



VIII Workshop
MDEF 2014

Modelli Dinamici per Economia e Finanza
Dynamic Models in Economics and Finance

Urbino, September 18-20, 2014

Palazzo Battiferri, Via Saffi n.42, Aula Rossa

PROGRAM and ABSTRACTS



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UNIVERSITÀ
DEGLI STUDI
DI URBINO
CARLO BO



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Dipartimento di Economia, Società, Politica
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MDEF
Modelli Dinamici in Economia e Finanza
Dynamic Models in Economics and Finance

8th Edition, Urbino (Italy) September 18-20, 2014

At the University of Urbino “Carlo Bo”
Department of Economics, Society, Politics (DESP)
Via Saffi n. 42

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Program

Thursday, September 18

8:30-9:00 *Registration*

9:00-10:40 Chair: Fabio Tramontana

- Ugo Merlone (with A. Matsumoto and F. Szidarovszky): *Oligopolies with Contingent Workforce and Unemployment Insurance Systems.*
- Luca Gori (with L. Fanti and M. Sodini): *A nonlinear Cournot duopoly with advertising.*
- Mauro Sodini (with L. Gori and L. Guerrini): *A continuous time Cournot duopoly with delays.*
- Serena Brianzoni (with L. Gori and E. Michetti): *Dynamics of a Bertrand duopoly with differentiated products and nonlinear costs: analysis, comparisons and new evidences.*
- Fabio Tramontana (with F. Cavalli and A. Naimzada): *Nonlinear dynamics and global analysis of a heterogeneous Cournot duopoly.*

10:40-11:10 *Coffee-Break*

11:10-12:50 Chair: Marco Marini

- Fausto Cavalli (with A. Naimzada and M. Pireddu): *Dynamics of heterogeneous oligopolies with best response mechanisms.*
- Fabio Lamantia (with G.I. Bischi and D. Radi): *An evolutionary Cournot model with limited market knowledge.*
- Lorenzo Cerboni Baiardi (with G.I. Bischi): *A dynamic marketing model with best reply and inertia.*
- Marius Ochea (with D. Lindeman): *Imitation Dynamics in Cournot Games with Heterogeneous Players.*
- Marco Marini (with Gani Aldashev and T. Verdier): *Brothers In Alms? Coordination Between Nonprofits on Markets for Donations.*

13:00 -15:00 *Lunch at University Guest House*

15:00-16:40 Chair: Volker Böhm

- Frank Westerhoff (with N. Schmitt): *Intensity of choice versus profit taxes: a measure against rational routes to randomness?*
- Alessandro Carraro (with G. Ricchiuti): *Heterogeneous Fundamentalists and Market Maker Inventories.*
- Marina Pireddu (with A. Naimzada): *A financial market model with endogenous fundamental values through imitative behavior.*
- Xuezhong (Tony) He: *Optimality of Momentum and Reversal.*
- Volker Böhm: *Rational Expectations and the Stability of Balanced Monetary Development.*

16:40-17:10 *Coffee-break*

17:10-19:10 Special Session. Chair: Tony He

- Roberto Dieci, Tony He, Cars Hommes: *book presentation.*
- Masaaki Kijima (with Y. Muromachi): *On the Risk Evaluation Method Based on the Market Model.*
- Matthieu Charpe (with C. Chiarella, P. Flaschel and C. Proaño): *Business Confidence and Macroeconomic Dynamics in a Nonlinear Two-Country Framework with Aggregate Opinion Dynamics.*
- Paolo Pellizzari (with D. Ladley): *The simplicity of optimal trading in order book markets.*
- Simone Landini (with M. Gallegati, A. Mandel and H. Gintis): *Generalized Market Exchange with Master Equations.*
- Carl Chiarella (with T. Zhi and C. Di Guilmi): *Modelling the "Animal Spirits" of Bank's Lending Behaviour.*

20:30 *Social Dinner at University College "Il Colle"*

Friday, September 19

9:00-10:40 Chair: Marcello Galeotti

- Alessandro Fiori Maccioni (with A. Antoci and P. Russu): *The Ecology of Defensive Medicine and Malpractice Litigation*.
- Davide Radi (with L. Gardini): *A Schelling-like Segregation Model with Heterogeneous Distributions of Tolerance and Entry Restrictions*.
- Tatyana Ryzanova (with J. Jungeilges): *Modeling of economic dynamics under stochastic noise*.
- Yoshiyuki Arata: *Endogenous business cycles caused by nonconvex costs and interactions*.
- Marcello Galeotti (with A. Antoci): *Global dynamics of a Solow-Swan model with environmental assets*.

10:40-11:10 *Coffee-Break*

11:10-12:50 Chair: Pasquale Commendatore

- Tõnu Puu: *Global Dynamics of the Hotelling Duopoly*.
- Anna Ressi (with M. Kopel and M. Pezzino): *Strategic Delegation, Bargaining and Location Choice*.
- Roberto Basile: *Regional productivity growth in Europe: a Schumpeterian perspective*.
- Ingrid Kubin (with P. Commendatore and I. Sushko): *Trade agreements in a linear FE model: preliminary considerations on fixed point and dynamic properties*
- Pasquale Commendatore and Pascal Mossay (with I. Kubin and I. Sushko): *Dynamic agglomeration patterns in a 2-country 4-regions NEG model*.

13:00 -15:00 *Lunch at University Guest House*

15:00-16:40 Chair: Iryna Sushko

- Alexandros K Karlis (with G. Galanis, S. Terovitis and M. S. Turner): *Information Heterogeneity and Clustering of Defaults*.
- Vincenzo Valori (with D. Colucci): *A parsimonious model of expectations to explain experimental forecasts*.
- Nicolò Pecora (with A. Agliari, D. Massaro and A. Spelta): *Inflation Targeting, Recursive Inattentiveness and Heterogeneous Expectations*.
- Giorgio Ricchiuti (with F. Tramontana): *A Dynamic Exchange Rate Model with Endogenous and Heterogeneous Beliefs*
- Iryna Sushko (with V. Avrutin, F. Tramontana and F. Westerhoff): *Bull and Bear market with different entry thresholds*.

16:40-17:10 *Coffee-break*

17:10-18:50 Chair: Kiminori Matsuyama

- Herbert Dawid (with M. Keoula, M. Kopel and P. Kort): *Product Innovation Incentives by an Incumbent Firm: A Dynamic Analysis*.
- Giovanni Villani (with M. Biancardi): *The effects of R&D investments in International Environmental Agreements with Asymmetric Countries*.
- Akio Matsumoto (with F. Szidarovszky): *Nonlinear Multiplier-Accelerator Model with Investment and Consumption Delays*.
- Hiroki Murakami: *Alternative stabilization policies in a Keynes-Kaldor-Tobin model of business cycles*.
- Kiminori Matsuyama (with I. Sushko and L. Gardini): *Globalization and Synchronization of Innovation Cycles*.

19:30 *Dinner at University Guest House*

21:30 - 22:30 *Jazz Music Concert*

Saturday, September 20

9:00-10:40 Chair: Fabio Privileggi

- Arianna Dal Forno (with U. Merlone): *Heterogeneous population in binary choices with externalities.*
- Alessandro Spelta (with N. Pecora): *Shareholding Network in the Euro Area Banking Market.*
- Jana Zavacka: *Endogenous economic cycles: an agent-based model of consumers' confidence.*
- Anna Maria Variato (with P. Ferri): *Contraction, austerity and debt dynamics.*
- Fabio Privileggi (with D. La Torre and S. Marsiglio): *Self-Similar Measures in Multi-Sector Endogenous Growth Models.*

10:40-11:10 *Coffee-Break*

11:10-12:50 Chair: Ilaria Foroni

- Simone Casellina (with S. Landini and M. Uberti): *A Non-Absorbing Migration Rate with Renewal Approach to the Dynamic Estimation of Credit Risk Economic Capital.*
- Ahmad Naimzada (with F. Cavalli and M. Pireddu): *An Evolutionary Approach to Nonlinear Heterogeneous Oligopolies.*
- Viviana Fanelli: *Investigating Statistical Arbitrage in Commodity Markets.*
- Jochen Jungeilges: *Investor Networks in Financial Markets.*
- Ilaria Foroni (with A. Avellone): *Statistical dynamics in economic models described by piecewise maps.*

Closing Address

13:00 *Lunch at University Guest House*

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Abstracts

Oligopolies with Contingent Workforce and Unemployment Insurance Systems

Akio Matsumoto

Department of Economics, Chuo University, Japan

Ugo Merlone

Psychology Department, University of Torino, Italy

Ferenc Szidarovszky

Department of Applied Mathematics, University of Pécs, Hungary.

In the recent literature the introduction of modified costs functions has added reality into the classical oligopoly analysis. Furthermore, the market evolution requires much more flexibility to firms, and in several countries contingent workforce plays an important role in the production choices by the firms. Therefore, an analysis of dynamic adjustment costs is in order to understand oligopoly dynamics. In this paper, dynamic single-product oligopolies without product differentiation are first examined with the additional consideration of production adjustment costs. Linear inverse demand and cost functions are considered and it is assumed that the firms adjust their outputs partially toward best response. The set of the steady states are characterized by a system of linear inequalities and there are usually infinitely many steady states. The asymptotic behavior of the output trajectories are examined by using computer simulation. The numerical results indicate that the resulting dynamics is richer than in the case of the classical Cournot model. This model and results are then compared to oligopolies with unemployment insurance systems.

JEL code: C72,C73.

References

- [1] G.-I. Bischi, C. Chiarella, M. Kopel, and F. Szidarovszky. *Nonlinear Oligopolies: Stability and Bifurcations*. Springer-Verlag, Berlin/New York, 2010.
- [2] C. Chiarella and F. Szidarovszky. A multiobjective model of oligopolies under uncertainty. *Cubo, A Mathematical Journal*, 11:111–119, 2009.
- [3] D. Denti. The unemployment insurance system in Sweden and Italy. Södertörns Högskola. Paper #2007-30-27 (Analysing Swedish Social Policy), 2007.
- [4] U. Merlone and F. Szidarovszky. Dynamic oligopolies with contingent workforce and investment costs. *Mathematics and Computers in Simulation*, in press.

A nonlinear Cournot duopoly with advertising

Luciano Fanti*• Luca Gori†• Mauro Sodini‡

August 15, 2014

Abstract

This paper aims at studying local and global dynamics of a nonlinear duopoly (Bischi et al., 1998) with quantity setting firms and advertising investments that affect the degree of (horizontally) differentiated products. The industrial economics literature distinguishes between purely informative advertising (Grossman and Shapiro, 1984) and persuasive advertising (Dixit and Norman, 1978). The former kind of investment provides information about price and product characteristics, but it does not influence the consumers' willingness to pay for the advertised good. The latter one consists in expenditures on interventions to persuade consumers that the own product is not perfectly substitutable with the rivals' one. Product differentiation has become of greater importance in oligopoly markets both with profit-maximising firms (Singh and Vives, 1984) and managerial firms (Kopel and Lambertini, 2013). This paper focuses on non-cooperative persuasive advertising in a nonlinear duopoly with quantity-setting firms. However, a model that directly captures the long-term effects of advertising on product differentiation with quantity-setting firms is still lacking. This paper aims to fill this gap by considering players (firms) with limited information about rival's decision variables. Specifically, in our differentiated duopoly we assume that the degree of substitutability between products is affected by the optimal level of advertising investment chosen by firms, and the larger such investment the more consumers perceive products as differentiated between each other. We find that several local and global dynamic phenomena (local and global bifurcations) and chaos may arise.

References

- Bischi, G.I., Stefanini, L., Gardini, L., 1998. Synchronization, intermittency and critical curves in a duopoly game. *Mathematics and Computers in Simulation* 44, 559–585.
- Dixit A.K, Norman, V., 1978. Advertising and welfare. *Bell Journal of Economics* 9, 1–17.
- Grossman, G., Shapiro, C., 1984. Informative advertising with differentiated products. *Review of Economic Studies* 51, 63–81.
- Hamilton, S.F., 2009. Informative advertising in differentiated oligopoly markets. *International Journal of Industrial Organization* 27, 60–69.

