

7. EQUILIBRIUM, EXPECTATIONS & DYNAMICS

Programme director: Prof. dr. C.H. Hommes & dr. ir. F.O.O. Wagener
 Metis-code: uva/feb/ase/eed
 JEL-Classification: C, D, E6
 Starting date: 1998
 Website: <http://cendef.uva.nl>

7.1 MEMBERS OF THE RESEARCH GROUP AND RESEARCH IN FTES

<i>Name</i>	<i>Title</i>	<i>Function</i>	<i>Total</i> <i>2013</i>	<i>Total</i> <i>2014</i>	<i>Total</i> <i>2015</i>	<i>Funding</i>
Amman, H.M.	prof dr	hgl				1
Anufriev, M.	dr	postdoc				2
Altaghlibi, M.	msc	guest	-	0,00	0,00	1
Amman, H.M.	prof. dr.	hgl	-	0,00	0,00	1
Anufriev, M.	dr.	guest	0,00	0,00	-	1
Assenza, T.	dr.	postdoc	0,16	0,16	0,16	1
Bao, T.	dr.	postdoc	0,47	-	-	3
Diks, C. (CeNDEF)	prof. dr.	hgl	0,50	0,50	0,50	1
Fang, H.	msc	phd	-	0,27	0,80	1
Heemeijer, P. (CeNDEF)	dr.	guest	0,00	0,00	-	1
Hennequin, M.	msc	phd	-	-	0,27	1
Hommes, C.H. (CeNDEF)	prof. dr.	hgl	-	0,50	0,50	1
Hommes, C.H. (CeNDEF)	prof. dr.	hgl	1,00	0,32	0,35	2
Huang, Z.	dr.	postdoc	0,07	0,80	-	2
Huang, Z.	dr.	guest	-	-	0,00	1
Kiseleva, T.	dr.	guest	0,00	0,00	-	1
Kopányi, D.	msc	phd	0,80	0,53	-	1
Kopányi-Peuker, A.	dr.	postdoc	-	-	0,27	1
Koster, M.A.L.	dr.	ud	0,25	0,25	-	1
Koster, M.A.L.	dr.	uhd	-	-	0,13	1
Leij, M. van der	dr.	postdoc	0,80	0,33	-	2
Leij, M. van der	dr.	ud	-	0,20	-	2
Leij, M. van der	dr.	ud	-	0,17	0,50	1
Leur, M. van de	msc	guest	0,00	0,00	0,00	1
Li, H.	msc	guest	-	-	0,00	1
Lustenhouwer, J.	msc	phd	-	0,27	0,80	1
Makarewicz, T.	msc	phd	0,80	0,67	-	2
Makarewicz, T.	dr.	postdoc	-	0,13	0,80	2
Massaro, D.	dr.	oz	0,80	0,80	-	2
Negriu, A.	msc	phd	0,80	0,80	0,60	1
Ochea, M.I.	dr.	ud	0,50	0,33	-	1
Papana, A.	dr.	guest	-	0,00	-	1
Ramer, R.	dr.	guest	0,00	0,00	0,00	1
Salle, I.	dr.	postdoc	0,27	0,80	-	3
Salle, I.	dr.	postdoc	-	-	0,80	2
Sniekers, F.	msc	phd	0,40	-	-	1
Sniekers, F.	msc	guest	-	0,00	0,00	1
Tuinstra, J. (CeNDEF)	prof. dr.	hgl	0,50	0,50	0,50	1

<i>Name</i>	<i>Title</i>	<i>Function</i>	<i>Total 2013</i>	<i>Total 2014</i>	<i>Total 2015</i>	<i>Funding</i>
Veld, D. in 't	msc	phd	0,80	0,53	-	2
Veld, D. in 't	dr.	guest	-	0,00	0,00	1
Wagener, F. (CeNDEF)	dr.	uhd	0,50	0,50	0,50	1
Wang, J.	msc	guest	0,00	0,00	0,00	1
Wang, H.-S.	msc	guest	0,00	0,00	0,00	1
Wolski, M.	msc	guest	0,00	0,00	0,00	1
Zeppini-Rossi, P.	dr.	guest	0,00	0,00	-	1
Zhu, M.	dr.	guest	0,00	0,00	0,00	1
Total 1st flow of funds			4,41	4,78	5,53	
Total 2nd flow of funds			4,27	3,78	1,95	
Total 3rd flow of funds			0,74	0,80	0,00	
Total 1st f.o.f. excl. PhD's			2,41	2,91	3,06	
Total 1st-3rd flow of funds			9,42	9,36	7,48	
PhD students			3,60	2,47	2,47	

7.2 PROGRAMME DESIGN

The objective of the programme is the development of (mathematical) economic theory, focussing on the understanding of economic processes. The programme aims at developing models of economic behaviour in different areas of economics, including microeconomics, macroeconomics and finance. Emphasis is given to behavioural models of dynamic market phenomena.

