

## Models With Heterogeneous Agents Introduction

It took me over five years to write this book. Finishing my research project and thus finishing this book would not have been possible without the help of many friends of mine. Thus, the first thing to do is to say 'Thanks a lot' . This means at first place the Evangelisches Studienwerk Haus Villigst. They gave me a grant for my work, thus laying the important financial grounds of everything I've done. There is such a large number of friends I worked and lived with over the last few years that I cannot possibly mention them all by name, but I'll try, anyway: So, thanks Christiane, Gilbert, Maik, Karl, and everybody else feeling that his or her name should appear in this list. And, of course, thanks Franz Haslinger, for letting me do whatever I wanted to - and for even encouraging me to stick with it. One more thing I'd like to mention: Although this work is based on very heavy use of computer power, it is my special pride to say that not a single penny (i.e. Deutschmark) had to be spent for software in order to do this work. Instead, all that has been done has been done by free software. Thus, I would like to mention some of my most heavily used software tools in order to let you, the reader, know that nowadays you don't depend on big commercial software packages any more.

Introduction to Agent-Based Economics describes the principal elements of agent-based computational economics (ACE). It illustrates ACE's theoretical foundations, which are rooted in the application of the concept of complexity to the social sciences, and it depicts its growth and development from a non-linear out-of-equilibrium approach to a state-of-the-art agent-based macroeconomics. The book helps readers gain a better understanding of the limits and perspectives of the ACE models and their capacity to reproduce economic phenomena and empirical patterns. Reviews the literature of agent-based computational economics Analyzes approaches to agents' expectations Covers one of the few large macroeconomic agent-based models, the Modellaccio Illustrates both analytical and computational methodologies for producing tractable solutions of macro ACE models Describes diffusion and amplification mechanisms Depicts macroeconomic experiments related to ACE implementations

The book presents new developments in the dynamic modeling and optimization methods in environmental economics and provides a huge range of applications dealing with the economics of natural resources, the impacts of climate change and of environmental pollution, and respective policy measures. The interrelationship between economic activities and environmental quality, the development of cleaner technologies, the switch from fossil to renewable resources and the proper use of policy instruments play an important role along the path towards a sustainable future. Biological, physical and economic processes are naturally involved in the subject, and postulate the main modelling, simulation and decision-making tools: the methods of dynamic optimization and dynamic games.

We introduce a generic simulation framework suitable for agent-based simulations featuring the support of heterogeneous agents, hierarchical scheduling, and flexible specification of design parameters. One key aspect of this framework is the design specification: we use a format based on the Extensible Markup Language (XML) that is simple-structured yet still enables the design of flexible models, with the possibility of varying both agent population and parameterization. Further, the tool allows the definition of communication channels to single or groups of agents, and handles the information exchange. Also, both (groups of) agents and communications channels can be added and removed at runtime by the agents, thus allowing dynamic settings with the agent population and/or communication structures varying during the simulation time. A second issue in agent-based simulations, especially when readymade components are used, is the heterogeneity arising from both the agents' implementations and the underlying platforms: for this, we introduce a wrapper technique for mapping the functionality of agents living in an interpreter-based environment to a standardized JAVA interface, thus facilitating the task for any control mechanism (like a simulation manager). Again, this mapping is made by an XML-based definition format. (author's abstract).

Modern business cycle theory and growth theory uses stochastic dynamic general equilibrium models. In order to solve these models, economists need to use many mathematical tools. This book presents various methods in order to compute the dynamics of general equilibrium models. In part I, the representative-agent stochastic growth model is solved with the help of value function iteration, linear and linear quadratic approximation methods, parameterised expectations and projection methods. In order to apply these methods, fundamentals from numerical analysis are reviewed in detail. In particular, the book discusses issues that are often neglected in existing work on computational methods, e.g. how to find a good initial value. In part II, the authors discuss methods in order to solve heterogeneous-agent economies. In such economies, the distribution of the individual state variables is endogenous. This part of the book also serves as an introduction to the modern theory of distribution economics. Applications include the dynamics of the income distribution over the business cycle or the overlapping-generations model. In an accompanying home page to this book, computer codes to all applications can be downloaded.

