghosh) [2005]. "Journal of the Royal Statistical Society", Series B, Vol. 67, pp. 219–234.
 - *Semiparametric Bayesian Analysis of Matched Case-Control Studies with Missing Exposure* (with R. Mukerjee) [1997]. "Biometrika", Vol. 84, pp. 970–975.
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- *Nonsubjective Priors via Predictive Entropy Loss* (with T.J. Sweeting and G.S. Datta) [2006]. "The Annals of Statistics", Vol. 34, pp. 441–468.
 - *Characteristic Functions without Contour Integration* (with G.S. Datta) [2007]. "The American Statistician", Vol. 61, pp. 67–70.
 - *Relative Performance of Classifiers for High-Dimensional Data and Small Sample Sizes* (with P. Hall and Y. Pittelkow) [2008]. "Journal of the Royal Statistical Society", Series B, Vol. 70, pp. 159–173.
 - *Influence Functions and Robust Bayes and Empirical Bayes Small Area Estimation* (with T. Maiti and A. Roy) [2008]. "Biometrika", Vol. 95, pp. 573–585.
 - *Empirical Bayes Estimation for Additive Hazards Regression Models* (with D. Sinha, B. McHenry, S. Lipsitz) [2009]. "Biometrika", Vol. 96, pp. 545–558.
 - *Empirical Likelihood for Small Area Estimation* (with S. Chaudhuri) [2011]. "Biometrika", Vol. 98, pp. 473–480.
 - *Benchmarking Small Area Estimators* [2013] (with W.R. Bell and G.S. Datta). "Biometrika", Vol. 100, pp. 189–202.
 - *Empirical Bayes Benchmarked Small Area Estimators under Multiplicative Models* (with T. Kubokawa and Y. Kawakubo) [2015]. "Biometrika", Vol. 102, pp. 647–659.
 - *Global-local Shrinkage Priors for Modelling Random Effects in Small Area Estimation* (with X.Tang, N.-S. Ha
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 - *Relative Performance of Classifiers for High-Dimensional Data and Small Sample Sizes* (with P. Hall and Y. Pittelkow) [2008]. "Journal of the Royal Statistical Society", Series B, Vol. 70, pp. 159–173.
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 - *Benchmarking Small Area Estimators* [2013] (with W.R. Bell and G.S. Datta). "Biometrika", Vol. 100, pp. 189–202.
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and J. Sedransk) [2018]. "Journal of the American Statistical Association", Vol. 113, pp. 1476–1489.

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- *Hierarchical Bayes versus Empirical Bayes Density Predictors under General Divergence Loss* (with T. Kubokawa) [2019]. "Biometrika", Vol. 106, pp. 495–500.
- ... i 9 artykułów prasowych w druku.

Inne osiągnięcia:

- Wypromowanie 60 doktorantów.
- Realizacja 31 grantów (główny wykonawca lub współgłówny wykonawca w 29 grantach) m.in. z National Science Foundation, Army Research Office, University of Florida, Census Bureau, National Institutes of Health, Centers for Disease Control and Prevention, National Security Agency, The United States Department of Agriculture.
- Wygłoszenie 83 wykładów na zaproszenie, 47 wykładów specjalnych na zaproszenie, 123 prezentacji na zaproszenie, przeprowadzenie 11 krótkich kursów teoretycznych i praktycznych.
- Przewodniczący i członek 79 komitetów m.in. w Iowa State University, University of Florida, International Society for Bayesian Analysis, Institute of Mathematical Statistics, American Statistical Association.

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- ... and 9 papers in press.

Other achievements:

- Supervision of 60 Ph. Ds.
- 31 grants (in 29 as Principal Investigator or Co-principal Investigator) from, i.a., National Science Foundation, Army Research Office, University of Florida, Census Bureau, National Institutes of Health, Centers for Disease Control and Prevention, National Security Agency, The United States Department of Agriculture.
- 83 invited lectures, 47 special invited lectures, 123 invited presentations, 11 tutorials and short courses.
- Chair and member of 79 committees of, i.a., Iowa State University, University of Florida, International Society for Bayesian Analysis, Institute of Mathematical Statistics, American Statistical Association.





Laudacja

Eulogy

prof. dr hab. Janusz Leszek Wywiół **Prof. Janusz Leszek Wywiół, Ph.D.**

*Magnificencjo, Wysoki Senacie,
Dostojny Doktorancie, Szanowni Goście*

Decyzją Senatu Uniwersytetu Ekonomicznego w Katowicach powierzono mi pełnienie zaszczytnej roli promotora w przewodzie o nadanie tytułu doktora *honoris causa* naszej Uczelni wybitnemu uczonemu Malayowi Ghoshowi, *distinguished Professor of University of Florida*.

Ojczyznę liczb są Indie, skąd m.in. wywodzi się system dziesiętny ich zapisu. Wszelkie dane o zjawiskach otaczających człowieka są kodowane za pomocą liczb. Analizę danych zajmują się statystycy. Wielu znanych na świecie statystyków pochodzi właśnie z Indii. Wśród nich jest również nasz dostojny gość Profesor Malay Ghosh, który urodził się 15 kwietnia 1944 r. w Kalkucie w Indiach.

Profesor Malay Ghosh swoją edukację uniwersytecką rozpoczął wybierając kierunki studiów związane ze statystyką, co jak się okazało, było bardzo dobrym początkiem jego późniejszych sukcesów. Studia licencjackie i magisterskie o profilu statystycznym ukończył odpowiednio w 1962 i 1964 r., w wieku 18 i 20 lat w Calcutta University, uzyskując stypendia West Bengal Government Junior Scholarship, West Bengal Government Senior Scholarship, National Scholarship Certificate

*Your Magnificence, Senate Members,
Honorable Conferee, Ladies and Gentlemen*

By decision of the Senate of the University of Economics in Katowice I have been entrusted with the honourable role of supervisor of the proceedings initiated to confer the honorary doctor's degree of our University upon prominent scientist, Professor Malay Ghosh, distinguished professor of the University of Florida.

The motherland of numbers is India, where i.a. the decimal system of their recording is derived from. All the data concerning phenomena surrounding man is encoded by means of numbers. Statisticians deal with data analysis, and it is from India that many world-famous statisticians come from. One of them is our honourable guest, Professor Malay Ghosh, who was born on 15 April 1944 in Calcutta, India.

Professor Malay Ghosh began his university education choosing courses related to statistics, which turned out to be a fortunate springboard into his later success. He completed his under-graduate and graduate courses in statistics in 1962, at the age of 18, and in 1964, at 20, respectively. As a student he was awarded The West Bengal Government Junior Scholarship, The West Bengal





and Post Graduate Merit Scholarship. Zarówno pierwszy, jak i drugi stopień studiów ukończył jako złoty medalista First Class First oraz Gold Medalist. To otworzyło mu drogę na studia doktorskie w University of North Carolina at Chapel Hill (UNC) w Stanach Zjednoczonych, które rozpoczął w 1966 r.

Kariera akademicka Profesora przebiegała w typowo amerykańskim stylu. Pracował jako asystent oraz adiunkt w katedrach statystyki lub biostatystyki, ale też jako matematyk albo inżynier systemów w korporacji IBM. W 1969 r., w wieku 25, uzyskał stopień doktora za dysertację pt. *Asymptotically optimal nonparametric tests for miscellaneous problems of linear regression*, którą napisał pod kierunkiem Pranaba K. Sena. W latach 1971–1978 pracował jako profesor nadzwyczajny Indian Statistical Institute. Od 1974 r. był zatrudniony przez osiem lat jako profesor w Katedrze Statystyki w Iowa State University. Natomiast od 1982 r. po dzień dzisiejszy pracuje w Katedrze Statystyki w University of Florida najpierw jako *professor*, a od 1998 jako *distinguished professor* po ukazaniu się w 1997 r. w renomowanych wydawnictwach dwóch monografii naukowych, których był współautorem. Ponadto odwiedził jako profesor wizytujący siedem uniwersytetów na świecie (poza USA), a wśród nich National University of Singapore oraz University of Technology w Sydney. Szeroka wiedza Profesora pozwala na prowadzenie wykładów na różne tematy, takie jak: zaawansowane wnioskowanie statystyczne, teoria decyzji, teoria bayesowska, analiza wielowymiarowa, analiza sekwencyjna i teoria niezawodności.

Government Senior Scholarship, The National Scholarship Certificate and Post Graduate Merit Scholarship. He completed his undergraduate, as well as his graduate course as a First Class First and Gold Medalist. This enabled him to enrol on a Ph.D. course at the University of North Carolina at Chapel Hill in the United States, where in 1969 he obtained his doctor's degree following a dissertation entitled *Asymptotically optimal nonparametric tests for miscellaneous problems of linear regression*, written under the supervision of Pranab K. Sen.

Professor Malay Ghosh's academic career was typically American in style. He began his Ph.D. course at the University of North Carolina in 1966 and worked as a research assistant and lecturer at the departments of statistics and biostatistics, but also as a business mathematician and a systems engineer for IBM. From 1971 to 1978 he worked as an associate professor at the Indian Statistical Institute. For eight years, beginning in 1974, he was employed as a professor at the Department of Statistics of Iowa State University. Since 1982 up to the present day Professor Malay Ghosh has worked at the Department of Statistics of the University of Florida, first as a professor, and next as a distinguished professor, after two monographs co-authored by him were published by two renowned publishing houses. Besides, as a visiting professor he has lectured at seven universities outside the US, including the National University of Singapore and the University of Technology in Sydney.

Professor Ghosh's extensive knowledge enables him to lecture on a variety of topics including advanced

Niewątpliwie najważniejszym aspektem działalności akademickiej Profesora Malaya Ghosha są jego prace naukowe, które wzbogacają zasoby wiedzy teoretycznej, jak i stosowanej w dziedzinie statystyki. Wiele spośród nich ma znaczenie fundamentalne i są powszechnie cytowane. Wymieńmy kilka z nich, które zasługują na szczególne podkreślenie, m.in. z powodu ich znaczenia w naukach ekonomicznych.

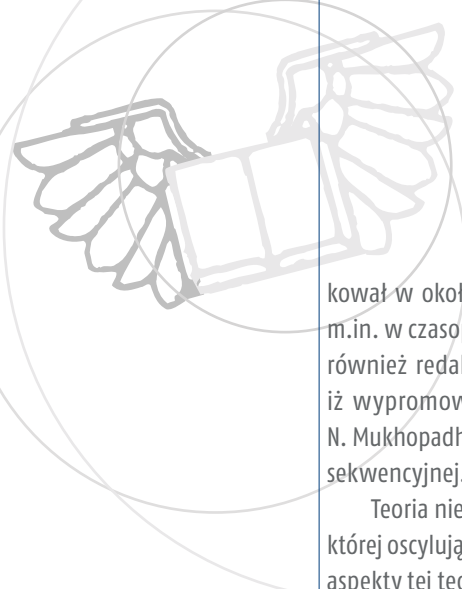
Pierwszym szerokim tematem jest estymacja sekwencyjna, m.in. bezpośrednio związana z kryterium maksymalizacji ekonomicznej efektywności przy ograniczonych nakładach. Profesor, wraz z N. Mukhopadhyayem i P.K. Senem, napisał monografię pod tytułem: *Sequential estimation*, która została wydana przez John Wiley & Sons w 1997 r. Ta do dziś ceniona książka prezentuje racjonalne metody sukcesywnego zwiększania rozmiaru próby, tak aby została osiągnięta postulowana dokładność estymacji. Dlatego te metody wnioskowania istotnie uzupełniają możliwości estymacji parametrów w praktyce badań statystycznych. W monografii znajdziemy syntezę ówczesnego dorobku naukowego w dziedzinie estymacji sekwencyjnej wzbogaconą o pewne nowe propozycje, dotyczące m.in. uogólnień metod wnioskowania na przypadek jednoczesnej estymacji wielu parametrów i wyznaczania dla nich obszarów ufności. Podkreślimy, że stosowanie w praktyce badań statystycznych metod estymacji sekwencyjnej pozwala przede wszystkim na istotne oszczędności środków na nie przeznaczanych. Inne osiągnięcia w dziedzinie estymacji sekwencyjnej Profesor Malay Ghosh opubli-

statistical inference, decision theory, Bayesian theory, multidimensional analysis, sequential analysis as well as reliability theory.

Professor Malay Ghosh's research works, which continually enrich the resource of theoretical and applied statistics, are undoubtedly the most important aspect of his academic activity. Many of them are of fundamental significance and are widely cited. Let us enumerate some of those which deserve particular attention owing to their significance in economics.

The first broad area is sequential estimation, which, among others, is directly related to the criterion of maximizing economic effectiveness with limited outlays. Professor Ghosh, together with N. Mukhopadhyay and P.K. Sen, wrote a monograph entitled *Sequential estimation*, which was published by John Wiley & Sons, Inc. in 1997. This book, highly regarded up to the present day, presents methods of increasing the sample size gradually, so as to achieve the posited accuracy of estimation. This is why these inference methods substantially complement the range of parameter estimation possibilities in the practice of statistical research. In this book we can find a synthesis of the scientific achievements in the field of sequential estimation at that time, enriched with certain new proposals concerning, among others, the generalization of inference methods onto the case of simultaneous estimation of many parameters and determining confidence sets for them. Let us emphasize that applying sequential estimation methods in the practice of statistical research allows considerable economies in





kował w około dwudziestu pięciu artykułach, w tym m.in. w czasopiśmie „Sequential Analysis”, którego był również redaktorem. Ponadto warto zwrócić uwagę, iż wypromowane przez Profesora prace doktorskie N. Mukhopadhyaya oraz D. Nickersona dotyczą estymacji sekwencyjnej.

Teoria niezawodności, jest drugą dziedziną, wokół której oscylują zainteresowania Profesora. Ekonomiczne aspekty tej teorii są związane m.in. z szeroko pojętymi ubezpieczeniami, a w szczególności z ustalaniem okresów gwarancji na sprzedawane produkty, którą wyznacza się na podstawie oczekiwanego czasu niezawodnego działania urządzenia. Z innej strony oceny oczekiwanego czasu bezwypadkowej jazdy kierowcy mają kluczowe znaczenie przy wyznaczaniu stawek ubezpieczenia komunikacyjnego. Blisko z tymi problemami wiążą się zainteresowania Malaya Ghosha dotyczące zagadnień tzw. ryzyk konkurujących, także będących elementem teorii niezawodności. Profesor, stosując metody bayesowskie, ma tu znaczące osiągnięcia w porównaniu z pracami opartymi na podejściu niebayesowskim. Prace Profesora wykorzystujące wnioskowanie bayesowskie mają prekursorskie znaczenie w badaniach praktycznych. W szczególności artykuł o estymacji udziału osób pozostających bez ubezpieczenia zdrowotnego opublikowany w „Survey Methodology” w 2009 r. dotyczy ubezpieczeń społecznych i polityki społecznej. Inna praca, opublikowana w „Journal of Multivariate Analysis” w 2006 r., dotyczy bayesowskich modeli przestrzennych częstości wypadków drogowych. Można ją również zaklasyfikować

allocated resources. Professor Malay Ghosh published his achievements in the field of sequential estimation in about 25 research papers, which appeared, among others, in “Sequential Analysis”, a journal whose editor he was. Besides, it is also noteworthy that the Ph.D. dissertations of N. Mukhopadhyay and D. Nickerson, supervised by Professor Ghosh, were also concerned with sequential estimation.