The research group employs a multi-disciplinary approach. The models are studied both from a theoretical and a computational perspective, and the validity of the models is tested in laboratory experiments with human subjects as well as empirically using real data. The NWO-Vernieuwingsimpuls Information Flows in Financial Markets, the EU STREP project Financial Markets and Complexity and the NWO-VIDI programme *Structural Stability in Economic Dynamics* are part of the research programme.

The programme can be subdivided into five closely related and interacting research themes:

Equilibrium theory

Individual optimising behaviour of economic agents generates aggregate supply and demand of commodities, as a function of prices and individual expectations. In equilibrium supply and demand are equal. Many types of equilibrium can be studied: partial versus general, competitive versus monopolistic, dynamic versus static, temporary equilibrium, single, representative agent as well as heterogeneous, interacting agents equilibria. The existence of equilibria is studied, as well as conditions for stability or instability of dynamic adjustment processes.

Game theory & Industrial organisation

This part of the programme focuses on modelling strategic behaviour of economic agents in markets with imperfect competition, such as duopoly and oligopoly. Equilibria in non-cooperative games (e.g. duopoly, oligopoly) as well as cooperative games (costs sharing, general equilibrium) are studied. Evolutionary games with heterogeneous, boundedly rational strategies competing against each other are also studied.

Expectations and learning

Bounded rationality models of expectation formation and learning schemes are becoming a serious alternative to rational expectations, which was the dominating paradigm until quite recently. The fully rational representative agent is replaced by a large *heterogeneous* population of boundedly rational interacting agents, who form expectations based upon time series observations and update their

forecasting rules according to new observations and new information about market fundamentals. Conditions under which learning schemes converge to rational expectations or to a boundedly rational expectations equilibrium with excess volatility are investigated. Formation of expectations is studied in theory, in laboratory experiments with human subjects and in real markets.

Nonlinear economic dynamics

This part of the programme focuses on nonlinear complexity models of dynamic market phenomena. Are market fluctuations mainly caused by random exogenous shocks, or can endogenous nonlinear economic laws of motion explain (a significant part of) the fluctuations? Various deterministic and stochastic economic models are studied theoretically, computationally as well as empirically, attempting to explain the most important stylised facts observed in real economic and financial time series. Emphasis is given to *complex adaptive systems* where markets consist of a large population of agents selecting simple strategies according to their relative success in the recent past. In these evolutionary adaptive systems endogenous variables such as prices and agents' beliefs co-evolve over time.

Dynamic optimisation

Emphasis is given to dynamic optimisation problems in environmental economics, characterised by a conflict between economic benefits and ecological costs. Tools from nonlinear dynamics and bifurcation theory are employed to investigate non-convex dynamic optimisation problems. The main thrust is a structural analysis, that is, investigation of the global solution structure of dynamic optimisation problems and dynamic games. The qualitative changes of these solutions are studied under changes of the parameters. Geometrical methods, like bifurcation theory, normal form theory and perturbation theory, as well as numerical methods yield insights that hold not just at isolated parameter values, but for the complete parameter set.

7.3 PROGRAMME EVALUATION

This programme grew out of a mathematical economics programme *Equilibrium and Dynamics*, led by Weddepohl, which was quite small until the mid nineties. The group was extended considerably at the end of 1998, thanks to an NWO-MaG Pionier grant awarded to Hommes, to set up the Center for Nonlinear Dynamics in Economics and Finance (CeNDEF). At that time the programme changed from a small specialized mathematical economics programme into a multi-disciplinary research programme with an emphasis on economic theory, but also running laboratory experiments (in cooperation with Joep Sonnemans at CREED) to test behavioural theories and doing empirical work as well (in cooperation with Peter Boswijk at UvA-Econometrics), in particular nonlinear time series analysis, to test behavioural models empirically. Weddepohl retired in 2002 while Furth and Koster joined the group in the same year; from that point onwards, game theory has been included as one of the research themes of the programme. At the end of 2003, the CeNDEF postdocs Diks, Tuinstra and Wagener obtained tenured positions, ensuring the continuation of the research program. In 2009 the research programme was ranked as one of the three top programmes at the FEB by the VSNU "Visitatiecommissie" (Quality 4.5, Productivity 4.5, Relevance 5, Viability 5). From the report of the committee: "*The group (...) is developing very fruitful projects on highly topical current issues.*"

The publication record of the year 2015 is very good. The output was 9 articles in international refereed journals, amongst which publications in *Games and Economic Behavior*, *Journal of Economic Dynamics and Control* and *Mathematics of Operations Research*. There were two PhD students, Dávid Kopányi and Juanxi Wang, that had a (co-)supervisor from the group, who defended their thesis successfully.

The programme is internationally established, as is shown by excellent citation statistics (e.g. according to the Science Citation Index (SCI) in 2015 almost 500 citations of published work by group members), many invited and several keynote lectures at international seminars, conferences and workshops by various members of the research group. In the IDEAS/RePEc ranking of Top 20% institutes (<http://ideas.repec.org/top/top.netherlands.html>), CeNDEF ranks as number 14, one position

down from last year. This ranking contains faculties of economics and departments; among the small institutes of the order of a research group (up to 16 researchers) CeNDEF ranks 4th on the list.