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A continuous time Cournot duopoly with delays

Luca Gori* • Luca Guerrini† • Mauro Sodini‡

August 7, 2014

Abstract

The literature on nonlinear duopolies has developed models to study the behaviour of quantity-setting firms with limited information in a discrete time context (Bischi et al., 1998, 1999, 2007). The main aim of these works was essentially to question the hypotheses of rational expectations (that require strong assumptions, such as, e.g., full information of decision makers, homogeneity of expectations and the efficient use of the set of available information) and homogeneous economic agents, to show that models with "bounded rationality" and heterogeneity of agents sometimes predict that instability holds under much weaker conditions than those implied in models with rational expectations (Brock and Hommes, 1997). Since obtaining and using efficiently information is costly, agents may use other behavioural rules to overcome their informational lacunae and try to go beyond the restrictions implied by the rational expectations paradigm, for which instability of equilibria is related to the existence of exogenous stochastic shocks. This literature has then stressed the importance of local and global phenomena (global bifurcations), endogenous fluctuations, chaotic motions, the complexity of the basins of attraction and, from an economic point of view, the crucial role of initial conditions that may lead economies starting by looking very similar to end up with very different long-term outcomes. This paper considers a continuous time version with different time delays of the Cournot duopoly studied by Bischi et al. (1998), and uses the method proposed by Berezowski (2001) - and adopted by Matsumoto and Szidarovszky (2014) to describe the dynamics in a nonlinear monopoly - to transform a discrete time model into a continuous time model. The paper provides some findings about local and global bifurcations and chaotic dynamics.

Keywords Chaos; Cournot duopoly; Time delays

JEL Classification D21; E32; C61; C62

References

- Berezowski, M., 2001. Effect of delay time on the generation of chaos in continuous systems. One-dimensional model. Two-dimensional model—tubular chemical reactor with recycle. *Chaos, Solitons & Fractals* 12, 83–89.
- Bischi, G.I., Naimzada, A., 2000. Global analysis of a dynamic duopoly game with bounded rationality. In: Filar, J.A., Gaitsgory, V., Mizukami, K., editors. *Advances in Dynamics Games and Application*, vol. 5. Boston: Birkhäuser, 361–385.
- Bischi, G.I., Gallegati, M., Naimzada, A., 1999. Symmetry-breaking bifurcations and representative firm in dynamic duopoly games, *Annals of Operations Research* 89, 253–272.
- Bischi, G.I., Naimzada, A., Sbragia, L., 2007. Oligopoly games with Local Monopolistic Approximation. *Journal of Economic Behavior & Organization* 62, 371–388.
- Bischi, G.I., Stefanini, L., Gardini, L., 1998. Synchronization, intermittency and critical curves in a duopoly game. *Mathematics and Computers in Simulation* 44, 559–585.
- Brock, W.A., Hommes, C.H., 1997. A rational route to randomness. *Econometrica* 65, 1059–1095.
- Matsumoto, A., Szidarovszky, F., 2014. Discrete and continuous dynamics in nonlinear monopolies. *Applied Mathematics and Computation* 232, 632–642.

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Dynamics of a Bertrand duopoly with differentiated products and nonlinear costs: analysis, comparisons and new evidences

Serena Brianzoni¹, Luca Gori², Elisabetta Michetti³

Abstract

In this paper we study the dynamics of a duopoly with price competition and horizontal product differentiation by introducing quadratic production costs (decreasing returns to scale), thus extending the model by Fanti et al. (2013) in which linear costs (constant returns to scale) have been considered. The economy is described by a two-dimensional non-invertible discrete time dynamic system. We first determine its fixed points and other invariant sets showing that synchronized dynamics can occur. Then, we compare the stability properties in the case of quadratic costs with those of the model with linear costs by considering two key parameters: the degree of horizontal product differentiation and the speed of adjustment of prices. We also show that synchronization takes place if products tend to be complements and stress similarities and differences between the quadratic and linear costs models. Finally, we focus on the phenomenon of multistability thus underlying new evidences in comparison with the model with linear costs.

References

- [1] Agiza, H.N., Elsadany, A.A., 2004: Chaotic dynamics in nonlinear duopoly game with heterogeneous players. *Applied Mathematics and Computation* 149, 843–860.
- [2] Bischi, G.I., Gardini, L., 2000: Global properties of symmetric competition models with riddling and blowout phenomena. *Discrete Dynamics in Nature and Society* 5, 149–160.
- [3] Bischi, G.I., Kopel, M., 2003. Multistability and path dependence in a dynamic brand competition model, *Chaos, Solitons and Fractals*, 18, 561-576.
- [4] Bischi, G.I., Naimzada, A.K., Sbragia, L., 2007: Oligopoly games with local monopolistic approximation. *Journal of Economic Behavior & Organization*, 62, 371–388.
- [5] Bischi, G.I., Stefanini, L., Gardini, L., 1998: Synchronization, intermittency and critical curves in a duopoly game. *Mathematics and Computers in Simulation* 44, 559–585.
- [6] Dixit, A.K., 1986: Comparative statics for oligopoly. *International Economic Review*, 27, 107–122.
- [7] Fanti, L., Gori, L., Sodini, M., 2012: Nonlinear dynamics in a Cournot duopoly with relative profit delegation. *Chaos, Solitons and Fractals*, 45, 1469–1478.
- [8] Fanti, L., Gori, L., Mammana, C., Michetti, E., 2013. The dynamics of a Bertrand duopoly with differentiated products: Synchronization, intermittency and global dynamics. *Chaos, Solitons and Fractals* 52, 73–86.
- [9] Kopel, M., Lambertini, L., 2013: On price competition with market share delegation contracts. *Managerial and Decision Economics*, 34, 40–43.
- [10] Puu, T., 1991: Chaos in duopoly pricing. *Chaos, Solitons and Fractals*, 1, 573–581.
- [11] Zhang, J., Da, Q., Wang, Y., 2007: Analysis of nonlinear duopoly game with heterogeneous players. *Economic Modelling* 24, 138–148.

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Nonlinear dynamics and global analysis of a heterogeneous Cournot duopoly

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August 11, 2014

This work concerns the study of a heterogeneous duopolistic Cournotian game, in which the firms, producing a homogeneous good, adopt respectively a “Local Monopolistic Approximation” (LMA) and a gradient-based approach. We assume that the economy is characterized by an isoelastic demand function and that the total cost functions are linear. The players we consider are endowed with a reduced degree of rationality, supposing they have a reduced information set and reduced computational capabilities. The gradient rule, that belongs to the class of “rules of thumb” mechanisms, firms do not have to solve any optimization problem. The next period production is decided by adjusting their production in the direction indicated by their (right) estimate of the marginal profit. In this work, we assume that the reactivity of the adaption is endogenous, to take into account the size of the firm. Conversely, in the LMA mechanism, firms can get the correct local estimate of the demand function, by means of which they conjectured a global linear demand function. Then, they solve an optimization problem for the next time profits using this approximated demand function. We study the resulting dynamical system, giving the conditions on reactivity and marginal costs under which the solution converges to the Cournot-Nash equilibrium. Moreover, we compare the stability regions of this oligopoly to a similar one, in which the LMA firm is replaced by another one having a higher degree of rationality. We investigate and show two different routes to complicated dynamics, consisting in a cascade of flip bifurcations leading to periodic cycles (and chaos) and Neimark-Sacker bifurcation which originates an attractive invariant closed curve. We show that the nonlinear, noninvertible map describing the model can give rise to several coexisting stable equilibria (*multistability*). We investigate analytically the shape of the basins of attractions, in particular proving the existence of shapes known in the literature as *lobes*. This global structure seems to be a property of a whole class of oligopoly model with isoelastic demand function. Compared with the existing literature on the emerging of lobes, we are able to analytically determined to values of the parameters that lead to their occurrence.

Dynamics of heterogeneous oligopolies with best response mechanisms

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Sommario

In this talk, we present and discuss several results about dynamic Cournotian oligopolies of generic size N , in which the agents can adopt different behavioral rules to choose the next production. The rules we consider are all based on best response mechanisms. We consider *rational players*, who are endowed with sufficient informational and computational capabilities to compute the exact best response function and have perfect foresight of the opponents next time strategies. Then we consider *best response players*, who, with respect to the rational players, are not able to predict the opponents next time strategies and so use static expectations. Finally, we consider *LMA players*, who compute a best response function conjectured on the base of a linear approximation of the true demand function.

We study oligopolies in which the firms can choose between two of the previous mechanisms and we are particularly interested in those situations in which all the firms do not adopt the same decisional rule (heterogeneous oligopolies). Moreover, we consider two different settings. In the first one, we assume that the rule each firm adopts is fixed in advance, while in the second one we allow the firm to change their adjustment mechanism, on the base of the profits of the previous period. We assume that each firm competes against all the others and we adopt a logit switching mechanism.

We present analytical results about possible equilibria, their local stability and the way they can lose stability. Stability is studied with respect to the oligopoly size N and its composition ω , which represents the fraction of the firms that adopt a particular mechanism. We compare the oligopolies in which different set of rules are assumed, investigating the effect of the different degrees of rationality on the stability.

We present computational confirmations of the analytical results, and we investigate through simulations the global behavior of resulting dynamical systems. This is a joint work with Ahmad Naimzada (Dipartimento di Economia, Metodi Quantitativi e Strategie di impresa) and Marina Pireddu (Dipartimento di Matematica per le Applicazioni), Università di Milano-Bicocca.

An evolutionary Cournot model with limited market knowledge

Gian Italo Bischi, Università di Urbino "Carlo Bo" (Italy)

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Davide Radi, Università Politecnica delle Marche, Ancona (Italy)

August 7, 2014

Abstract

In this paper, we analyze the dynamics of an evolutionary game of Cournot competition with firms choosing between two different adaptive behavioral rules in deciding output strategies. The oligopoly structure is standard, with N firms producing with constant returns-to-scale technology homogeneous goods, which are sold in a market characterized by constant price elasticity. In this setup, we assume that a fraction of firms employs a quite rough rule of thumb, the so-called Local Monopolistic Approximation (LMA), whereas the complementary fraction plays Best Reply (BR) with naïve expectations on future quantities in the market. The model is first considered with exogenously fixed fractions of firms in the two complementary groups, then it is generalized by considering an endogenous evolutionary switching process between the two behavioral strategies based on profit-driven replicator dynamics. The influence on stability of the number of firms, information costs and inertia (or anchoring attitude) in production decisions are analyzed, and some general global mathematical properties of the game with evolutionary pressure between behavioral rules are discussed, with particular respect to cases in which Nash equilibria are unstable.

JEL classification: L13, D83, C61, C73

Keywords: Local Monopolistic Approximation; bounded rationality; evolutionary dynamics.

A dynamic marketing model with best reply and inertia

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We consider a nonlinear discrete-time dynamical system proposed by Farris et al. [2] as a market share attraction model where two firms decide marketing efforts over time according to best reply strategies with naïve expectations. The model also includes an adaptive adjustment towards best reply, a form of inertia or anchoring attitude. The analysis given in [2] is mainly focused on the case of n homogeneous firms, to study the relation between market stability and the number of firms by taking the n as a bifurcation parameter in a one-dimensional model that summarizes the common behaviour of the identical firms. In this paper we follow a complementary approach, as we consider just two competing firms and we stress the effects of the heterogeneities. A first step towards this direction has been moved in the recent paper [1], where the effects of small heterogeneities have been investigated in order to discuss how much the one-dimensional model analyzed in [2] is robust. However, the rich spectrum of dynamic behaviors that the two-dimensional discrete-time model exhibits under different parameters' constellations is worth to be further investigated, in particular in regions of parameters' space where heterogeneity between the two firms may play an important role. Analytical results can be proved under assumptions of some (not all) identical parameters. Moreover, even if numerical explorations are necessary in order to investigate the global properties of the model with arbitrary parameters' values, some general statements can still be given. A comparison is proposed with apparently similar duopoly models based on repeated best reply dynamics with naïve expectations and adaptive adjustment.

Key-words: Market share models, Heterogeneity, Nonlinearity, Stability. Bifurcations.

References

- [1] Bischi, G.I., Cerboni Baiardi L. “Fallacies of composition in nonlinear marketing models”, *Communications in Nonlinear Science and Numerical Simulation*, DOI: 10.1016/j.cnsns.2014.04.018 (2014, in press)
- [2] Farris, P., Pfeifer, P.E., Nierop, E., Reibstein, D. “When Five is a Crowd in the Market Share Attraction Model: The Dynamic Stability of Competition” *Marketing - Journal of Research and Management*, 1 (1) (2005) 29-45.