Reliability theory is the second area of Professor Ghosh's scientific interest. The economic aspects of this theory are related, among others, to insurance in general, and in particular to determining guarantee cover periods for products offered for sale, which are established on the basis of the estimated reliable operation time of a device. On the other hand, estimating a driver's expected accident-free time of service is of key significance in setting motor insurance premiums. Closely related to these problems are Professor Ghosh's interests in the issue of so-called competing risks, which constitute part of reliability theory. Using Bayesian methods, Professor Ghosh achieved considerable success in comparison with works based on the non-Bayesian approach. Professor Ghosh's works using Bayesian inference are of pioneering significance for practical research, particularly the article on estimating the proportion of people not covered by health insurance, also concerned with social security and social policy and published in “Survey Methodology” in 2009. Another article, published in “The Journal of Multivariate Analysis” in 2006, deals with Bayesian spatial models of traffic accident incidence. This article


do obszaru szeroko rozumianej ekonometrii przestrzennej. Zwróćmy uwagę, że mamy tu do czynienia ze swego rodzaju podobieństwem tego fragmentu dorobku naukowego Profesora Malaya Ghosha i dorobku Profesora Jeana H.P. Paelincka z Holenderskiego Instytutu Ekonomicznego (Netherland Economic Institute), któremu w 1987 r. Uniwersytet Ekonomiczny (ówczesnie Akademia Ekonomiczna) w Katowicach nadał tytuł doktora honoris causa za prekursorskie zasługi w dziedzinie ekonometrii przestrzennej. Dodajmy jeszcze, że teorii niezawodności dotyczą wypowiedziane przez Profesora doktoraty N. Ebrahimiego oraz C. P. Wanga.

Statystyka małych obszarów jest kolejną dziedziną, która aż do dziś stanowi szczególnie pole zainteresowań Profesora. Jedną z ważniejszych prac, którą można zaliczyć do tego tematu, jest monografia opublikowana w 1997 r. przez Chapman & Hall pt.: *Bayesian methods for finite population sampling*, którą Professor M. Ghosh napisał wraz z G. Mideedenem. Dotyczy ona ówczesnie najnowszych możliwości zastosowania wnioskowania bayesowskiego w metodzie reprezentacyjnej. Konstruowano tu probabilistyczne modele generowania obserwacji zmiennych w populacji skończonej, co dawało różne nowe możliwości estymacji parametrów tych zmiennych. Procedury estymacji bayesowskiej z uwzględnieniem jej empirycznej wersji wykorzystano do oceny średniej na podstawie prób warstwowych i wielostopniowych. Daje to solidne podstawy teoretyczno-metodologiczne do estymacji średnich na podstawie m.in. danych obserwowanych w badaniach ankietowych lub pochodzących

can also be classified as one representing the field of spatial econometrics in a broad sense. Let us note that we can witness here a unique encounter of the scientific output of Professor Ghosh with that of Professor Jean H.P. Paelinck of the Netherland Economic Institute, to whom the University of Economics in Katowice awarded the honorary doctor's degree in 1987 for his pioneering contribution to spatial econometrics. Let us also add that the Ph.D. dissertations of N. Ebrahimi and C.P. Wang, supervised by Professor Ghosh, also concerned reliability theory.

Small area estimation is another field which has been of special interest to Professor Ghosh up to the present day. A major work which falls under this category is the monograph published by Chapman & Hall in 1997, entitled *Bayesian Methods for finite population sampling*, which Professor M. Ghosh co-authored with G. Mideeden. The book deals with the latest modes of applying Bayesian inference to the survey sampling method. Probabilistic models of generating observations of variables in a finite population were devised in it. This created new modes of estimating the parameters of those variables. Procedures of Bayesian inference together with its empirical version were used to estimate a mean based on stratified or multi-stage samples. This creates solid theoretical and methodological foundations for estimating means on the basis of data observed in surveys and obtained from administration records. These procedures are therefore useful for statistical offices, and organizations dealing with consumer market research





z rejestrów administracyjnych. Zatem te procedury są przydatne np. dla urzędów statystycznych oraz firm zajmujących się badaniem rynków konsumpcyjnych lub badaniem opinii społecznej. Dodajmy jeszcze, iż monografia zapoczątkowała cykl artykułów dotyczących wnioskowania bayesowskiego, a zwłaszcza empirycznej albo hierarchicznej estymacji bayesowskiej. Prace Profesora dotyczące statystyki małych obszarów wykorzystują metody estymacji bayesowskiej, obok innych metod wnioskowania statystycznego o bardziej złożonych modelach badanych populacji występujących w analizach ekonomicznych. Podyktowane to jest potrzebą możliwie najbardziej dokładnej estymacji parametrów podpopulacji zwanych domenami przy małej i zwykle jeszcze losowej liczbie obserwacji zmiennych badanych. Ma to ogromne znaczenie w badaniach ekonomicznych. Zachodzi tu potrzeba poszukiwania oryginalnych metod estymacji lub adaptacji już istniejących procedur, znanych np. w teorii tzw. uogólnionych modeli liniowych. Tym wyzwaniom sprostały liczne artykuły Profesora, dając podstawy wnioskowania wykorzystywanego w statystyce małych obszarów. M. Ghosh swoje poglądy na wiele aspektów wnioskowania w statystyce małych obszarów przedstawia wraz z J.N.K. Rao w artykule *Small area estimation: An appraisal*, opublikowanym w „Statistical Science” 1994, który miał znaczący wpływ na kierunki badań w tym zakresie, o czym świadczą bardzo wysokie wskaźniki cytowań notowane w różnych bazach. Profesor M. Ghosh realizował co najmniej dziesięć grantów związanych

and public opinion polls. Let us also add that the book initiated a series of articles on Bayesian inference, as well as empirical and hierarchical Bayesian estimation. Professor Ghosh's works on small area estimation use Bayesian estimation methods along with other methods of statistical inference used for more complex models of studied populations, which occur in economic analyses. This is determined by the need for the possibly most accurate estimation of parameters in subpopulations called domains with a small and usually random number of observations of the variables in question. This is of great significance in economic research. There arises a need to search for original estimation methods or to adapt already existing procedures known, for instance, in the theory of generalized linear models. Professor Ghosh's numerous articles rose to this challenge by creating the foundations for inference used in small area estimation. He presents his views on many aspects of inference in small area estimation jointly with J.N.K. Rao in the article entitled *Small area estimation: An appraisal*, published in “Statistical Science” in 1994. This article considerably influenced research trends in that field, which is proved by the very high citation indexes recorded in various bases.

Professor Ghosh has carried out at least 10 grants related to small area estimation. Particular examples of these projects were *Parametric and semiparametric Bayesian methods for small area estimation* and *Empirical and hierarchical Bayesian methods with applications to small area estimation*. Professor Ghosh conducted

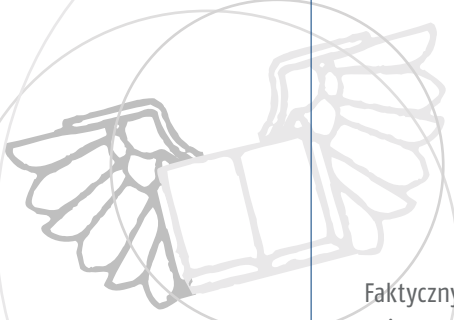
ze statystyką małych obszarów. W szczególności tymi projektami były: *Parametric and semiparametric Bayesian methods for small area estimation* oraz *Empirical and Hierarchical Bayesian methods with applications to small area estimation*. Profesor prowadził cztery kursy z zakresu statystyki małych obszarów, a wśród nich *Model-dependent small area estimation: Theory and practice* na Uniwersytecie w Jyväskylä. Zaslugi w zakresie wzbogacania wiedzy statystycznej w szeroko rozumianej dziedzinie statystyki małych obszarów oraz estymacji bayesowskiej były doceniane na świecie m.in. poprzez powierzanie Profesorowi organizowania sesji na konferencjach międzynarodowych i obowiązków redaktora liczących się czasopism statystycznych, a także wykładów wygłoszonych na uniwersytetach w charakterze *visiting professor*. W szczególności organizował sesje na tematy: *Empirical Bayes methods in small area estimation*, *Applications of empirical and hierarchical Bayes methods in survey sampling*, *Time series analysis of small domain data*. Ponadto był członkiem Executive Board of the International Society for Bayesian Analysis. Reasumując, problemom w zakresie zagadnień statystyki małych obszarów lub wnioskowania bayesowskiego była poświęcona ponad połowa publikacji Profesora. Podobnie tym zagadnieniom jest poświęcona prawie połowa prac doktorskich wypromowanych przez Profesora, w szczególności G. Datta, N. Nangia, K. Sinha i A. Roya. Podkreśliśmy też, że w 2019 r. za wyżej wspomniane zasługi uhonorowano M. Ghosha nagrodą Small Area Estimation Award.

four courses in small area estimation, including *Model-dependent small area estimation: Theory and practice* at the University of Jyväskylä. Professor Ghosh's merits in enhancing the knowledge of statistics in broadly understood small area estimation and Bayesian estimation found their worldwide appreciation in the fact that Professor Ghosh was entrusted with the organization of sessions at international conferences and offered the position of editor on statistical journals as well as invited to lecture as a visiting professor at numerous universities. Examples of sessions organized by Professor Ghosh include: *Empirical Bayes methods in small area estimation*, *Applications of empirical and hierarchical Bayes methods in survey sampling*, *Time series analysis of small domain data*. Besides, Professor Ghosh was a member of The Executive Board of the International Society for Bayesian Analysis.

Summing up, over half of Professor Ghosh's publications were devoted to issues of small area estimation or Bayesian inference. Likewise, almost half of the Ph.D. dissertations supervised by Professor Ghosh are concerned with those issues, in particular those written by G. Datt, N. Nangi, K. Sinh and A. Roy. Last but not least, let us stress the fact that Professor Ghosh's merits were honoured by awarding him the Small Area Estimation Award.

The actual range of Professor Ghosh's scientific output exceeds the three areas of research mentioned here because his articles also concern issues like non-parametric inference, which is a valued tool in the statistical analysis





Faktyczny zakres dorobku naukowego Profesora znacznie przekracza wskazane trzy pola badawcze, ponieważ Jego artykuły są również związane z takimi zagadnieniami, jak np. wnioskowanie nieparametryczne, które jest bardzo cenionym narzędziem w statystycznych analizach danych ekonomicznych. Ponadto wiele prac poświęcił problemowi dopuszczalności estymatorów. Analizowany dorobek naukowy Profesora daje szerokie podstawy teoretyczno-metodologiczne, które można stosować w analizach statystycznych wykonywanych na rzecz nie tylko nauk ekonomicznych, lecz również np. badań naukowych prowadzonych w medycynie, technice i rolnictwie. Świadczy to o niezwyklej uniwersalności Jego dorobku. Warto też zwrócić uwagę, że w zdecydowanej większości prac są wykorzystywane metody bayesowskie. Ta tendencja przejawia się również w innych aspektach działalności naukowej, jak np. w przypadku wygłaszanych przez Niego wykładów na licznych konferencjach międzynarodowych. Czyni to Profesora wybitnym przedstawicielem właśnie podejścia bayesowskiego we wnioskowaniu statystycznym.

Dodajmy jeszcze, iż z ilościowego punktu widzenia M. Ghosh był autorem lub współautorem ponad 310 publikacji naukowych (artykułów, monografii i rozdziałów w pracach zbiorowych) z dziedziny metodologii statystycznej i jej zastosowań. Jego prace charakteryzują się ogromną cytawalnością w środowisku naukowym. Większość czasopism, w których były publikowane artykuły, w tym najbardziej cenione przez statystyków: „Annals of Statistics”, “Journal of the American Statistical

of economic data. Besides, Professor Ghosh devoted many of his works to the problem of estimator admissibility. Professor Ghosh's scientific output and his monographs constitute extensive theoretical and methodological foundations which can be applied to statistical analyses in economics, medicine, technology and agriculture. This proves the unusual versatility of his output. An analysis of Professor Ghosh's publications makes one realize that Bayesian methods are used in a decisive majority of his works. This tendency is also manifested in other aspects of his scientific activity, like, for instance, in the lectures delivered by him at numerous international conferences. This makes Professor Ghosh an outstanding representative of the Bayesian approach to statistical inference.

Numerically speaking, Professor Ghosh has authored or co-authored a total of over 310 scientific publications, including articles, monographs and chapters in books on statistical methodology and its applications, and his works are widely cited in the scientific circles. Most journals in which they were cited are on the prestigious list of the Journal of the Citation Index. Many of his articles were published in journals like “Annals of Statistics”, “Journal of the American Statistical Association”, “Journal of the Royal Statistical Association” and “Biometrika”, which are the most highly-regarded by statisticians.

Many of Professor Ghosh's publications resulted from his work on at least 30 research grants between 1979 and 2016, most of which were headed by him. Those projects were financed by such prominent institutions

Association", "Journal of the Royal Statistical Association" oraz "Biometrika", znajduje się na prestiżowej liście Journal of the Citation Index.

Wiele spośród analizowanych publikacji Profesora M. Ghosha jest wynikiem jego prac w latach 1979–2016 nad realizacją co najmniej 30 grantów naukowo-badawczych, z czego w prawie wszystkich był głównym wykonawcą. Te projekty naukowe były finansowane m.in. przez tak znaczące instytucje, jak National Science Foundation, United State Army Research Office, US Census Bureau, National Institute of Health oraz United State Center for Disease Control.

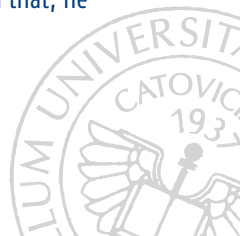
Wyniki prac Profesora M. Ghosha są bardzo doceniane w środowisku statystyków, co się przekłada na liczne zaproszenia do wygłoszenia wykładów w co najmniej 80 ośrodkach akademickich. Profesor był zapraszany do wygłoszenia 150 wykładów jako *invited lecturer* na liczących się międzynarodowych konferencjach naukowych, z czego na 47 jako *special invited lecturer*. Ponadto wypromował 60 doktorów. Swoje umiejętności dydaktyczne Profesor miał okazję zademonstrować poprzez prowadzenie co najmniej dziesięciu specjalnych kursów na tematy głównie związane ze statystyką małych obszarów, z czego wynika, iż znakomicie przyczynił się do popularyzowania wiedzy statystycznej i kształcenia specjalistów z tej dziedziny.

