Contents

Notes on Contributors xiii
Foreword xxi
Preface xxvii

Part I INTRODUCTION

1 Agent-Based Modeling and Tax Evasion: Theory and Application 3
Sascha Hokamp, László Gulyás, Matthew Koehler and H. Sanith Wijesinghe

1.1 Introduction 3
1.2 Tax Evasion, Tax Avoidance and Tax Noncompliance 4
1.3 Standard Theories of Tax Evasion 5
1.4 Agent-Based Models 10
1.5 Standard Protocols to Describe Agent-Based Models 11
  1.5.1 The Overview, Design Concepts, Details, and Decision-Making Protocol 13
  1.5.2 Concluding Remarks on the ODD+D Protocol 17
1.6 Literature Review of Agent-Based Tax Evasion Models 18
  1.6.1 Public Goods, Governmental Tasks and Back Auditing 22
  1.6.2 Replication, Docking, and Calibration Studies 25
  1.6.3 Concluding Remarks on Agent-Based Tax Evasion Models 26
1.7 Outlook: The Structure and Presentation of the Book 27
  1.7.1 Part I Introduction 28
  1.7.2 Part II Agent-Based Tax Evasion Models 28
References 31
2 How Should One Study Clandestine Activities: Crimes, Tax Fraud, and Other “Dark” Economic Behavior? 37
Aloys L. Prinz

2.1 Introduction 37
2.2 Why Study Clandestine Behavior At All? 38
2.3 Tools for Studying Clandestine Activities 40
2.4 Networks and the Complexity of Clandestine Interactions 42
2.5 Layers of Analysis 45
2.6 Research Tools and Clandestine Activities 48
2.7 Conclusion 55
Acknowledgment 56
References 56

3 Taxpayer’s Behavior: From the Laboratory to Agent-Based Simulations 59
Luigi Mittone and Viola L. Saredi

3.1 Tax Compliance: Theory and Evidence 59
3.2 Research on Tax Compliance: A Methodological Analysis 62
3.3 From Human-Subject to Computational-Agent Experiments 68
3.4 An Agent-Based Approach to Taxpayers’ Behavior 73
3.4.1 The Macroeconomic Approach 74
3.4.2 The Microeconomic Approach 77
3.4.3 Micro-Level Dynamics for Macro-Level Interactions among Behavioral Types 80
3.5 Conclusions 83
References 84

Part II AGENT-BASED TAX EVASION MODELS

4 Using Agent-Based Modeling to Analyze Tax Compliance and Auditing 91
Nigar Hashimzade and Gareth Myles

4.1 Introduction 91
4.2 Agent-Based Model for Tax Compliance and Audit Research 93
4.2.1 Overview 93
4.2.2 Design Concepts 94
4.2.3 Details 98
4.3 Modeling Individual Compliance 98
4.3.1 Expected Utility 98
4.3.2 Behavioral Models 101
4.3.3 Psychic Costs and Social Customs 102
4.4 Risk-Taking and Income Distribution 106
4.5 Attitudes, Beliefs, and Network Effects 111
  4.5.1 Networks and Meetings 113
  4.5.2 Formation of Beliefs 113
4.6 Equilibrium with Random and Targeted Audits 115
4.7 Conclusions 119
Acknowledgments 122
References 122
Appendix 4A 123

5 SIMULFIS: A Simulation Tool to Explore Tax Compliance Behavior 125
Toni Llacer, Francisco J. Miguel Quesada, José A. Noguera and Eduardo Tapia Tejada
5.1 Introduction 125
5.2 Model Description 126
  5.2.1 Purpose 127
  5.2.2 Entities, State Variables, and Scales 127
  5.2.3 Process Overview and Scheduling 131
  5.2.4 Theoretical and Empirical Background 131
  5.2.5 Individual Decision Making 132
  5.2.6 Learning 135
  5.2.7 Individual Sensing 136
  5.2.8 Individual Prediction 136
  5.2.9 Interaction 137
  5.2.10 Collectives 137
  5.2.11 Heterogeneity 138
  5.2.12 Stochasticity 138
  5.2.13 Observation 139
  5.2.14 Implementation Details 140
  5.2.15 Initialization 140
  5.2.16 Input Data 141
  5.2.17 Submodels 141
5.3 Some Experimental Results and Conclusions 145
Acknowledgments 148
References 148