Imitation Dynamics in Cournot Games with Heterogeneous Players

D. Lindeman and M. Ochea

We investigate the performance of the “imitate-the-average-play” heuristic when competing with the naïve (Cournot) and rational-play heuristics in homogenous-good, quantity-setting oligopolies. An evolutionary model is used where the fractions of firms that use a specific heuristic are updated based on accrued (past) profits. Main findings are that: (i) in the case when Cournot firms compete with imitators we found that the threshold on the number of firms that changes the system from stable to unstable is 7, (ii) when rational firms compete with imitators, in the specific scenario of linear inverse demand and constant marginal cost, the system is always stable regardless of the game and behavioural parameters. (iii) in the case when rational firms, Cournot firms and imitators compete the stability depends on the evolutionary pressure and the the stability of the cheapest heuristic(s). When the cheapest behavioural rule is stable, the dynamics converge to a situation where most firms use this behavioural rule and all firms produce the Cournot-Nash equilibrium quantity. When the cheapest heuristic is unstable, complicated endogenous fluctuations may occur.

Keywords: Imitation, Cournot games, Evolutionary switching

BROTHERS IN ALMS? COORDINATION BETWEEN NONPROFITS ON MARKETS FOR DONATIONS

GANI ALDASHEV, MARCO MARINI, AND THIERRY VERDIER

ABSTRACT. Mission-driven nonprofit organizations compete for donations through fundraising activities. Such competition can lead to inefficient outcomes, if nonprofits impose externalities on each others' output. This paper studies the sustainability of fundraising coordination agreements, using a game-theoretic model of coalition formation. Three key characteristics determine the stability of cooperation: (i) the alliance formation rule, (ii) the extent to which fundraising efforts are strategic complements/substitutes, and (iii) whether deviation from the agreements is by an individual or by a group of nonprofits. We also characterize necessary and sufficient conditions for the stability of Pareto-optimal full coordination in fundraising.

Keywords: nonprofits, charitable giving, coordination, endogenous coalition formation, non-distribution constraint.

JEL codes: L31, D74, L44, C72.

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Intensity of choice versus profit taxes: a measure against rational routes to randomness?

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Abstract

In the adaptively rational equilibrium (A.R.E.) framework of Brock and Hommes (Econometrica, 1997), agents can adapt their beliefs over time by switching between a finite set of prediction rules. Agents' choices are rational in the sense that they select prediction rules with a high past performance. As an example, they consider a simple cobweb model in which agents switch between costly rational and free naïve expectations. They show that in such a framework fixed point dynamics may turn into increasingly complex dynamics as the agents' sensitivity of choice increases and call this phenomenon a rational route to randomness. Using a mixture of analytical and numerical tools, we show that policy makers may have the opportunity to reverse such a harmful development and thereby to reestablish market stability by taxing agent's profits. As it turns out, the stabilizing impact of profit taxes is quite robust and holds, for instance, also in a noisy environment.

Keywords: Cobweb models; intensity of choice; complex dynamics; profit taxes; stability analysis; policy implications.

Heterogeneous Fundamentalists and Market Maker Inventories

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DISEI - Università degli Studi di Firenze

Abstract

Heterogeneous Agents Models (HAMs) have been successful in replicating volatility clusters, excess volatility, boom and bust cycles and other intricate price dynamics which closely reproduce the behaviour of actual prices (Day and Huang 1990, Chiarella 1992, Brock and Hommes 1998, Westerhoff and Dieci 2006). In these models it is assumed either the presence of the market maker or the Walrasian auctioneer framework. Since the paradigm shift operated by Beja and Goldman (1980) an increasing relevance has been given to the role of market makers in price formation mechanism, but still few contributions on the impact of their inventory on the market price formation have been proposed (Westerhoff 2003, Zhu et al 2009).

We develop a dynamic HAM model of asset-price and inventory in a scenario where a market maker manages his/her portfolio exposure and adjusts the price according to the aggregate excess demand. As in Madhavan and Smidt (1993) the specialist long-term desired inventory position is endogenously chosen and may be occasionally revised. On this basis, similarly to Zhu et al. (2009) model, we set the specialist's desired inventory as a share of the past inventory. We employ the same framework of Naimzada and Ricchiuti (2009) which consists of a market populated by two groups of fundamentalists that employ the same trading strategy to determine their orders but with different beliefs about the fundamental prices. The dynamics of our model are driven by a bi-dimensional random discrete non-linear map.

We show that the specialist's active trading behaviour has a destabilizing role when he actively manages the inventory. As it turns out, the inventory share and agents' heterogeneous beliefs about the fundamentals strongly affect the market stability. Simulations reveal also that such map is able to replicate important stylized facts of financial markets: excess volatility and volatility clustering.

References

- Beja A., Goldman M.B. (1980) - On the dynamic behavior of prices in disequilibrium, *The Journal of Finance*, 35, pp. 235-247.
- Brock W., Hommes C. (1998) - Heterogeneous beliefs and routes to chaos in a simple asset pricing model - *J. Econ. Dyn. Control*, 22, pp. 1235-74
- Chiarella C. (1992) - The dynamics of speculative behaviour, *Annals of Operations Research*, 37 101–123
- Day R., Huang W. (1990) - Bulls, bears and market sheep *J. Econ. Behav. Organ.* 14, pp. 299-329
- Hendershott, T., Seasholes M.S. (2007a) - Market maker inventories and stock prices, *Am. Ec. Review*, 97 (2), pp. 210-214.
- Lux, T. (1995) - Herd behaviour, bubbles and crashes, *Economic Journal* 105, pp. 881-896.
- Madhavan A., Smidt S.(1993) - An analysis of changes in specialist inventories and quotations. *The J. of Finance*, 48 (5), pp.1595-1628.
- Naimzada A. K., Ricchiuti G. (2009) - Dynamic Effects of Increasing Heterogeneity in Financial Markets, *Chaos, Solitons and Fractals*, 41 (4), pp. 1764-1772
- Westerhoff, F. (2003) - Market-maker, inventory control and foreign exchange dynamics, *Quantitative Finance*, 3, pp. 363-369.
- Westerhoff, F., Dieci R (2006) - The effectiveness of Keynes–Tobin transaction taxes when heterogeneous agents can trade in different markets: a behavioral finance approach, *Journal of Economic Dynamics and Control*, 30, pp. 293–322
- Zhu, M., Chiarella, C., He, X. Z., and Wang, D. (2009) - Does the market maker stabilize the market?. *Physica A: Statistical Mechanics and its Applications*, 388 (15), pp. 3164-3180.

A financial market model with endogenous fundamental values through imitative behavior

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Abstract

In this talk we propose a financial market model with heterogeneous speculators, i.e., optimistic and pessimistic fundamentalists, that respectively overestimate and underestimate the true unobserved fundamental value due to belief biases, similarly to the models in De Grauwe and Rovira Kaltwasser (2012) and Naimzada and Pireddu (2014a). More precisely, in De Grauwe and Rovira Kaltwasser (2012) both the optimistic and pessimistic belief biases and the perceived fundamental value are exogenously determined, while in Naimzada and Pireddu (2014a) the agents perceive an endogenous fundamental value. Differently from those papers, in the present model even the belief biases are not exogenous, but are rather determined by an imitative process. Indeed, in forming their beliefs, speculators consider the relative profits realized by optimists and pessimists and update their fundamental values proportionally to those relative profits. Such kind of updating mechanism bears resemblances to the so-called “Proportional Imitation Rules” in Schlag (1998). Moreover, differently from the majority of the literature on the topic and similarly to Naimzada and Pireddu (2014b), the stock price is determined by a nonlinear Walrasian mechanism that prevents divergence issues. For our model we study, via analytical and numerical tools, the stability of the unique steady state, its bifurcations, as well as the emergence of complex behaviors. We also investigate multistability phenomena, characterized by the presence of coexisting attractors.

References

- P. De Grauwe and P. Rovira Kaltwasser (2012), Animal spirits in the foreign exchange market, *Journal of Economic Dynamics and Control* 36, 1176–1192.
- A. Naimzada and M. Pireddu (2014a), Real and financial interacting markets: a behavioral macro-model with animal spirits, submitted.
- A. Naimzada and M. Pireddu (2014b), Chaos control in a behavioral financial market model, working paper.
- K. Schlag (1998), Why imitate, and if so, how? : A boundedly rational approach to multi-armed bandits, *Journal of Economic Theory* 78, 130–156.

OPTIMALITY OF MOMENTUM AND REVERSAL

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Abstract: We develop a continuous-time asset price model to capture short-run momentum and long-run reversal in time series. By studying a dynamic asset allocation problem with time delay, we derive the optimal investment strategy in closed form and show that the combined time series momentum and reversal strategies are optimal. We then estimate the model to the S&P 500 and demonstrate that, by taking the timing opportunity with respect to trend in return and market volatility, the optimal strategies outperform not only pure momentum and pure mean reversion strategies, but also the market index and time series momentum strategy. Furthermore we show that the optimality also holds for the out-of-sample tests and with short-sale constraints and the outperformance is immune to market states, investor sentiment and market volatility.

Rational Expectations and the Stability of Balanced Monetary Development*

by

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Abstract

The expanding/contracting behavior of monetary economies under perfect foresight or rational expectations is primarily driven by government deficits. Their effects on inflation and monetary growth determine the real value of money which guarantees stationary positive levels of output and employment in the long run only if the stationary real value of money is *positive*. For a class of *nonlinear monetary macroeconomic models* of the AS-AD type derived from a microeconomic structure with OLG consumers, it is shown that such economies generically have no stationary equilibria under perfect foresight/rational expectations when tax revenue is income dependent (no lump sum taxes) and government consumption is autonomous.

Proportional deficit rules induce constant proportional monetary growth. However, in such cases, all positive orbits with balanced monetary expansion and rational expectations are unstable.

When government consumption is autonomous, nonrandom, and not too large, there typically exist two positive balanced equilibria under perfect foresight, a stable and an unstable one, both with constant positive real money balances, plus a stable nonmonetary one under hyperinflation (or a monetary bubble). The results of the paper imply that these properties are true for a large class of deterministic AS-AD models.

Under (Hicks neutral) stochastic production shocks, such economies may have positive stable balanced stationary equilibria under rational expectations dynamics if the government policy has a small strictly positive *nonrandom autonomous* demand component in all cases of uncertainty. There exists a stochastic monetary trap inducing a threshold dividing the possible long run behavior into two mutually exclusive regimes of excessive money creation, outgrowing prices and price expectations, with diverging allocations *or* positive balanced monetary expansion which may be converging or diverging depending on parameters and the perturbations.

The results are derived using techniques from the theory of random dynamical systems which allows a complete theoretical and numerical analysis of the *dynamics of random expanding time series and their stability* of the *nonlinear stochastic model*.

*Preliminary and incomplete; to be presented at MDEF-2014, Urbino, Italy

On the Risk Evaluation Method Based on the Market Model

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Abstract: This paper presents a risk evaluation model for interest-rate sensitive products within the no-arbitrage framework. A yield-curve dynamics is modeled, based on the results of the principal component analysis (PCA), to generate future scenarios of interest rates under the observed probability measure. The market model is adopted for the pricing of interest-rate derivatives under the risk-neutral measure by identifying market prices of risk that are consistent with the yield-curve model. Given the future scenarios of yield curve and the market prices of risk, the prices of interest-rate sensitive products are calculated at any future time. Risk measures such as Value-at-Risk (VaR) of portfolios with interest-rate sensitive products can be evaluated through simple Monte Carlo simulation. It is shown, however, that some market models often used in practice are not consistent with the no-arbitrage paradigm.

Keywords: Monte Carlo simulation, Market model, Principal component analysis, Change of measure, VaR

Business Confidence and Macroeconomic Dynamics in a Nonlinear Two-Country Framework with Aggregate Opinion Dynamics

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Abstract

The main objective of the present paper is to investigate explicitly the role of the state of confidence for the macroeconomic dynamics of two interacting economies using the opinion dynamics approach by Weidlich and Haag (1983) and Lux (1995). Particularly, the overall state of confidence in the world (two-country) economy plays not only for the dynamics of the nominal exchange rate but also for the dynamics of the real economy through the determination of aggregate investment. This novel feature allows us to consider far richer international macroeconomic interactions than most standard models. Further, it features wage-price dynamics that interact with output and employment fluctuations – leading to a Goodwin (1967)-type of distributive cycle –, as well as debt dynamics due to a credit-financed investment behavior. The resulting framework is both advanced as well as flexible enough to generate various types of persistent fluctuations, and also complex dynamics.