Over the past two decades, the issue of equilibrium indeterminacy has been one of the major research concerns in macroeconomic dynamics. Growth and Business Cycles with Equilibrium Indeterminacy discusses the main topics in this literature. Based on comprehensive surveys and the author's original research, this book explores sunspot-driven fluctuations in real business cycle models, multiple equilibria in endogenous growth models, and the stabilization effects of fiscal and monetary policy rules. The book also considers equilibrium indeterminacy in open economy models.

In this paper we study the dynamics of a simple asset pricing model describing the trading activity of heterogeneous agents in a "stylized" market. The economy in the model contains two assets: a bond with risk-less return and a dividend paying stock. The price of the stock is determined through market clearing condition. Traders are speculators

described as expected utility maximizers with heterogeneous beliefs about future stock price and with heterogeneous estimation of risk. In particular, we consider traders who base their investment decision on different time horizons and we analyze the effect of these differences on the price dynamics. Under suitable parameterization, the stock no-arbitrage "fundamental" price can emerge as a stable fixed point of the model dynamics. For different parameterizations, however, the market shows cyclical or chaotic price dynamics with speculative bubbles and crashes. We find that the sole heterogeneity of agents with respect to their time horizons is not enough to guarantee the instability of the fundamental price and the emergence of non-trivial price dynamics. However, if different groups of agents are characterized by different trading behaviors, the introduction of heterogeneous investment horizons can help to decrease the stability region of the "fundamental" fixed point. The role of time horizons turns out to be different for different trade behaviors and, in general, depends on the whole ecology of agents' beliefs. We demonstrate this effect discussing a case in which the increase of fundamentalists time horizons can lead to cyclical or chaotic price behavior, while the same increase for the chartists helps to stabilize the fundamental price. -- Asset pricing ; Heterogeneous beliefs ; Investment horizons

Agent-based modeling and social simulation have emerged as an interdisciplinary area of social science that includes computational economics, organizational science, social dynamics, and complex systems. This area contributes to enriching our understanding of the fundamental processes of social phenomena caused by complex interactions among agents. Bringing together diverse approaches to social simulation and research agendas, this book presents a unique collection of contributions from the Second World Congress on Social Simulation, held in 2008 at George Mason University in Washington DC, USA. This book in particular includes articles on norms, diffusion, social networks, economy, markets and organizations, computational modeling, and programming environments, providing new hypotheses and theories, new simulation experiments compared with various data sets, and new methods for model design and development. These works emerged from a global and interdisciplinary scientific community of the three regional scientific associations for social simulation: the North American Association for Computational Social and Organizational Science (NAACSOS; now the Computational Social Science Society, CSSS), the European Social Simulation Association (ESSA), and the Pacific Asian Association for Agent-based Approach in Social Systems Sciences (PAAA). The second edition of this important textbook introduces students to the fundamental ideas of heterodox economics. It is written in a clear way by top heterodox scholars. This introductory book offers not only a critique of the dominant approach to economics, but also presents a positive and constructive alternative. Students interested in an explanation of the real world will find the heterodox approach not only satisfying, but ultimately better able to explain a money-using economy prone to periods of instability and crises.

Handbook of Computational Economics summarizes recent advances in economic thought, revealing some of the potential offered by modern computational methods. With computational power increasing in hardware and algorithms, many economists are closing the gap between economic practice and the frontiers of computational mathematics. In their efforts to accelerate the incorporation of computational power into mainstream research, contributors to this volume update the improvements in algorithms that have sharpened econometric tools, solution methods for dynamic optimization and equilibrium models, and applications to public finance, macroeconomics, and auctions. They also cover the switch to massive parallelism in the creation of more powerful computers, with advances in the development of high-power and high-throughput computing. Much more can be done to expand the value of computational modeling in economics. In conjunction with volume one (1996) and volume two (2006), this volume offers a remarkable picture of the recent development of economics as a science as well as an exciting preview of its future potential. Samples different styles and approaches, reflecting the breadth of computational economics as practiced today Focuses on problems with few well-developed solutions in the literature of other disciplines Emphasizes the potential for increasing the value of computational modeling in economics