In 2015, Anita Kopányi-Peuker joined the group as postdoc in the EU Horizon 2020 project IBSEN, and Gavin Goy, Myrna Hennequin and Gregor Boehl as PhD students.

The evaluation can be summarized in the following **SWOT analysis** of the CeNDEF activities.

Strengths: international reputation as an excellent research group on nonlinear dynamics and complexity applications in economics and finance, high scientific impact (e.g., with both having been cited about 500 times (Web of Science), Brock and Hommes (*Econometrica* 1997), and Brock and Hommes (*JEDC* 1998), are two of the best cited journal articles co-authored by a Dutch economist), regular international visitors, active seminars and international workshops, own working paper series, frequently visited website, good facilities for computing and travel.

Weaknesses: relatively few publications in top mainstream journals, where multi-disciplinary work and non-mainstream approach such as agent-based modelling and complexity modelling are far from being well accepted; the number of links with practitioners and policy makers has been relatively low, but is now increasing.

Opportunities: development of UvA Graduate School in Economics; application of group-specific know-how to core economic problems, to demonstrate in this way the value of the programme's characteristic approach; developing more policy oriented research, e.g. through a new project on heterogeneous expectations in macro economics and monetary policy; for example, the NWO-complexity project is a research project jointly with researchers and policy makers at DNB.

Threats: A multidisciplinary group is likely to be handicapped when evaluated in a mono-disciplinary environment; and the complexity of the tools used may turn out to be an impediment at disseminating the research approach.

7.4 RESOURCES AND FUNDING

The budget received from ASE-RI every year only covers on average one conference per researcher per year and some of the costs for the Economics Colloquia; another budget of the Tinbergen Institute covers the costs of joint research seminars *Cooperative Behaviour, Strategic Interaction and Complex Systems - CSC* together with the VU mathematical economics group.

The group has been very successful in obtaining additional external funding. Joep Lustenhouwer is a PhD student since September 2014 funded by a NWO Talent project Monetary and Fiscal Policy under Bounded Rationality and Heterogeneous Expectations CeNDEF is part of several European consortia that obtained grants: the *Macro-Risk Assessment and Stabilization Policies with New Early Warning Signals (RASTANEWS)*, the EU COST action IS1104 "*The EU in the new complex geography of economic systems: models, tools and policy evaluation*", and two INET projects, "*Coordination of Expectations*", led by Roger Guesnerie and "*Heterogeneous Expectations and Financial Crises*", led by Cars Hommes. The EU FP7-SHS Collaborative project (with 12 European partners) "*Integrated Macro-Financial Modelling for Robust Policy Design (MACFINROBODS)*" started in May 2014 is coordinated by Cars Hommes for UvA. A new EU Horizon 2020 project Bridging the gap: from Individual Behaviour to the Socio-technical MaN (IBSEN) has started in September 2015. Anita Kopányi-Peuker has been appointed as postdoc in this project. In May 2014 Cars Hommes was awarded the *Distinguished Lorentz Fellowship 2014/2015* of the Netherlands Institute of Advanced Studies (NIAS).

7.5 OUTPUT

Key publications

- Anufriev, M. & Hommes, C.H. (2012). Evolutionary selection of individual expectations and aggregate outcomes. *American Economic Journal–Micro*, 4 (4), 35-64.
- Diks, C., Panchenko, V. & Dijk, D. van (2011). Likelihood-based scoring rules for comparing density forecasts in tails. *Journal of Econometrics*, 163, 215-230.
- Hommes, C.H. and Zhu, M. (2014). Behavioural learning equilibria. *Journal of Economic Theory*, 150, 778-814.
- Leij, M.J. van der (2011). Experimenting with buddies. *Science*, 334, 1220-1221.
- J. Linde, J. Sonnemans & J. Tuinstra (2014). Strategies and evolution in the minority game: a multi-round strategy experiment. *Games and Economic Behavior*, 86, 77-95.
- Wagener, F. (2014). Expectations in experiments. *Annual Review of Economics*, 6, 421-443.