Keywords: Macroeconomic (In-)Stability, Business Cycles, Opinion Dynamics, FX Markets

JEL Codes: E12, E24, E31, E52

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The simplicity of optimal trading in order book markets

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August 13, 2014

Abstract

A trader's execution strategy has a large effect on his profits. Identifying an optimal strategy, however, is often frustrated by the complexity of markets' microstructures. We analyse an order book in a continuous double auction market under two different models of traders' behaviour. In the first case actions only depend on a linear combination of the best bid and ask, see [Pellizzari, 2011]. In the second model traders adopt the Markov perfect equilibrium strategies of the trading game, see [Goettler et al., 2009]. Both models are analytically intractable and so optimal strategies are identified by the use of numerical techniques. Using the Markov model we show that, beyond the best quotes, additional information has little effect on either the behaviour of traders or the dynamics of the market. The remarkable similarity of the results obtained by the linear model indicates that the optimal strategy may be reasonably approximated by a linear function. We conclude that whilst the order book market and strategy space of traders are potentially very large and complex, optimal strategies may be relatively simple and based on a minimal information set.

Keywords: Continuous Double Auction, Order Book, Information, Optimal Trading
JEL codes: D44, G10, C63

References

- [Goettler et al., 2009] Goettler, R. L., Parlour, C. A., and Rajan, U. (2009). Informed traders and limit order markets. *Journal of Financial Economics*, 93(1):67–87.
- [Pellizzari, 2011] Pellizzari, P. (2011). Optimal trading in a limit order book using linear strategies. Working Papers 16, Department of Economics, University of Venice "Ca' Foscari".

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Generalized Market Exchange with Master Equations¹

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Abstract

The present paper develops an analytic approach to make inference on one of the main and recent results found with the computational analysis of the generalized market exchange framework [1, 2, 4]: interaction and adaptive learning induce heterogeneous private-prices convergence towards quasi public-prices [3, 5].

A three goods exchange economy with private-price formation is assumed as a complex system at the roots of the aggregate dynamics. The model develops at the subsystems level as ensembles of initiators and responders in trading relationships. The three goods market exchange allows a single agent to be involved in two separate trading relationships contemporaneously: on the demand side as an initiator (e.g. a consumer) and on the supply side as a responder (e.g. a producer) as in the frame of an input-output analysis. With reference to the agents interactive behavior phenomenology, systems behavior and interaction is probabilistically described to make inference about agents decision making and opinion formation in trading. This allows for a stochastic description of two events. The stochastic decision making models the probability for a responder to accept or refuse the interaction. Stochastic interaction models the probability for a trader to switch her own set of private-prices to that of her counterpart or maintain her own.

The dynamic evolution of goods' traders as interactive species is described by means of master equations. Being a single trader either a responder and an initiator in two different relationships, it is possible specifying two separate master equations: one for swingers and the other for maintainers of own private-prices set. Solutions of the master equations provide the expected dynamics of the number of swingers and maintainers for each of the three possible exchanges. Convergence criteria are developed to meet the conditions to approach convergence results to a statistical equilibrium over a dynamic-set of market prices.

Keywords: Market Exchange, Price Formation; Stochastic Decision Making; Complex systems; Heterogeneity; Interaction; Master Equations; Statistical Equilibrium.

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- [1] GINTIS, H. (2007): The Dynamics of General Equilibrium, *Economic Journal*, **117**: pp. 1289–1309.
 - [2] GINTIS, H. (2012): The Dynamics of Pure Market Exchange, in: GINTIS, H. (ed.), *Approaches to the Evolving World Economy: Complex Dynamics, Norms and Organizations*, Palgrave, London.
 - [3] GINTIS, H. (2013): Markov Models of Social Dynamics: Theory and Applications, *ACM Transactions on Intelligent Systems and Technology*, **4**(3).
 - [4] GINTIS, H. and MANDEL, A. (2012): The Stability of Walrasian General Equilibrium, Documents de travail du Centre d'Économie de la Sorbonne 12065, Université Panthéon-Sorbonne (Paris 1), Centre d'Économie de la Sorbonne, URL <http://ideas.repec.org/p/mse/cesdoc/12065.html>.
 - [5] MANDEL, A., LANDINI, S., GALLEGATI, M. and GINTIS, H. (2013): Price dynamics, financial fragility and aggregate volatility, Documents de travail du Centre d'Économie de la Sorbonne 13076, Université Panthéon-Sorbonne (Paris 1), Centre d'Économie de la Sorbonne, URL <http://ideas.repec.org/p/mse/cesdoc/13076.html>.

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Modelling the "Animal Spirits" of Bank's Lending Behaviour

Carl Chiarella, Tianhao Zhi and Corrado Di Guilmi

Abstract.

The idea of "animal spirits" has been widely treated in the literature with particular reference to investment in the productive sector. This paper takes a different view and analyses from a theoretical perspective the role of banks' collective behaviour in the creation of credit that, ultimately, determines the credit cycle. In particular, we propose a dynamic model to analyse how the transmission of waves of optimism and pessimism in the supply side of the credit market interacts with the business cycle. We adopt the Weidlich-Haag-Lux approach to model the opinion contagion of bankers. We test different assumptions on banks' behaviour and find that opinion contagion and herding amongst banks play an important role in propagating the credit cycle and destabilizing the real economy. The boom phases trigger banks' optimism that collectively lead the banks to lend excessively, thus reinforcing the credit bubble. Eventually the bubbles collapse due to an over-accumulation of debt, leading to a restrictive phase in the credit cycle.

The Ecology of Defensive Medicine and Malpractice Litigation

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We analyse the relations between defensive medicine and medical malpractice litigation by an evolutionary game between physicians and patients. When medical treatment fails, patients may sue the physician and seek compensation. Conversely, physicians may prevent negligence charges by practising defensive medicine. We study the population dynamics and find the Nash equilibria and their Pareto-ranking. Furthermore, we show that, when the mixed-strategy equilibrium exists, then the shares of defensive physicians and litigious patients exhibit time-evolution paths similar to prey-predator relations in the Lotka-Volterra model, in which physicians can be seen as preys and litigious patients as their predators. Then, defensive physicians can be seen as adapted preys who improved their Darwinian fitness through mutation. The increase in adapted preys (*i.e.* defensive physicians) decreases predators' fitness leading to a decrease in predators (*i.e.* litigious patients). In this context, we show that perfect cooperation with neither defensive physicians nor litigious patients can be the social first best. Our results may explain heterogeneous findings in empirical literature on these phenomena.

Essential literature

Hofbauer, Josef, and Karl Sigmund. 1988. *The Theory of Evolution and Dynamical Systems: Mathematical Aspects of Selection*. Cambridge University Press Cambridge.

Kessler, Daniel, and Mark McClellan. 1996. "Do doctors practice defensive medicine?" *The Quarterly Journal of Economics*, 111(2): 353–390.

Tancredi, Laurence R., and Jeremiah A. Barondess. 1978. "The problem of defensive medicine." *Science*, 200(4344): 879–882.

Weibull, Jorgen W. 1997. *Evolutionary Game Theory*. MIT press.

A Schelling-like Segregation Model with Heterogeneous Distributions of Tolerance and Entry Restrictions

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Abstract.

In this paper we investigate the dynamics of a Schelling-like segregation model proposed in Bischi and Merlone (2011) [1], see also Schelling (1969) [3] and Radi et al. (2014) [4]. In particular, we consider a residential district populated by two groups of individuals that differ for some features, such as political beliefs, religion and skin color, and have heterogeneous distributions of tolerance for members of the other group. We distinguish the group of locals composed of a bigger number of individuals and the group of newcomers composed of a smaller number of individuals. The model describes the entry and exit dynamics in a residential district of the members of the two groups. The dynamics is based on the assumption that members of a group enter the residential district every time the number of members of the other group currently established in the residential area is tolerated and leave otherwise in accordance to an adaptive mechanism. It is worth to point out that the assumption of non-homogeneous distributions of tolerance between the two groups is justified by empirical evidences, see e.g. Clark (1991) [2].

The investigation is divided in two parts. In the first one we explore the dynamics of the model and we identify the combinations of parameters' values that prevent residential segregation. The analysis reveals that the fixed points that represent residential segregation are always feasible and in some cases coexist with either stable or unstable fixed points of non segregation. The investigation also reveals rich and complicated dynamic scenarios with many smooth and non-smooth (or border collision) bifurcations that regulate the transaction from stable fixed points to periodic and chaotic attractors. Moreover, many attractors may coexist at the same time and their basins of attraction can be characterized by complex structures and fractal borders. This indicates high sensitivity of the dynamics to initial conditions.

The second part is devoted to study the effects of possible entry limitations for newcomers. This restrictive measure is commonly adopted by policymakers with the aim of avoiding residential segregation. The analysis reveals that this policy is particularly useful in avoiding issues of overshooting that occur for high level of tolerances. Overshooting dynamics are extreme reactions driven by "emotional human decisions" and represented by massive waves of exits or entries of members of the two population in the residential district as reaction to tolerated or non-tolerated levels of members of the other group. This phenomenon is of great concern for policymakers and should be limited as it is often responsible for residential segregation.

Keywords: Schelling's models; Border collision bifurcations; Piecewise smooth maps; Residential Segregation; .

References

- [1] G. I. Bischi and U. Merlone. *Nonlinear economic dynamics*, Chapter An Adaptive dynamic model of segregation, pages 191–205. Nova Science Publisher, New York, 2011.
- [2] WAV Clark. Residential preferences and neighborhood racial segregation: a test of the Schelling segregation model. *Demography*, 28(1):1–19, 1991.
- [3] T. C. Schelling. Models of segregation. *The American Economic Review*, 59(2):488–493, 1969.
- [4] D. Radi, L. Gardini and V. Avrutin, The Role of Constraints in a Segregation Model: The Symmetric Case. *Chaos, Solitons & Fractals*, 66:103–119, 2014.

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Modeling of economic dynamics under stochastic noise

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We provide an explicit outline of a possible transition from the classical equation of Goodwin [1]

$$\epsilon\theta\ddot{Y}(t) + [\epsilon + (1 - \alpha)\theta]\dot{Y}(t) - \varphi(\dot{Y}(t)) + (1 - \alpha)Y(t) = O^*(t) \quad (1)$$

to the van der Pol type equation

$$\ddot{Y}(t) + a\frac{Y^2(t)-1}{Y^2(t)+1}\dot{Y}(t) - bY(t) + cY^3(t) = 0. \quad (2)$$

The parameters $a > 0$, $b > 0$, $c > 0$ of (2) are identified in terms of the parameters of (1).

We consider the Goodwin dynamical model under random external disturbances

$$\ddot{Y}(t) + a\frac{Y^2(t) - 1}{Y^2(t) + 1}\dot{Y}(t) - bY(t) + cY^3(t) = \varepsilon\dot{\omega},$$

where ω is a standard Wiener process and ε is a additive noise intensity.

A full parametric analysis of equilibria and cycles of the deterministic model is developed. The phenomenon of the ‘birth’ of a stable cycle in a parametrical zone where equilibria are stable is investigated. The analysis of the separatrix dividing basins of attraction is carried out numerically.

We study the probabilistic properties of stochastic attractors using the method of confidence areas based on the stochastic-sensitivity-functions technique [2] and on numerical methods. A phenomenon of the generation of stochastic business cycles in the zones of stable equilibria and noise-induced transitions between stable attractors is discussed.

[1] The Nonlinear Accelerator and the Persistence of Business Cycles. // *Econometrica*, Vol 19, No 1 (Jan., 1951), pp 1-17.

[2] Stochastic sensitivity analysis of noise-induced excitement in a prey-predator plankton system. // *Frontiers in Life Science*, 2011, Vol 5, pp 141-148.

