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Competition and the Evolution of Market Structure in the E-conomy

A Simulation Analysis

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Competition and the Evolution of Market Structure in the E-conomy
A Simulation Analysis

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Abstract:

In this paper an evolutionary simulation model, based on replicator dynamics, is developed. The purpose is to identify changes in the patterns of evolution of the market structure caused by Information and Communication Technologies (ICT) in the E-conomy in comparison to the Old Economy (without ICT). The relationship between the two economy concepts can be summed up from an industrial organization point of view with the help of stylized facts about the evolution of the market structure as phases in an industrial life cycle. The simulation results show that economic development progresses from the E-conomy to the (next) Old Economy.

JEL-Classification: L11; O12; D43

Keywords: Industrial life cycle; ICT; Evolution of market structure; Replicator dynamics; Simulation analysis

1. Introduction[1]

In the last years the catchphrase "New Economy" played a dominant role in the headlines of the press. In the academic literature, in general, the "New Economy" has been analyzed in productivity studies and in studies about the changes in long-term growth rates of economies. There is a common sense in the literature that there are fundamental changes in the competition environment of the firms caused by Information and Communication Technologies (ICT). So far, however, even in the academic literature the impact of ICT on the market structure evolution has not been analytically treated. The main purpose of the present investigation is to identify changes in the patterns of evolution of the market structure that usually are alleged in the literature as a result of the introduction of ICT into the "New Economy" in comparison to the Old Economy (OE) (without ICT). Instead of the somewhat sketchy and exaggerated term "New Economy", and the implied polarized pair "old" versus "new" the concept of an "E-conomy" (EE) is suggested in the present study to explain economic changes.[2] The concept of an EE substantiates the blurred term "New Economy" and emphasizes ICT as the fundament of a "new", or rather a "changed" economy.

The present investigation has been inspired by three strands of literature. The first one is given by empirical studies on the impacts of ICT in several branches of the type of the so-called history-friendly studies, for example by Malerba et al. (2001), Malerba and Orsenigo (1990). These studies analyze the unique, history dependent circumstances in the development of a special branch, but they do not offer a general market modeling framework in which the impact of ICT could be formally analyzed. The second strand of literature that is relevant here is about diffusion of innovations and technologies reflecting the common sense that innovations are a key factor of the "New Economy". Usually, however, the diffusion models base on logistic progression functions. Therefore, this model type cannot approximately reflect the precise impact of competition conditions, e.g. changes in these conditions, in the competition environment of the firms to the diffusion progress. A third strand of literature is about the method of the replicator dynamics which has the potential for modeling a general framework for market condition. Replicator dynamics has been applied by Cantner and Hanusch (1997, 1998) for modeling the competition of two technologies. To my knowledge, Mazzucato (2000) gives the only extensive application of the replicator dynamics to analyze an industry evolution. Mazzucato models an industry with ten firms and integrates dynamic economies of scale, but she excludes market entries. Hence, a genuine market structure evolution cannot be analyzed.

My investigation uses the replicator feedback equation from classical replicator dynamics and expands and generalizes the research perspective of the three mentioned strands of literature. A general framework for the modeling of market environment will be offered, which bases on replicator dynamics by the integration of the essential parameters of the competi-

1 Correspondence and comments to B.C.Friedrich@gmx.de. A preliminary version of this paper was presented at the "VI. Buchenbach-Workshop for Evolutionary Economics", May 2003. I am indebted to Prof. Ulrich Blum for helpful comments.

2 The E-conomy-concept has been fostered by Baily et al. (2001) and Cohen et al. (2000). Furthermore, analogous to the terms E-commerce/E-Business as synonyms for the use of ICT-infrastructure for transaction/entrepreneurial activities, the E- of E-conomy refers to ICT as the central reference point in an economy that is changed due to the pervasive use of ICT.

tion environment of the firms. Thus, it is possible to conceptualize the "Old" and the "New Economy" as two extreme regimes of competition environment in a simple and transparent model. Beyond the so far applications of replicator dynamics in this investigation market entries and exits will be modeled endogenously. In addition, the fitness of the firms does not depend on the relative cost situation as it is usually modeled in classical replicator dynamics. Because in the NE innovations are a key element for competitive ability, fitness is modeled here in relation to product characteristics, which will be the higher the more innovative a firm is relatively to the other firms on the market. The final conclusion from the direct comparison of the EE and OE regime will be that the economic development progresses from the E-conomy, the "new" economy, to the (next) Old Economy.

The paper is organized as follows. In Section 2, an evolutionary simulation model which is based on replicator dynamics is developed.[3] In a number of parameter specifications the implications of the EE-regime for changing the pattern of market structure evolution are analyzed. On the basis of the findings of the simulation runs, Section 3 discusses 8 hypotheses from the literature on postulated changes between the OE and the EE. Section 4 sums up the relationship between the EE and the OE, from an industrial organization point of view with the help of the stylized facts about the evolution of the market structure. Concluding, Section 5 gives an outlook for further research.