Forthcoming

- Agliari, A., Hommes, C.H. and Pecora, N. (2016). Path dependent coordination of expectations in asset pricing experiments: a behavioural explanation. *Journal of Economic Behavior & Organization*, in press.
- Assenza, T., Brock, W.A., and Hommes, C.H. (2016). Animal Spirits, Heterogeneous Expectations and the Emergence of Booms and Busts. *Economic Inquiry*, in press.
- Bao, T., Hommes, C.H. and Makarewicz, T. (2016). Bubble formation and (in)efficient markets in learning-to-forecast and -optimize experiments. *The Economic Journal*, in press.
- S.Battiston, J.D.Farmer, A.Flache, D.Garlaschelli, A.Haldane, H..Heesterbeek, C.Hommes, C.Jaeger, R.May, M.Scheffer. Complexity theory and financial regulation. Economic policy needs interdisciplinary network analysis and behavioral modeling. *Science* (19 februari 2016), 351 (6275), 818-819.
- Diks, C. and Wolski, M. (2015). Nonlinear Granger causality: Guidelines for multivariate analysis. *Journal of Applied Econometrics*, in press.
- Kopányi-Peuker, A., T. Offerman & R. Sloof (2016). Fostering cooperation through the enhancement of own vulnerability. *Games and Economic Behavior*, in press.
- Papana, A., Kugiumtzis, D., Kyrtsov, K., and Diks, C. (2015). Detecting causality in non-stationary time series using Partial Symbolic Transfer Entropy. *Computational Economics*, in press.
- Salle I. and Sepecher P. (2016). Social learning about consumption. *Macroeconomic Dynamics*, in press.

Publications in numbers

Output type	Classification	#
Articles in journals	Refereed	10
	Non-refereed	0
	Professional	3
	Popular	0
Books or book chapters	Refereed	0
	Non-refereed	0
	Professional	0
	Popular	0
Conference proceedings		0
PhD theses		2
Working papers		13

Article in journal - refereed

- Assenza, T., Delli Gatti, D. & Grazzini, J. (2015). Emergent dynamics of a macroeconomic agent based model with capital and credit. *Journal of Economic Dynamics & Control*, 50, 5-28.
- Assenza, T., Grazzini, J., Hommes, C. & Massaro, D. (2015). PQ strategies in monopolistic competition: some insights from the lab. *Journal of Economic Dynamics & Control*, 50, 62-77.
- Grass, D., Kiseleva, T. & Wagener, F. (2015). Small-noise asymptotics of Hamilton-Jacobi-Bellman equations and bifurcations of stochastic optimal control problems. *Communications in Nonlinear Science & Numerical Simulation*, 22 (1-3), 38-54.
- Hommes, C. & Iori, G. (2015). Introduction special issue crises and complexity. *Journal of Economic Dynamics & Control*, 50, 1-4.
- Kendrick, D.A. & Amman, H.M. (2014). Quarterly fiscal policy. *Economist's Voice*, 11 (1), 7-12.
- Kiseleva, T. & Wagener, F. (2015). Bifurcations of optimal vector fields. *Mathematics of operations research*, 40 (1), 24-55.
- Molina-Borboa, J.L., Martínez-Jaramillo, S., López-Gallo, F. & Leij, M. van der (2015). A multiplex network analysis of the Mexican banking system: link persistence, overlap, and waiting times. *The Journal of Network Theory in Finance*, 1 (1), 99-138.
- Poledna, S., Molina-Borboa, J.L., Martínez-Jaramillo, S., Leij, M. van der & Thurner, S. (2015). The multi-layer network nature of systemic risk and its implications for the costs of financial crises. *Journal of Financial Stability*, 20, 70-81.
- Salle, I.L. (2015). Modeling expectations in agent-based models: an application to central bank's communication and monetary policy. *Economic Modelling*, 46, 130-141.
- Sepecher, P. & Salle, I. (2015). Deleveraging crises and deep recessions: a behavioural approach. *Applied Economics*, 47 (34-35), 3771-3790.

Article in journal - professional

- Leij, M. van der (2015). Het woord aan... Marco van der Leij. *Economisch-Statistische Berichten*, 100 (4711), 352.
- Moen, E., Nenov, P. & Sniekers, F. (2015). Eerst kopen of eerst verkopen op de woningmarkt. *Economisch-Statistische Berichten*, 100 (4706), 166-169.
- Veld, D.L. in 't (2015). Weinig vertrouwen beleggers in aandelenwaardering. *Statistiek: Economie en samenleving. Economisch-Statistische Berichten*, 100 (4716), 493-493.

Working- or discussion paper

- Agliari, A., Hommes, C.H. & Pecora, N. (2015). Path dependent coordination of expectations in asset pricing experiments: a behavioral explanation. (CeNDEF working paper, no 15-05). University of Amsterdam.
- Amman, H.M. (2015). Approximating the Value Function for Optimal Experimentation. QE.
- Anufriev, M., Hommes, C.H. & Makarewicz, T. (2015). Simple forecasting heuristics that make us smart: evidence from different market experiments. (CeNDEF working paper, no 15-07). University of Amsterdam.
- Bao, T. & Hommes, C.H. (2015). When speculators meet constructors: positive versus negative feedback in experimental housing markets. (CeNDEF working paper, no 15-10). University of Amsterdam.
- Diks, C.G.H., Hommes, C.H. & Wang, J. (2015). Critical slowing down as an early warning signal for financial crises. (CeNDEF working paper, no 15-04). University of Amsterdam.
- Hommes, C. & Veld, D. in 't (2015). Booms, busts and behavioural heterogeneity in stock prices. (Tinbergen Institute discussion paper, no TI 2015-088/II). Amsterdam: Tinbergen Institute.
- Hommes, C. & Veld, D. in 't (2015). Booms, busts and behavioural heterogeneity in stock prices. University of Amsterdam.
- Hommes, C., Lustenhouwer, J.E. & Mavromatis, K. (2015). Fiscal Consolidations and Heterogeneous Expectations. Mimeo.