Endogenous business cycles caused by nonconvex costs and interactions

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August 14, 2014

Abstract This paper investigates the relationship between microeconomic shocks and aggregate fluctuations. The conventional argument against the relevance of the microeconomic shocks for the aggregate fluctuations invokes the law of large numbers (“diversification argument”). That is, whatever the microeconomic structure is, such shocks would average out at the aggregate level. In order to explain aggregate fluctuations, aggregate exogenous shocks that affect all firms in the economy are indispensable. However, this paper shows that it is not the case and illustrates how aggregate fluctuations can arise from microeconomic stochastic behavior. At the micro level, empirical data suggest that the standard production-smoothing theory, in which a firm use its inventories as a buffer stock for cost minimization, does not hold, and the firm behavior is characterized by lumpiness (e.g. Blinder and Maccini(1991)). To account for that, a nonconvex cost function is assumed in our model. In addition to that, we assume interactions among firms. We especially focus on a feedback mechanism, by which we mean a situation where the behavior of a firm is affected by the entire economic condition while the economic condition is determined by the aggregation of the firms. This is closely related to the “macro-macro loop” emphasized by F. Hahn(2003), where a macro variable acts as an externality. Under these assumptions, we show that an endogenous cycle of production emerges at the aggregate level, given that the degree of the interaction effect exceeds a critical point. This is an explanation for Kitchin cycles.

Keywords: Nonconvex Cost Function; McKean-Vlasov equation; Bifurcation.

JEL Classification Numbers: E32, E23, D21.

References

Blinder, A. S., Maccini, L. J., 1991. Taking stock: A critical assessment of recent research on inventories. *The Journal of Economic Perspectives* 5 (1), pp. 73-96.

Hahn, F., 2003. Macroeconomics and general equilibrium. in *General Equilibrium: Problems and Prospects* edited by Petri and Hahn. Routledge.

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Global dynamics of a Solow-Swan model with environmental assets.

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Abstract In this paper we examine the role played by environmental externalities in

shaping the dynamics of a small open economy with two sectors – an industrial sector (I-sector) and a sector dependent on a free-access natural resource (F-sector) –, free inter-sectoral labour mobility and heterogeneous agents. Economic agents belong to two different communities, one consisting of ‘workers’ (F-agents), the other of ‘industrial entrepreneurs’ (I-agents). The former are endowed only with their own working capacity and use it either in the F-sector or working as employees of industrial entrepreneurs in the I-sector. In turn, the latter, who own physical capital and hire labourers, produce industrial goods. Given the size of the economy, the prices of the goods produced in the F- and I-sectors are exogenously determined regardless of what happens in the economy (without loss of generality, we assume that both prices are equal to unity).

The aggregated production functions of the F- and I-sectors are given, respectively, by:

$$Y_A = NE$$

$$Y_I = (\bar{N} - N)^\alpha K^{1-\alpha} \quad 1 > \alpha > 0, \bar{N} > 0$$

where the variable $N \in [0, \bar{N}]$ (respectively, $\bar{N} - N$) represents the labor force employed in the F-sector (respectively, I-sector), E is the stock of a free-access natural resource and K is the aggregated stock of physical capital accumulated by the I-agents. The dynamics of the variables K , E and N are assumed to be represented by the three-dimensional dynamic system:

$$\dot{K} = s[(\bar{N} - N)^\alpha K^{1-\alpha} - w(\bar{N} - N)] - dK$$

$$\dot{N} = \eta[E - w]$$

$$\dot{E} = E(\bar{E} - E) - \delta NE - \varepsilon Y_I$$

Hence we analyze the above system defined in a box $\mathcal{B} = (0, \bar{K}] \times [0, \bar{N}] \times [0, \bar{E}]$. If the carrying capacity of the environmental resources, \bar{E} , lies in an interval determined by the total number of the workers, there exists exactly one equilibrium in \mathcal{B} , which, for certain values of the parameters, turns out to be attractive (i.e. a sink). However, even in this case, there are trajectories leading, in a finite time, to the boundary of the box, i.e. to situations where the stock of environmental resources or the number of workers employed in the traditional sector are zero. Next we analyze the dynamics when the unique equilibrium is a saddle endowed with a 2-dimensional stable manifold. In such a case we prove that the box can be separated in two regions, in one of which the trajectories reach in a finite time either $E = 0$ or $N = 0$, while in the other they tend, as $t \rightarrow +\infty$, to a specific point of the side $K = 0$. Finally we postulate, through a slight modification of the system, that a dynamics takes place also when the number of workers employed in the traditional sector is zero. It is quite interesting that, by this further analysis, we can draw a robust conjecture on the nature of the Hopf bifurcations of the original system.

Tõnu Puu, Global Dynamics of the Hotelling Duopoly

The Hotelling model of duopoly on a fixed line segment, was introduced in 1929. It was the first really convincing case of Bertrand oligopoly with price competition, where the heterogeneity was obtained through space and transportation costs, providing local market areas for the competitors.

Unfortunately, Hotelling only analyzed a case with totally inelastic demand, which resulted in the paradox that both competitors would crowd in the centre so that the problems Bertrand pointed at in his criticism of Cournot were back. Further, inelasticity was self-contradictory. The market areas were defined so that the customers would buy from the supplier offering lowest delivered price (mill price accrued by transportation cost); yet every customer would buy one unit of commodity, no matter how high or low the price was. So Hotelling came up with a paradox - the duopolists would crowd in the centre, instead of somewhere around the quartiles as would be socially optimal.

Actually, Hotelling himself in the original discussion claimed that the crowding paradox would disappear if demand was elastic - there would remain a tendency to gravitate towards the centre, though the crowding paradox would disappear. It is a bit surprising that Hotelling himself did not follow this track.

Lerner and Singer in 1937 provided the first proof that the crowding paradox evaporated even if one only assumed the consumers to have a reservation price - if delivered price was higher they would buy nothing, otherwise just one unit as in the original case. The contribution is still most enjoyable through its ingenious use of graphic argument.

Very soon later Smithies 1941 in two articles, put up the problem with a linear downsloping demand function, which seems to correspond to what Hotelling had in mind. However, he claimed that the integrals were too complicated to evaluate. So it was left to the present author as late as 2002 to carry out the analysis. There was also an attempt at a dynamical setting (Puu, Gardini 2002) which showed the dynamic to be a simple contraction.

However, all this analysis was done under the assumption that the competitors shared the market as a duopoly in a common boundary point, and that in the other ends each market extended to the boundary points of the fixed interval.

In a communication to the present author Helge Sanner pointed out that the last may not be true - the competitors might also end the markets where local demand dropped to zero. Unfortunately the present author has not been able to locate any publication by Dr. Sanner on this.

As a matter of fact, the issue of setting up a global dynamic model of Hotelling's duopoly is even more complicated than that. It should be possible with three different outcomes; (i) disjoint monopolies that do not compete, (ii) a duopoly with competition in a common boundary point, and (iii) cutting out the competitor so establishing a single monopoly. It turns out that there are different subcases depending on the choice of endpoints for the market intervals - they can be the endpoints of the fixed interval, common boundary points of duopoly, or points where local demand drops to zero. In all, considering that the competitors may change places, we end up with a map with 15 different branches (even if we skip the cases where the firms cut themselves out).

Our first task is to formulate this map, and then study its dynamic. We should at least have three different fixed points, disjoint monopolies, genuine duopoly, and cutting out monopoly. Whether there are also other attractors remains to be seen. Likewise, even if we only have fixed points attraction basins and bifurcation diagrams may present interesting features.

Strategic Delegation, Bargaining and Location Choice

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Abstract. In our analysis we try to link three aspects of decisions that we regard as important for modern firms whose organizational design is characterized by the separation of ownership and control. All in all, we combine the three issues of strategic delegation, bargaining and location choice and embed them in an environment of duopolistic price competition. Our results can be summarized as follows: If managers are responsible both for the location choice and for setting prices, the principle of maximum differentiation still holds in the restricted location case, which means that managers will choose the respective ends of the city. Furthermore, in the unrestricted location choice, managers will not locate inside the city but close to the two edges. However, contrary to earlier studies, it is not a priori clear whether restricting or not restricting the firms' location choice is socially desirable. Only if the bargaining power of managers is sufficiently high, consumers benefit from restricting the location. Otherwise, not restricting the location is socially desirable. ...delegation vs. no delegation... In another setting, where the long-term location decision is in the hands of the owners and managers are responsible for setting prices, some interestingly converse results emerge. First, given that the bargaining power of managers is high, owners do not want to locate as far away as possible from each other which contradicts the principle of maximum differentiation that was validated in the previous setting. With regard to the consumers preferences, restricted the location at least weakly dominates the policy of unrestricted location choice. Last but not least, if owners are free to choose whether they would want to hire a manager or not, the latter is the dominant strategy in the restricted case. In the unrestricted case, the decision depends on the fixed cost associated with hiring a manager and on the distribution of the bargaining power. Intuitively, both firms will choose a manager if the fixed cost and the manager's bargaining power is sufficiently low and choose not to if either one exceeds some threshold.

Regional productivity growth in Europe: a Schumpeterian perspective

Roberto Basile*

June 21, 2014

Abstract

Using data for the European regions at NUTS-2 level, we test the predictions of a micro-founded Schumpeterian growth model with technological interdependence recently developed by Ertur and Koch (2011, EK11). Spatial interdependence is identified by means of a *semiparametric geoaddivitive spatial autoregressive model* which permits us to disentangle the effect of nonlinearities, spatial heterogeneity and spatial dependence. A control function approach is applied to estimate this particular SAR-type model using the spatial lag of the *quality of regional governance* and the spatial lags of *various social capital measures* as instrumental variables for the endogenous term Wy . The results corroborates the predictions of EK11's model: R&D investments and R&D spillovers are important drivers of regional growth in Europe. However, spillover effects are much lower after controlling for spatial unobserved heterogeneity. Moreover, important nonlinearities in the effect of physical capital investments emerge, putting into question the strong homogeneity assumption and suggesting a threshold effect in growth behavior.

Keywords: Regional growth, spatial dependence, nonlinearities, semiparametric models.

Jel codes: R11, R12, C14

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Trade agreements in a linear FE model: preliminary considerations on fixed point and dynamic properties

Ingrid Kubin, P. Commendatore, I. Sushko

Abstract

Usually, the effects of trade agreements are analysed in a three country Heckscher-Ohlin model: two countries that are forming a Union are reducing their mutual tariffs, while maintaining the tariff wrt the third country. Trade increases between the member countries, because countries increase their specialisation and import commodities that they formerly produced for themselves (trade is created) and because member countries import commodities from other member countries that they formerly imported from the country outside the Union (trade is diverted).

A Heckscher-Ohlin framework assumes countries that differ wrt relative factor endowments; markets that are fully competitive; and productive factors that are immobile between countries. However, many trade agreements - the treaty of Rome is a prominent example - are actually formed between countries that are similar wrt factor endowment and productive factors are free to move between the member countries; in addition, production is often characterised by decreasing average costs, products are differentiated and markets are monopolistically competitive.

Therefore, in the following paper we analyse the effects of trade agreements in a New Economic Geography framework that allows for all that elements. We use the Footloose entrepreneur model in which two types of productive factors are accounted for - unqualified and qualified "entrepreneurial" labour - and in which only qualified labour is mobile between the countries (which roughly corresponds to the mobility pattern in the EU). Note that this differentiation between two types of labour bears a resemblance to a Heckscher-Ohlin perspective. In addition, we use the so-called linear version of this model (that involves a linear demand function), because this setup permits more analytical results than the standard version (with an iso-elastic demand function) that is notoriously analytically intractable.

We study how production and trade patterns change with an intensified integration within the Union and how these effects depend upon the skill composition of the labour force and the sizes of the market in- and outside the Union. In addition, we pay particular attention to how the effects we find depend upon the preference for product variety, one of the driving forces in a NEG model. Finally, we shed light on the dynamic implications of a deeper integration.

Dynamic agglomeration patterns in a 2-country 4-regions NEG model

P. Commendatore, I. Kubin, P. Mossay, and I. Sushko

Abstract

We present a New Economic Geography model in which we extended the modelling of the geographical structure: We have two countries each of which is divided into two regions, one border region and one interior region. Natural geography puts the four regions on a line; the interior regions only trade with the border region in the same country, whereas the border regions trade also with the border region in the other country. We assume that the two countries are symmetric: Internal trade costs are the same in the two countries. External trade costs may be higher or lower than the internal trade cost. Each region is endowed with the same amount of unskilled labour that are not mobile between the regions; and both countries have the same number of entrepreneurs that are mobile between the regions. Entrepreneurs react to differences in regional utility levels; and we introduce explicitly a parameter that indicates how easy entrepreneurs relocate. We are thus studying a geographically generalised Footloose Entrepreneur (FE) model. In particular, we are investigating the dynamic implications of an intensified internal integration, which facilitates within-country trade and capital relocation and which is not equally matched by an exterior integration trend.