In this article we extend the agent-based model of firms' formation and growth proposed in [4]. In [4] the firms' creation, expansion or contraction results from the interaction of heterogeneous utility maximizers. While the original model was able to replicate the power law distribution in the firms' sizes agents in the model set their utility maximizing effort levels completely freely and undetected. This led to the emergence of free riding and influenced the overall dynamics of the model. Therefore we decided to extend the original model by introducing the monitoring which is seen in the economic literature, besides for example the proper incentive scheme ([18]), as a possible way how to make employees work harder. Our motivation is to compare the extended model with both to the original case without monitoring and empirical data about firms' sizes distribution. -- monitoring ; firms' size ; power law ; agent-based model ; simulation ; heterogeneous agents

This book contains extended versions of the best papers presented at the 13th International Conference on Information and Communication Technologies in Education, Research, and Industrial Applications, ICTERI 2017, held in Kyiv, Ukraine, in May 2017. The 11 revised full papers included in this volume were carefully reviewed and selected from 151 initial submissions during several rounds of reviewing. The papers are organized in the following topical sections: modeling and theoretical frameworks; ICT in teaching, learning, and education management; and ICT evaluation and applications.

Nonlinearity, Bifurcation and Chaos - Theory and Application is an edited book focused on introducing both theoretical and application oriented approaches in science and engineering. It contains 12 chapters, and is recommended for university teachers, scientists, researchers, engineers, as well as graduate and post-graduate students either working or interested in the field of nonlinearity, bifurcation and chaos.

In Chapter 2 we extend the heterogeneous discounting model introduced in Marín-Solano and Patxot (2012) to a stochastic environment. Our main contribution in this chapter is to derive the DPE providing time-consistent solution for both the discrete and continuous time case. For the continuous time problem we derive the DPE following the two different procedures described above: the formal limiting procedure and the variational approach. However, an important limitation of these approaches is that the DPE obtained is a functional equation with a nonlocal term. As a consequence, it becomes very complicated to find solutions, not only analytically, but also numerically. For this reason, we also derive a set of two coupled partial differential equations

which allows us to compute (analytically or numerically) the solutions for different economic problems. In particular, we are interested in analyzing how time-inconsistent preferences with heterogeneous discounting modify the classical consumption and portfolio rules (Merton (1971)). The introduction of stochastic terminal time is also discussed. In Chapter 3, the results of Chapter 2 are extended in several ways. First, we consider that the decision maker is subject to a mortality risk. Within this context, we derive the optimal consumption, investment and life insurance rules for an agent whose concern about both the bequest left to her descendants and her wealth at retirement increases with time. To this end we depart from the model in Pliska and Ye (2007) generalizing the individual time preferences by incorporating heterogeneous discount functions. In addition, following Kraft (2003), we derive the wealth process in terms of the portfolio elasticity with respect to the traded assets. This approach allows us to introduce options in the investment opportunity set as well as to enlarge it by any number of contingent claims while maintaining the analytical tractability of the model. Finally, we analyze how the standard solutions are modified depending on the attitude of the agent towards her changing preferences, showing the differences with some numerical illustrations. In Chapter 4 we extend the heterogeneous discount framework to the study of differential games with heterogeneous agents, i.e., agents who exhibit different instantaneous utility functions and different (but constant) discount rates of time preference. In fact, although the non-standard models have usually focused on individual agents, the framework has proved to be useful in the study of cooperative solutions for some standard discounting differential games. Our main contribution in this chapter is to provide a set of DPE in discrete and continuous time in order to obtain time-consistent cooperative solutions for  $N$ -person differential games with heterogeneous agents. The results are applied to the study of a cake eating problem describing the management of a common property exhaustible natural resource. The extension to a simple common renewable natural resource in infinite horizon is also discussed. Finally, in Chapter 5, we present a summary of the main results of the thesis.

