## Introduction

1. Why Physics Needs Economics or Finance?
   1.1 What Are Physical Ideas?
   1.2 What Are Physical Methods?

2. Why Economics or Finance Needs Physics?

3. Physics + Economics or Finance → Econophysics

4. Dividing Econophysics into Two Branches: Empirical Econophysics and Experimental Econophysics

5. Methodology of Experimental Econophysics

## Fundamentals

1. Hayek Hypothesis
2. How to Design Computer-Aided Controlled Experiments
3. El Farol Bar Problem and Minority Game
   3.1 El Farol Bar Problem
   3.2 Minority Game
4. How to Design Agent-Based Models
   4.1 Modeling by Abstracting Real-World Systems
   4.2 Modeling Through Borrowing from Physical Models
   4.3 How to Test the Reliability of Agent-Based Models
5. Information Theory
   5.1 Initial Remarks
   5.2 Shannon Entropy: Historical Beginning and the Unit of Information
   5.3 When Information Meets Physics: The Principle of Maximum Entropy and the Fight with Maxwell’s Demon
   5.4 Discussion
5.7.4 Part IV: A Closed CAS—Simulations Based on Agent-Based Modeling ........................................... 78
5.7.5 Part V: An Alternative Approach to Analyzing Preferences of Normal Agents and Imitating Agents in the Agent-Based Modeling: Analysis of the Shannon Information Entropy .......... 79
5.7.6 Part VI: A Different Agent-Based Modeling in Which Imitating Agents Follow the Majority, Rather than the Best Agent: An Open CAS Versus a Closed One ............................................ 82

6 Contrarian Behavior: Beyond the Known Helpful Role .............. 83
6.1 Opening Remarks ................................................................ 83
6.2 Controlled Experiments .................................................... 84
6.3 Agent-Based Modeling ...................................................... 88
6.4 Simulation Results .......................................................... 89
6.5 Theoretical Analysis ......................................................... 91
6.5.1 The properties of the transition point, (M_1 / M_2) ................................................................. 92
6.5.2 Finding the expressions of \( \sum_{i}^{N_n} (L_i)_{max} \)
and \( \sum_{c}^{N_c} \langle x_c \rangle \) ......................................................... 93
6.6 Conclusions ..................................................................... 95
6.7 Supplementary Materials .................................................. 97
6.7.1 About the Experiment .................................................... 97
6.7.2 Leaflet to the Experiment ............................................... 98

7 Hedge Behavior: Statistical Equivalence of Different Systems .... 99
7.1 Opening Remarks ............................................................. 99
7.2 Controlled Experiments .................................................... 100
7.3 Agent-Based Simulations ................................................... 106
7.4 Theoretical Analysis ........................................................ 111
7.4.1 The Properties of Critical Points. ................................. 111
7.4.2 Solve \( \sum_{i}^{N_n} (L_i)_{max}, \sum_{h}^{N_h} \langle x_h \rangle \) and \( \sum_{c}^{N_c} \langle x_c \rangle \) ................................................. 112
7.5 Conclusions ..................................................................... 113
7.6 Supplementary Materials .................................................. 114
7.6.1 Leaflet to the experiment ............................................... 114

8 Cooperation: Spontaneous Emergence of the Invisible Hand ...... 115
8.1 Opening Remarks ............................................................. 115
8.2 Controlled Experiments .................................................... 117
8.3 Agent-Based Modeling ...................................................... 120
8.4 Results .......................................................................... 121
8.5 Discussion and Conclusions ............................................... 123
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Business Cycles: Competition Between Suppliers and Consumers</td>
<td>9.1 Opening Remarks, 9.2 The Design of an Artificial Market, 9.3 Human Experiments and Results Analyses, 9.4 Agent-Based Modeling and Results Analyses, 9.5 Conclusions, 9.6 Supplementary Materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.3.1 Scenario of Human Experiments, 9.3.2 Smoothing Regression, 9.3.3 Frequency Spectrum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.4.1 Agents' Decision-Making Process, 9.4.2 Stationarity Analysis, 9.4.3 Phase Transitions</td>
</tr>
<tr>
<td>10</td>
<td>Partial Information: Equivalent to Complete Information</td>
<td>10.1 Opening Remarks, 10.2 Agent-Based Modeling, 10.3 Controlled Experiments, 10.4 Results, 10.5 Discussion and Conclusions</td>
</tr>
<tr>
<td>11</td>
<td>Risk Management: Unusual Risk-Return Relationship</td>
<td>11.1 Opening Remarks, 11.2 Controlled Experiments, 11.3 Agent-Based Modelling, 11.4 Comparison Between Experimental and Simulation Results, 11.5 Comparison among Experimental, Simulation, and Theoretical Results, 11.6 Discussion and Conclusions</td>
</tr>
<tr>
<td>12</td>
<td>Prediction: Pure Technical Analysis Might not Work Satisfactorily</td>
<td>12.1 Opening Remarks, 12.2 Controlled Experiments, 12.2.1 Experiment Design, 12.2.2 Experimental Process</td>
</tr>
</tbody>
</table>