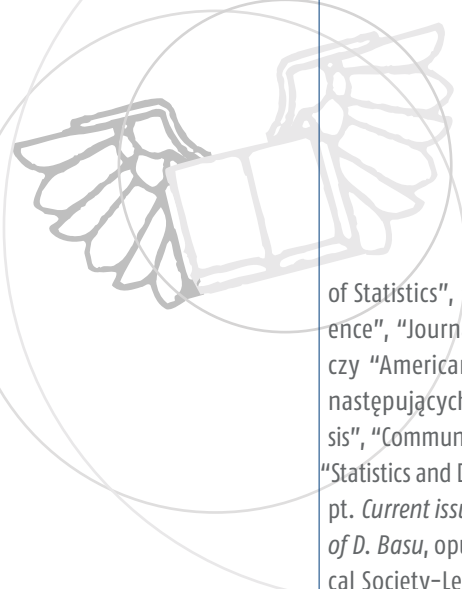
Wybitna wiedza i umiejętności Profesora stały się pożądanymi w dwudziestu redakcjach czasopism naukowych. W szczególności był redaktorem lub redaktorem działowym takich czasopism, jak: "Sankhya B", "Annals

as The National Science Foundation, The United State Army Research Office, The US Census Bureau, The National Institute of Health as well as The United States Center for Disease Control.

The results of Professor Ghosh's work have been most appreciated in the statisticians' environment as he has been invited to lecture in at least 80 academic centres. Professor Ghosh has participated as an invited lecturer in 150 prestigious international conferences. Besides, he has supervised 60 Ph.D. dissertations and has led 30 research grants. Professor Ghosh has demonstrated his teaching skills conducting at least 10 special courses on topics related mainly to small area estimation. This substantiates his significant contribution to promoting the knowledge of statistics and educating specialists in this field.

Thanks to his outstanding knowledge and skills Professor Ghosh's was invited to act as editor or associate editor of 20 scientific journals, such as "Sankhya B", "Annals of Statistics", "Journal of Statistical Planning and Inference", "Journal of the American Statistical Association", "The American Statistician. Besides, he was a member of the Editorial Boards of the following journals: "Sequential Analysis", "Communications in Statistics-Theory and Methods", "Statistics and Decisions", "Statistics in Transition". In collaboration with P.K. Pathak he edited the book entitled *Current issues in statistical inference: Essays in Honor of D. Basu*, published by The Institute of Mathematical Society in the Lectures, Notes, Monographs series in 1992. Apart from that, he





of Statistics", "Journal of Statistical Planning and Inference", "Journal of the American Statistical Association" czy "American Statistician", a także członkiem m.in. następujących rad redakcyjnych: "Sequential Analysis", "Communications in Statistics-Theory and Methods", "Statistics and Decisions", "Statistics in Transition". Książkę pt. *Current issues in statistical inference: Essays in honor of D. Basu*, opublikowanej przez Institute of Mathematical Society-Lectures Notes Monograph Series w 1992 r., M. Ghosh współredagował wraz P.K. Pathakiem. Ponadto Profesor opiniował ogromną liczbę artykułów i książek, a w szczególności pisał recenzje monografii do "Journal of the American Statistical Association".

Profesor Malay Ghosh znajdował również czas na aktywne uczestnictwo w życiu akademickim uczelni, na których pracował. Był członkiem kolegów i licznych komisji naukowych. W szczególności podczas pracy w Iowa State University był członkiem lub wykonywał funkcje w siedmiu komisjach, a w szczególności jako przewodniczący Ph.D. Preliminary Examination Committee. Z kolei w University of Florida był członkiem dwunastu komisji oraz członkiem Senatu przez trzy kadencje, a od 2006 r. jest członkiem Mathematical Sciences Committee.

Zasługi i prestiż naukowy Profesora M. Ghosha są docenione na międzynarodowym forum statystyków. Wyrazem tego jest wiele Jego prac wykonanych na rzecz międzynarodowych towarzystw naukowych. W szczególności jest członkiem z wyboru American Statistical Association, International Society for Bayesian Analysis, International Statistical Institute oraz Institute of Mathe-

has reviewed a vast number of articles and books, in particular monographs for "The Journal of the American Statistical Association".

Professor Malay Ghosh found time to actively participate in academic life as a member of colleges and scientific committees at the universities where he worked. At Iowa State University he was a member, or was appointed to various functions in 7 committees, in particular that of chairman of the Ph.D. Preliminary Examination Committee. At the University of Florida, he belonged to 12 committees and was a member of the Senate for 3 terms of office.

Professor Ghosh's merits and academic prestige are recognized on the statisticians' international forum, which is corroborated by his involvement in international scientific bodies. For example, he was an elected fellow of The American Statistical Association, The International Society for Bayesian Analysis, The International Statistical Institute and The Institute of Mathematical Statistics, where he served as Chairman for a term of office. Professor Ghosh was entrusted with the organization of 15 scientific sessions at prestigious international conferences, among others, the session on *Empirical Bayes methods in small area estimation* during the Annual Meeting of the American Statistical Association. The statisticians' community expressed their admiration for Professor's Ghosh's scientific achievements organizing in his honour a conference on *Frontiers of hierarchical modelling in observational studies, complex surveys, and big data* at the University of Maryland, College Park in 2014.

mathematical Statistics, którego był przewodniczącym przez jedną kadencję. Profesorowi powierzono organizację piętnastu sesji naukowych na znaczących konferencjach międzynarodowych, z których warto wymienić *Empirical Bayes methods in small area estimation* podczas Annual Meeting of the American Statistical Association. Środowisko statystyków wyraziło swój podziw dla osiągnięć naukowych Profesora organizując na jego cześć konferencję pt. *Frontiers of Hierarchical Modelling in Observational Studies, Complex Surveys, and Big Data* w 2014 w University of Maryland at College Park.

Niewątpliwie obok ogromnej wiedzy naukowej Profesor M. Ghosh posiada również umiejętności dzielenia się nią oraz łatwość nawiązywania współpracy z innymi ludźmi, co owocowało pisaniem wspólnych artykułów oraz pracami nad realizacją grantów. Podkreśmy tutaj, że niezwykła osobność Profesora oraz Jego erudycja i pomysły naukowe stały się inspiracją dla sześćdziesięciu osób do przygotowania pod Jego kierunkiem prac doktorskich. Wielu Jego doktorantów już zdobyło uznanie w środowisku statystyków, jak np. Partha Lahiri, Gauri Datta, Nitis Mukopadhyay czy Ratan Dasgupta, których prace badawcze ustawicznie wzbogacają wiedzę w dziedzinie statystyki. Te osoby i pozostali doktoranci z pewnością pamiętają, że na początku ich drogi naukowej był ich wybitny mentor w osobie Profesora M. Ghosha.

Podkreśmy jeszcze, iż Profesor podczas „wędrówek naukowych po świecie” nie zapomniał o swoich hinduskich korzeniach. Po studiach statystycznych w USA

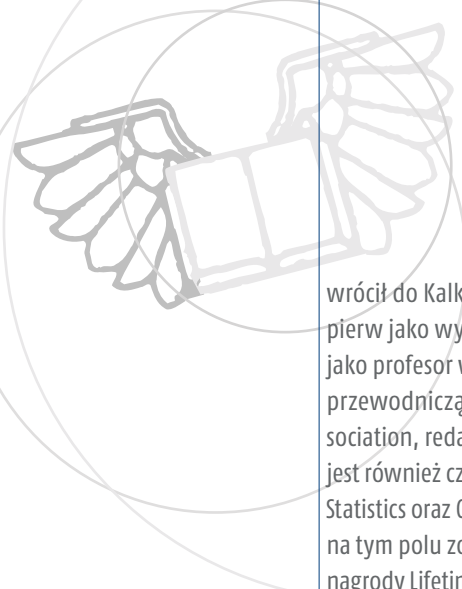
Apart from his vast scientific knowledge Professor Malay Ghosh undoubtedly possesses the ability to share it and easily establish cooperation with others, which has resulted in jointly written articles and research papers based on grants. It is worth stressing that Professor Ghosh's extraordinary personality and his erudition, as well as his scientific ideas, have inspired over sixty people to write their Ph.D. dissertations under his supervision.

Many of his former Ph.D. students like Partha Lahiri, Gauri Datta, Nitis Mukopadhyay or Ratan Dasgupta, have already won recognition in the statistical environment and their research works continually enrich the corpus of statistical know-how. Those people, as well as Professor Ghosh's other Ph.D. students will certainly remember their outstanding mentor, who launched them onto their careers.

It is also noteworthy that in his scientific itinerary across the world Professor Ghosh did not forget about his Indian roots. After completing his university courses in statistics in the USA he returned to Calcutta to work as a lecturer at Presidency College and then as a professor at the Indian Statistical Institute. In addition, he was chairman of the International Indian Statistical Association, editor of "Sankhya B" and a member of the Indian Society of Probability and Statistics and the Calcutta Statistical Association. The International Indian Statistical Association honoured his merits in this field by granting him the Lifetime Achievement Award in 2017.

The aforementioned examples of Professor Ghosh's scientific activity give us a sense of pride in the fact that it





wrócił do Kalkuty, aby przez krótki okres pracować najpierw jako wykładowca w Presidency College, a potem jako profesor w Indian Statistical Institute. Ponadto był przewodniczącym International Indian Statistical Association, redaktorem czasopisma Sankhya B, a obecnie jest również członkiem: Indian Society of Probability and Statistics oraz Calcutta Statistical Association. Jego zasługi na tym polu zostały uhonorowane przez przyznanie Mu nagrody Lifetime Achievement Award przez International Indian Statistical Association w 2017 r.

Przytoczone informacje o działalności naukowej Profesora M. Ghosha wzbudzają poczucie dumy, że to właśnie On wielokrotnie uczestniczył w konferencjach naukowych organizowanych w Polsce. W latach 2008, 2009, 2011 i 2017 gościł na konferencji: *Survey Sampling in Economic and Social Research*, organizowanej przez Katedrę Statystyki Uniwersytetu Ekonomicznego w Katowicach przy współdziałaniu Polskiego Towarzystwa Statystycznego. Wygłosił na specjalne zaproszenie, jako *plenary special invited lecturer*, następujące referaty: *Bayesian benchmarking in small area estimation* (2008), *Benchmarked small area estimators* (2009), *Bayesian penalized splines for small area estimation* (2011), *Adjustment of survey weights via modeling* (2017). W roku 2012 – także na specjalne zaproszenie jako *special invited speaker* – na sesji plenarnej Pierwszego Kongresu Statystyki Polskiej w Poznaniu z okazji 100-tnej rocznicy utworzenia Polskiego Towarzystwa Statystycznego wygłosił wykład pt. *Finite population sampling: A model-design synthesis*. Ponadto na tym Kongresie prof. M. Ghosh został

was him that on many occasions participated in scientific conferences organized in Poland. In the years 2008, 2009, 2011, 2017 he was an invited lecturer at the conference on *Survey sampling in economic and social research* organized by the Department of Statistics of the University of Economics in Katowice in collaboration with The Polish Statistical Association. As a plenary special invited lecturer he read the following papers: *Bayesian benchmarking in small area estimation* (2008), *Benchmarked small area estimators* (2009), *Bayesian penalized splines for small area estimation* (2011), and *Adjustment of survey weights via modeling* (2017). In 2012 he was hosted as a special invited speaker at the First Congress of Polish Statistics held on the occasion of the one hundredth anniversary of the foundation of the Polish Statistical Association, and at the plenary session he delivered a lecture entitled *Finite population sampling: A model-design synthesis*. At the same congress Professor Ghosh was honoured with the Jerzy Sława–Neyman Medal, which is awarded by the Polish Statistical Association to outstanding statisticians to commemorate Jerzy Sława–Neyman, a world-famous statistician of Polish descent, who, along with Karl Pearson and Ronald Fisher is included in the group of three pioneers of modern statistics. In 2014, as an invited speaker, Professor Ghosh read a paper entitled *Benchmarked empirical Bayes estimators for multiplicative area level models* at the conference on *Small Area Estimation* organized in Poznan by the International Association for Survey Statisticians and the University of Economics in Poznan. During that Conference he was invited to join

uhonorowany Medalem im. Jerzego Sławy–Neymana. Podkreśliśmy, że ten medal jest nadawany przez Polskie Towarzystwo Statystyczne wybitnym statystykom na pamiątkę światowej sławy statystyka pochodzenia polskiego, Jerzego Sławy–Neymana, który jest zaliczany do trojga prekursorów nowoczesnej statystyki obok Karla Pearsona oraz Ronalda Fishera. W 2014 r. jako *invited lecturer* wygłosił referat pt. *Benchmarked empirical Bayes estimators for multiplicative area level models* podczas konferencji *Small Area Estimation*, organizowanej w Poznaniu przez *International Association for Survey Statisticians* i Uniwersytet Ekonomiczny w Poznaniu. Podczas tej konferencji został również zaproszony na członka rady redakcyjnej czasopisma „Statistics in Transition” wydawanego przez Polskie Towarzystwo Statystyczne oraz Główny Urząd Statystyczny.

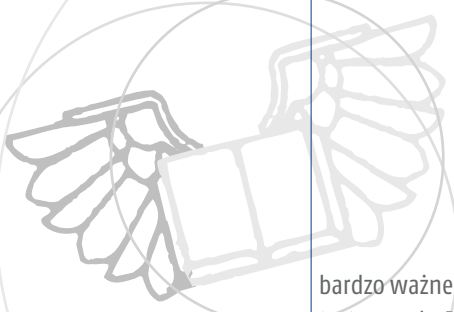
Reasumując, działalność naukowa Profesora jest godna naśladowania, ponieważ jego prace naukowe miały i wciąż mają niewątpliwie duży wpływ na rozwój różnych aspektów teorii statystyki i jej zastosowań. W szczególności publikacje z zakresu statystyki małych obszarów oraz wnioskowania bayesowskiego są prekursorskie. Podobnie osiągnięcia Profesora w zakresie estymacji sekwencyjnej są już zaliczane do klasyki wnioskowania statystycznego. Uzyskane wyniki naukowe na polu teorii niezawodności stanowią również wartościowy dorobek obok innych zagadnień statystyki, jak np. analizy dopuszczalności estymatorów, które są nie mniej znaczące dla zasobów wiedzy statystycznej. Ponadto należy podkreślić, że wszystkie jego prace mają

the Editorial Board of “Statistics in Transition”, a journal published by the Polish Statistical Association and the Statistics Poland.

In summary, Professor Ghosh's scientific merits, which I have presented here, are certainly exemplary as his research works have exerted a considerable effect on the development of various aspects of statistical theory and its applications and will certainly continue to do so. Particularly noteworthy are his pioneering works in the field of small area estimation and Bayesian inference. Similarly, Professor Ghosh's achievements in sequential estimation are already categorized as classics of statistical inference. The scientific results obtained by Professor Ghosh in the field of reliability theory constitute a valuable output, together with other areas like estimator admissibility analysis, which is of equal significance in the corpus of statistical know-how. It must also be stressed that all his works are of great importance for practical statistical research. This is also true for the increasingly appreciated statistical analyses in empirical economic research.