This second book on financial and economic simulations in Swarm marks the continued progress by a group of researchers to incorporate agent-based computer models as an important tool within their discipline. It is encouraging to see such a clear example of Swarm helping to foster a community of users who rely on the Swarm framework for their own analyses. Swarm aims at legitimizing agent-based computer models as a tool for the study of complex systems. A further goal is that a common base framework will lead to the growth of user communities in specific areas of application. By providing an organizing framework to guide the development of more problem-specific structures, and by dealing with a whole range of issues that affect their fundamental correctness and their ability to be developed and reused, Swarm has sought to make the use of agent-based models a legitimate tool of scientific investigation that also meets the practical needs of investigators within a community.

Modern business cycle theory and growth theory uses stochastic dynamic general equilibrium models. Many mathematical tools are needed to solve these models. The book presents various methods for computing the dynamics of general equilibrium models. In part I, the representative-agent stochastic growth model is solved with the help of value function iteration, linear and linear quadratic approximation methods, parameterised expectations and projection methods. In order to apply these methods, fundamentals from numerical analysis are reviewed in detail. Part II discusses methods for solving heterogeneous-agent economies. In such economies, the distribution of the individual state variables is endogenous. This part of the book also serves as an introduction to the modern theory of distribution economics. Applications include the dynamics of the income distribution over the business cycle or the overlapping-generations model. Through an accompanying home page to this book, computer codes to all applications can be downloaded.

Heterogeneous agents models have become the norm in modern macroeconomics as the limitations of the representative-agent paradigm and the importance of studying household heterogeneity grow in recognition. Agent heterogeneity may not only be important to accurately capture the description of an aggregate equilibrium. Also, the representative agent assumption may hide many distributional effects and therefore could change the answer to many normative questions usually given by representative agent models. This dissertation contains three chapters exemplifying ways in which the consideration of heterogeneous agents in the modelling of macroeconomic phenomena has important repercussions for the predictions of the model and its normative implications. Chapters 1 and 2 show the importance of accounting for worker heterogeneity in the analysis of labor markets. Chapter 1 presents a search and matching model of unemployment with heterogeneous workers which's main features, are ex-ante worker heterogeneity and undirected search. These features enable the model to replicate the empirical correlations between labor market outcomes and proxy variables for worker productivity. The model displays job rationing, which makes it useful to understand the high levels of unemployment observed in deep recessions. It also constitutes a versatile tool for the analysis of several labor-market aspects in which worker heterogeneity could play an important role, such as the impact of employment policies that are believed to have asymmetric effects across the labor force. Chapter 2 provides an example of such applications by analyzing the effects of increments of a minimum wage. It explores theoretically and empirically the notion that minimum wages affect low-skill workers asymmetrically due to productivity differences. Using the model presented in chapter 1, with the incorporation of endogenous search intensity to account for the effects that minimum wages could have on worker participation, I show that a rising minimum wage lowers the employment and labor force participation of low-productivity workers by pricing them out of the market, while it increases the employment, participation, and wages of more productive workers that remain hireable. Chapter 2 also contains an empirical analysis that investigates and ultimately validates the model's predictions of changes in the minimum wage. Within the labor market for low-education (high school or lower) workers, increments in the minimum wage have diametrically opposed effects: they reduce the employment and labor force participation of teenagers with less than high school education, while increasing the employment and labor force participation of mature workers with high school educational attainment. A calibrated version of the model targeting the low-education labor market shows that, despite its opposite effects across the labor force, an increase in the minimum wage negatively impacts aggregate employment, labor force participation, and social welfare. Chapter 3 investigates the existence of complex dynamics in the behavior of exchange rates due heterogeneity in the expectations of their future value. A simple model of exchange rate dynamics featuring traders with heterogeneous expectations is introduced. The model is based on the asset pricing model in Brock and Hommes (1998) and features the BNN dynamic presented in Brown et al. (1950), a

dynamic with desirable properties absent in other dynamics used in the literature. The chapter shows that even this simple model can easily generate complex and even chaotic dynamics in the exchange rate because of the interaction of traders with different beliefs. An important implication is that long-term exchange rate prediction is, in theory, difficult. Economic application of nonlinear dynamics, microscopic agent-based modelling, and the use of artificial intelligence techniques as learning devices of boundedly rational actors are among the most exciting interdisciplinary ventures of economic theory over the past decade. This volume provides us with a most fascinating series of examples on "complexity in action" exemplifying the scope and explanatory power of these innovative approaches.