- Hommes, C., Makarewicz, T., Massaro, D. & Smits, T. (2015). Genetic Algorithm Learning in a New Keynesian Macroeconomic Setup. (CeNDEF Working paper, no 15-01). University of Amsterdam.
- Hommes, C.H. & Lustenhouwer, J.E. (2015). Inflation Targeting and Liquidity Traps under Endogenous Credibility. (CeNDEF working paper, no 15-03). University of Amsterdam.
- Hommes, C.H., Massaro, D. & Salle, I.L. (2015). Monetary and fiscal policy design at the zero lower bound - Evidence from the Lab. (CeNDEF working paper, no 15-11). University of Amsterdam.
- Makarewicz, T.A. (2015). Networks of Heterogeneous Expectations in an Asset Pricing Market. (CeNDEF working paper, no 15-08). University of Amsterdam.
- Moen, E.R., Nenov, P.T. & Sniekers, F. (2015). Buying first or selling first in housing markets. (CEPR Discussion Paper Series, no 10342). London: Centre for Economic Policy Research.

UvA Dissertation – internally prepared

- Kopányi, D. (2015, Februari 13). Bounded rationality and learning in market competition. Universiteit van Amsterdam (vii, 203 pag.) (Amsterdam: Tinbergen Institute). Prom./coprom.: prof.dr. J. Tuinstra & prof.dr. C.H. Hommes.

UvA Dissertation – externally prepared

- Wang, J. (2015, Oktober 23). Modelling and estimation of dynamic instability in complex economic systems. Universiteit van Amsterdam (v, 148 pag.). Prom./coprom.: prof.dr. C.G.H. Diks, H. Dawid & prof.dr. C.H. Hommes.

Conference organiser

- Hommes, C.H. (2015, March 23-27). NIAS-Lorentz workshop on *Socio-Economic Complexity*, Lorentz Center Leiden.
- Diks, C.G.H. (2015, May 18-20). 10th Tinbergen Institute Conference on *Complexity in Economics and Finance*, Tinbergen Institute, Amsterdam.
- Hommes, C.H. (2015, May 18-20). 10th Tinbergen Institute Conference on *Complexity in Economics and Finance*, Tinbergen Institute, Amsterdam.
- Leij, M.J. van der (2015, May 18-20). 10th Tinbergen Institute Conference on *Complexity in Economics and Finance*, Tinbergen Institute, Amsterdam.

Recognition

- Diks, C.G.H. (2015). 10th Tinbergen Institute Conference.
- Diks, C.G.H., Hommes, C.H. & Leij, M.J. van der (2015). 10th Tinbergen Institute Conference 2015: Complexity in Economics and Finance.
- Evans, G. & Salle, I. (2015). *INEXC Fellowship (financed by INET, 13,500 euros)* Research project “Fiscal Policy in Expectation-driven Recessions when Long Horizons Matter: a lab experiment”.
- Hommes, C.H., Sonnemans, J., Tuinstra, J. and Diks, C.G.H. (2015). Additionele Financiering Zwaartepunt *Behavioral Economics* (300K p.y.)
- Hommes, C.H. (2014-2017). EU FP7 grant (nr 612796, budget 2.5M) Collaborative project *Integrated Macro-Financial Modelling for Robust Policy Design* (MACFINROBODS), Coordinator consortium of 12 European Universities & Research Institutes.
- Hommes, C.H. and Lustenhouwer, J. (2014-2017). NWO Talent grant (nr 406-14-011, budget 198K).
- Hommes, C.H. (2014/2015). *Distinguished Lorentz Fellowship*, Netherlands Institute for Advanced Studies (NIAS).
- Hommes, C.H. (2014-2016). President Elect, *Society of Computational Economics*.
- Moen, E., Nenov, P. & Sniekers, F. (2015). ESB Award. Best paper award for articles that appeared in *Economisch Statistische Berichten* in 2015.

Tuinstra, J. (2011). Team leader for the Netherlands of the Open Research Area grant (nr 464-15-143, budget 298,196 Euro for the Dutch Team) for project titled “Behavioral and Experimental Analyses in Macro-Finance”

Book review

Hommes, C.H. (2015). Review of "Rethinking housing bubbles. The role of household and bank balance sheets in modelling economic cycles" by Steven D. Gjerstad and Vernon L. Smith. *Journal of Economic Psychology* 50, 138-142.