Professor Ghosh's strictly scientific output substantiated in his articles and books goes together with his unusual commitment to promoting the knowledge of statistics in the world. This is best proved by the already mentioned enormous number of lectures delivered not only at American universities. Besides, Professor Ghosh has delivered a considerable number of lectures at important international conferences, at which he organized scientific sessions.





bardzo ważne znaczenie w praktycznych badaniach statystycznych. Dotyczy to również coraz bardziej docenianych analiz statystycznych w empirycznych badaniach ekonomicznych.

Merytoryczną stroną dorobku naukowego uzupełnia wręcz niezwykła aktywność na polu upowszechniania wiedzy statystycznej na świecie. Uzasadnia to już wcześniej sygnalizowana ogromna liczba prowadzonych wykładów na rzecz nie tylko uczelni amerykańskich, ale też na zaproszenie podczas liczących się międzynarodowych konferencji, na których również organizował sesje naukowe. Aktywnie działał w liczących się na świecie międzynarodowych organizacjach naukowych. Tak znaną i cenioną na świecie naukowym osobowością Profesor Malay Ghosh stał się dzięki jego ogromnej i niekwestionowanej wiedzy oraz chęci dzielenia się z nią ze wszystkimi. Publikacje Profesora oraz jego aktywne uczestnictwo w konferencjach i seminariach niewątpliwie było źródłem inspiracji naukowych dla wielu statystyków.

Przedstawioną sylwetkę naukową profesora należy jeszcze uzupełnić o jego osobowość – jest to człowiek niezwykle otwarty na ludzi, których od razu obdarza swoją życzliwością i kredytem zaufania. Wysłuchuje ich z uwagą i daje im dobre rady, co pracownicy Katedry Statystyki naszego Uniwersytetu mieli okazję doświadczać. Na co dzień żyje problemami naukowymi.

Opisany dorobek Profesora Malaya Ghosha jest imponujący w sferach zarówno naukowej, jak i współpracy międzynarodowej. Jego dokonania naukowe są godne naśladowania dla nas wszystkich, a nie tylko statystyków.

Laudacja/Eulogy

He has been an active member of prestigious international scientific organizations. Professor Malay Ghosh has become such a well-known and highly-regarded person thanks to his vast and undisputed knowledge, as well as his willingness to share it with others. His publications and his active participation in conferences and seminars were undoubtedly a source of scientific inspiration for many statisticians.

Professor Ghosh's academic profile needs to be supplemented by his uncommon personality. He has always been an extremely outgoing and kindly person, ready to trust others, a person who attentively listens to others and willingly offers good advice, which the employees of the Department of Statistics of our University had the opportunity to experience. His commitment to science is simply part and parcel of his life.

Professor Malay Ghosh's output, which I have just described, is impressive in terms of both scientific merit and international cooperation. His academic achievements are exemplary for us all, not only for statisticians. We take pride in having another opportunity to host such a prominent member of the world league of scientists.

In view of this, the Senate was fully justified in initiating the proceedings to award the honorary doctor's degree of the University of Economics in Katowice to Professor Malay Ghosh in recognition of his outstanding achievements in the field of statistics and its applications, as well as his commitment to promoting science and international scientific cooperation.

Laudacja/Eulogy

Możemy być dumni, że mamy okazję po raz kolejny gościć tak wybitnego naukowca rangi światowej.

W związku z tym jest rzeczą oczywistą, że Senat postanowił nadać tytuł doktora honoris causa Uniwersytetu Ekonomicznego w Katowicach Profesorowi Malayowi Ghoshowi za wybitne osiągnięcia w dziedzinie teorii statystyki i jej zastosowań, aktywne popularyzowanie nauki oraz promowanie międzynarodowej współpracy naukowej.





Yves G. Berger

University of Southampton, Wielka Brytania
22 stycznia 2020 r.

Professor Yves G. Berger, PhD

University of Southampton, United Kingdom
22nd January 2020

Wybitny wkład Profesora Malaya Ghosha w rozwój statystyki

Profesor Malay Ghosh wniósł wkład w rozwój wielu zagadnień z zakresu statystyki teoretycznej, takich jak: metoda reprezentacyjna, statystyki porządkowe i nieparametryczne, analiza sekwencyjna, teoria decyzji, statystyka bayesowska oraz statystyka małych obszarów. Miał również swój udział w badaniach stosowanych dotyczących raka prostaty, badań kliniczno-kontrolnych, zapewnienia jakości, estymacji na poziomie okręgowym oraz wykrywania egzoplanet.

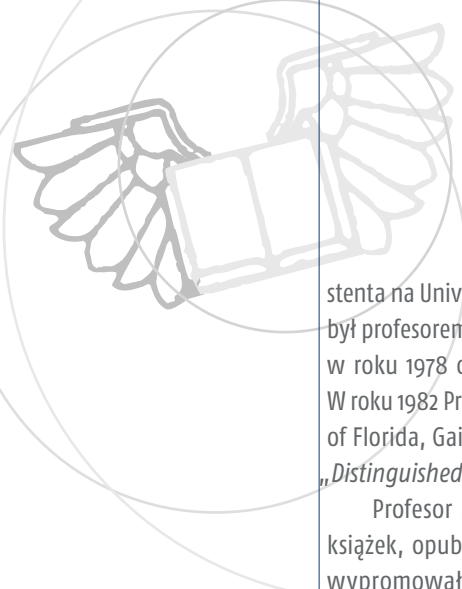
W roku 1962 Profesor Malay Ghosh uzyskał tytuł licencjata z dziedziny statystyki na University of Calcutta, a w roku 1964 – tytuł magistra na tej samej uczelni. Następnie przeprowadził się do Stanów Zjednoczonych, gdzie w roku 1969 uzyskał tytuł doktora na University of North Carolina w Chapel Hill pod kierunkiem Pranaba K. Sena. Jego rozprawa doktorska nosiła tytuł *Asymptotically optimal nonparametric tests for miscellaneous problems of linear regression*. Po zdobyciu tytułu doktora, Profesor Ghosh kilkakrotnie piastował stanowisko asy-

Professor Malay Ghosh's outstanding contribution to statistics

Professor Malay Ghosh's contribution to theoretical statistics covers a wide range of area, such as survey statistics, order and nonparametric statistics, sequential analysis, decision theory, Bayesian statistics and small-area estimation. Malay also contributed to applied research projects on prostate cancer studies, case-control studies, quality assurance, county-level estimation and on detection of exoplanets.

Professor Malay Ghosh obtained a B.A. in Statistics in 1962 from the University of Calcutta, and a M.A. in 1964 from the same university. Afterwards, he moved to the United States and obtained his PhD degree in 1969 from the University of North Carolina at Chapel Hill, under the supervision of Pranab K. Sen. His PhD dissertation title is *Asymptotically optimal nonparametric tests for miscellaneous problems of linear regression*. After his PhD, Malay took several research assistant positions at the University of North Carolina. He was an associate professor at the Indian Statistical Institute from 1971 to





stenta na University of North Carolina. W latach 1971–1978 był profesorem w Indian Statistical Institute, a następnie w roku 1978 objął profesurę na Iowa State University. W roku 1982 Profesor Ghosh rozpoczął pracę na University of Florida, Gainesville, gdzie w roku 1998 uzyskał tytuł „Distinguished Professor” w Katedrze Statystyki.

Profesor Malay Ghosh jest współautorem dwóch książek, opublikował około 315 prac badawczych oraz wypromował sześćdziesięciu doktorantów, między innymi Parthę Lahiriego, Gauriego S. Dattę, Kannana Natarajana i Nitisa Mukhopadhyaya. Przez ponad dwie dekady zajmował się statystyką małych obszarów, wnosząc istotny wkład w jej rozwój. Razem ze swoimi doktorantami, Parthą Lahirim, Gaurim Dattą i Kannanem Natarajanem, jako pierwszy opracował jednolite podejście do rozwiązywania zagadnień z zakresu statystyki małych obszarów w ujęciu bayesowskim. W latach 1996–2001 Profesor Ghosh zasiadał w United States Census Advisory Committee jako przedstawiciel American Statistical Association.

Profesor Ghosh wniósł wkład w metodę reprezentacyjną także w formie opracowania nowych empirycznych bayesowskich przedziałów ufności w oparciu o rozwinięcie Edgewortha, korekty wartości oddalonych oraz zastosowania modeli błędów pomiarowych. Zastosował wnioskowanie bayesowskie i empiryczne metody bayesowskie do korekty wartości spisowych, estymacji median dochodów rodzin czteroosobowych, estymacji proporcji osób nieposiadających ubezpieczenia zdrowotnego dla niewielkich domen w przekrojowej klasyfikacji

1978, then became a professor at the Iowa State University in 1978. In 1982, Malay joined the University of Florida, Gainesville, where he became the Distinguished Professor of the Department of Statistics in 1998.

Professor Malay Ghosh has co-authored two books, published about 315 research manuscripts and supervised sixty PhD students, including Partha Lahiri, Gauri S. Datta, Kannan Natarajan and Nitis Mukhopadhyay. His contribution to small area estimation spans over two decades. With his PhD students, Partha Lahiri, Gauri Datta and Kannan Natarajan, Malay was the first to develop a unified Bayesian approach for solving small area estimation problems. He served from 1996 to 2001 in the United States Census Advisory Committee as a representative of the American Statistical Association.

Malay's other methodological contributions to Survey Statistics include development of new empirical Bayes confidence intervals based on Edgeworth expansion, outlier adjustment, and use of measurement error models. Malay has applied Bayesian and empirical Bayesian methods for the adjustment of census counts, estimation of median income of four-person families, estimation of the proportion of people without health insurance for small domains cross-classified by age, sex, ethnicity and other characteristics.

Malay was the editor of “Sequential Analysis” for eight years, and “Sankhya, B” for four years. He is currently a member of the Editorial Board of “Statistics in Transition”. Previously, he was part of the Editorial Board of the “Journal of Statistical Research” and the “Brazil-

ze względu na wiek, płeć, pochodzenie etniczne oraz inne charakterystyki.

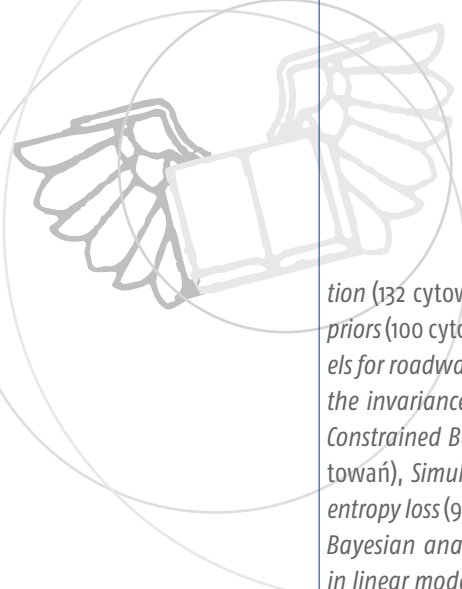
Profesor Ghosh był redaktorem naczelnym „Sequential Analysis” przez osiem lat oraz „Sankhya, B” przez cztery lata. Obecnie jest członkiem kolegium redakcyjnego pisma „Statistics in Transition”. Był także członkiem kolegiów redakcyjnych pism „Journal of Statistical Research” oraz „Brazilian Journal of Statistics”. Sprawował funkcję redaktora działowego w wielu czasopismach: „Journal of the American Statistical Association”, „Sequential Analysis”, „Statistics and Decisions”, „Communications in Statistics – Theory and Methods”, „Journal of Nonparametric Statistics”, „Journal of Statistical Planning and Inference”, „Annals of Statistics”, „Statistics”, „American Statistician” oraz „Metron”.

Profesor Ghosh opublikował około 315 artykułów, niektóre z nich znalazły się w najbardziej prestiżowych czasopismach. Według stanu na styczeń 2020 roku na stronie researchgate.net, do artykułów Profesora Ghosha odwołano się 5638 razy. Jego wynik ResearchGate, wynoszący 39,28 przy indeksie H równym 36, jest wyższy od 95% wyników wszystkich członków ResearchGate. Najczęściej cytowanymi artykułami Profesora Ghosha są: *Small area estimation: An appraisal* (601 cytowań) oraz *Small area estimation: An approach* (321 cytowań), które napisał we współpracy z J.N.K. Rao. Inne często cytowane artykuły to *Penalized regression, standard errors, and Bayesian lassos* (271 cytowań), *Multivariate negative dependence* (175 cytowań), *Generalized linear models for small-area estimation* (156 cytowań), *Sequential estima-*

ian Journal of Statistics”. He acted as Associate Editor for many journals: “Journal of the American Statistical Association”, “Sequential Analysis”, “Statistics and Decisions”, “Communications in Statistics – Theory and Methods”, “Journal of Nonparametric Statistics”, “Journal of Statistical Planning and Inference”, “Annals of Statistics”, “Statistics”, “American Statistician” and “Metron”.

Malay published about 315 papers, some in the most prestigious journals. In January 2020, he has 5,638 citations on researchgate.net and a ResearchGate score of 39.28, with an h-index of 36. Malay’s score is higher than 95% of all ResearchGate members’ scores. His most h-cited papers are *Small area estimation: An appraisal* (601 citations), *Small area estimation: An approach* (321 citations) both co-authored with J.N.K. Rao. Other highly cited papers are *Penalized regression, standard errors, and Bayesian lassos* (271 citations), *Multivariate negative dependence* (175 citations), *Generalized linear models for small-area estimation* (156 citations), *Sequential estimation* (132 citations), *Some remarks on non-informative priors* (100 citations), *Bayesian multivariate spatial models for roadway traffic crash mapping* (99 Citations), *On the invariance of noninformative priors* (95 citations), *Constrained Bayes estimation with applications* (92 citations), *Simultaneous estimation of parameters under entropy loss* (91 citations), *Statistical decision theory and Bayesian analysis* (90 citations), *Bayesian prediction in linear models: Applications to small area estimation* (83 citations), *Miscellanea. Second-order probability matching priors* (81 citations), *Bayesian methods for*





tion (132 cytowań), *Some remarks on non-informative priors* (100 cytowań), *Bayesian multivariate spatial models for roadway traffic crash mapping* (99 cytowań), *On the invariance of noninformative priors* (95 cytowań), *Constrained Bayes estimation with applications* (92 cytowań), *Simultaneous estimation of parameters under entropy loss* (91 cytowań), *Statistical decision theory and Bayesian analysis* (90 cytowań), *Bayesian prediction in linear models: Applications to small area estimation* (83 cytowań), *Miscellanea. Second-order probability matching priors* (81 cytowań) oraz *Bayesian methods for finite population sampling* (78 cytowań). Pięć z powyższych artykułów zostało opublikowanych w „Journal of the American Statistical Association”, a dwa kolejne w „Annals of Statistics”. Pozostałe artykuły opublikowano w „Bayesian Analysis”, „Biometrika”, „Statistical Science” oraz „Technometrics”. Profesor Ghosh jest także współautorem dwóch znanych książek: *Sequential estimation* (wydawnictwo Wiley and Sons), którą napisał razem z N. Mukhopadhyayem i P.K. Senem oraz *Bayesian methods for finite population sampling* (wydawnictwo Chapman and Hall), napisanej wspólnie z G. Meedenem.