The problem of efficient or optimal allocation of resources is a fundamental concern of economic analysis. This book provides surveys of significant results of the theory of optimal growth, as well as the techniques of dynamic optimization theory on which they are based. Armed with the results and methods of this theory, a researcher will be in an advantageous position to apply these versatile methods of analysis to new issues in the area of dynamic economics.

This handbook contains surveys of state-of-the-art concepts, systems, applications, best practices as well as contemporary research in the intersection between IT and finance. Included are recent trends and challenges, IT systems and architectures in finance, essential developments and case studies on management information systems, and service oriented architecture modeling. The book shows a broad range of applications, e.g. in banking, insurance, trading and in non-financial companies. Essentially, all aspects of IT in finance are covered.

This volume contains a collection of papers suggested by the Scientific Committee that includes the best papers presented in the 2nd International Conference (CHAOS2009) on Chaotic Modeling, Simulation and Applications, that was held in Chania, Crete, Greece, June 15, 2009. The aim of the conference was to invite and bring together people working in interesting topics of chaotic modeling, nonlinear and dynamical systems and chaotic simulation. The volume presents theoretical and applied contributions on chaotic systems. Papers from several nonlinear analysis and chaotic fields are included and new and very important results are presented. Emphasis was given to the selection of works that have significant impact in the chaotic field and open new horizons to further develop related topics and subjects. Even more the selected papers are addressed to an interdisciplinary audience aiming at the broad dissemination of the theory and practice of chaotic modeling and simulation and nonlinear science.

We introduce a generic simulation framework suitable for agent-based simulations featuring the support of heterogeneous agents, hierarchical scheduling and flexible specification of design parameters. One key aspect of this framework is the design specification: we use an XML-based format which is simple-structured yet still enables the design of flexible models. Another issue in agent-based simulations, especially when ready-made components are used, is the heterogeneity arising from both the agents' implementations and the underlying platforms. To tackle these kind of obstacles, we introduce a wrapper technique for mapping the functionality of agents living in an interpreter-based environment to a standardized JAVA interface, thus facilitating the task for any control mechanism (like a simulation manager) because it has to handle only one set of commands for all agents involved. Again, this mapping is made by an XML-based definition format. We demonstrate the technique by applying it to a simple sample simulation of two mass marketing firms operating in an artificial consumer environment. (author's abstract).

The explosive growth in computational power over the past several decades offers new tools and opportunities for economists. This handbook volume surveys recent research on Agent-based Computational Economics (ACE), the computational study of economic processes modeled as dynamic systems of interacting agents. Empirical referents for "agents" in ACE models can range from individuals or social groups with learning capabilities to physical world features with no cognitive function. Topics covered include: learning; empirical validation; network economics; social dynamics; financial markets; innovation and technological change; organizations; market design; automated markets and trading agents; political economy; social-ecological systems; computational laboratory development; and general methodological issues. \*Every volume contains contributions from leading researchers \*Each Handbook presents an accurate, self-contained survey of a particular topic \*The series provides comprehensive and accessible surveys