The model is defined by a 2D piecewise smooth map depending on 7 parameters. We analyse the nature of its attractors, their local and global stability properties. In particular, we investigate dynamics of 1D maps to which the 2D map is reduced. These maps are defined on the main diagonal of the phase plane and on the border lines of the definition region of the model, which all are invariant under the 2D map. Description of dynamics of the 1D maps help to investigate overall 2D dynamics that is characterised by coexistence of several regular and chaotic attractors.

We detect a bifurcation scenario that corresponds to the one found in standard NEG models: dispersion for low values of the trade freeness and agglomeration for high values. However, in our case dispersion involves a higher share of industrial activity for the border regions in comparison to the interior region of the same country; and agglomeration can take several forms: Industrial activity is agglomerated in both countries in the resp. border regions (interior regions); or in one country industry is agglomerated in the border region, while in the other country it is agglomerated in the interior region. Most interesting, for intermediate values of the trade freeness also partial agglomeration is possible, ie in one country industrial activity is agglomerated in the border region whereas in the other country industrial activity is spread to both regions. In particular, those endogenously generated asymmetric patterns are new for NEG models and their occurrence nicely corresponds to the modifications of the agglomerating and dispersing forces imposed by our specific geographical structure.

Information Heterogeneity and Clustering of Defaults

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The existence of power-laws in finance and economics has widely been discussed since the seminal studies of Mandelbrot and Fama about the non-Gaussianity and the extremely anomalous “variability” of financial prices. A considerable amount of research in Financial Economics over the last twenty years has strengthened and expanded the links between (Financial) Economics and Statistical Mechanics. These links have taken the form of both theoretical and computational tools, such as heterogeneous agent-based models. The study of the latter class of models has allowed the study of emergent phenomena, which are impossible to understand within the rational representative agent framework. The heterogeneity of the interacting agents is a key feature in these models and in many cases is the source of the observed complexity (Lux, 1998; Levy, 2008; Brock, Hommes, and Wagener, 2009).

Our work discusses the impact of heterogeneous information in a leveraged market. To accomplish this, we study a market with two assets (one risky and one riskless), hedge funds, noise traders and a commercial bank. Here the heterogeneity stems from the different precision of the private signal received from the market by each HF about the fundamental value of the risky asset. We focus on the survival statistics (failure function) of the HFs. We show that the failure function of the HFs is qualitatively different when observed on the micro and the macro level. Specifically, the failure function of all HFs decays exponentially on the micro-level, indicating thus a constant default rate. However, on the aggregate level, we prove that the failure function tends to a power-law, with an exponent such that the variance becomes infinite (heavy-tail). We show that the emergent power-law (scale-free) statistics leads to the observed clustering of defaults.

References

Brock, W., Hommes, C., Wagener, F., November 2009. More hedging instruments may destabilize markets. *Journal of Economic Dynamics and Control* 33 (11), 1912–1928.

URL <http://ideas.repec.org/a/eee/dyncon/v33y2009i11p1912-1928.html>

Levy, M., January 2008. Stock market crashes as social phase transitions. *Journal of Economic Dynamics and Control* 32 (1), 137–155.

URL <http://ideas.repec.org/a/eee/dyncon/v32y2008i1p137-155.html>

Lux, T., January 1998. The socio-economic dynamics of speculative markets: interacting agents, chaos, and the fat tails of return distributions. *Journal of Economic Behavior & Organization* 33 (2), 143–165.

URL <http://ideas.repec.org/a/eee/jeborg/v33y1998i2p143-165.html>

A parsimonious model of expectations to explain experimental forecasts

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Urbino, MDEF 2014

In the recent past, a copious stream of literature has grown around the question of how exactly individuals form market expectations. This question has been addressed using data about individual learning behaviour obtained both from surveys and from laboratory experiment. In general there is a wide agreement about the fact that bounded rationality forces the agents far from rational behaviour whereas simple heuristic rules show greater predictive power. Which heuristic fits better the observed behaviour is, in contrast, a much more debated question. Different experimental settings seem to induce different forecasting behaviours; hence no simple heuristic seems to be able to reproduce adequately the bulk of available data. A fruitful way to address and overcome this problem is by assuming that agents select the best context-dependent rule within a set of available heuristics. In this case the evolutionary selection among available rules is supposed to be performed mainly by means of discrete choice mechanisms *à la* Brock and Hommes [2]: it comes out that this approach is able to give an appropriate description of the experimental outcomes at the cost of an increased complexity. In particular, agents seem to commit to different expectations rules when asked to forecast prices in environment with positive *vs.* negative feedback. In such a context, Heemeijer *et al.* [3] shows that agents tend to adopt trend following strategies in the positive feedback case while some average or adaptive expectations rule is preferred with negative feedback. Assuming that agents choose between the two heuristics on the basis of their past performance, Anufriev *et al.* [1] gives a possible explanation of the apparent discrepancy of behaviour in the two alternative scenarios.

In this work we argue the possibility of explaining experimental data using a simple mixture of adaptive expectations on observed levels and trends. Such mechanism, while simple and analytically tractable, can be defended on behavioral grounds and is parsimonious. The study of its properties in terms of local stability of the equilibrium yields interesting observations and suggests that the mechanism might suitably reproduce experimental stylized facts. Indeed, using the experimental dataset of Heemeijer *et al.* [3] and Anufriev *et al.* [1], we estimated the model at various layers (subject level, group level, treatment level). Our empirical results show a good capacity of the model to replicate the individual predictions of the subjects, the observed prices in each group and the aggregate behaviour. In particular, at the aggregate level, the studied heuristic gives the best results among the considered alternatives.

References

- [1] Anufriev, M., Hommes, C.H., Philipse, R.H.S. (2013) Evolutionary selection of expectations in positive and negative feedback markets. *Journal of Evolutionary Economics*, Vol. 23(3), pp. 663-688.
- [2] Brock, W.A. and Hommes, C.H. (1997) A rational route to randomness. *Econometrica*, Vol. 65, pp. 1059-1095.
- [3] Heemeijer, P., Hommes, C.H., Sonnemans, J, Tuinstra, J. (2009) Price stability and volatility in markets with positive and negative expectations feedback: An experimental investigation. *Journal of Economic Dynamics and Control*, Vol. 33, pp. 1052-1072.

Inflation Targeting, Recursive Inattentiveness and Heterogeneous Expectations

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Abstract

Modern monetary policy has emphasized that maintaining a stable monetary environment depends crucially on the ability of the policy regime to control inflation expectations. Policy decisions should be transparent in order to reduce informational asymmetries between central bank and private sector. Policy makers develop communication strategies that aim explicitly to align expectations with their own policy objectives. The provision of an explicit numerical inflation target is an example of such communication strategies.

In this paper we consider a scenario in which the central bank announces the target in order to anchor private sector expectations but a biased perception of the target may arise due to information imperfections and transparency issues. In particular, due to idiosyncrasies in the process of understanding and processing information, heterogeneous beliefs about the true inflation target may arise. Although the private sector may have a biased view of the true target, we introduce discipline in the evolution of beliefs in order to minimize departures from models characterized by full information and rational expectations. In fact, we assume that private sector's beliefs about inflation are revised over time as new information becomes available and the direction of change is determined by the distance between beliefs and actual realizations. Within this framework, in which co-evolution of beliefs and realizations of aggregate variables emerges through the ongoing evaluation of such beliefs, we ask the following question: can a simple instrument rule implemented by the central

A Dynamic Exchange Rate Model with Heterogenous Agents and Endogenous Beliefs

Giorgio Ricchiuti **Fabio Tramontana**

August 11, 2014

In the last decades, models of financial markets have shown how complex dynamics of price fluctuations are related to the interactions between heterogenous agents. Heterogeneity is either related to the strategies applied or may emerge in the beliefs about the fundamental value. In general, there is a lot of uncertainty on what the “true fundamental” is because the estimations about the future have a subjective dimension: (i) agents may have a different ‘structural model of the world’, (ii) even when they use the same model, they may hardly reach the true fundamental value and/or show the same expectations. Moreover, a shortcoming of this literature is that the fundamental value is fixed and exogenous or sometimes, as stated by De Grauwe and Rovira (JEDC, 2012), ‘the fundamental is a time varying variable but it still is exogenously determined. That is, it is not connected to the real part of the economy in any way’.

Gori and Ricchiuti (mimeo, 2014) analyze an heterogenous agent model in which the fundamental exchange rate is endogenously determined by the real markets. The exchange rate market and the real markets are linked through the balance of payments (as in the Absorbtion Model). They have, analytically, found that there exists at least a steady state in which the exchange rate is at its fundamental value and incomes of both countries are equal the autonomous components times the over-simplified multiplier (as in the Income-Expenditure model). That steady state can be unique and always unstable when all agents act as contrarians, while when agents act as fundamentalists is unique but its stability depends on the reactivity of actors of the market. Finally, we demonstrate that the (in)stability of the economic system depends on both the reactivity of the markets and that of different agents involved.

Starting from this model we introduces the financial account of the balance of payment, in order to take into account the effects of capital movement on the exchange rate. This means that movements of the money markets must be taken into account. Moreover, we assume that there are two groups of heterogenous fundamentalists. For the first the fundamental is the exchange rate for which the current account is equal zero, while for the second the fundamental is the value of the exchange rate which satisfies the uncovered interest parity. Therefore the economic system regards the foreign market, the money markets and the goods markets, leading to a five-dimensional map. We firstly study the map when the countries are equal and then when the countries are different.

Bull and Bear market with different entry thresholds

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Abstract

The financial market models with heterogeneous interacting agents are in focus of many researchers since the seminal paper by Day and Huang [1] in which it was proposed a simple model with three types of agents, namely, a *market maker* who adjusts prices with respect to excess demand, *chartists* who believe in the persistence of bull and bear markets, and *fundamentalists* who bet on mean reversion. In this model market participants' transactions may cause apparently unpredictable price dynamics with randomly alternating periods of generally rising or generally falling prices (so-called bull and bear market dynamics). For a survey of numerous follow-up papers see, for instance, [2].

The one-dimensional map considered in [1] is nonlinear since fundamentalists become increasingly aggressive as the price runs away from its fundamental value. In [3] the original model is reformulated in such a way that it becomes defined by a one-dimensional *continuous piecewise linear map*. It is assumed that close to the fundamental value only chartists are active in the market, hence, the slope of the inner branch of the map is larger than one. If the price deviates too far from the fundamental value, additional fundamentalists enter the market. Since their demand is zero when they enter the market, all three branches of the map are connected, and the slope of the two outer branches is lower than the slope of the inner branch. Instead, in [4] it is assumed that a number of chartists and fundamentalists are always active in the market, that additional chartists and additional fundamentalists may enter the market when the distance between the price and its fundamental value exceeds a critical level, and that new traders' demand may be non-zero at the market entry level. As a result, the model is defined by a one-dimensional *discontinuous piecewise linear map*. In particular, the three branches are typically disconnected, and there are no restrictions to the values their slopes may assume. In [4] quite a comprehensive analysis of the dynamics of this map is presented for a special case where entry thresholds are *symmetric*.

In the present work we analyze dynamics of the map considered in [4] for a more generic case of *asymmetric* thresholds. We study how the bifurcation structure of the parameter space of the map changes breaking the symmetry. Particular attention is paid to *bistability* which is characteristic for maps with two discontinuity points.

References

- [1] Day, R., Huang, W., 1990. Bulls, bears and market sheep. *Journal of Economic Behavior and Organization* 14, 299–329.
- [2] Hens, T., Schenk-Hoppé, K.R. (Eds.), *Handbook of Financial Markets: Dynamics and Evolution*, North-Holland, Amsterdam, 2009.
- [3] Huang, W., Day, R., 1993. Chaotically switching bear and bull markets: the derivation of stock price distributions from behavioral rules. In: Day, R., Chen, P. (Eds.), *Nonlinear Dynamics and Evolutionary Economics*, Oxford University Press, Oxford, 169–182.
- [4] Tramontana, F., Westerhoff, F., Gardini, L., 2013. The bull and bear market model of Huang and Day: Some extensions and new results. *Journal of Economic Dynamics & Control* 37, 2351–2370.

Product Innovation Incentives by an Incumbent Firm: A Dynamic Analysis

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Abstract.