Keynote/invited talk

- Altaghlubi, M. (2015, May 15). Unconditional Aid and Green Growth. 13th Viennese Workshop on Optimal Control and Dynamic Games, Vienna University of Technology, Vienna, Austria.
- Altaghlubi, M. (2015, December 8). Unconditional Aid and Green Growth. 10th BiGSEM Doctoral Workshop on Economic Theory 2015, University of Bielefeld, Bielefeld, Germany.
- Assenza, T. (2015, March 17). Individual Expectations and Aggregate Macro Behavior, Research seminar series at the University of Florence, Florence
- Assenza, T. (2015, March 31). Individual Expectations and Aggregate Macro Behavior, Research seminar series at the Sant' Anna School of Economics, Pisa
- Diks, C. (2015, March 26). Critical Slowing Down as Early Warning Signals for Financial Crises? Workshop on Socio-Economic Complexity, Lorentz Center, Leiden, The Netherlands
- Diks, C. (2015, May 18). Critical Slowing Down as Early Warning Signals for Financial Crises? Tinbergen Institute Conference, Tinbergen Institute, Amsterdam, The Netherlands
- Diks, C. (2015, September 9). Nonlinear Granger Causality: Guidelines for Multivariate Analysis. Talk in the Time Series, Causality, Networks and Applications session (host: prof. Dimitris Kugiumtzis) at XXXV Dynamics Days Europe 2015, University of Exeter, Exeter, UK.
- Hommes, C.H. (2015, January 9). Laboratory Experiments with Human Subjects, EU FP7 CRISIS Final Review, City University, London, UK.
- Hommes, C.H. (2015, January 26). Bubble Formation and (In)Efficient Markets in Learning-to-Forecast and -Optimize Experiments, *Finance Seminar*, Radboud Universiteit Nijmegen.
- Hommes, C.H. (2015, February 2). Bounded Rationality and Agent-based Macro-models Theory, Experiments, Empirical Validation and Policy, *Seminar CPB*, Den Haag
- Hommes, C.H. (2015, February 5). Booms and Busts in House Prices under Heterogeneous Expectations : Estimation and Experimental Evidence, *Probability & Statistics Seminar TU Delft*.
- Hommes, C.H. (2015, February 24). Bubble Formation and (In)Efficient Markets in Learning-to-Forecast and -Optimize Experiments, *Seminar Department of Economics*, University of Namur, Namur, Belgium.
- Hommes, C.H. (2015, April 17). Managing self-organization of expectations through monetary policy: a macro experiment, Seminar Economics & Econometrics, RUG, Groningen.
- Hommes, C.H. (2015, April 21). Will computing change human decision making? *ABC Symposium Decision Making*, UvA.
- Hommes, C.H. (2015, June 9). Complexity in Economics and Finance: Theory, Experiments, Empirical Validation & Policy, *TNO Complexity Meeting*, Utrecht.
- Hommes, C.H. (2015, June 25). Nonlinear dynamics in the laboratory, 9th International Conference on Nonlinear Economic Dynamics, Chuo University, June 25-27, Tokyo, Japan.
- Hommes, C.H. (2015, August 13). Behavioral learning equilibria and monetary policy for the New Keynesian model, Workshop Expectations in Dynamic Macroeconomic Models, University of Oregon, USA.
- Hommes, C.H. (2015, October 7). Managing self-organization of expectations through monetary policy: a macro experiment, CeDEx Seminar, Nottingham, UK.
- Hommes, C.H. (2015, November 20). Behavioral learning equilibria and monetary policy for the New Keynesian model, Workshop on Agent-Based and DSGE Macroeconomic Modeling: Bridging the Gap, University of Surrey, UK.

- Hommes, C.H. (2015, December 2). Managing self-organization of expectations through monetary policy: a macro experiment, Macroeconomics Seminar Universitat Autònoma Barcelona (UAB) & Inst. for Economic Analysis (IEA-CSIC), Barcelona.
- Tuinstra, J. (2015, November 27). Learning and imitation in the minority game: A strategy experiment. Seminar University of Technology Sydney, Australia
- Leij, M.J. van der (2015, January 19). Do Correlated Markets Have More Volatility Spillovers? Invited seminar (host: Dr. Sophie Béreau), CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium.
- Leij, M.J. van der (2015, April 2). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Invited seminar (host: Prof. Yann Bramoullé), GREQAM, Université Aix-Marseille, Marseille, France.
- Leij, M.J. van der (2015, April 8). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Invited seminar (host: Dr. Paolo Pin), University of Siena, Siena, Italy.
- Leij, M.J. van der (2015, May 8). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Invited seminar (host: Prof. Federico Valenciano and Dr. Jaromir Kovarik), BRIDGE, University of the Basque Country, Bilbao, Spain.
- Leij, M.J. van der (2015, May 26). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Invited seminar (host: Dr. Michiel Bijlsma), Centraal Planbureau, The Hague, The Netherlands.
- Salle, I. (2015, October 29). Monetary and Fiscal Policy Design at the ZLB: evidence from the lab, at Macro-MIE TI Seminar, Erasmus University, Rotterdam, NL.
- Salle, I. (2015, April 24). Deleveraging crises and deep recessions: a behavioral approach, (host: prof. Giovanni Dosi) at Sant'Anna School of Advanced Studies, Pisa, Italy.
- Salle, I. (2015, March 25). Monetary and Fiscal Policy Design at the ZLB: evidence from the lab, at the 'Socio-Economic Complexity' workshop, Lorentz Center, Leiden, NL.
- Wagener, F.O.O. (2015, December 8). Classifying Markov perfect Nash equilibria in a patent portfolio race with knowledge accumulation. Invited seminar (host: Dr. Grega Smrkolj), Newcastle Business School, Newcastle-on-Tyne, UK.