The goal of this paper is to simultaneously unbundle two interacting reduced-form building blocks of traditional macroeconomic models: the representative agent and the aggregate production function. We introduce a broad class of disaggregated general equilibrium models with Heterogeneous Agents and Input-Output networks (HA-IO). We elucidate their properties through two sets of results describing the propagation and aggregation of shocks. First, we characterize how shocks affect prices and quantities of goods and factors. Even with purely microeconomic shocks, the mapping from structural primitives to observed effects is complicated by "local" general equilibrium forces. Our framework shows how to account for these forces, and helps interpret IV-based cross-sectional regression results. We also uncover a surprising property of a large class of efficient representative agent models: they feature symmetric propagation in that a shock to producer  $i$  affects the sales of producer  $j$  in exactly the same way that a shock to  $j$  affects the sales of  $i$ . This improbable symmetry breaks in the presence of heterogeneous agents or distortions. Second, we provide aggregation results characterizing the responses of industry-level variables such as markups and productivity. The behavior of these aggregates is particularly delicate in inefficient economies: they respond to microeconomic shocks outside of the industry; and they can give rise to fallacies of composition whereby aggregates move in the opposite direction of their microeconomic counterparts. Our results shed light on many seemingly disparate applied questions, such as: sectoral co-movement in business cycles; factor-biased technical change in task-based models; structural transformation; the effects of corporate taxation; and the dependence of fiscal multipliers on the composition of government spending.

Macroeconomics with Heterogeneous Agents and Input-Output Networks

"We present in the paper an extension of the model of Bloch and Dutta (2009) where we introduce agent's heterogeneity. We characterize Nash stable and efficient networks in this setting." [source : résumé].

Liquid markets generate hundreds or thousands of ticks (the minimum change in price a security can have, either up or down) every business day. Data vendors such as Reuters transmit more than 275,000 prices per day for foreign exchange spot rates alone. Thus, high-frequency data can be a fundamental object of study, as traders make decisions by observing high-frequency or tick-by-tick data. Yet most studies published in financial literature deal with low frequency, regularly spaced data. For a variety of reasons, high-frequency data are becoming a way for understanding market microstructure. This book discusses the best mathematical models and tools for dealing with such vast amounts of data. This book provides a framework for the analysis, modeling, and inference of high frequency financial time series. With particular emphasis on foreign exchange markets, as well as currency, interest rate, and bond futures markets, this unified view of high frequency time series methods investigates the price formation process and concludes by reviewing techniques for constructing systematic trading models for financial assets.

'International Handbook on the Economics of Integration edited by Miroslav Jovanovi? provides timely and rich academic contributions to considerations of the widest array of integration-related issues. European integration has been providing an inspiration to a number of academics and researchers. the Handbook is a recognition of the dynamic and strong solidarity of European integration. At the same time, the European Union often provided an example for integration schemes throughout the world which spread enormously since the mid-1990s. Leading experts from all continents contributed to this Handbook which will be a valuable input into academic and policy-making discussions and actions.' - José Manuel Barroso, President of the European Commission

This book represents an ongoing research agenda the aim of which is to contribute to the Keynesian paradigm in macroeconomics. It examines the Dynamic General Equilibrium (DGE) model, the assumption of intertemporal optimizing behavior of economic agents, competitive markets and price mediated market clearing through flexible wages and prices.

This book offers a thorough introduction to the highly promising complex agent-based approach to economics, in which agent-based models (ABMs) are used to represent economic systems as complex and evolving systems composed of heterogeneous agents of limited rationality who interact with each other, generating the system's emergent properties in the process. This approach represents a response to the limitations of the dominant theory in economics, which does not consider the possibility of a major crisis, and to the inability of dynamic stochastic general equilibrium theory to generate empirically falsifiable propositions. In the new perspective, the focus is on identifying the elements of instability rather than the triggering event. As the theory of complexity demonstrates, the interactions of heterogeneous agents produce non-linearity: this puts an end to the age of certainties. With ABMs, the methodology is "from the bottom up". The individual parameters and their distribution are estimated, and then evaluated to verify whether aggregate regularities emerge on the whole. In short, not only micro, but also meso and macro empirical validation are employed. Moreover, it shows that the mantra of growth should be supplanted by the concept of a growth?. Given its depth of coverage, the book will enable students at the undergraduate and Master's level to gain a firm grasp of this important emerging approach. "This book is flower blossomed by one of the two greatest Italian economists."