We employ a dynamic framework to study how product innovation activities of a firm are influenced by its production capacity investments for the established product and vice versa. The firm initially has capacity to sell an established product, and it also has the option to undertake an R&D project, which upon completion allows the firm to introduce a new vertically and horizontally differentiated product to the market, thereby extending its product range. The breakthrough probability of detecting the new product depends on both the value of the firm's R&D stock and its current R&D investment. It is shown that the initial production capacity for the established product influences the intensity of R&D activities of the firm. In particular, there are constellations such that for large initial production capacity for the established product the firm never invests in R&D and the new product is never introduced. For small initial capacity the firm keeps investing in R&D implying that eventually the new product is always introduced. Finally, for an intermediate range of initial capacity levels the firm initially invests in product R&D, but then reduces these investments to zero. In this scenario the new product is introduced with a positive probability, which is however substantially smaller than 1. Finally, the optimal innovation strategy of the firm is compared to a welfare maximizing investment scheme. From a technical perspective our analysis gives the example of a new type of Skiba threshold phenomenon in the framework of a multi-mode optimization model and introduces an innovative numerical procedure for calculating Skiba curves.

The effects of R&D investments in International Environmental Agreements with Asymmetric Countries

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Abstract

This paper examines the stability of international environmental agreements (IEAs) in a pollution abatement model. We focus our attention on two meaningful aspects. Firstly, we consider asymmetry among countries dividing them in two types: developed countries characterized by a strong measure of environmental awareness and developing ones characterized by less attention to environmental preservation. Secondly, we introduce a positive externality in the cooperation, for which countries coordinate their R&D activities and share the R&D investments to avoid duplication of green activities. Otherwise, outsiders have to provide on their own R&D costs. These two aspects encourage the formation of stable coalitions till to determine conditions for which also the grand coalition is stable.

Keywords: IEA; Coalition stability; Asymmetries; R&D.

JEL Classification: F50, C72, F42, O32.

References

- Barrett, S. (2003). *Environment and Statecraft: The Strategy of Environmental Treaty-Making*. Oxford University Press, Oxford.
- Biancardi, M. (2010). *International Environmental Agreement: A Dynamical Model of Emissions Reduction*. Nonlinear Dynamics in Economics, Finance and Social Sciences, Eds. Springer, 73-93.

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Nonlinear Multiplier-Accelerator Model with Investment and Consumption Delays

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This paper shows how cyclic dynamics of national income can emerge in the multiplier-accelerator model with continuous time scale when delays in investment and consumption are presented.

An S-shaped functional form of investment and a linear consumption function are adopted to illustrate the phenomenon and to compute the stability-switching curves on which a stability gain or loss occurs. Assuming that the equilibrium national income is locally stable if there are no delays, the system can produce limit cycles and the stability switch repeatedly occurs when one of the delays increases and the other is kept to be positive constant.

Alternative stabilization policies in a Keynes-Kaldor-Tobin model of business cycles

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August 14, 2014

In this paper, we formulate a model of business cycles, based upon the ideas of Keynes (1936), Kaldor (1940) and Tobin (1975), (the Keynes-Kaldor-Tobin model) and discuss two alternative monetary policies, the quantity policy and the interest rate policy, to investigate which of them has more powerful in stabilizing the economy. Consequently, we find that the quantity policy can cause a periodic orbit (persistent fluctuations) by way of Hopf bifurcations while the interest rate policy does not have such a property and in this sense, we may conclude that the interest rate policy is superior to the quantity policy in stabilizing the economy.

Keywords: Keynesian Economics, Bifurcations, Business Cycles, Nonlinear Analysis

JEL Classifications: E12, E21, E22, E31, E32, E41, E44

References

- [1] Kaldor, N., 1940. A model of the trade cycle, *Economic Journal*, 50, 78-92.
- [2] Keynes, J. M., 1936. *The General Theory of Employment, Interest and Money*, London, Macmillan.
- [3] Tobin, J., 1975. Keynesian models of recession and depression, *American Economic Review*, 65 (2), 195-202.

Globalization and Synchronization of Innovation Cycles

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Abstract

We propose and analyze a two-country intra-industry model of endogenous innovation fluctuations. In autarky, innovation dynamics of the two countries are decoupled. As trade cost falls and intra-industry trade rises, they become more synchronized. This is because trade integration leads to the alignment of incentives among innovators across countries, as they respond to the increasingly global (hence common) market environment. Furthermore, synchronization occurs faster with more unequal country sizes and it is the smaller country that adjusts its rhythm to synchronize to the rhythm of the bigger country. These results suggest that adding endogenous sources of fluctuations might go a long way toward explaining the trade-comovement puzzle, i.e., countries that trade more with each other have more synchronized business cycles, one of the empirical regularities that the standard RBC model has difficulty explaining.

Heterogeneous population in binary choices with externalities

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We consider a dynamical population game with two available choices and externalities. The case with a homogeneous population of agents presents different dynamical characteristics depending on the agents' behavior. In fact, with *impulsive* agents, i.e., agents who switch choice as soon as a better one appears, the dynamics is a one-dimensional piecewise linear map with one discontinuity [1]. In this case, we observe a period adding structure, periodic cycles create and destroy, equilibria coexist, and border-collision bifurcations occur. On the contrary, with *proportional* agents [2], who switch to the better choice proportionally to its convenience, the dynamics is a one-dimensional piecewise smooth continuous map. In this case there exists a unique fixed point that is globally attracting even if locally unstable.

In this paper we study the dynamics of a heterogeneous population consisting of both impulsive and proportional agents. The resulting non-trivial dynamics is a three-dimensional piecewise smooth map with one discontinuity, which inherits some of the characteristics of the two homogeneous populations, while others are lost. As the proportional percentage in the population increases, the period adding structure fades away and the symmetry vanishes, while cycles persist. We derive sufficient conditions for the existence of cycles of period two and provide numerical evidences of coexistence of cycles with different periods.

References

- [1] A. Dal Forno, and U. Merlone, Border-collision bifurcations in a model of Braess paradox, *Mathematics and Computers in Simulation*, 87:1–18, 2013.
- [2] A. Dal Forno, U. Merlone, and V. Avrutin. Dynamics in Braess paradox with non-impulsive commuters, *Discrete Dynamics in Nature and Society*, in press.

Shareholding Network in the Euro Area Banking Market

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Abstract

Analyzing the topological properties of the network of shareholding relationships among the Euro Area banks we evaluate the relevance of a bank in the financial system respect to ownership and control of other banks. We find that the degree distribution of the European banking network displays power laws in both the binary and the weighted case. We also find that the exponents are linked by a scaling relation revealing a direct connection between an increase of control diversification and an increase of market power. Results also reveal Single Supervisory Mechanism, recently introduced by the European Central Bank and based on banks' total assets is a good proxy for the systemic risk associated to a particular financial institution. Moreover we study how control and wealth are structured and concentrated within the banking system. Interestingly, our analysis reveals that control is highly concentrated at banking level, namely, lying in the hands of very few important shareholders that have weak relationships between them. This means that each main holder controls approximately a separate subset of banks.

References

- [1] Battiston, Stefano, James B. Glattfelder. "Backbone of complex networks of corporations: The flow of control." *Physical Review E* 80.3 (2009): 036104.
- [2] Battiston, S., Glattfelder, J. B., Garlaschelli, D., Lillo, F., & Caldarelli, G. (2010). "The structure of financial networks". In *Network Science* (pp. 131-163). Springer London.

Endogenous economic cycles: an agent-based model of consumers' confidence

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Preliminary version (work in progress)

Abstract

The main goal of this paper is to present consumers' confidence as an important source of cyclical economic activity. We use a simplified agent based model with a single economic sector and agents that get income from labour, save and consume based on the macrostate of the economy as well as on the their local neighborhood. The spread of economic confidence in the society, distinguished into three possible states (optimism/stable/pessimism) follows the ideas introduced by Westerhoff(2010). The level of confidence in society determines the agents' expectations about their future incomes together with the marginal rate of substitution between present and future consumption. Firms form their supply according to the unique production source labor. The level of aggregate supply is always adjusted to attempt to satisfy the aggregate demand, even at the price of growing inventories.

We find that the model is capable of generating persistent endogenous business cycles. Differently to Westerhoff(2010) the peaks of waves of optimism/pesimism in the society correspond to the peaks of growth rate rather than the level of economic activity. The variable marginal rate of substitution between present and future consumption causes the slowdown of the growth rate of economic activity in the phases of economic expansion. The peaks of waves of the level of economic activity are accompanied with the maximum of stable agents in the society. During economic cycles the aggregate supply usually exceeds the aggregate demand with generating some inventories. The aggregate demand dominates aggregate supply only in bottoms of economic cycles.

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Literature

WESTERHOFF, F. An agent-based macroeconomic model with interacting firms, socio-economic opinion formation and optimistic/pessimistic sales expectations. *New Journal of Physics*. 2010, 12(7).

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CONTRACTION, AUSTERITY AND DEBT DYNAMICS

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Abstract

There has always been much debate regarding the capability of fiscal policy to restore equilibrium after that an economy has been hit by some kind of shocks. The nature of controversy is complex in the sense that it entails not only quantitative aspects but also methodological and analytical ones (see Sims, 2012). Regarding to method, one must evaluate the measures to be taken, the type of equilibrium to be considered and the nature of the shock to be studied. From the analytical standpoint, a key assumption is the existence of slack resources along with the presence of a deflationary state, where the rate of interest tends towards zero. The paper addresses three related questions: first it focuses on the possibility that fiscal policy may have an equilibrating role. In particular, we will try to assess whether it is possible to reconcile what Harrod (1939) called respectively the “warranted rate of growth”, i.e. the rate of growth that ensures a dynamic equilibrium to the product markets, with the “natural rate of growth”, ensuring equilibrium on the labour market. In the second place, we will study whether fiscal policy can have a dynamic role in fighting situations of disequilibrium. Finally, we will examine if the ensuing evolution of debt can remain constrained, even though no explicit Ricardian equivalence is taken into consideration. In order to explore these issues we present a macro model where the role of spare resources and a deflationary state can be explicitly considered. The nonlinearity of the system does not allow to obtain closed-form solutions. This implies that the main results of the analysis are obtained by means of simulations. Such results are in keeping with the Keynesian tradition. In this context, expansive policies do not degenerate in an unsustainable debt problem even though they do not postulate a Ricardian equivalence. The stability of the debt is ensured by the stability of the economy.

REFERENCES

- Benhabib, Jess, George W. Evans, and Seppo Honkapohja, 2012, Liquidity traps and expectation dynamics: Fiscal stimulus or fiscal austerity?, (National Bureau of Economic Research, Inc, NBER Working Papers: 18114).
- Bullard, James, 2012, Death of a theory, *Federal Reserve Bank of St. Louis Review* 94, 83-101.
- Bullard, James, and Aarti Singh, 2012, Learning and the great moderation, *International Economic Review* 53, 375-397.
- Evans, George W., Seppo Honkapohja, and Kaushik Mitra, 2012, Does ricardian equivalence hold when expectations are not rational?, *Journal of Money, Credit, and Banking* 44, 1259-1283.
- Fazzari, Steven M., Piero Ferri, and Edward Greenberg, 2010, Investment and the taylor rule in a dynamic keynesian model, *Journal of Economic Dynamics and Control* 34, 2010-2022.
- Ferri, Piero, 2011. *Macroeconomics of growth cycles and financial instability* (New Directions in Modern Economics. Cheltenham, U.K. and Northampton, Mass., Elgar).
- Harrod, Roy F., 1939, An essay in dynamic theory, *Economic Journal* 49, 20.
- Hasanov, Fuad, and Reda Cherif, 2012, Public debt dynamics: The effects of austerity, inflation, and growth shocks, (International Monetary Fund, IMF Working Papers: 12/230).
- Ireland, Peter N., 2011, A new keynesian perspective on the great recession, *Journal of Money, Credit, and Banking* 43, 31-54.
- Reinhart, Carmen M., and Vincent R. Reinhart, 2010, After the fall, (National Bureau of Economic Research, Inc, NBER Working Papers: 16334).
- Reinhart, Carmen M., and Kenneth S. Rogoff, 2011, From financial crash to debt crisis, *American Economic Review* 101, 1676-1706.
- Thornton, Daniel L., 2012, The dual mandate: Has the fed changed its objective?, *Federal Reserve Bank of St. Louis Review* 94, 117-133.