Profesor Ghosh był głównym wykonawcą w wielu projektach finansowanych przez National Science Foundation: *Jednoczesna estymacja parametrów w rodzinie rozkładów wykładniczych*, *Dopuszczalność w estymacji wielu parametrów oraz w zagadnieniach związanych z losowaniem z populacji skończonych*, *Estymacja wielu parametrów i estymacja w przypadku losowania z populacji skończonych*, *Empiryczna i hierarchiczna estymacja*

finite population sampling (78 citations). Five of these papers are published in the “Journal of the American Statistical Association”, two papers are published in the “The Annals of Statistics”. The other journals are “Bayesian Analysis”, “Biometrika”, “Statistical Science” and “Technometrics”. Malay is also the co-author of two famous books: *Sequential estimation* (Wiley and Sons) with N. Mukhopadhyay and P.K. Sen, and *Bayesian methods for finite population sampling* (Chapman and Hall) with G. Meeden.


Malay was principal investigator on several projects awarded by the National Science Foundation: “Simultaneous estimation of parameters in exponential families”, “Admissibility in multiparameter estimation and in finite population sampling”, “Multiparameter estimation and estimation in finite population sampling”, “Empirical and hierarchical Bayes estimation in finite population sampling, quality assurance and random effects models”, “Hierarchical and empirical Bayes estimation in survey sampling, linear models and quality assurance”, “Bayesian methods and inference”, “Bayesian Methods for small area estimation and latent structure models”, “Parametric and semiparametric Bayesian methods for small area estimation”, “Bayesian and likelihood based multilevel models for small area estimation”, “Some topics in small area estimation”, “Empirical and hierarchical Bayesian methods with applications to small area estimation”, “Case-control studies, new directions and applications”, “Some contributions to sampling theory with applications” and “Bayesian empirical likelihood and penalized splines

bayesowska w przypadku losowania z populacji skończonych, zapewnienia jakości i modeli z efektami losowymi, Hierarchiczna i empiryczna estymacja bayesowska w metodzie reprezentacyjnej, w modelach liniowych i w zapewnieniu jakości, Metody bayesowskie i wnioskowanie, Metody bayesowskie dla statystyki małych obszarów oraz modele struktur ukrytych, Parametryczne i pół-parametryczne metody bayesowskie dla statystyki małych obszarów, Wnioskowanie bayesowskie i wiarygodność w oparciu o modele wielopoziomowe dla statystyki małych obszarów, Kilka zagadnień z zakresu statystyki małych obszarów, Empiryczne i hierarchiczne metody bayesowskie wraz z zastosowaniami dla statystyki małych obszarów, Badania kliniczno-kontrolne, nowe kierunki i zastosowania, Wkład w rozwój metod asymptotycznych wraz z zastosowaniami oraz Bayesowska empiryczna wiarygodność i P-splajny w statystyce małych obszarów. Inne projekty Pana Profesora to: *Estymacja nieparametryczna i estymacja w przypadku losowania z populacji skończonych* (nagroda Research Development Award), *Konferencja dotycząca uogólnionych modeli liniowych* (U.S. National Security Agency), *Bayesowskie neutralne sieci dla badań nad rakiem prostaty* (National Institute of Health), *Badania walidacyjne metod estymacji subdomen* (Centre of Diseases Control and Prevention), *Zagadnienia z zakresu analizy bayesowskiej, empiryczna wiarygodność i teoria decyzji* (U.S. National Security Agency), *Wielowymiarowe empiryczne i hierarchiczne metody bayesowskie w statystyce małych obszarów* oraz *Opracowanie modeli małych obszarów*

for small area estimation". Other projects are: "Nonparametric estimation and estimation in finite population sampling" (Research Development Award), "Conference on topics in generalized linear models" (US National Security Agency), "Bayesian neural networks for prostate cancer studies" (National Institute of Health), "Validation study of subdomain estimation method" (Centre of Diseases Control and Prevention), "Topics in Bayesian analysis, empirical likelihood and decision theory" (US National Security Agency), "Multivariate empirical and hierarchical Bayes methods for small area estimation", "Developing small area models for improved county-level estimation of agricultural cash rent" (U.S. Department of Agriculture), and "Small area estimation" (ASA Senior Research Fellowship). Malay collaborated in other research projects: "Order statistics and nonparametric statistics", "Conference on topics in generalized linear models" and "Search for Earth-mass planets: Bayesian Algorithms to analyse transit timing observations".

Malay is an elected fellow of the American Statistical Association, the Institute of Mathematical Statistics, the International Statistical Institute and the International Society for Bayesian Analysis. In 1993, he received the Eugene Lukacs Distinguished Visiting Professorship of Statistics at the Bowling Green State University. Malay was awarded the Jerzy Sława-Neyman Medal at the 100th Anniversary of the Polish Statistical Society in 2012, the Lifetime Achievement Award from the International Indian Statistical Association in 2017 and the Small Area Estimation Award in 2019.





dla ulepszonej estymacji na poziomie okręgowym dla dzierżawy gruntów rolnych (U.S. Department of Agriculture) oraz *Statystyka małych obszarów* (ASA Senior Research Fellowship). Profesor Ghosh brał także udział w innych projektach badawczych: *Statystyki porządkowe i statystyki nieparametryczne*, *Konferencja dotycząca uogólnionych modeli liniowych* oraz *Poszukiwanie planet o masie Ziemi: algorytmy bayesowskie do analizy obserwacji czasów tranzytowych*.

Profesor Ghosh jest członkiem z wyboru American Statistical Association, Institute of Mathematical Statistics, International Statistical Institute oraz International Society for Bayesian Analysis. W roku 1993 Profesor Ghosh odebrał tytuł „*Eugene Lukacs Distinguished Visiting Professorship of Statistics*” na Bowling Green State University. Inne wyróżnienia to: Medal im. Jerzego Sławy–Neymana nadany w setną rocznicę powstania Polskiego Towarzystwa Statystycznego (2012), Lifetime Achievement Award przyznana przez International Indian Statistical Association (2017) oraz Small Area Estimation Award (2019).

W maju 2014 roku w ramach *Joint Program in Survey Methodology* na University of Maryland, College Park została zorganizowana na cześć Profesora Malaya Ghosha międzynarodowa konferencja zatytułowana „Frontiers of Hierarchical Modelling in Observational Studies, Complex Surveys, and Big Data”. Konferencja skupiła się na kilku dziedzinach, do których rozwoju Profesor Ghosh znacząco się przyczynił. Były to: statystyka małych obszarów, wnioskowanie bayesowskie, hierarchiczne modelowanie

In May 2014, an international conference in honour of Professor Malay Ghosh, entitled “Frontiers of Hierarchical Modelling in Observational Studies, Complex Surveys, and Big Data”, was hosted by the Joint Program in Survey Methodology, University of Maryland at College Park. Several areas to which Ghosh made substantial contributions were represented, including small-area estimation, objective Bayesian inference, hierarchical Bayesian modelling, and statistical inference for case-control studies. More than 200 people (including 16 of his doctoral students) celebrated Ghosh's outstanding contributions to statistics and his dedicated role as researcher, teacher and mentor.

At last but not least, Malay taught a wide ranges of course: Intermediate probability and inference, Advanced inference, Sequential analysis, Nonparametric inference, Decision theory, Large sample theory, General theory of linear estimation and hypothesis testing, Multivariate analysis, descriptive statistics, Statistical models, Statistical methods, Multivariate nonparametric inference, Reliability theory, Introductory probability theory, Introductory inference, Advanced probability theory, Introductory statistical methods, Applied Bayesian statistics, Bayesian theory and likelihood.

The outstanding academic and research curriculum mentioned above are the reasons to propose Professor Malay Ghosh as a candidate for a Degree of Doctor *Honoris Causa*. I have no doubt that he is an ideal candidate, given the quality of his research curriculum during his impressive academic career. I strongly request that Pro-

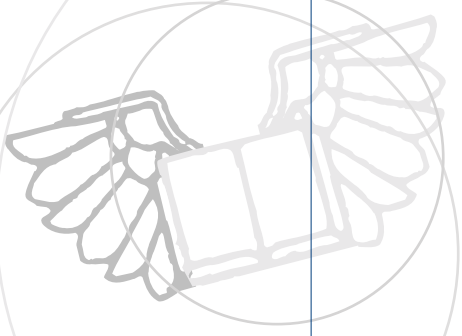
bayesowskie oraz statystyczne wnioskowanie w badaniach kliniczno-kontrolnych. Ponad 200 osób (w tym jego 16 doktorantów) uczciło wybitny wkład Profesora Ghosha w rozwój nauk statystycznych oraz jego zaangażowanie w pracę, w której występował w roli badacza, nauczyciela i mentora.

Profesor Ghosh prowadził ponadto zajęcia obejmujące szeroki zakres tematyczny: prawdopodobieństwo i wnioskowanie – kurs średniozaawansowany, zaawansowane wnioskowanie, analiza sekwencyjna, wnioskowanie nieparametryczne, teoria decyzji, metody asymptotyczne, ogólna teoria estymacji liniowej i weryfikacja hipotez, wielowymiarowa analiza, statystyka opisowa, modele statystyczne, metody statystyczne, wielowymiarowe wnioskowanie nieparametryczne, teoria niezawodności, podstawy teorii prawdopodobieństwa, podstawy wnioskowania, teoria prawdopodobieństwa – kurs zaawansowany, podstawy metod statystycznych, stosowana statystyka bayesowska, teoria bayesowska oraz wiarygodność.

Bogaty dorobek akademicki i badawczy przytoczony powyżej w pełni uzasadniają kandydaturę Profesora Malaya Ghosha do tytułu doktora *honoris causa*. Pan Profesor jest bez wątpienia idealnym kandydatem, biorąc po uwagę jakość jego badań przeprowadzonych w trakcie imponującej kariery akademickiej. Z głębokim przekonaniem wnoszę o nadanie Profesorowi Malayowi Ghoshowi tytułu doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach.

Professor Malay Ghosh be awarded the Degree of Doctor *Honoris Causa* by the University of Economics in Katowice.





Ralf T. Münnich

Trier University

Trewir, 28 stycznia 2020 r.

Professor Dr. Ralf T. Münnich

Trier University

Trier, 28th January 2020

Osiągnięcia naukowe Profesora Malaya Ghosha

Był styczeń 2004 roku. Profesor Ghosh przestąpił próg sali konferencyjnej w Raichak, indyjskiej wiosce położonej w Bengalu Zachodnim, gdzie odbywało się spotkanie IMS/ASA-SRMS. Właśnie przygotowywałem się do wystąpienia. Oczywiście wiedziałem, kto wszedł do sali. Niesamowita aura otaczająca Profesora sprawiła jednak, że na chwilę przerwałem pracę. Powitał mnie w zaskakująco skromny sposób, słowami „Witaj, jestem Malay”. Ten imponujący naukowiec okazał się niezwykle przyjacielskim, miłym i życzliwym człowiekiem, co wcale nie umniejszało wrażenia, jakie robił. Podczas wszystkich spotkań, rozmów i wizyt – o niektórych z nich powiem za chwilę kilka słów – w wyjątkowy dla siebie sposób łączył profesjonalizm z uprzejmością. Przygotowanie laudacji z okazji przyznania tytułu doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach tak wybitnemu naukowcowi, jakim jest Profesor Malay Ghosh, to dla mnie wielki zaszczyt i przyjemność.

Nie ulega wątpliwości, że profesor Ghosh jest w swojej dziedzinie wiodącym światowym ekspertem. Wniósł

Scientific achievements of Professor Malay Ghosh

It was in January 2004 when Professor Ghosh entered the conference room at the IMS/ASA-SRMS Joint Mini Meeting, Raichak, West Bengal, India. Of course, I knew who had just entered the room when I was preparing my talk. But it was the incredible aura that surrounded him and made me pause. Quite unpretentiously he greeted me with a “Hi, I’m Malay” – this incredibly impressive researcher immediately showed his very friendly, warm and human manner with which he was no less impressive. This special professional though kind manner was evident in all meetings, conversations and invitations, and I’ll mention some of them in a moment. Therefore, it is a special pleasure and honour for me to formulate a laudation for this outstanding researcher, Professor Malay Ghosh, on the occasion of his honorary doctorate from the University of Economics in Katowice.

Professor Ghosh is without any doubt a world-leading researcher in statistics. His contributions to statistics cover a wide range of topics from theoretical findings to very important applications in many differ-

wkład zarówno w rozwój teorii statystyki, jak i w badania nad jej różnorodnymi praktycznymi zastosowaniami. Zajmuje się głównie wnioskowaniem bayesowskim, empirycznymi metodami bayesowskimi, metodami estymacji na podstawie próbek, modelami hierarchicznymi, metodą reprezentacyjną oraz statystyką małych obszarów. Jego życiorys, liczący 59 stron, mówi sam za siebie – z łatwością można w nim znaleźć wiele innych tematów, które wzbudziły ogromne zainteresowanie.

Po ukończeniu studiów w Kalkucie, Profesor Ghosh kontynuował karierę na University of North w Chapel Hill, Indian Statistical Institute w Kalkucie oraz Iowa State w Ames, aby ostatecznie uzyskać tytuł profesora zwyczajnego w Kalkucie. Wrócił na jakiś czas na Iowa State University, a w roku 1982 rozpoczął pracę na wydziale statystyki na University of Florida w Gainesville. Choć wielokrotnie pracował jako profesor wizytujący w różnych miejscach świata, nigdy nie porzucił tej uczelni. W 1998 roku otrzymał tytuł *Distinguished Professor* w dziedzinie statystyki na University of Florida. Dziś jest jedynym przedstawicielem tej uczelni posiadającym taki tytuł.

Pan Profesor piastował prawie 20 stanowisk redaktora oraz redaktora działowego w wielu międzynarodowych czasopismach, takich jak prestiżowy „Journal of the American Statistical Association” czy „Annals of Statistics”.

Jeśli chodzi o badania własne, Profesor Ghosh może pochwalić się ponad 300 publikacjami, kolejnych dzieł więc znajduje się w druku. Ta liczba z pewnością wzrosła od momentu napisania niniejszej recenzji. Jego badania

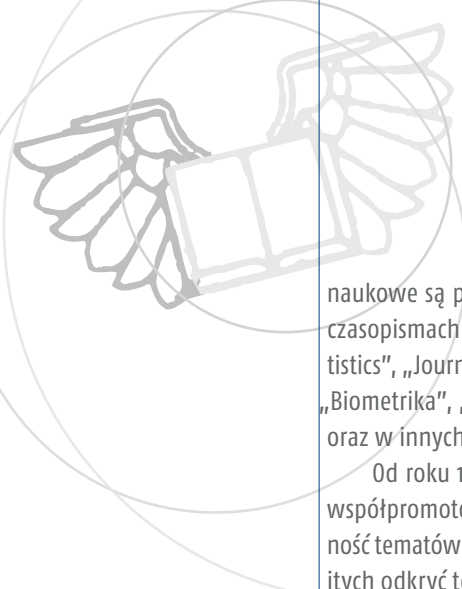
ent areas. His main areas of interest are Bayesian and empirical Bayesian methodology, resampling methods, and hierarchical modelling, as well as sampling and small area estimation. His amazing 59 page curriculum vitae speaks for itself and you can easily find many other topics that have stimulated major interest.