2. The simulation model

The model to be developed here will formalize the supply side by applying replicator dynamics in discrete time. In an extension to classical replicator dynamic applications[4], an (exogenously) increasing market growth rate, γ, (i.e. increasing number of consumers) is assumed, and market entries and exits are modeled endogenously. Generally, in replicator dynamics applications the fitness of the firms refers to their (static/dynamic) cost situations. However, this paper models the absolute fitness, $f_{i,t}$, of a firm i=1,…,n, as the sum of the scalar valued characteristic values, $C^j_{i,t}$, for m characteristics of the product supplied by firm i. Each firm i active in the market offers only one product. For the sake of simplification, higher characteristic values, $C^j_{i,t}$, imply a higher fitness, $f_{i,t}$, and consequently cause a competition advantage. In the model, changes in demand, ($D_{i,t}$ - $D_{i,t-1}$), depend on the replicator speed, α, the absolute fitness, $f_{i,t}$ of i (1), the relative fitness, $\overline{f_t}$, (2) and the exogenous market growth rate, γ. Because the market share, $\vartheta_{i,t}$ (3), depends on the overall demand, D_t^{Ges}, γ can be inserted directly into the calculation of the actual demand, $D_{i,t}$, ((4) =replicator principle). Each consumer buys one unit of one of the products offered i=1,...,n on the market per period. Because the price p=1 is standardized, the turnover, $\Pi_{i,t}$, of i directly correlates to the number of consumers, $D_{i,t}$, of i (5). In the model each firm i invests a proportion η=0.20 of the capital stock, $K_{i,t}$, (10) into research and development (R&D), $F_{i,t}$ (6).[5] Dependent on the R&D-budget, $F_{i,t}$, and R&D-efficiency, $k_{i,t}$, (alternatively, $\kappa^a_{i,t}$, $\kappa^b_{i,t}$), firm i realizes its product improvements. It's a stylized fact of the industrial organization field that firms promote

3 The replicator dynamic approach was originally purposed for the examination of polymorphic systems by R.A. Fisher and can be viewed as a formalisation of the Darwinian principle of selection, more precisely, of Spencer's dictum of the "survival of the fittest". (Fisher, R.A., 1930, The Genetic Theory of Natural Selection, Oxford)
4 See as an overview about replicator dynamics Cantner (2003).
5 The specified level of the budget for R&D is not in the focus of the analysis in this paper. It will be standardized.

product innovations of a radical nature at the beginning of their life cycle. Later, firms tend to promote process innovations of an incremental nature.[6] Hence, the effects of innovations diminish within a technological paradigm over the course of time. Therefore, to model the decreasing effectiveness of innovations in the simulation study a decreasing progression of the parameter R&D-efficiency, $\kappa_{i,t}$, depending on the level of the characteristic number, $C^j_{i,t}$, will be assumed. Because the sum of $C^j_{i,t}$ characterizes the fitness, $f_{i,t}$ (1), the R&D-efficiency, $k_{i,t}$, can be calculated depending on fitness, $f_{i,t}$, (7, 8).[7] Over the course of time same R&D-budgets, $F_{i,t}$, have a decreasing effect on the characteristic number, $C^j_{i,t}$, depending on the absolute fitness, $f_{i,t}$. In order to analyze the implications of product improvement potentials in the simulation study, two R&D-efficiency scenarios with different decreasing speeds of effective potential, $k^a_{i,t}$, $k^b_{i,t}$, will be compared. For each characteristic, $C^j_{i,t}$, in the m-dimensional characteristic space there is a proportion, $\zeta=1/m$, of the R&D-budget, $F_{i,t}$, (9) that is for R&D of this particular characteristic $j=1,\ldots,m$.[8] Over the course of time same R&D-budgets, $F_{i,t}$, contribute less to improvements in the characteristics, $C^j_{i,t}$, due to increasing fitness $f_{i,t}$. If the capital stock, $K_{i,t}$, (10) decreases below a critical value $K^{krit}=10$ for a maximum number of periods $\iota=5$ firm i exits the market in $t=t^A$.

$$f_{i,t} = \sum_{j=1}^{m} C^j_{i,t} \,. \qquad (1)$$

$$\overline{f}_t = \frac{\sum_{i=1}^{n} D_{i,t} f_{i,t}}{D^{Ges}_t} \,. \qquad (2)$$

$$\vartheta_{i,t} = \frac{D_{i,t}}{D^{Ges}_t} \,. \qquad (3)$$

$$D_{i,t} = \left(\alpha \left(\frac{f_{i,t-1} - \overline{f}_{t-1}}{\overline{f}_{t-1}} \right) + 1 \right) D_{i,t-1} (1+\gamma) \,. \qquad (4)$$

$$\Pi_{i,t} = p D_{i,t} \,. \qquad (5)$$

$$F_{i,t} = \eta K_{i,t} \,. \qquad (6)$$

$$\kappa^a_{i,t} = \frac{1}{f_{i,t}} \,. \qquad (7)$$

$$\kappa^b_{i,t} = \frac{1}{f^2_{i,t}} \,. \qquad (8)$$

$$C^j_{i,t} = \left((\eta K_{i,t-1}) \zeta \kappa_{i,t-1} \right) + C^j_{i,t-1} \,. \qquad (9)$$

$$K_{i,t} = (p D_{i,t}) + (1-\eta) K_{i,t-1} \,. \qquad (10)$$

In industrial organization literature there is disagreement about the concrete reasons for market entries. The (neo-) classical assumption that market entry (exit) occurs if an industry gains profits above (below) a normal level may be disputed empirically.[9] Hence, it is assumed in the simulation study that it is industry profitability that provokes market entries but not the profitability of one single firm, i. Once the interest on the invested capital of i increases above a critical value, δ, market entry of a new competitor is induced. The original firm, i, provides the imitation pattern (with respect to $C^j_{i,t}$) for the entering firm in the period

6 See Klepper (1996), p. 565.

7 For simplicity, between product and process innovations are not distinguished in this paper. A high level of R&D-efficiency implies a relatively strong impact of innovations, which implies a product innovation (and vice versa for the case of process innovations).

8 For the sake of simplification in the simulation study only innovations will be considered, which means a new quality of an otherwise equal product in the Schumpeterian sense. The technological paradigm already exists. An existing market with supply and demand sides is assumed. With increasing maturity of the paradigm, the size of the alternative space of possible product improvements decreases. For the sake of simplification, the expected technological jump in a new technological paradigm will be ignored. Further, because the analysis focuses on the evolution of market structure, a stochastic distortion of the characteristic improvements depending on the R&D-budget, Fi,t, is also omitted.