Bruce Greenwald, Columbia University "The author's - the ABM prophet's - thoughts on economics have been at the forefront of the world. Without a firm belief in and dedication to human society, it is impossible to write such a book. This is a work of high academic value, which can help readers quickly understand the history and current situation of complex economic theory. In particular, we can understand the basic viewpoints, academic status, advantages and shortcomings of various schools of economic theory." Jie Wu, Guangzhou Milestone Software Co., China

This thesis comprises three chapters which share an emphasis on the importance of agent heterogeneity in different areas of macroeconomics. The first chapter shows that the introduction of heterogeneous risk aversion into a consumption based asset pricing model with Epstein-Zin preferences allows to replicate several features of stock markets such as the counter-cyclical variation in the equity premium and its predictability from the price dividend ratio. The second chapter complements a Mortensen-Pissarides matching model with individual savings for precautionary reasons in order to analyze the welfare effects of reforming unemployment insurance. Our fully dynamic analysis reveals significant transition costs that static comparisons miss. The third chapter is concerned with optimal capital and labor taxation when agents differ in their wage-wealth ratio. We find that if all agents are to benefit from a reform (vis-à-vis the status quo) capital taxes are abolished only after a long period. Esta tesis se compone de tres capítulos que enfatizan en la importancia de la heterogeneidad de agentes económicos en distintas áreas de la macroeconomía. El primer capítulo demuestra que la introducción de heterogeneidad en la aversión al riesgo en un modelo de consumption based asset pricing con utilidad de tipo Epstein-Zin permite reproducir algunas regularidades empíricas de los mercados financieros como por ejemplo la variación anticíclica de la prima de riesgo y su previsibilidad a través del cociente precio-dividendos. El segundo capítulo introduce en un modelo de matching tipo Mortensen-Pissarides ahorros precaucionarios con el objetivo de analizar los efectos sobre el bienestar de reformas del seguro de desempleo. Nuestro análisis dinámico revela costes significativos de transición no presentes en comparaciones estáticas. El tercer capítulo investiga la imposición óptima de capital y trabajo cuando los agentes son heterogéneos con respecto a su cociente sueldo-patrimonio.

The six-volume set LNCS 12742, 12743, 12744, 12745, 12746, and 12747 constitutes the proceedings of the 21st International Conference on Computational Science, ICCS 2021, held in Krakow, Poland, in June 2021.\* The total of 260 full papers and 57 short papers presented in this book set were carefully reviewed and selected from 635 submissions. 48 full and 14 short papers were accepted to the main track from 156 submissions; 212 full and 43 short papers were accepted to the workshops/ thematic tracks from 479 submissions. The papers were organized in topical sections named: Part I: ICCS Main Track Part II: Advances in High-Performance Computational Earth Sciences: Applications and Frameworks; Applications of Computational Methods in Artificial Intelligence and Machine Learning; Artificial Intelligence and High-Performance Computing for Advanced Simulations; Biomedical and Bioinformatics Challenges for Computer Science Part III: Classifier Learning from Difficult Data; Computational Analysis of Complex Social Systems; Computational Collective Intelligence; Computational Health Part IV: Computational Methods for Emerging Problems in (dis-)Information Analysis; Computational Methods in Smart Agriculture; Computational Optimization, Modelling and

Simulation; Computational Science in IoT and Smart Systems Part V: Computer Graphics, Image Processing and Artificial Intelligence; Data-Driven Computational Sciences; Machine Learning and Data Assimilation for Dynamical Systems; MeshFree Methods and Radial Basis Functions in Computational Sciences; Multiscale Modelling and Simulation Part VI: Quantum Computing Workshop; Simulations of Flow and Transport: Modeling, Algorithms and Computation; Smart Systems: Bringing Together Computer Vision, Sensor Networks and Machine Learning; Software Engineering for Computational Science; Solving Problems with Uncertainty; Teaching Computational Science; Uncertainty Quantification for Computational Models \*The conference was held virtually.