Other lectures

- Diks, C. (2015, October 5). Nonlinear Granger Causality: Guidelines for Multivariate Analysis. KAFEE Lunch Seminar, ASE, University of Amsterdam, The Netherlands
- Hommes, C.H. (2015, January 3-5). Managing self-organization of expectations through monetary policy: a macro experiment, ASSA meetings 2014, ESA Session *Macroexperiments*, Boston, USA.
- Hommes, C.H. (2015, January 3-5). Discussant "Perpetual Learning and Stability in Macroeconomic Models", by William Branch, ASSA/SCE session on Emergent Dynamics in Multi-Agent Models of Growth and Social Interactions, Boston.
- Hommes, C.H. (2015, January 15-16). Bounded rationality and heterogeneous expectations in macroeconomics, EU FP7 MACFINROBODS Workshop, City Univ., London, UK.
- Hommes, C.H. (2015, June 20). Equilibrium selection in a complex OG economy: evidence from the Lab, 21st Conference on *Computation in Economics and Finance* (CEF), June 20-22, Taipeh, Taiwan.
- Hommes, C.H. (2015, July 8). Paper Discussant: In search of a nominal anchor, by C. Carvalho, S. Eusepi, E. Moench and B. Preston, *NBER Workshop Behavioral Macroeconomics*, Boston.
- Hommes, C.H. (2015, August 13). Paper Discussant: Perpetual learning and stability in macroeconomic model, by W.A. Branch, G. Evans and B. McGough, *Workshop Expectations in Dynamic Macroeconomic Models*, University of Oregon.
- Hommes, C.H. (2015, August 26). Monetary and fiscal policy design at the zero lower bound: evidence from the lab, 11th *Econometric Society World Congress*, August 17-21, Montreal, Canada.
- Hommes, C.H. (2015, August 26). Monetary and fiscal policy design at the zero lower bound: evidence from the lab, 30th *Annual Congress European Economic Association*, August 24-27, Mannheim, Germany.

- Hommes, C.H. (2015, November 20). Paper Discussant: A New Keynesian behavioural model with individual rationality and heterogeneous agents, Workshop on Agent-Based and DSGE Macroeconomic Modeling: Bridging the Gap, University of Surrey, UK.
- Hommes, C.H. (2015, December 1). Inflation targeting and liquidity traps under endogenous credibility, EU FP7 MACFINROBODS Workshop, CSIC, Barcelona, Spain.
- Leij, M.J. van der (2015, May 19). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Hosting talk, 10th TI Conference “Complexity in Economics and Finance”, Tinbergen Institute, Amsterdam, The Netherlands.
- Leij, M.J. van der (2015, June 5). Multi-layer Network Nature of Systemic Risk in Financial Networks and its Implications. SYRTO Conference on Systemic Risk, Amsterdam, The Netherlands.
- Leij, M.J. van der (2015, August 17). On Relations in the Unsecured and Secured Overnight Interbank Lending Markets. Econometric Society World Congress 2015, Montréal, Canada.
- Leij, M.J. van der (2015, August 25). The Formation of a Core-Periphery Structure in Heterogeneous Financial Networks. Hosting talk, 30th European Economic Association Meeting, Mannheim, Germany.
- Leij, M.J. van der (2015, September 24). On Relations in the Unsecured and Secured Overnight Interbank Lending Markets. 2015 RiskLab/BoF/ESRB Conference on Systemic Risk Analytics, Helsinki, Finland.
- Leij, M.J. van der (2015, December 17). Multi-layer Network Nature of Systemic Risk in Financial Networks and its Implications. Internal seminar, De Nederlandsche Bank, Amsterdam, The Netherlands.
- Makarewicz, T. A. (2015, 15 April). Bubble formation and (in)efficient markets in learning-to-forecast and -optimize experiments. IMEBESS 2015, Toulouse, France.
- Makarewicz, T. A. (2015, May 22). Simple forecasting heuristics that make us smart: Evidence from different market experiments. WEHIA 2015, Nice, France .
- Makarewicz, T. A. (2015, 25 August). Bubble formation and (in)efficient markets in learning-to-forecast and -optimize experiments. The 30th Annual Congress of the European Economic Association, Mannheim, Germany.
- Salle, I. (2015, June-July 29-02). Monetary and Fiscal Policy Design at the ZLB: evidence from the lab, at the Western Economic Association International Conference, Honolulu, USA.
- Salle, I. (2015, June 19-21). Deleveraging crises and deep recessions: a behavioral approach, at the International CEF, Taipei, Taiwan.
- Salle, I. (2015, February 20-23). Deleveraging crises and deep recessions: a behavioral approach, at the Eastern Economic Association Conference, New York, USA.
- Wagener, F.O.O. (2015, July 16). Classifying Markov perfect Nash equilibria in a patent portfolio race with knowledge accumulation. 10th International ISDG Workshop, Glasgow, UK.
- Wang, H. (2015, May). A patent portfolio race with knowledge accumulation. “13th Viennese Workshop on Optimal Control and Dynamic Games”, Vienna, Austria.
- Wang, H. (2015, June). A patent race with the complementary property and spillovers. “21th Computing in Economics and Finance”, Taipei, Taiwan.
- Wang, H. (2015, July). A patent race with knowledge accumulation and product market. EDEEM summer meeting, University of Venice, Venice, Italy.