After completing his studies in Calcutta, Professor Ghosh subsequently took the next steps of his career at UNC in Chapel Hill, the Indian Statistical Institute in Calcutta, and Iowa State University in Ames, until he became full professor in Calcutta. After another period at Iowa State, he finally arrived at the department of statistics at the University of Florida at Gainesville in 1982. Though he completed several prominent visiting professorships far off, he never left Florida. Since 1998, he has been Distinguished Professor of Statistics at the University of Florida, Gainesville, and currently the only one at this institution.

Professor Ghosh has served in almost 20 different roles as an editor and an associate editor for international journals. Amongst these journals are highly prestigious publications as the “Journal of the American Statistical Association” and the “Annals of Statistics”.

Relating to his own research, Professor Ghosh can be proud of over 300 peer-reviewed papers with nine more in press, and by the time of writing this laudatory speech surely even more. His research work is published in the most prestigious statistics journals including the “Annals of Statistics”, the “Journal of the American Statistical Association”, “Biometrika”, the





naukowe są publikowane w najbardziej prestiżowych czasopismach statystycznych, takich jak „Annals of Statistics”, „Journal of the American Statistical Association”, „Biometrika”, „Journal of the Royal Statistical Society B” oraz w innych znanych czasopismach naukowych.

Od roku 1976 Profesor Ghosh był promotorem lub współpromotorem ponad 60 doktorantów. Różnorodność tematów rozpraw doktorskich, dotyczących rozmaitych odkryć teoretycznych i praktycznych, jest równie imponująca jak zakres jego własnych badań. Pośród jego studentów są znani naukowcy, również mogący poszczycić się tytułem profesora, tacy jak: Nitis Mukhopadhyay, Partha Lahiri i Gauri Datta. Z bogactwa pomysłów Profesora czerpali nie tylko doktoranci. Gdy rozmawiam z jego studentami, zawsze słyszę ciepłe słowa na temat wsparcia naukowego i duchowego, jakie okazuje swoim podopiecznym. Prawdziwym wyzwaniem jest dla nich dotrzymanie kroku Profesorowi w przekuwaniu coraz to nowych pomysłów w rzeczywiste rozwiązania. Intensywność procesu badawczego oraz prac nad doktoratami może czasami stanowić wyzwanie, jednak Profesor Ghosh zawsze stara się wspierać swoich podopiecznych i zapewnić im jak najlepsze możliwości rozwoju.

Można by sądzić, że tak wybitny naukowiec nie znajdzie już czasu, aby angażować się w życie uczelni. Nic bardziej mylnego – Profesor Ghosh zawsze był i jest aktywnym członkiem społeczności uniwersyteckiej, skupiając się przede wszystkim na edukacji podyplomowej. Był zaangażowany również w działalność pozauniwersytecką. To niewiarygodne, że udało mu się łączyć

„Journal of the Royal Statistical Society B”, as well as many other well-known journals.

Since 1976, Professor Ghosh has supervised and co-supervised more than 60 PhD students. The variety of topics of the theses is as impressive as the range of his own research, covering theoretical and practical findings in so many directions. Amongst his students are so famous researchers who have also become professors, such as Nitis Mukhopadhyay, Partha Lahiri, and Gauri Datta. It is not solely his own list of PhD students who have benefitted from his rich set of ideas but also a long list of guests. And whenever I speak to one of his students, I hear only very warm words about his research and mental support. Possibly sometimes so impressive that students face a challenge of making his ideas into reality as quickly as Professor Ghosh develops them. This unbelievable intensity in research ideas and promotion of students may sometimes provide a special challenge for students. However, he has always associated this with particularly positive support to foster a best possible development of his students and guests.

As you might expect that this outstanding researcher would likely be less committed to committee services, you will be surprised to see his very long list of contributions to all faculties where he was and is present. He has been active in many directions in the university system, with special emphasis on postgraduate education. In addition to these university committees, he showed major support on many different occasions outside the university. It is unbelievable, how he could

tak wiele dodatkowych obowiązków z fantastyczną pracą badawczą. Pełnił różne funkcje w stowarzyszeniach takich jak Institute for Mathematical Statistics czy American Statistical Association. Szacunek, jakim cieszy się Pan Profesor, sprawia, że często zaprasza się go do udziału w pracach komitetów programowych międzynarodowych konferencji. Nie trzeba wyjaśniać, że sama jego obecność zwiększa zainteresowanie poszczególnymi wydarzeniami. Podczas cyklu Small Area Statistics Conferences był zawsze wybierany na członka komitetu doradczego.

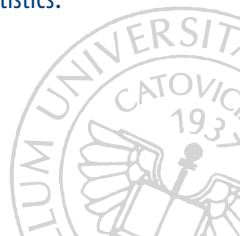
Profesor Ghosh był często proszony o zorganizowanie sesji naukowych, napisał również ponad 120 artykułów w odpowiedzi na zaproszenia płynące z całego świata. Ponadto wygłosił 130 wykładów na zaproszenie, dotyczących różnych tematów związanych z jego zainteresowaniami badawczymi. Biorąc pod uwagę tak niewiarygodny dorobek, trudno się dziwić, że w życiorysie Pana Profesora znajdziemy stosunkowo niewiele referatów wygłoszonych nie na zaproszenie.

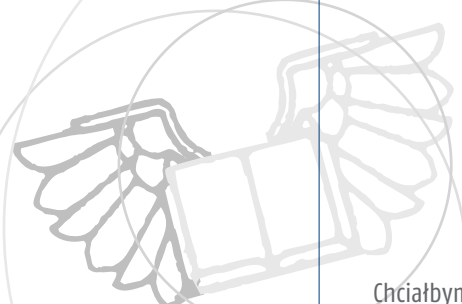
Profesor Ghosh nie tylko wniósł ogromny wkład w badania naukowe, ale był też głównym wykonawcą w licznych cenionych projektach badawczych i grantach naukowych, w tym w wielu wspieranych przez National Research Foundation. Współpracował również z wiodącymi organizacjami, takimi jak U.S. Census Bureau, Bureau of Labor Statistics oraz National Agriculture Statistics Services. To kolejny dowód na to, jak wiele teoretycznych odkryć Profesora Ghosha znajduje praktyczne zastosowanie w różnych obszarach statystyki.

manage all these duties besides his amazing research record. These activities encompass various roles in societies such as the Institute for Mathematical Statistics and the American Statistical Association, for which he served in many different positions. Additionally, he was well respected and often invited to participate in programme committees for international conferences. It is self-explanatory that having him on a board was already a major point of attraction for any conference. Especially for the series of Small Area Statistics Conferences, he was always appointed as member of the advisory committee.

As Professor Ghosh was certainly often asked to organise invited sessions, he himself has provided an impressively long list of over 120 invited papers covering so many regions all over the world. Additionally, he has provided 130 invited and special invited lectures in such different areas of his interest. This incredible reputation is almost certainly the reason why he shows comparatively few contributed papers in his curriculum vitae.

Besides his amazing list of research contributions, he was the principal investigator in many highly recognised research projects and grants, of which many stemmed from the National Research Foundation. This amazing list was enriched by further collaborations with important organisations such as the U.S. Census Bureau, the Bureau of Labor Statistics, and the National Agriculture Statistics Services. This again proves how the many theoretical findings of Professor Ghosh serve as an important contribution to applications in many fields of statistics.





Chciałbym omówić teraz wybitne zasługi Profesora Ghosha, przedstawiając mój własny punkt widzenia. Jego osiągnięcia w zakresie statystyki małych obszarów są bez wątpienia pionierskie.

W 1987 roku, razem z profesorem Lahirim, opublikował artykuł *Robust empirical Bayes estimation of variances from stratified samples* w „Journal of the American Statistical Association”. Publikacja dotyczy jednoczesnej estymacji średnich w wielu populacjach skończonych. Metoda ta znajduje zastosowanie w estymacji rocznych przychodów lub stopy bezrobocia, które muszą być szacowane jednocześnie w wielu podpopulacjach. Praca Profesora Ghosha wywarła znaczący wpływ na szerokie spektrum badań, poczynając od empirycznego wnioskowania bayesowskiego, a kończąc na statystyce małych obszarów, czego dowodem może być ponad 100-krotna liczba cytowań w tych dziedzinach nauki.

Artykuł *Small area estimation: An appraisal*, napisany wspólnie z J.N.K Rao, został opublikowany w „Statistical Science” w roku 1994. Skalę zainteresowania artykułem ukazuje fakt, że był on cytowany ponad 1000 razy.

Badania Profesora Ghosha dotyczą wielu dziedzin: przyczynił się znacząco także do rozwoju ekonomii. Liczne prace i prezentacje dotyczyły konkretnych aspektów przychodu oraz jego parametrów. Metody zastosowane w tych badaniach to m.in. przekrojowe i międzyokresowe podejścia bayesowskie oraz regionalne aspekty statystyki małych obszarów. Szczególnie istotnym tematem są badania nad dochodami regionalnymi – znajdują one szerokie zastosowanie również jako element wspierający

Let me focus on some of Professor Ghosh's outstanding contributions, though this is more a personal view. His contributions to small area statistics are surely pioneering.

In 1987, he published, together with Professor Lahiri, a paper on *Robust empirical Bayes estimation of variances from stratified samples* in the “Journal of the American Statistical Association”. The focus of the paper is a simultaneous estimation of means in multiple finite populations. This is essentially useful and applicable for estimating annual incomes or unemployment rates which are to be estimated in many areas simultaneously. The research has influenced a wide spectrum of research from empirical Bayes prediction to frequentist methodology of small area estimation, which can be drawn from far more than 100 citations in these research areas.

His article on *Small area estimation: An appraisal*, together with J.N.K. Rao, has been published in “Statistical Science” in 1994 and received major attention being cited over 1,000 times.

Professor Ghosh's research covers so many different areas: he has also provided important contributions to economics. Several papers and presentations focused on specific aspects of income and its parameters. The methods in use cover Bayesian cross-sectional and intertemporal approaches as well as regional aspects using small area techniques. Especially research on regional incomes provides an important topical theme which plays an important role in applications and even in policy support. Reliable figures more and more play

decyzje i działania polityczne. Pewne i rzetelne dane pełnią rolę najwyższej wagi we współczesnej demokracji, a badania Profesora Ghosha dotyczące benchmarkingu w statystyce małych obszarów zapewniają niezbędną podstawę w tym zakresie. W związku z prowadzonymi badaniami dotyczącymi ekonomii Pan Profesor kilkakrotnie odwiedził Katowice.

Kolejnym ważnym obszarem badań Profesora Ghosha jest amerykański spis powszechny, który z całą pewnością jest źródłem istotnych danych ekonomicznych na temat społeczeństwa. Oczywiście jest, iż wkład Profesora w rozwój metod z zakresu analizy regresji stanowi wybitną podstawę współczesnych metod ilościowych. Dodatkowo badania Profesora Ghosha na temat losowania z populacji skończonych oraz wnioskowania bayesowskiego w statystyce i ekonometrii dostarczają doskonałych danych wejściowych niezbędnych do prowadzenia współczesnych badań z zakresu ekonomii.

Jako statystyk, Profesor Ghosh zdobył światowe uznanie. Jest członkiem American Statistical Association, Institute of Mathematical Statistics oraz International Society for Bayesian Statisticians, a także członkiem z wyboru International Statistical Institute. Jest zdobywcą Medalu im. Jerzego Spławy-Neymana (2012), Lifetime Achievement Award, przyznawanej przez Indian Statistical Association (2017), a także The Small Area Estimation Award (2019).

Bez cienia wątpliwości można uznać Profesora Malaya Ghosha za wybitny autorytet w dziedzinie statystyki. Jego dokonania inspirowały zarówno młodych, jak


an utmost important role for a modern democracy and Professor Ghosh's research on benchmarking in small area statistics enables the provision of the necessary basis. In light of this economics related research, Professor Ghosh visited Katowice several times.

Another important area of his research focuses on the American census which surely serves as an important source of economic data for the society. I don't need to remind you that his many contributions on a variety of regression methods surely serve as an outstanding basis for modern quantitative research. Finally, Professor Ghosh's research on finite population sampling and Bayesian inference for statistics, in general, and for econometrics provides excellent findings which are necessary input for modern economic research.

Professor Ghosh's eminence as a statistician has already been well recognised internationally. He is a fellow of the American Statistical Association, the Institute of Mathematical Statistics, and the International Society for Bayesian Statisticians. He is an elected member of the International Statistical Institute. He is a holder of the Jerzy Spława-Neyman Medal (2012), the Lifetime Achievement Award from the Indian Statistical Association (2017), and the Small Area Estimation Award (2019).

Without a shadow of doubt, Professor Ghosh is an distinguished authority in statistics. His contributions to statistics have not only been an example for junior researchers but for everyone working in this field. They have shown important methods providing paths for future research. In all ways, Professor Ghosh's a remark-





i doświadczonych badaczy. Metody przez niego opracowane wytyczały ścieżki kolejnych badań. Ze wszechmiar pozytywna i życzliwa postawa Profesora Ghosha połączona z niewiarygodną wydajnością i kreatywnością zasługują na wyróżnienie tytułem doktora *honoris causa*.

Wszystko to pozwala mi wyrazić głębokie przekonanie, iż Profesor Malay Ghosh zasługuje na tytuł doktora *honoris causa* Uniwersytetu Ekonomicznego w Katowicach.

ably positive kind manner combined with his incredible productivity and creativity deserves to be awarded the doctorate *honoris causa*.

Finally, I recommend with strong emphasis this outstanding researcher, Professor Malay Ghosh, for the doctorate *honoris causa* from the University of Economics in Katowice.



Malay Ghosh
University of Florida

Small Area Estimation: An Early History

Abstract

The objective of my talk is to trace the early history of small area estimation. In particular, synthetic estimators, Fay–Herriot (Fay and Herriot, 1979) area level model-based estimators and Battese, Harter and Fuller (1988) unit level model-based estimators are discussed at some length, and examples are provided to illustrate these methods.

1. Prologue

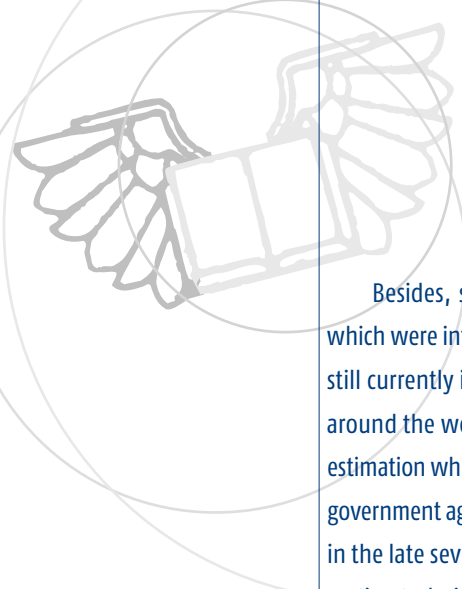
I am deeply honoured and happy to receive this Honorary Doctoral Degree from the University of Economics in Katowice. This honour is beyond my dream, and I accept it very humbly with sincerest gratitude. I thank everyone in the Senate who selected me for this award. Also, I take this opportunity to acknowledge my eternal indebtedness to my longtime friend Janusz Wywiiał for

his continued support, friendship and for recommending my nomination for this award, and the Honourable Rector of this University for the actual nomination. I also want to acknowledge my parents and grandparents for their support towards my academic advancement and to my wife for her unfailing support for forty nine years.