Self-Similar Measures in Multi-Sector Endogenous Growth Models*

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Abstract

We first consider a stochastic version in discrete time of the original Lucas-Uzawa (1988) two-sector endogenous growth model with physical and human capital as state variables. Utility is logarithmic and production of the final good is Cobb-Douglas, while that of education is linear. This allows us to find a closed-form solution for the Bellman equation and explicitly compute the optimal dynamics of physical and human capital. Consistently with endogenous growth, such state variables diverge in the long-run; thus we ‘detrend’ them by taking their ratio so to obtain a one-dimensional dynamic converging to some compact set on the real line. We show that this dynamic is conjugate to a linear Iterated Function System (IFS) which is equivalent to that discussed in Mitra et al. (2003), so that their results can be directly applied to characterize the attractor and invariant (self-similar) measure in our model. Next, we extend this model by adding endogenous technical progress in the form of knowledge (based on La Torre and Marsiglio, 2010). Now human capital can be endogenously employed in the production of the final consumption good, education and knowledge; physical capital is instead used only to produce the final good, while knowledge is an input of both the final output and knowledge production functions. Again utility is logarithmic, production of both the final good and knowledge are Cobb-Douglas, and that of education is linear. This construction allows for the explicit computation of the optimal dynamics of the state variables, which are transformed into a two-dimensional dynamic of physical over human capital and knowledge over human capital ratios so to let them converge to some compact set on the plane. Through an appropriate log-transformation, it is shown that these ‘detrended’ dynamics can be converted into an IFS converging to an invariant self-similar measure supported on an attractor which is a generalized Sierpinski gasket.

Keywords: Multi-Sector Models, Endogenous Growth, Self-Similar Measure, Sierpinski Gasket.

JEL Classification: C61, O41

References

- [1] La Torre D, Marsiglio S (2010). Endogenous technological progress in a multi-sector growth model, *Economic Modelling* 27: 1017–1028.
- [2] La Torre D, Marsiglio S, Privileggi F (2011). Fractals and self-similarity in economics: the case of a two-sector growth model. *Image Analysis & Stereology* 30: 143–151.
- [3] Lucas RE (1988). On the mechanics of economic development. *J Monetary Econ* 22: 3–42.
- [4] Mitra T, Montrucchio L, Privileggi F (2003). The nature of the steady state in models of optimal growth under uncertainty. *Econ Theor* 23: 39–71.
- [5] Uzawa H (1965). Optimum technical change in an aggregate model of economic growth, *Int Econ Rev* 6: 18–31.

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A Non-Absorbing Migration Rate with Renewal Approach to the Dynamic Estimation of Credit Risk Economic Capital

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Abstract

Standard transition matrices among classes of credit risk are grounded on few fundamental assumptions. Among them, two are specifically relevant. The first standard methodological assumption considers migrations are ruled by a transition matrix induced by a homogeneous Markov process generator, even though the recent approaches available in literature are revising its feasibility. In fact, the Markovian assumption implies different borrowers in the same rating class share the same probability to migrate to the same rating class in the future, without care of their rating history. As a second simplifying hypothesis, default state is assumed absorbing even if, very often, empirical evidence rejects it.

A further relevant but neglected aspect to take care is that the universe of borrowers is never the same: some borrowers exit the credit system while new ones enter it through time; clearly this extends also to the sample data of a given lender. As a consequence, standard transition matrices are suitable to describe transitions of borrowers already and persistently in the credit system, while they should take care of the system renewal and, therefore, how the system dimension evolves.

In this paper, the proposed model tackles the dynamic evolution of the borrowers' universe. New entries as well as exits from the system are regarded as pure births and deaths processes: their dynamics explains the renewal of the system through time. The migrations of borrowers already inside the credit system over a set of rating classes are looked as *recombinations*. That is, by following a demographic analogy, the former describe the natural balance of population while the latter one concerns the migratory balance.

By associating a diversified provision rate to each rating class, it is possible evaluating the amount of own funds the lender must prompt as economic capital at risk to obey regulatory norms. This is in order to make their credit activity more sound and sustainable in terms of macro-prudential and systemic financial stability.

Moreover, the proposed model allows for linking the borrowers dynamics to the business cycle, or exogenous policy forecasts provided by international economic institutions, to predict the dynamics of the number of the borrowers as well as the dynamics of the economic capital at risk for lenders. In this framework, the change of lender's own funds at risk can also be analysed where, in normal conditions, such a change is financed by means of interest margins. When this is not enough, i.e. when the lenders are stressed, the lender resorts to its own capital.

Specifically, the model enables to estimate the dynamics of the lender's portfolio configuration in three situations. The first one concerns the unconditioned expected migrations at one year by using the long run estimate of transition matrices: this provides estimates of the unconditional expected losses, the average cost of risk to be financed by revenues of lenders. The second situation concerns the conditional expected migrations at one year under an extreme case hypothesis: it gives the estimate of the expected losses while conditioning on a given policy or exogenous scenario. The third case provides the unexpected losses estimate the lender uses to set the value of economic capital at risk to be provisioned by conditioning the migration matrix on a macroeconomic scenario.

Keywords: Macro prudential and regulatory criteria; Rating classes; Credit risk migration models; Lenders' economic capital at risk; Markov processes generators.

An Evolutionary Approach to Nonlinear Heterogeneous Oligopolies

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Abstract

In this paper we propose and compare dynamic oligopolistic Cournotian games, which differentiate themselves for the degree of rationality of the firms, the shape of the demand function and for the presence of evolutionary switching mechanisms. In all the situations we consider firms that adopt a best response mechanism, versus firms that also use a best response strategy but can be provided with different informational and computational abilities. In the first case, we suppose that the firms are completely rational, being perfect foresight firms that know exactly the output produced by other firms at the next time. In the second case we assume that a second group of firms is boundedly rational, in the sense that they adopt best response mechanism with static expectations; in this case the firms are able to get correctly the best response function, but are unable to correctly anticipate the output of others firms. From the point of view of the demand function, we consider the linear case and a non-linear case given by the isoelastic demand. The models are analyzed both in the case in which the share of different kind of firms is exogenously given and in the case in which the shares are regulated by the evolutionary pressure. We study the convergence to the Cournot-Nash equilibrium, the effect of rationality on the stability regions, instabilities and related complex dynamics.

Investigating Statistical Arbitrage in Commodity Markets

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Abstract

Statistical arbitrage is a long run trading opportunity that generates riskless profit and is designed to exploit persistent anomalies. Statistical arbitrage definition can be given without reference to any equilibrium model and it circumvent the joint-hypothesis dilemma of traditional market efficiency tests. In this paper we investigate the existence of statistical arbitrage opportunities in commodity markets due to mispricing of financial security prices. We also devise a general trading strategy on these statistical arbitrages. We use cointegration techniques to find a long run relationship among commodities and build a portfolio whose value is represented by the deviation, called mispricing, from this long run equilibrium. We verify that the mispricing dynamics mean-revert and contain some predictable components. The developed trading strategy is based on trading rules that rely on the predictability properties of the mispricings. The performance of the strategy is measured by several profit indicators and evaluated according to an out-of-sample approach. Finally we develop a model for forecasting the maximum expected loss of the strategy over an established holding period according to a Monte Carlo simulation approach.

Keywords: commodity markets, statistical arbitrage, trading strategy, cointegration, Value at Risk

References

- O. Bondarenko (2003). Statistical arbitrage and securities prices. *The Review of Financial Studies* 16, 3 (Autumn): 875–919
- Burgess, A. N. (1999a). A computational methodology for modelling the dynamics of statistical arbitrage models of the FTSE 100. Ph.D. Thesis, London Business School.
- Do, B., Faff, R., & Hamza, K. (2006). A new approach to modeling and estimation for pairs trading. Monash University, Working Paper.
- Elliot, R., van der Hoek, J., & Malcolm, W. (2005). Pairs trading. *Quantitative Finance*, 5(3):271-276.
- Gregory, A. & Hansen, B. (1996). Residual-based tests for cointegration in models with regime shift. *Journal of Economics*, 70:99-126.
- Hogan, S., Jarrow, R., Teo, M., & Warachka, M. (2004). Testing market efficiency using statistical arbitrage with applications to momentum and value strategies. *Journal of Financial economics*, 73(3), 525-565.
- Jarrow, R. A. and Teo, M. and Tse, Y. and Warachka, M., Statistical Arbitrage and Market Efficiency: Enhanced Theory, Robust Tests and Further Applications (February 2005). Available at SSRN: <http://ssrn.com/abstract=659941> or <http://dx.doi.org/10.2139/ssrn.659941>
- Johansen, S. (1991). Cointegration and hypothesis testing of cointegration vectors in gaussian vector autoregressive models. *Econometrica*, 59(6):1551-1580. Pole, A. (2007). *Statistical Arbitrage*. WILEY FINANCE.

Investor Networks in Financial Markets

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MDEF 2014

Abstract

We study the dynamics of a stochastic capital market model which is motivated by the effort of Day and Huang (1990). In the original deterministic model, a population of sophisticated and unsophisticated market participants exist together with a market maker. Maintaining most of the basic assumptions, we model the unsophisticated investors as a group of heterogeneous, naive – but socially integrated – investors who are able to implement technical trading rules (algorithms). In each period the algorithm traders have the choice between investing their wealth in a risky asset or putting it in a safe interest bearing account. Based on past prices, an algorithm produces a binary signal that suggests to the investor whether to buy or to sell the risky asset.

Our algorithm traders are able to reflect their own situation, i.e the position in (wealth, stress)-space, experienced as a consequence of applying a given algorithm. By communicating with other algorithm traders, an investor might identify market participants who have currently reached a higher wealth position at a lower stress level. The stress level experienced depends on the number of successive past losses. Consecutive losses provide the stimulus for investor i to communicate with investors in his network to assess their performance relative to his own. If in the course of such communications investor i identifies network members who have reached positions in (wealth, stress)-space which according to her own preferences are better than her own position then investor i will switch to the algorithm used by the most successful network member unless she uses it already. The investor maintains her *status quo* if none of the network members exhibit superior performance.

In the most general case, the algorithm traders are heterogenous with respect to initial wealth and their preferences over the (wealth, stress)-space. Alternative network structures can be specified. We study the dynamics of the resulting stochastic system in discrete time using analytical techniques as well as the numerical/simulation approach. The resulting model and the associated simulation tool allow us to investigate a variety economic questions over and above the price dynamics. The current version of the paper focuses on the question of how basic network properties affect the stability of the system. Our findings suggest that the existence of socially–integrated naive algorithm traders do not necessarily imply an increase in the complexity of the dynamics.

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Statistical dynamics in economic models described by piecewise maps

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Many economic and financial problems lead to the study of the asymptotic behavior of discrete dynamical systems. It is now well known, that the asymptotic properties of the dynamical systems describing quite standard models often exhibit chaotic phenomena which appear to be unpredictable. However, if we study chaotic dynamical systems from the statistical point of view we may find some kind of regularity in the probabilistic sense, and their time-paths, when viewed in the limit, may obey certain properties of stochastic processes. Thus, the evolution process of density functions governed by the underlying deterministic dynamical system needs to be investigated and, as a consequence, the study of the statistical properties of sequences of iterated measurable transformations must be considered. These statistical properties often depend on the existence of probability measures which are absolutely continuous with respect to the Lebesgue measure and invariant under the transformation with respect to time. Hence, through the invariant density, the long-term behavior of a chaotic dynamical process can be investigated using the results available in the field of stochastic processes. Following this approach, in this work we investigate the existence of absolutely continuous invariant densities by means of analytical and computational tools ([2] and [4]) in some economic models described by piecewise smooth dynamical systems which have recently become quite a popular topic of research (see [1], [3] and [5] to quote only a few examples).

References

- [1] Huang, W., *The long-run benefits of chaos to oligopolistic firms*, J Econ Dyn Control, 32, 1332–1355, 2008.
- [2] Lasota, A., Mackey M. C., *Chaos, Fractals, and Noise: Stochastic Aspects of Dynamics*, Cambridge University Press, 1994.
- [3] Matsumoto, A., *Density function of piecewise linear transformation*, J Econ Behav Organ , 56, 631-653, 2005.
- [4] Stachurski, J., *Economic Dynamics: Theory and Computation*, MIT Press, 2009.
- [5] Tramontana, F., Westerhoff, F., Gardini, L., *On the complicated price dynamics of a simple one-dimensional discontinuous financial market model with heterogeneous interacting traders*, J Econ Behav Organ, 74 (3), 187-205, 2010.

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