X Table of Contents Table of Contents XI XII Table of Contents Table of Contents XIII XIV Table of Contents Table of Contents XV XVI Table of Contents K.S. Leung, L.-W. Chan, and H. Meng (Eds.): IDEAL 2000, LNCS 1983, pp. 3-8, 2000. Springer-Verlag Berlin Heidelberg 2000 4 J. Sinkkonen and S. Kaski Clustering by Similarity in an Auxiliary Space 5 6 J. Sinkkonen and S. Kaski Clustering by Similarity in an Auxiliary Space 7 0.6 1.5 0.4 1 0.2 0.5 0 0 10 100 1000 10000 10 100 1000 Mutual information (bits) Mutual information (bits) 8 J. Sinkkonen and S. Kaski 20 10 0 0.1 0.3 0.5 0.7 Mutual information (mbits) Analyses on the Generalised Lotto-Type Competitive Learning Andrew Luk St B&P Neural Investments Pty Limited, Australia Abstract, In generalised lotto-type competitive learning algorithm more than one winner exist. The winners are divided into a number of tiers (or divisions), with each tier being rewarded differently. All the losers are penalised (which can be equally or differently). In order to study the various properties of the generalised lotto-type competitive learning, a set of equations, which governs its operations, is formulated. This is then used to analyse the stability and other dynamic properties of the generalised lotto-type competitive learning.

This introduction to modern business cycle theory uses a neoclassical growth framework to study the economic fluctuations associated with the business cycle. Presenting advances in dynamic economic theory and computational methods, it applies concepts to t

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An innovative textbook for use in advanced undergraduate and graduate courses; accessible to students in financial mathematics, financial engineering and economics. Introduction to the Economics and Mathematics of Financial Markets fills the longstanding need for an accessible yet serious textbook treatment of financial economics. The book provides a rigorous overview of the subject, while its flexible presentation makes it suitable for use with different levels of undergraduate and graduate students. Each chapter presents mathematical models of financial problems at three different degrees of sophistication: single-period, multi-period, and continuous-time. The single-period and multi-period models require only basic calculus and an introductory probability/statistics course, while an advanced undergraduate course in probability is helpful in understanding the continuous-time models. In this way, the material is given complete coverage at different levels; the less advanced student can stop before the more sophisticated mathematics and still be able to grasp the general principles of financial economics. The book is divided into three parts. The first part provides an introduction to basic securities and financial market organization, the concept of interest rates, the main mathematical models, and quantitative ways to measure risks and rewards. The second part treats option pricing and hedging; here and throughout the book, the authors emphasize the Martingale or probabilistic approach. Finally, the third part examines equilibrium models—a subject often neglected by other texts in financial mathematics, but included here because of the qualitative insight it offers into the behavior of market participants and pricing.

This book is a collection of essays which examine how the properties of aggregate variables are influenced by the actions and interactions of heterogenous individuals in different economic contexts. The common denominator of the essays is a critique of the representative agent hypothesis. If this hypothesis were correct, the behaviour of the aggregate variable would simply be the reproduction of individual optimising behaviour. In the methodology of the hard sciences, one of the achievements of the quantum revolution has been the rebuttal of the notion that aggregate behaviour can be explained on the basis of the behaviour of a single unit: the elementary particle does not even exist as a single entity but as a network, a system of interacting units. In this book, new tracks in economics which parallel the developments in physics mentioned above are explored. The essays, in fact are contributions to the analysis of the economy as a complex evolving system of interacting agents.

Assembles theoretical contributions to monetary theory, banking and finance. This book includes papers spanning themes from monetary policy to the optimal design of financial systems, and from the study of the causes of financial crises to payment systems design. It serves as a reference to researchers interested in the study of financial systems.

This book constitutes the refereed proceedings of the International Conference on Artificial Neural Networks, ICANN 2001, held in Vienna, Austria in August 2001. The 171 revised papers presented together with three invited contributions were carefully reviewed and selected from around 300 submissions. The papers are organized in topical sections on data analysis and pattern recognition, theory, kernel methods, topographic mapping, independent component analysis, signal processing, time series processing, agent-based economic modeling, selforganization and dynamical systems, robotics and control, vision and image processing, computational neuroscience, and connectionist and cognitive science.

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