My association with your University, and particularly the statistics group, spans over more than a decade, and I am particularly impressed by the high quality of research of the faculty of statistics. As an example. I may draw attention to the work of Janusz Wywiiał on audit sampling, a non-standard and highly innovative work, and of Tomasz Źądło on mixed effect models with many applications to small area estimation.

Back to the topic of today's talk, I want to trace the early history of small area estimation. Small area estimation is a topic of current interest and research in this area is simply phenomenal. It will take a whole semester or more of lectures potentially to bring a person up to date to all aspects of small area estimation. In my assessment, even that may not be feasible.





Besides, some of the early small area techniques, which were introduced in the seventies and eighties, are still currently in vogue, and are used by many agencies around the world. Mention may be made of 'synthetic' estimation which because of its simplicity is used by many government agencies. The Fay–Herriot model, introduced in the late seventies, is still by far the most popular estimation technique around the globe. The same comment applies to the model of Battese, Harter and Fuller which is applicable whenever microdata is available.

People looking for a more up to date account of the topic should consult Rao and Molina (2015) as well as some excellent review articles by Pfeiffermann (2002, 2013) and by Rao (2003, 2006).

I also want to acknowledge my indebtedness to many of my colleagues influencing my own research either by collaboration or by prolonged meaningful discussion. They are too many to mention individually. J.N.K. Rao and Danny Pfeiffermann deserve particular mention. I also want to thank Partha Lahiri, Gauri Datta and Rebecca Steorts, some of my most successful students in this area of research.

2. Introduction

The first and foremost question that one may ask is "what is small area estimation?". Small area estimation

is any of several statistical techniques involving estimation of parameters in small 'sub-populations' of interest included in a larger 'survey'. The term 'small area' in this context generally refers to a small geographical area such as a county, census tract or a school district. It can also refer to a 'small domain' cross-classified by several demographic characteristics, such as age, sex, ethnicity etc. I want to emphasize that it is not just the area, but the 'smallness' of the targeted population within an area which constitutes the basis of small area estimation. For example, if a survey is targeted towards a population of interest with prescribed accuracy, the sample size in a particular subpopulation may not be adequate to generate similar accuracy. This is because if a survey is conducted with sample size determined to attain prescribed accuracy in a large area, one may not have the resources available to conduct a second survey to achieve similar accuracy for smaller areas.

A domain (area) specific estimator is 'direct' if it is based only on the domain-specific sample data. A domain is regarded as 'small' if domain-specific sample size is not large enough to produce estimates of desired precision. Domain sample size often increases with population size of the domain, but that need not always be the case. This requires use of 'additional' data, be

it other administrative data not used in the original survey, or data from other related areas. The resulting estimates are called 'indirect' estimates that 'borrow strength' for the variable of interest from related areas and/or time periods to increase the 'effective' sample size. This is usually done through the use of models, mostly 'explicit', or at least 'implicit' that links the related areas and/or time periods.

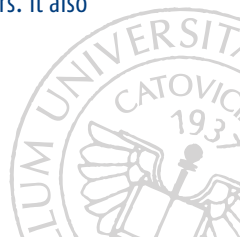
Historically, small area statistics have long been used, albeit without the name 'small area' attached to it. For example, such statistics existed in eleventh century England and seventeenth century Canada based on either census or on administrative records. Demographers have long been using a variety of indirect methods for small area estimation of population and other characteristics of interest in postcensal years.


In recent years, the demand for small area statistics has greatly increased worldwide. The need is felt for formulating policies and programs, in the allocation of government funds and in regional planning. For instance, legislative acts by national governments have created a need for small area statistics. A good example is SAIPE (Small area Income and Poverty Estimation) mandated by the US Legislature. Demand from the private sector has also increased because business decisions, particularly

those related to small businesses, rely heavily on local socio-economic conditions. Small area estimation is of particular interest for the economics in transition in central and eastern European countries and the former Soviet Union countries. In the 1990's these countries have moved away from centralized decision making. As a result, sample surveys are now used to produce estimates for large areas as well as small areas.

3. Examples

Before tracing this early history, let me cite a few examples which illustrate the ever increasing current day importance of small area estimation. One important ongoing small area estimation problem at the U.S. Bureau of the Census is the small area income and poverty estimation (SAIPE) project. This is a result of a Bill passed by the US House of Representatives requiring the Secretary of Commerce to produce and publish at least every two years beginning in 1996, current data related to the incidence of poverty in the United States. Specifically, the legislation states that "to the extent feasible", the secretary shall produce estimates of poverty for states, counties and local jurisdictions of government and school districts. For school districts, estimates are to be made of the number of poor children aged 5-17 years. It also





specifies production of state and county estimates of the number of poor persons aged 65 and over.

These small area statistics are used by a broad range of customers including policy makers at the state and local levels as well as the private sector. This includes allocation of Federal and state funds. Earlier the decennial census was the only source of income distribution and poverty data for households, families and persons for such small geographic areas. Use of the recentmost decennial census data pertaining to the economic situation is unreliable especially as one moves further away from the census year. The first SAIPE estimates were issued in early 1997 for states and counties for the income year 1993. The SAIPE state and county estimates include median household income and number of poor people, poor children under age 5 (for states only), poor children aged 5–17 and poor people under age 18. Also starting early 1999 estimates of the number of poor school-aged children were provided for 14,000 school districts.

Another old example is the Federal–State Co–Operative Program (FSCP). The goal was to provide high–quality consistent series of post–censal county population estimates with comparability from area to area. In addition to the county estimates, several members of FSCP now produce subcounty estimates as well. Also, the US Census

Bureau used to provide the Treasury Department with Per Capita Income (PCI) estimates and other statistics for state and local governments receiving funds under the general revenue sharing program. Treasury Department used these statistics to determine allocations to local governments within the different states by dividing the corresponding state allocations.

United States Department of Agriculture (USDA) has long been interested in prediction of areas under corn and soybeans. Battese, Harter and Fuller (1988) considered the problem of predicting areas under corn and soybeans for 12 counties in North–Central Iowa based on the 1978 June enumerative survey data as well as Landsat Satellite Data. The USDA statistical reporting Service field staff determined the area of corn and soybeans in 37 sample segments of 12 counties in North Central Iowa by interviewing farm operators. In conjunction with LANDSAT readings obtained during August and September 1978, USDA procedures were used to classify the crop cover for all pixels in the 12 counties.

4. Synthetic estimation

An estimator is called 'Synthetic' if a direct estimator for a large area covering a small area is used as an indirect estimator for that area. The terminology was first used

by the U.S. National Center for Health Statistics. These estimators are based on a strong underlying assumption is that the small area bears the same characteristic for the large area.

For example, if y_1, \dots, y_m are the direct estimates of average income for m areas with population sizes N_1, \dots, N_m , we may use the overall estimate $\bar{y}_s = \sum_{j=1}^m N_j y_j / N$ for a particular area, say, i , where $N = \sum_{j=1}^m N_j$. The idea is that this synthetic estimator has less mean squared error (MSE) compared to the direct estimator y_i if the bias $\bar{y}_s - y_i$ is not too strong. However, a heavily biased estimator can affect the MSE as well.

One of the early use of synthetic estimation appears in Hansen, Hurwitz and Madow (1953, pp. 483–486). They applied synthetic regression estimation in the context of radio listening. The objective was to estimate the median number of radio stations heard during the day in each of more than 500 counties in the US. The direct estimate y_i of the true (unknown) median M_i was obtained from a radio listening survey based on personal interviews for 85 county areas. The selection was made by first stratifying the population county areas into 85 strata based on geographical region and available radio service type. Then one county was selected from each stratum with probability proportional to the estimated

number of families in the counties. A subsample of area segments was selected from each of the sampled county areas and families within the selected area segments were interviewed.

In addition to the direct estimates, an estimate x_i of M_i , obtained from a mail survey was used as a single covariate in the linear regression of y_i on x_i . The mail survey was first conducted by sampling 1,000 families from each county area and mailing questionnaires. The x_i were biased due to nonresponse (about 20% response rate) and incomplete coverage, but were anticipated to have high correlation with the M_i . Indeed, it turned out that $\text{Corr}(y_i, x_i) = .70$. For nonsampled counties, regression synthetic estimates were $\hat{M}_i = .52 + .74x_i$.

Another example of Synthetic Estimation is due to Maria Gonzalez and Christine Hoza (1978, pp. 7–15). Their objective was to develop intercensal estimates of various population characteristics for small areas. They discussed synthetic estimates of unemployment where the larger area is a geographic division and the small area is a county.

Specifically, let p_{ij} denote the proportion of labor force in county i that corresponds to cell j ($j = 1, \dots, G$). Let u_j denote the corresponding unemployment rate for cell j based on the geographic division where county



i belongs. Then the synthetic estimate of the unemployment rate for county i is given by $u_i^* = \sum_{j=1}^G p_{ij} u_j$. These authors also suggested synthetic regression estimate for unemployment rate.

While direct estimators suffer from large variances and coefficients of variation for small areas, synthetic estimators suffer from bias which often can be very severe. This led to the development of composite estimators which are weighted averages of direct and synthetic estimators. The motivation was to balance the design bias of synthetic estimators and the large variability of direct estimators in a small area.

Let y_{ij} denote the characteristic of interest for the j th unit in the i th area; $j = 1, \dots, N_i$; $i = 1, \dots, m$. Let x_{ij} denote some auxiliary characteristic for the j th unit in the i th local area. Note that the population means are $\bar{Y}_i = \sum_{j=1}^{N_i} y_{ij} / N_i$ and $\bar{X}_i = \sum_{j=1}^{N_i} x_{ij} / N_i$. We denote the sampled observations as y_{ij} , $j = 1, \dots, n_i$ with corresponding auxiliary variables x_{ij} , $j = 1, \dots, n_i$. Let $\bar{x}_i = \sum_{j=1}^{n_i} x_{ij} / n_i$.

A Direct Estimator (Ratio Estimator of \bar{Y}_i is $\bar{y}_i^R = (\bar{y}_i / \bar{x}_i) \bar{X}_i$. The corresponding Ratio Synthetic Estimator of \bar{Y}_i is $(\bar{y}_s / \bar{x}_s) \bar{X}_i$, where $\bar{y}_s = \sum_{i=1}^m N_i \bar{y}_i / \sum_{i=1}^m N_i$ and $\bar{x}_s = \sum_{i=1}^m N_i \bar{x}_i / \sum_{i=1}^m N_i$. A Composite Estimator of \bar{Y}_i is $(n_i / N_i) \bar{y}_i + (1 - n_i / N_i) (\bar{y}_s / \bar{x}_s) \bar{X}_i'$, where

$\bar{X}_i' = (N_i - n_i)^{-1} \sum_{j=n_i+1}^{N_i} x_{ij} / (N_i - n_i)$. Note $N_i \bar{X}_i = n_i \bar{x}_i + (N_i - n_i) \bar{X}_i'$. All one needs to know is the population average \bar{X}_i in addition to the already known sample average \bar{x}_i to find \bar{X}_i' .

The Composite Estimator can be given a model-based justification as well (Holt, Smith and Tomberlin, 1979, pp. 405-410). Consider the model $y_{ij} \stackrel{\text{ind}}{\sim} (bx_{ij}, \sigma^2 x_{ij})$. Best linear unbiased estimator of b is obtained by minimizing $\sum_{i=1}^m \sum_{j=1}^{n_i} (y_{ij} - bx_{ij})^2$. The solution is $\hat{b} = \bar{y}_s / \bar{x}_s$. Now estimate $\bar{Y}_i = (\sum_{j=1}^{n_i} y_{ij} + \sum_{j=n_i+1}^{N_i} y_{ij}) / N_i$ by $\sum_{j=1}^{n_i} y_{ij} / N_i + \hat{b} \sum_{j=n_i+1}^{N_i} x_{ij} / N_i$. This simplifies to the expression given in the previous paragraph.

5. Model-based small area estimation

Small area models link explicitly the sampling model with random area specific effects. The latter accounts for between area variation beyond that is explained by auxiliary variables. We classify small area models into two broad types. First the 'area level' models that relate small area direct estimators to area-specific covariates. Such models are necessary if unit (or element) level data are not available. Second the 'unit level' models that relate the unit values of a study variable to unit-specific covariates. Indirect estimators based on small area models will be called 'model-based estimators'.

The model-based approach to small area estimation offers several advantages. First, 'optimal' estimators can be derived under the assumed model. Second, area specific measures of variability can be associated with each estimator unlike global measures (averaged over small areas) often used with traditional indirect estimators. Third, models can be validated from the sample data. Fourth, one can entertain a variety of models depending on the nature of the response variables and the complexity of data structures.

The classic small area model is due to Fay and Herriot (1979) with Sampling Model: $y_i = \theta_i + e_i, i = 1, \dots, m$ and Linking Model: $\theta_i = \mathbf{x}_i^T \mathbf{b} + u_i, i = 1, \dots, m$. The Target is estimation of the $\theta_i, i = 1, \dots, m$. It is assumed that e_i are independent $(0, D_i)$, where the D_i are known and the u_i are iid $(0, A)$, where A is unknown. The assumption of known D_i can be put to question because they are, in fact, sample estimates. But the assumption is needed to avoid nonidentifiability in the absence of microdata. This is evident when one writes $y_i = \mathbf{x}_i^T \mathbf{b} + u_i + e_i$. In the presence of microdata, it is possible to estimate the D_i as well. An example appears in Ghosh, Myung and Moura (2018).

A few notations are needed to describe the Fay–Herriot procedure. Let $\mathbf{y} = (y_1, \dots, y_m)^T$; $\mathbf{e} = (e_1, \dots, e_m)^T$;

$$\mathbf{u} = (u_1, \dots, u_m)^T; \mathbf{X} = (\mathbf{x}_1^T, \dots, \mathbf{x}_m^T); \mathbf{b} = (b_1, \dots, b_p)^T.$$

We assume \mathbf{X} has rank $p (< m)$. In vector notations, we write $\mathbf{y} = \boldsymbol{\theta} + \mathbf{e}$ and $\boldsymbol{\theta} = \mathbf{X}\mathbf{b} + \mathbf{u}$.

For known A , the best linear unbiased predictor (BLUP) of $\boldsymbol{\theta}$ is $(1 - B_i)y_i + B_i \mathbf{x}_i^T \tilde{\mathbf{b}}$ where $\tilde{\mathbf{b}} = (\mathbf{X}^T \mathbf{V}^{-1} \mathbf{X})^{-1} \mathbf{X}^T \mathbf{V}^{-1} \mathbf{y}$, $\mathbf{V} = \text{Diag}(D_1 + A, \dots, D_m + A)$ and $B_i = D_i / (A + D_i)$. The BLUP is also the best unbiased predictor under assumed normality.