9 See Geroski (1995), pp. 423-426.

$t=t^E$.[10] This assumption will be supported by the common sense opinion in the literature that in the EE, the feasibility of imitation of business models is increased by the opportunities provided by ICT.[11]

For t=1 there exists an oligopoly with $k=1,...,g$ firms, which are differentiated with respect to their initial capital stocks, $K_{k,t=1}$, which are normally distributed (μ=100; σ=10;50). For entrants the same parameters (μ,σ) are valid for the calculation of their initial capital stock, $K_{e,tE}$, in t_E. It will be assumed that entrants enter the market with a minimum number of consumers, $D_{e,tE}$ (11). As the capital stock in the previous period, $D_{i,t-1}$, exerts a multiplicative bias on $D_{i,t}$ this assumption allows entry to be modeled within the framework of replicator dynamics. Furthermore, it is known from the stylized facts in industrial organization theory that small-scale entries are common, but large-scale entries are not, and, moreover, entrants are usually much smaller than incumbents.[12] Therefore, it will be assumed that entrants capture a proportion, τ=0.05, of D_t^{Ges} from all incumbent firms, $i=1,...,n-1$, already in the market, for instance through aggressive advertising, by setting penetration prices or even by giving their product away.[13]

Entry in $t=t^E$, if: $\delta < \frac{\Pi_{i,t}}{\eta K_{i,t.1}} - 1$. (11) $D_{e,tE=}t\ D_t^{Ges}$. (12)

For each parameter constellation, 50 simulations with $t=1,..., T$, T=160 periods are run; then a unique representative run will be calculated.[14] The firm $k\in\{1,...,g\}$ in t=1 with the randomly best starting condition, $K_{k,t=1}^{Max}$, will be called U=1 (the second best will be called U=2 and so on, for entrants analogously). For all $U=1,\dots,n$ the representative evolution of the market data $\vartheta_{U,t}$, $K_{U,t}$, $D_{U,t}$, $f_{U,t}$ and their standard deviations, will analogously be calculated in order to assess alternative patterns of market structure evolutions. Analogously, entry and exit of all U will be stored in a lifetime graphic (see for instance Figures 16 and 27 below), which shows how probable entry and exit of a firm i is over the course of time.

$H_t = \sum_{i=1}^{n} \left(\vartheta_{i,t}\right)^2$. (13) $H_t^I = \frac{1}{H_t}$. (14) $I_t = \sum_{i=1}^{n} \left(\left|\vartheta_{i,t} - \vartheta_{i,t-q}\right|\right)$. (15)

For measuring the concentration of the market shares, $\vartheta_{i,t}$, the Herfindahl index H_t (13) in the interval [0.1] and the inverse Herfindahl Index H^I_t (14), which have been representatively calculated, will be applied. H_t=1 indicates the maximum market concentration. H^I_t in the interval [1,n] indicates the number of firms, i, with identical market shares, $\vartheta_{i,t}$, that would result in the same H_t. Additionally, for the stability comparison of the evolution of the market structure in different parameter constellations, the instability index, I_t (15), will be calculated also representative.

10 For simplicity and because it is not the focus of this paper, a stochastic distortion of this imitation procedure will be omitted.

11 Above all, the easier feasibility of imitation is an increasing problem in the context of compatibility as a strategic tool of competition positioning. See in this context for example Shapiro and Varian (1998).

12 See Geroski (1995), pp. 422 f.

13 The enticement is weighted by the individual market shares, $\vartheta_{i,t}$, of the incumbents.

14 I have used the public domain simulation software Lsd (Laboratory for Simulation Development) developed by Marco Valente (www.business.auc.dk/~mv/), Università dell'Aquila, Facoltà di Economia e Commercio.

The purpose of Section 3 is it to distinguish the EE- from the OE-regime by emergent features of development of the market structure. Therefore, the differences between the EE and the OE postulated in the academic literature and the economics press will be condensed into 8 hypotheses. The main concern of this paper is the impact of regime-specific parameter constellations on the evolution of the market structure.

3. E-conomy vs. Old Economy? – 8 Hypotheses.

The following eight hypotheses provide the common sense characteristics of the EE postulated in the literature along two lines of argument. The first line includes industrial economic characteristics of the EE that are relevant for the subsequent parameter choices in EE scenarios (EES). The second line of argument includes statements about the evolution patterns of the market structure in EES.

Hypothesis I. The market structure development in the EE is dynamic. In contrast, the OE markets are characterized by stability and persistence.[15]

Hypothesis I postulates a characteristic evolution of the market structure in EES based on the second line of arguments. Hypothesis I will be analyzed within the context of Hypotheses II and III, which will be the basis for the parameter choices of R&D-efficiency, $\kappa_{i,t}$, and market growth γ in EES (line 1).

Hypothesis II. In contrast to the OE, the EE is characterized by expanding markets.[16]

This Hypothesis is the basis for the parameter γ in EES. In order to investigate the implications of different levels of market growth, γ, on market structure developments, five alternative scenarios are examined: γ^a=0.00 for a stagnating, γ^b=0.01 for a slightly expanding and γ^c=0.05 for a strongly expanding market, $\gamma^d=1/t$ for slightly decreasing and $\gamma^e=1/t^2$ for rapidly decreasing market growth rate.

The simulation data show that an increased market growth, γ, accelerates the dynamic evolution of market shares because it improves the individual firm's returns. New firms tend to enter the market earlier. The augmented entry weakens all incumbents, U=1,...,g, in the market, which tends to reduce their market shares $\vartheta_{U,t}$. Figure 1 shows an Old Economy scenario (OES) (γ^a) and Figure 2 an EES (γ^c) with higher market structure instability, I_t, in all replicator speeds α=0.1; 1; 3.