6 TAXSIM: A Generative Model to Study the Emerging Levels of Tax Compliance in a Single Market Sector 153
László Gulyás, Tamás Máhr and István J. Tóth
6.1 Introduction 153
6.2 Model Description 155
  6.2.1 Overview 155
  6.2.2 Design Concepts 165
6.2.3 Observation and Emergence 172
6.2.4 Details 173
6.3 Results 175
6.3.1 Scenarios 175
6.3.2 Sensitivity Analysis 182
6.3.3 Adaptive Audit Strategy 190
6.3.4 Minimum Wage Policies 192
6.4 Conclusions 194
Acknowledgments 196
References 196

7 Development and Calibration of a Large-Scale Agent-Based Model of Individual Tax Reporting Compliance 199
Kim M. Bloomquist

7.1 Introduction 199
7.1.1 Taxpayer Dataset 201
7.1.2 Agents 202
7.1.3 Tax Agency 204
7.1.4 Taxpayer Reporting Behavior 207
7.1.5 Filer Behavioral Response to Tax Audit 209
7.1.6 Model Execution 210
7.2 Model Validation and Calibration 211
7.3 Hypothetical Simulation: Size of the “Gig” Economy and Taxpayer Compliance 214
7.4 Conclusion and Future Research 216
Acknowledgments 216
References 217
Appendix 7A: Overview, Design Concepts, and Details (ODD) 218

7A.1 Purpose 218
7A.2 Entities, State Variables, and Scales 218
7A.3 Process Overview and Scheduling 219
7A.4 Design Concepts 219
7A.4.1 Basic Principles 219
7A.4.2 Emergence 220
7A.4.3 Adaptation 220
7A.4.4 Objectives 220
7A.4.5 Learning 220
7A.4.6 Prediction 221
7A.4.7 Sensing 221
7A.4.8 Interaction 221
7A.4.9 Stochasticity 221
7A.4.10 Collectives
7A.4.11 Observation
7A.5 Initialization
7A.6 Input Data
7A.7 Submodels

8 Investigating the Effects of Network Structures in Massive Agent-Based Models of Tax Evasion
Matthew Koehler, Shaun Michel, David Slater, Christine Harvey, Amanda Andrei and Kevin Comer
8.1 Introduction
8.2 Networks and Scale
8.3 The Model
8.3.1 Overview
8.3.2 Design Concepts
8.3.3 Details
8.4 The Experiment
8.5 Results
8.5.1 Impact of Scale
8.5.2 Distributing the Model on a Cluster Computer
8.6 Conclusion
References

9 Agent-Based Simulations of Tax Evasion: Dynamics by Lapse of Time, Social Norms, Age Heterogeneity, Subjective Audit Probability, Public Goods Provision, and Pareto-Optimality
Sascha Hokamp and Andrés M. Cuervo Díaz
9.1 Introduction
9.2 The Agent-Based Tax Evasion Model
9.2.1 Overview of the Model
9.2.2 Design Concepts
9.2.3 Details
9.3 Scenarios, Simulation Results, and Discussion
9.3.1 Age Heterogeneity and Social Norm Updating
9.3.2 Public Goods Provision and Pareto-optimality
9.3.3 The Allingham-and-Sandmo Approach Reconsidered
9.3.4 Calibration and Sensitivity Analysis
9.4 Conclusions and Outlook
Acknowledgments
References
Appendix 9A
## 10 Modeling the Co-evolution of Tax Shelters and Audit Priorities

*Jacob Rosen, Geoffrey Warner, Erik Hemberg, H. Sanith Wijesinghe and Una-May O’Reilly*

10.1 Introduction 289
10.2 Overview 291
10.3 Design Concepts
   - 10.3.1 Simulation 294
   - 10.3.2 Optimization 297
10.4 Details
   - 10.4.1 IBOB 299
   - 10.4.2 Grammar 302
   - 10.4.3 Parameters 304
10.5 Experiments
   - 10.5.1 Experiment LimitedAudit: Audit Observables That Do Not Detect IBOB 305
   - 10.5.2 Experiment EffectiveAudit: Audit Observables That Can Detect IBOB 308
   - 10.5.3 Experiment CoEvolution: Sustained Oscillatory Dynamics Of Fitness Values 308
10.6 Discussion 311
References 314

## 11 From Spins to Agents: An Econophysics Approach to Tax Evasion

*Götz Seibold*

11.1 Introduction 315
11.2 The Ising Model
   - 11.2.1 Purpose 316
   - 11.2.2 Entities, State Variables, and Scales 316
   - 11.2.3 Process Overview and Scheduling 318
11.3 Application to Tax Evasion 320
11.4 Heterogeneous Agents 324
11.5 Relation to Binary Choice Model 330
11.6 Summary and Outlook 333
References 334

Index 337