Membership academies

- Amman, H. (2015). Fellow of the Society for Economic Measurement (SEM).
- Assenza, T. (2015). Member of the Scientific board of the PhD program of the Graduate School in Public Economics (DEFAP), Università Cattolica del Sacro Cuore
- Diks, C. (2015). Tinbergen Institute Research Fellow.
- Diks, C. (2015, 12 Oct.). Member PhD committee of João da Gama Batista, *Collective destabilising phenomena in socio-economic systems*, CentraleSupélec, Université Paris-Saclay, Paris.
- Hommes, C.H. (2015). Tinbergen Institute Research Fellow
- Hommes, C.H. (2015). Center for Financial Studies Research Fellow, Frankfurt
- Hommes, C.H. (2015). NWO *Complexity* Program Committee.

- Hommes, C.H. (2015, April 22). Member PhD committee Dr. S.A. Osinga, *The knowledge management arena: agent-based modelling of the pig sector*, Wageningen University.
- Hommes, C.H. (2015, May 28). Member PhD committee Dr. S. ter Ellen, *Measurement, dynamics and implications of heterogeneous beliefs in financial markets*, Erasmus University Rotterdam.
- Hommes, C.H. (2015, September 7). Member PhD committee Dr. F. Brauning, *Interbank lending relationships, financial crises and monetary policy*, VU Amsterdam.
- Kopányi-Peucker, A. (Oct. 2015). Tinbergen Institute Candidate Fellow.
- Leij, M.J. van der (2015). Tinbergen Institute Research Fellow.
- Salle, I. (2015), Tinbergen Institute Candidate Fellow.
- Wagener, F.O.O. (2015). Tinbergen Institute Research Fellow.

Editorship

- Amman, H.M. (Ed.). (2015) Computational Economics.
- Amman, H.M. (Ed.). (2015) Computational Management Science.
- Amman, H.M. (Ed.). (2015) Netnomics.
- Hommes, C.H. (Ed.). (2015) Journal of Economic Dynamics & Control, 50(Special Issue Crisis & Complexity, January 2015).
- Hommes, C.H. (Ed.). (2015) Journal of Economic Dynamics & Control.
- Hommes, C.H. (Ed.). (2015) Journal of Economic Interaction and Coordination.
- Hommes, C.H. (Ed.). (2015) Macroeconomic Dynamics.
- Hommes, C.H. (Ed.). (2015) Review of Behavioral Economics.
- Leij, M.J. van der (Ed.). (2015) Complexity Economics.
- Leij, M.J. van der (Ed.). (2015) Network Science.

Relevant position

- Hommes, C.H. (2015). Referee for: Journal of Finance, European Economic Review, Journal of Difference Equations and Applications, International Journal of Forecasting, Economic Modelling, Journal of Evolutionary Economics, Advances in Decision Sciences, Research Council Canada (SSHRC), National Science Foundation (NSF)
- Leij, M.J. van der (2015). Referee for: International Journal of Game Theory, Journal of Economic Behavior & Organization (2x), Journal of Economic Theory, Journal of Network Theory in Finance, Network Science (2x), RAstaNEWS.
- Salle, I. (2015). Referee for: Macroeconomic Dynamics, Journal of Economic Behavior and Organisation, Journal of Economic Dynamics and Control, Springer.
- Sniekers, F. (2015). Referee for: International Economic Review, Journal of Economic Dynamics and Control.
- Tuinstra, J. (November 2015). Visiting Professor, University of Technology Sydney, Sydney, Australia
- Tuinstra, J. (2015). Referee for: Annals of the International Society of Dynamic Games, Chaos, Solitons and Fractals, Economic Journal, Economics Letters, International Journal of Game Theory, Journal of Evolutionary Economics, Macroeconomic Dynamics.
- Wagener, F.O.O. (2015). Referee for: Environmental and Resource Economics, European Journal of Applied Mathematics, Journal of Economic Dynamics and Control, Journal of Environmental Economics and Management, Journal of Political Economy, Journal of Public Economics.