Figure 1 and 2 all about here

Hypothesis III. The EE is based on technical progress. In contrast, the importance of innovations in the OE is relatively slight because there is little potential for product improvements in the matured OE markets.[17]

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15 See for example Atkinson and Court (1998), p. 7; Audretsch and Thurik (2000a), p. 12-14.

16 See for example Atkinson and Court (1998), pp. 30-35.

17 In relation to permanent innovations as building blocks of the EE see, for instance, Welfens (2002), pp. 19-24, Atkinson and Court (1998), p. 7. See, e.g., Hickel (2002) for the mature satiated markets of the Old Economy. In

Hypothesis III will be analyzed within two R&D-efficiency scenarios. If the R&D-efficiency decreases relatively slightly ($\kappa^{a}_{i,t}$), the potential of *i* is relatively high until *T*=160 which characterizes the EES. As Figure 3 (OES) in comparison to Figure 4 (EES) shows for α=0.1; 1; 3, this produces instability in the evolution of the market structure because the diseconomies of R&D in the EES are too small to allow an oligopolistic polymorphism in the firm population. Instead, the EES will be characterized by extreme market structures: on the one hand by strong monopolistic tendencies (Hypothesis IV), and on the other hand by competitive markets (Hypotheses V and VI). In the OES the diseconomies of R&D are strong enough to allow an oligopolistic polymorphism in the firm population and the instability in the evolution of the market structure, I_t, is minor. To sum up, Hypothesis I can be validated on the basis of Hypotheses II and III.

Figure 3 and 4 all about here

Hypothesis IV. The EE is characterized by "winner-takes-all" markets. The first firm that enters the market (*U*=1*)* will monopolize this market.[18]

In the context of this hypothesis on the EE regime, such catchphrases as "first mover advantage" and "competition of time" can be seen as characteristic for the EE. (second line of argument) The simulation data show that in EES (high γ (Hypothesis II), high R&D-efficiency (Hypothesis III)) a high replicator speed, α, increases the first mover advantage of *U*=1. *U*=1 then monopolizes the market.[19] Figures 5-7 show the impact of an increasing α on $\vartheta_{1,t}$. For an interpretation of α, both perspectives of the replicator dynamic should be noted. However, the current development depends, to a large degree, on past development , and it is a cumulative, path-dependent evolution. Conversely, the relative degree of fitness super(infer-)iority influences the current evolution of market data. The replicator speed, α, weighs these two influences. A high α remunerates (penalizes) small differences of fitness, $(f_{i,t} - \overline{f_t})/\overline{f_t}$, whereby for a firm, individual demand increases (decreases) ($D_{i,t}$-$D_{i,t-1}$) in a relatively strong way. This emphasizes the first mover's advantage. In the meantime, a small α makes it difficult for a firm, *i*, to be better off than its competitors because fitness differences only have a minor impact. Consequently, the replicator speed is an indicator of competition pressure, which is the higher, the smaller α becomes.[20]

Figure 5-7 all about here

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this context "Moore's law" should be mentioned, according to which the computer's processor performance is doubled every 18 months. See Zerdick et al. (2002), p. 149.

18 See for example Kalmbach (2001), p. 57.

19 See Hypothesis VI for a discussion of why, in the presence of extreme market growth, U=1 cannot monopolize the whole market despite of the first mover advantage.

20 An aspect that appears to be relevant in the "winner-takes-all"-hypothesis is the impact of more (un-)equal (σ=10;50) initial capital stocks, Kk,t=1, of the firms k$\in${1,...,g}. It appears to be plausible that the better is initial condition of U=1 the better are the chances of capturing a greater market share, ϑ1,t, than in markets with more similar firms (σ=10). The simulation results, however, show a different pattern. In fact, the initial position of U=1 is better, but higher interest on capital generally provokes more market entries. This effect de-stabilizes the better initial position of U=1 and results in an inferior market share, ϑ1,t. An increasing α also leads, in the presence of a greater inequality of Kk,t=1, to faster improvements in the market share, ϑ1,t, and thus tends to counteract the previously mentioned de-stabilizing effect. Hence, the impact of σ must be examined in the context of the value of α and of augmented market entries. This interdependency prohibits a general assessment of (un-)equal initial conditions of firms as being (dis-)advantageous for U=1.

A second aspect that should be noted in the context of the "winner-takes-all" Hypothesis is that it increases the stability in the evolution of market structure by strongly decreasing R&D-efficiency. This limits monopolization tendencies of $\vartheta_{1,t}$ ex ante and moreover is typical for OES. The potentials for the market share development, $\vartheta_{1,t}$, are significantly greater with higher levels of efficiency (EES) (Figure 9) than with a strongly decreasing R&D-efficiency (Figure 8). In addition, the standard deviation of the market share development, $\sigma^{\vartheta}_{1,t}$, is, significantly larger (Figure 10) than with strongly decreasing R&D-efficiency (Figure 11). Hence, "winner-takes-all" markets are not typical for OES, but they do occur in some of the EES studied.