It is possible to give an alternative Bayesian formulation of the Fay–Herriot model. Let $y_{ij} | \theta_i \stackrel{\text{ind}}{\sim} N(\theta_i, D_i)$; $\theta_i | \mathbf{b} = \stackrel{\text{ind}}{\sim} N(\mathbf{x}_i^T \mathbf{b}, A)$. Then the Bayes estimator of θ_i is $(1 - B_i)y_i + B_i \mathbf{x}_i^T \mathbf{b}$, where $B_i = D_i / (A + D_i)$. If instead we put a uniform (R^p) prior for \mathbf{b} , the Bayes estimator of θ_i is the same as its BLUP. Thus, there is a duality between the BLUP and the Bayes estimator.

However, in practice, A is unknown. A hierarchical prior joint for both \mathbf{b} and A is $\pi(\mathbf{b}, A) = 1$ (Morris, 1983). Otherwise, estimate A to get the resulting empirical Bayes or empirical BLUP. We now describe the latter.

There are several methods for estimation of A . Fay and Herriot (1979) suggested solving iteratively the two equations (i) $\tilde{\mathbf{b}} = (\mathbf{X}^T \mathbf{V}^{-1} \mathbf{X})^{-1} \mathbf{X}^T \mathbf{V}^{-1} \mathbf{y}$ and (ii) $\sum_{i=1}^m (y_i - \mathbf{x}_i^T \tilde{\mathbf{b}})^2 = m - p$. The motivation for (i) comes from the fact that $\tilde{\mathbf{b}}$ is the best linear unbiased estimator (BLUE) of \mathbf{b} when A is known. The second is a method



of moments equation noting that the expectation of the left hand side equals $m - p$.

The Fay–Herriot method is not too convenient for analytical studies. Prasad and Rao (1990) suggested instead a unweighted least squares approach to estimate A . Specifically, they proposed the estimator $\hat{\mathbf{b}}_L = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{y}$. Then $E \|\mathbf{y} - \mathbf{X} \hat{\mathbf{b}}_L\|^2 = (m - p)A + \sum_{i=1}^m D_i(1 - r_i)$, $r_i = \mathbf{x}_i^T (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{x}_i$, $i = 1, \dots, m$. This leads to $\hat{A}_L = \max(0, \frac{\|\mathbf{y} - \mathbf{X} \hat{\mathbf{b}}_L\|^2 - \sum_{i=1}^m D_i(1 - r_i)}{m - p})$ and accordingly $\hat{B}_i^L = \frac{D_i}{\hat{A}_L} + D_i$. The corresponding estimator of θ is $\hat{\theta}_i^{EB} = (1 - \hat{B}_i^L)y_i + \hat{B}_i^L \mathbf{x}_i^T \tilde{\mathbf{b}}(\hat{A}_L)$, where $\tilde{\mathbf{b}}(\hat{A}_L) = [\mathbf{X}^T \mathbf{V}^{-1}(\hat{A}_L) \mathbf{X}]^{-1} \mathbf{X}^T \mathbf{V}^{-1}(\hat{A}_L) \mathbf{y}$.

Prasad and Rao (1990) also found an approximation to the mean squared error (Bayes risk) of their EBLUP or EB estimators. Under the subjective prior $\theta_i \stackrel{\text{ind}}{\sim} N(\mathbf{x}_i^T \mathbf{b}, A)$, the Bayes estimator of θ_i is $\hat{\theta}_i^B = (1 - B_i)y_i + B_i \mathbf{x}_i^T \mathbf{b}$, $B_i = D_i/(A + D_i)$. Also, write $\tilde{\theta}_i^{EB}(A) = (1 - B_i)y_i + B_i \mathbf{x}_i^T \tilde{\mathbf{b}}(A)$. Then $E(\hat{\theta}_i^{EB} - \theta_i)^2 = E(\hat{\theta}_i^B - \theta_i)^2 + E(\hat{\theta}_i^{EB} - \tilde{\theta}_i^{EB}(A))^2$. The first term is the Bayes risk if both \mathbf{b} and A were known. The second term is the additional uncertainty due to estimation of \mathbf{b} when A is known. The third term accounts for further uncertainty due to estimation of A .

One can get exact expressions $E(\theta_i - \hat{\theta}_i^B)^2 = D_i(1 - B_i) = g_{1i}(A)$, say, and $E(\hat{\theta}_i^{EB}(A) - \hat{\theta}_i^B)^2$

$= B_i^2 \mathbf{x}_i^T (\mathbf{X}^T \mathbf{V}^{-1} \mathbf{X})^{-1} \mathbf{x}_i = g_{2i}(A)$, say. However, the third term $E(\hat{\theta}_i^{EB} - \hat{\theta}_i^{EB}(A))^2$ needs an approximation, and an approximate expression correct up to $O(m^{-1})$ as given in Prasad and Rao (1990) is $2B_i^2(D_i + A)^{-1}A^2 \sum_{i=1}^m (1 - B_i)^2/m^2 = g_{3i}(A)$, say. Further, an estimator of this MSE correct up to $O(m^{-1})$ is $g_{1i}(\hat{A}) + g_{2i}(\hat{A}) + 2g_{3i}(\hat{A})$. This approximation is justified by noticing $E[g_{1i}(\hat{A})] = g_{1i}(A) - g_{3i}(A) + o(m^{-1})$. A further refinement to this approximation is due to Datta, Rao and Smith (2005). Alternately, an estimator based on the MLE of A is given in Datta and Lahiri (2000).

A well-known example where this method has been applied is estimation of median income of four-person families for the 50 states and the District of Columbia. The U.S. Department of Health and Human Services (HHS) has a direct need for such data at the state level in formulating its Energy assistance program for low-income families. The basic source of data is the annual demographic supplement to the March sample of the Current Population Survey (CPS) which provides the median income of four-person families for the preceding year. Direct use of CPS estimates is usually undesirable because of large CV's associated with them. More reliable results are obtained in these days by using empirical and hierarchical Bayesian methods.

Here sample estimates of the state medians for the current year (c) as obtained from the Current Population Survey (CPS) were used as dependent variables. Adjusted census median (c) defined as the base year (the recent most decennial census) census median (b) times the ratio of the BEA PCI in year (c) to year (b) was used as the dependent variable. Following the suggestion of Fay (1987), we used the census median for the base year (b) as a second independent variable. We compared the EB estimates, CPS estimates, and the Bureau of the Census estimates against the 1979 census estimates.

Table 1. Average relative bias, Average squared relative bias, Average absolute bias and Average squared deviations (in 100,000) of the estimates

Specification	Bureau estimate	Sample median	EB
Aver. rel. bias	0.325	0.498	0.204
Aver. sq. rel. bias	0.002	0.003	0.001
Aver. abs. bias	722.8	1090.4	450.6
Aver. sq. dev.	8.36	16.31	3.34

The comparison was based on four criteria recommended by the panel on small area estimates of population and

income set up by the committee on National Statistics. They recommended the following four criteria for comparison. Here e_i denotes the estimate while $e_{i,TR}$ denotes the „truth“.

$$\text{Average relative bias} = (51)^{-1} \sum_{i=1}^{51} |e_i - e_{i,TR}| / e_{i,TR}$$

$$\text{Average squared relative bias} = (51)^{-1} \sum_{i=1}^{51} (e_i - e_{i,TR})^2 / e_{i,TR}^2$$

$$\text{Average absolute bias} = (51)^{-1} \sum_{i=1}^{51} |e_i - e_{i,TR}|$$

$$\text{Average squared deviation} = (51)^{-1} \sum_{i=1}^{51} (e_i - e_{i,TR})^2$$

Table 1 compares the Sample Median, the Bureau Estimate and the Empirical BLUP according to the four criteria as mentioned above.

6. Unit Specific Models

Unit Specific Models are ones where observations are available for the sampled units in the local areas. In addition, unit-specific auxiliary information is available for these sampled units, and possibly for the non-sampled units as well. We consider m local areas where the i th local area has N_i units with a sample of size n_i .

The sampled observations are denoted by $y_{i1}, \dots, y_{in_i}, i = 1, \dots, m$. The model considered is $y_{ij} = \mathbf{x}_{ij}^T \mathbf{b}$



$+ u_i + e_{ij}, j = 1, \dots, N_i, i = 1, \dots, m$. The u_i 's and e_{ij} 's are mutually independent with the u_i iid $(0, \sigma_u^2)$ and the e_{ij} independent $(0, \sigma^2 \psi_{ij}), i = 1, \dots, m$.

Battese, Harter and Fuller (1988) considered the nested error regression model in the context of estimation of corn and soybean for 12 counties in north-central Iowa. Let y_{ij} denote the area devoted to corn or soybean for the j th segment in the i th county. Also, let $\mathbf{x}_{ij} = (1, x_{ij1}, x_{ij2})^T$ where x_{ij1} denote the no. of pixels classified as corn for the j th segment in the i th county and x_{ij2} denotes the no. of pixels classified as soybean for the j th segment in the i th county. The vector of regression coefficients is denoted by $\mathbf{b} = (b_0, b_1, b_2)^T$ They took $\psi_{ij} = 1$

A second example appears in Ghosh and Rao (1994). Let y_{ij} denote wages and salaries paid by the j th business firm in the i th census division in Canada. Also, let $\mathbf{x}_{ij} = (1, x_{ij})^T$, where x_{ij} denotes the gross business income of the j th business firm in the i th census division. Here $\psi_{ij} = x_{ij}$ was found more appropriate than the usual model involving homoscedasticity.

Battese, Harter and Fuller (1988) considered predicting areas under corn and soybeans for 12 counties in North Central Iowa based on 1978 June Enumerative Survey data as well as LANDSAT satellite data. The

USDA Statistical Reporting Service field staff determined the area of corn and soybeans in 37 sample segments (each segment was about 250 hectares) of 12 counties in North Central Iowa by interviewing farm operators. Based on LANDSAT readings obtained during August and September 1978, USDA procedures were used to classify the crop cover for all pixels (a term for picture element about 0.45 hectares) in the 12 counties. An alternative approach based on Hierarchical Bayesian (HB) model is available in Datta and Ghosh (1992).

Table 2. The predicted hectares of soybeans and standard errors

County	e_{HB}	e_{EB}	e_{BHF}	S_{HB}	S_{EB}	S_{BHF}
Cerro Gordo	78.8	78.2	77.5	11.7	11.6	12.7
Franklin	67.1	65.9	64.8	8.2	7.5	7.8
Hamilton	94.4	94.6	95.0	11.2	11.4	12.4
Hancock	100.4	100.8	101.1	6.2	6.1	6.3
Hardin	75.4	75.1	74.9	6.5	6.4	6.6
Humboldt	81.9	80.6	79.2	10.4	9.3	10.0
Kossuth	118.2	119.2	120.2	6.6	6.0	6.2
Pocahontas	113.9	113.7	113.8	7.5	7.5	7.9
Webster	110.0	109.7	109.6	6.6	6.6	6.8
Winnebago	97.3	98.0	98.7	7.7	7.5	7.9
Worth	87.8	87.2	86.6	11.1	11.1	12.1
Wright	111.9	112.4	112.9	7.7	7.6	8.0

Table 2 gives HB predictors (e_{HB}), the EB predictors (e_{EB}), the Battese, Harter and Fuller (1988) predictors (e_{BHF}), and the associated standard errors s_{HB} , s_{EB} , and s_{BHF} , respectively for mean areas under soybeans in the 12 counties.

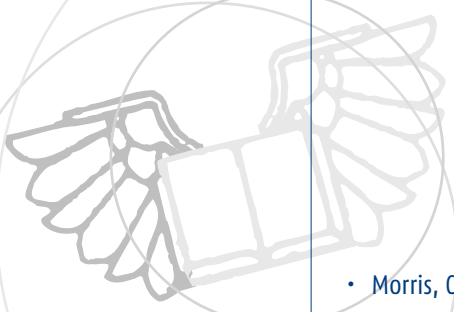
7. Final Remarks

The literature on small area estimation is vast, and new methodology with applications is appearing in growing numbers. Rather than covering each and every aspect of the subject, I have included a few topics which trace early history of the subject ending in the late eighties. I sincerely hope that I have been able to provide a synopsis which will help the interested reader to delve further into the subject.

References

- Battese, G.E., Harter, R.M. and Fuller, W.A. (1988). An error components model for prediction of county crop area using survey and satellite data. *Journal of the American Statistical Association*, 83, 28–36.
- Datta, G.S. and Ghosh, M. (1991). Bayesian prediction in linear models: Applications to small area estimation. *The Annals of Statistics*, 19, 1748–1770.
- Datta, G.S. and Lahiri. P. (2000). A unified measure of uncertainty of estimated best linear unbiased predictors in small area estimation problems. *Statistica Sinica*, 10, 613–627.
- Datta, G.S., Rao, J.N.K. and Smith, D.D. (2005). On measuring the variability of small area estimators under a basic area level model. *Biometrika*, 92, 183–196.
- Fay, R.E. and Herriot, R.A. (1979). Estimates of income for small places: An application of James–Stein procedure to census data. *Journal of the American Statistical Association*, 74, 269–277.
- Ghosh, M. and Rao, J.N.K. (1994). Small area estimation: An appraisal. *Statistical Science*, 9(1), 55–93.
- Ghosh, M., Myung, J. and Moura, F.A.S. (2018). Robust Bayesian small area estimation. *Survey Methodology*, 44, 101–115.
- Gonzalez, M.E. and Hoza, C. (1978). Small area estimation with application to unemployment and housing estimates. *Journal of the American Statistical Association*, 73, 7–15.
- Hansen, M.H., Hurwitz, W.N. and Madow, W.G. (1953). *Sample survey methods and theory*. Wiley, New York.
- Holt, D., Smith, T.M.F. and Tomberlin, T.J. (1979). A model-based approach for small subgroups of a population. *Journal of the American Statistical Association*, 74, 405–410.





- Morris, C.N. (1983). Parametric empirical Bayes inference: theory and applications. *Journal of the American Statistical Association*, 78, 47–55.
- Pfeiffermann, D. (2002). Small area estimation: New developments and direction. *International Statistical Review*, 70, 125–143.
- Pfeiffermann, D. (2013). New important developments in small area estimation. *Statistical Science*, 28, 40–68.
- Prasad, N.G.N. and Rao, J.N.K. (1990). The estimation of mean squared error of small area estimators. *Journal of the American Statistical Association*, 85, 163–171.
- Rao, J.N.K. (2003). Some new developments in small area estimation. *Journal of the Iranian Statistical Society*, 2, 145–169.
- Rao, J.N.K. (2006). Inferential issues in small area estimation: Some new developments. *Statistics in Transition*, 7, 523–526.
- Rao, J.N.K. and Molina, I. (2015). *Small area estimation*, 2nd edition. Wiley, New Jersey.





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