Figure 8-11 all about here

A final aspect that is relevant within the context of Hypothesis IV is related to the innovator-imitator-sequence according to Schumpeter. Imitators close the gap that results from an innovation edge and hence reduce pioneer-profits. Imitator-entries counteract monopolization tendencies. The "Schumpeter-gap" is then only a temporary phenomenon. The simulation data show that, in fact, imitators are a necessary, but not a sufficient condition for the prevention of severe monopolization tendencies: in the presence of a high level of market entry barriers, δ, and a high value of the speed parameter, α, of the replicator dynamic, it is difficult for entrants to close the "Schumpeter-gap". This is because the above-mentioned monopolization tendencies are significantly strong. To prevent such "winner-takes-all" tendencies, there are two possibilities. The first possibility to prevent monopolization tendencies is the combination of extreme market growth (γ^c) and high R&D-efficiency ($\kappa^a_{i,t}$) which increases the interest on capital which causes a greater number of entries. In the presence of such EE conditions, this greater number of entries can weaken monopolization tendencies "ex post" (see also Hypothesis V). The second possibility to prevent monopolization tendencies, a decrease in R&D-efficiency to ex ante limit monopolization tendencies (Figure 12), as has already been discussed above. (See also Hypothesis III) Note that the methods to prevent monopolization tendencies differ from the first to the second possibility. In the latter case, because of the decrease in R&D-efficiency, it is more difficult for firms U=1,...,n (analogous to a low α=high competition pressure) to perform better than the competitors, and the growth of their market share, $\vartheta_{U,t}$-$\vartheta_{U,t-1}$, stagnates. In sharp contrast the "Schumpeter-gap" is not sufficiently strong from an ex ante perspective to prevent monopolization tendencies in this case.

Figure 12 all about here

As one of the conjectured typical symptoms of the EE, the "winner-takes-all" situations can be characterized by a situation where, first, a high potential of innovation exists and, second, a high remuneration of better fitness reinforces monopolization tendencies. Thus, under these two conditions Hypothesis IV can be verified.

Hypothesis V. In addition to the phenomenon described in Hypothesis IV, the EE is also characterized by a reduction of friction and market entry barriers due to the potential of information processing by use of ICT.[21] This means that in contrast to the OE, in the EE there is

21 See for example Balsameda (2002), p. 77.

continual market entry of new firms, which destroys local monopoly power.[22] Hence, the competition pressure in the EE is greater than in the OE.

This Hypothesis contains statements on the first and the second lines of argument. The statement in the first line specifies the height of market entry barriers, δ. For EES a lower δ will be postulated. The statement in the second line postulates that this lower δ induces more entries and destroys local monopolies. Figures 13 (excessive entry) and 14 (high δ) elucidate this in a direct comparison. In the presence of low market entry barriers entries can restrict monopolization tendencies. In order to investigate this Hypothesis, two cases have to be discerned: on the one hand, monopolization tendencies will be restricted by entries (ex post) (see also Hypothesis IV) and on the other hand, they will be completely inhibited by entries ex post. In the first case there exists a growing firm, U=1, together with small-sized firms U=2,…,n with negligible market shares. The market share development of $\vartheta_{1,t}$ is relatively stable, but among the small firms, U=2,…,n, turbulence dominates the market share development as a consequence of continuing market entries of new firms and exits of small incumbents. In fact, the death rate of the entrants is high (Figure 16[23]). Nevertheless, the attack on the incumbents k has an effect, particularly to U=1.[24] The potential market share $\vartheta_{1,t}$ in EES is stable on a high level, but an absolute monopolization of the market cannot be achieved as Figure 14 illustrates (see also Hypothesis II).

Figure 13 and 14 all about here

In the second case of excessive entry in the EE, monopolization tendencies are completely inhibited. If, in addition to excessive entry, there is a high competition pressure, a competitive market structure is created.[25] A low α (Hypothesis IV) implies, for fitness differences between firms U, only a relatively slight gain in demand $D_{U,t}$-$D_{U,t-1}$. To increase $D_{U,t}$ firm U must be much better off than its competitors. The contest for market shares is stronger than in the case of a high α. Figure 17 shows such a case.[26]

Figure 15 and 16 all about here

As already discussed in Hypothesis IV, there are stable oligopolies in OES (Figure 12). Monopolization tendencies are prohibited ex ante. Existing local monopolies (narrow oligopoly) cannot be destroyed in these stable market structures. The competitive market structure is fairly typical for some EES and atypical for OES. Hypothesis V can be validated under specified conditions: local monopolies are prohibited by low market entry barriers. If, additionally, there is high competition pressure, local monopolies will be destroyed and a competitive market structure results.

22 See for example Atkinson and Court (1998), p. 13; Audretsch and Thurik (2000), pp. 24-27.
23 The lifetime graphic illustrates very explicitly how turbulent the market is. Firms enter and exit the market continually so that the no individual periods of entry and exit of a firm can be seen. A detailed explanation of the lifetime graphic can be found at the end of section 2 in this paper.
24 See Foster (1986), p. 217
25 See Figure 13 und 14 for the case of α=0.1.
26 See, for further discussion of the competitive market structure Hypothesis VI.

Hypothesis VI. Competition in the EE approximates the perfect competition of the neoclassical theory due to the phenomenon of excessive market entry (Hypothesis V).[27]

This Hypothesis postulates a pattern of market structure development that is based on excessive entry and conforms the neoclassical perfect competition argument (Line 2). Due to the model assumption (11) the market share of an entrant, $\vartheta_{e,t}$, is 5% at $t=t^E$. In the case of a competitive market structure (Hypothesis V) $\vartheta_{i,t}$ decreases over the course of time, which finally leads to the market exit of *i*. Figure 17 presents the case of excessive entry. Market entry requires that capital interest is above the provoking level of interest, δ. However, the neoclassical theory of perfect competition also implies that no excessive profits can be obtained. Consequently, market entry activities come to a standstill and a static equilibrium prevails. However, contrary to a static state, this simulation model exhibits a turbulent market structure development on the micro level. This means a steady equilibrium cycle in the sense that incumbents loose market shares to entrants and they themselves in turn loose market shares by newer entrants. On the micro level, structural change endogenously created in the firms' landscape creates an evolving self transformation of the whole system on the macro level. The macroeconomic process appears to be of a static neoclassical perfect competition type, but it is based on microeconomic disequilibria through firms that gain a capital interest above the provoking level, δ. The simulation results thus show that this competitive market structure is not conforming to the neoclassical idea of perfect competition. Consequently, Hypothesis VI cannot be validated.

Figure 17 all about here

Hypothesis VII. The calendar of the EE is accelerated compared to the OE.[28] One "year" in the EE is estimated to be 3 months in the OE.

This Hypothesis is also a statement in the second line of the argument, which postulates a distinct pattern of evolution of market structure in the EES in relation to the OES. As Figures 18 and 19 show at first sight, the OES (Figure 18) can be interpreted as a temporary part of an EES (Figure 19) because the parameter constellations of the OES imply a slower evolution of the market share. However, the return on capital per period is much lower, particularly because of the slower and more stable development of the market share, $\vartheta_{U,t}$. Continuing market entries are fundamental characteristics of EES. The comparison of a general "time abbreviation" for EES relative to OES thus is not possible. The parameters are interdependent, which prohibits an undifferentiated identification of EES with an accelerated calendar and OES with a normal calendar. Hypothesis VII cannot be validated.

Figure 18 and 19 all about here

Hypothesis VIII. The strong market growth and the great innovation potentials in the EE justify the high level of stock valuation of EE firms. The high stock prices are bets on the enforcement of one product as a standard on the market. The entrepreneurial investments are expected to amortize as monopoly profits.

27 See for example Kalmbach (2001), p. 57.
28 See for example Atkinson and Court (1998), p. 17.

This is also a hypothesis of the second argument line. As has already been discussed in the context of Hypotheses IV and V, in comparison with other market growth scenarios in the presence of an extreme market growth rate, γ^c, U=1 cannot monopolize the whole market. This is an important argument against Hypothesis VIII. A second argument is that the standard deviation of EES, i.e. its space of alternatives of the actual market share development, $\sigma^{\vartheta}_{U,t}$, exceeds that of the more stable OES. The EES displayed in Figure 21 shows a tenfold increase in $\sigma^{\vartheta}_{U,t}$ in comparison to the OES in Figure 20. This generates more opportunities in the market share development for the individual firm, but also more risk. Obviously, the possibilities for EE firms to achieve larger market shares due to the enlarged alternative space were overvalued, whereas the risks were undervalued by investors during the stock hype at the end of the 1990's.[29]

Figure 20 and 21 all about here

A third argument against Hypothesis VIII is that the combination of extreme market growth, a high level of R&D-efficiency and low market entry barriers not only augment the space of alternatives for the market share development, $\sigma^{\vartheta}_{U,t}$, this combination also offers the opportunity for the second mover's advantage. In the course of time a few U accomplish a market share $\vartheta_{U,t}>D_{e,tE}$ (=5%) (Figure 22). These firms are not subject to a completely competitive market structure. More conspicuously than in Figure 22, the opportunity of the second mover's advantage can be seen in Figure 23, which depicts the standard deviation of the market shares, $\sigma^{\vartheta}_{U,t}$, in the same EES. As an example for the possibility for second mover advantage, U=96; 106 were marked in Figures 22 and 23.

Figure 22 and 23 all about here

A final argument against Hypothesis VIII is that in the presence of strong market growth, firms cannot realize whether their performance actually equals that of the market growth rate through their individual demand, $D_{i,t}$,. If i is growing but only under-proportionally with respect to the market growth rate, then, in fact, firm turnover, $\Pi_{i,t}$, increases even if $\vartheta_{i,t}$ decreases. Firms thus risk reacting to the loss of market share too late. This fact augments the hazard of incorrect strategic management decisions in EES, as the temporary activity windows for strategic decisions are missed. This is an additional risk factor of EE firms which results from high market growth and which should be integrated as risk increasing / value depreciating in stock valuation. Figure 24 shows $\vartheta_{U,t}$ for U=1,…,3 in such an EES. Figure 25 shows the demand, $D_{U,t}$, of the EES, analogously.

Figure 24 and 25 all about here

4. From the E-conomy to the Old Economy

Commonly, the EE is attributed as being driven by speed of progress, by technology and innovation, by entrepreneurship and by market shares.[30] Replicator dynamics model the dy-

29 See Shiller (2000).

30 This list is an incomplete numeration of characteristics that are attributed to the E-conomy. Only the characteristics that are relevant for market structure developments from an industrial organization point of view were selected. For further characteristics see, for example, Berger (2002); Atkinson and Court (1998), p.7.

namics of polymorphic populations using their population shares and their relative fitness against the population average. In the model developed in this paper, firms are the selection object in the relevant market. Due to the EE characteristic, "driven by market shares", it is suggested that replicator dynamics are an adequate analytical instrument for market structure evolution in the EE. (3, 4) The characteristics, "driven by technology and innovations", are realized in so far as the fitness does not refer to the cost situation of firm *i*, which is the classical application of replicator dynamics. (1) In this model, fitness refers to the characteristic numbers of the product, which can be improved by R&D. (6, 9) The characteristic, "driven by knowledge", gives a minor importance to the firm's endowment with specific means of production in favor of an augmented importance of human capital, skills and know-how. This reallocation permits more a flexible market entry. In the present context, "driven by entrepreneurs" more precisely means, "driven by entrants", which has been modeled above by endogenous variation of the market entry frequency. (11, 12)

What are the stylized facts of the evolution of market structure?[31] As is summarized by Jovanovic and MacDonald (1994), a young industry is characterized by a high number of small-sized firms whose number increases trough the entry of additional competitors. Due to a still positive, but already decreasing market output growth rate below the average growth rate of the incumbents, a „shakeout" of firms out of the market occurs. „[The] nonmonotonic time path of firm numbers [is]..the response of competitive firms to, first, the opportunity to innovate and, later, the relative failure to do so."[32] In addition, Klepper (1996) notes that entry frequency and the number of incumbents is increasing in a market in the beginning, then reaches a peak, and finally decreases, although the market output continuously rises. Klepper also emphasizes, as a stylized fact, that the rate of change of the market share of the market leader, $\vartheta_{1,t}$, finally stabilizes, which results in OES.

Figure 26 and 27 all about here

Geroski (1995) suggests that market entry rates come in waves over the course of time and often reach their peak when the market is young. Figure 26 shows this as a simulation result with the help of $\vartheta_{U,t}$, and Figure 27 shows the lifetime of the firms for the same scenario. Market entries emerge intensely in the beginning and dwindle over the course of time. Furthermore, Geroski emphasizes that through, e.g., antitrust commissions, the pro-competitive effect of market entries is often overstated: The number of market entries can be too small, too large or too erratic, and the effective pro-competitive effect does not develop. In fact, market entry has an important but only very selective influence on industry performance , as the simulation results show (Hypothesis IV, V). Figure 26 shows that market entries cannot prevent the monopolization of the market by U=1. Figures 28 and 29 show the corresponding measurement of concentration, the Herfindahl Index H_t and the inverse Herfindahl Index H^I_t.

Figure 28 and 29 all about here

Furthermore, Audretsch (1995) states that the equilibrium-function of entrants in relation to prices and profits can be validated empirically. However, in contrast to this validated rela-

31 The following brief overview of the stylized facts from an industrial economics viewpoint, extracted from empirical investigations, is not complete. Only the facts that are pertinent to this paper were selected.
32 Jovanovic and MacDonald (1994), p. 346.

tionship, there is merely a slight positive relationship between market entries and industry profitability. Therefore, as explained in Section 2, it will be assumed that market entry in the model is induced by above normal interest on capital (>δ) of one firm, *i*. (11) This "provoking" firm provides an imitation pattern for the entrant. Moreover, Audretsch elucidates a positive relation between the industry growth rate and the market entry rate, which also supports the results of the simulation study in this paper. (Hypothesis IV)

Conclusion: the EE is characterized by dynamic market evolution (Hypothesis I) in contrast to the OE, which is characterized by stable market evolution. Turbulences (Hypothesis VI), comparatively radical innovations (Hypotheses III, IV), market expansion (Hypothesis II), low market entry barriers (Hypothesis V) and high competition pressure (Hypothesis V) characterize, in the simulation model, the parameter constellations that create the tendency towards a competitive market structure in EES. This configuration of characteristic is typical for the first phase of the stylized industry cycle.[33] The second and third phases of the industry cycle are characterized by a decreasing radicality of innovations, a decreasing number of market entries and decreasing competition pressure, increasing firm size and decreasing market turbulence. In the presence of these parameter constellations, the simulation results reflected increasing oligopolistic and monopolistic tendencies and a stabilization of the market share evolution in OES. [34] Hence, the various EES and OES can be interpreted as market structure evolution phases: varying from high market growth rates with high instability to stagnating markets – from relatively great innovation potentials to merely incremental innovation possibilities which generate market structure stability – from low interest on capital which induces new firms to excessively enter the market, which eventually triggers higher market entry barriers, which then decrease the turbulence of the market structure evolution because of greater stability, larger sizes of firms and higher levels of market concentration. To summarize, the empirical stylized facts lead to the conclusion that the EES describe a "young" market and in contrast, the OES describe a mature, stabilized market.

The parameter constellations in this simulation study can be interpreted as specific combinations, which are characteristic for certain industries. On the one hand, EE and OE can then be considered as two very different industries. On the other hand, due to the stylized facts of the market structure evolution, it is natural to interpret the simulation runs as "temporary phases" of an industry life cycle. The EES and OES can be put into a consistent sequence of evolution. The EE typical market structure regularities are not in opposition to OE in the sense of "new" versus "old". To the contrary, the EE appears to be an early phase in the industrial life cycle. In industrial economics it is common sense that the potentials of a technological paradigm decrease over the course of time. Thus, it is also likely that the innovation potential and market expansion of the EE will decrease. This causes stabilizing and oligopolistic tendencies. The EE then enters the next phase of the industry life cycle. Although the sequence of words in the title of Section 4 may appear inconsistent – a "new economy"

33 For a brief overview of the concept of an industry life cycle see Cantner and Hanusch (1998).

34 The concept of the industry life cycle should not be understood as an invariant sequence of the three phases. Rather, with the specification of the several phases in the evolution of industries, it should be possible to identify patterns and tendencies. The regularities extracted from primary empirical material are differently strong, but the direction of the evolution of industries accompanied by dynamic developmental tendencies continues to exist, in spite of the variety of the individual cases.

should follow an “old” one and not the other way round, the simulation results show that economic development progresses “from the EE to the (next) OE”.

5. Further research directions

Any model approach can be criticized due to its simplifications. In this model, all simplifications were made to allow the analysis to focus on the evolution of the market structure; for instance it was assumed that all market entries start with a minimum market share of 5% even though the entrant has not observed the market or justified the risk calculation of the anticipated profit. Due to the simplifications, the simulation model is easily comprehensible with respect to the aim of the analysis. Thus, the concrete implications of the EE critical parameters can be analyzed in detail. Further criticism may refer to the networking quality of the ICT. The conventional replicator dynamics cannot model network effects, because network effects imply the existence of an installed base. The latter is a benefit-increasing product characteristic for future consumers and so it will be an essential facility for a firm to have success.

Replicator dynamics instead is conceptualized as a non-overlapping generation model in which each consumer makes a new decision in each period about a purchase. Indeed, this disadvantage is not too serious because the market share of the past period, $\vartheta_{i,t-1}$, has a large influence on the actual market share, $\vartheta_{i,t}$, in the replicator equation. This means the consumer base, $D_{i,t-1}$, from the past period is already included in the purchase decision of each consumer.

From these criticisms tasks for further research follow directly. Furthermore, the endogenization of the evolution of the demand side is a meaningful extension of the present model. Endogenization of the evolution of the demand side generates a market model in which variation is generated by firms that are selected from the consumers. The endogenization of the demand side, however, must not use (intertemporal) optimization for preserving the consistency of the whole model.

6. Appendix

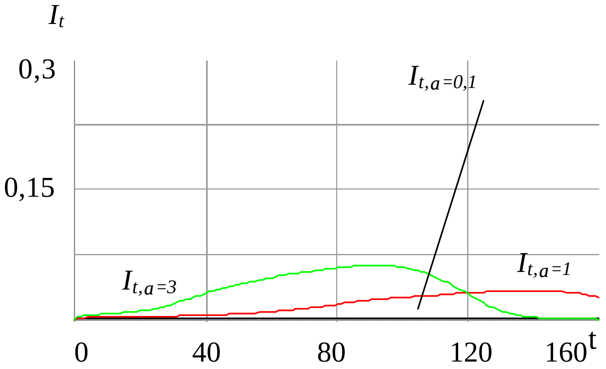


Figure 1 Instability index I_t for g=10, σ=10, $\kappa^a_{i,t}$, γ^a=0,00, δ=0,08, α=0,1;1;3

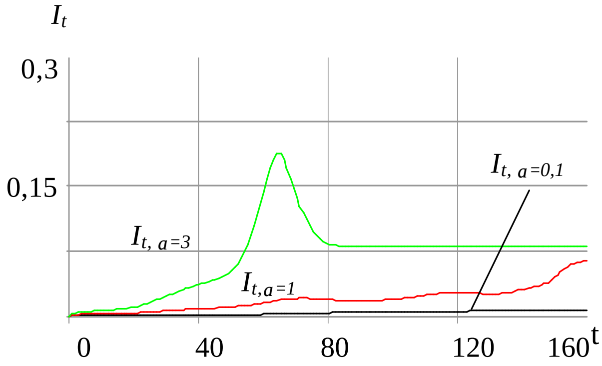


Figure 2 Instability index I_t for g=10, σ=10, $\kappa^a_{i,t}$, γ^a= 0,05, δ=0,08, α=0,1;1;3

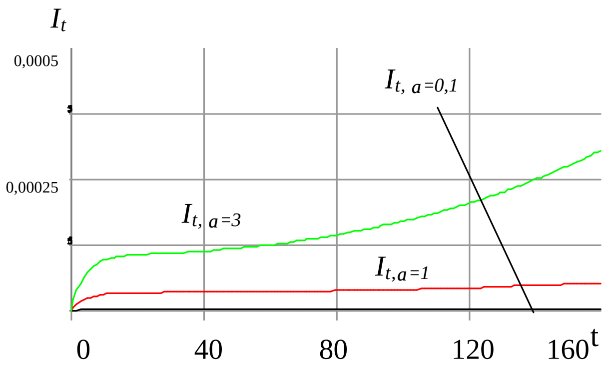


Figure 3 Instability index I_t for g=10, σ=10, $\kappa^b_{i,t}$, γ^a=0 ,00, δ=0,08, α=0,1;1;3

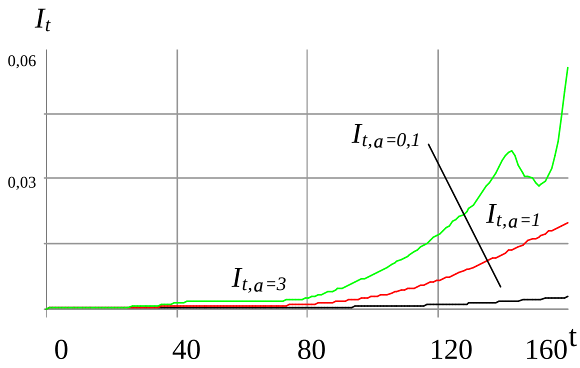


Figure 4 Instability index I_t for g=10, σ=10, $\kappa^a_{i,t}$, γ^c=0,05, δ=0,08, α=0,1;1;3

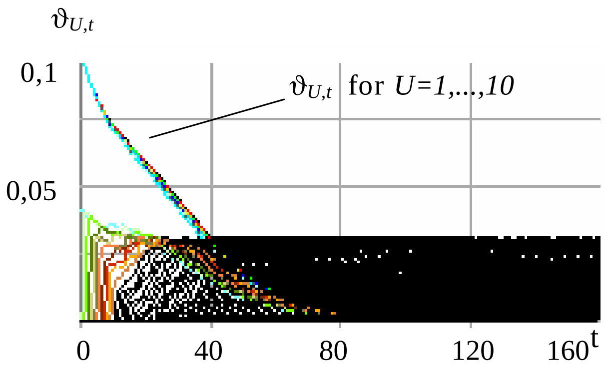


Figure 5 Market share $\vartheta_{U,t}$, U=1,…,n for g=10, σ=50, $\kappa^a_{i,tt}$, γ^c=0,05, δ=0,15, α=0,1

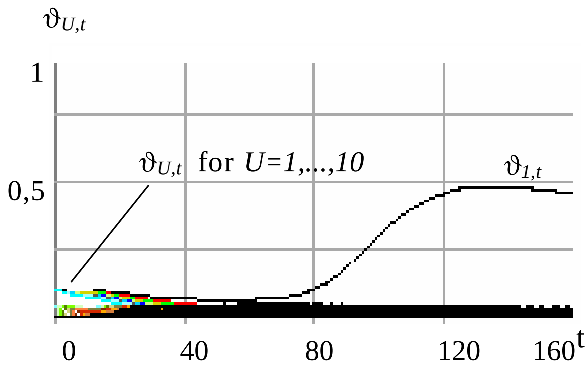


Figure 6 Market share $\vartheta_{U,t}$ U=1,…,n for g=10, σ=50, $\kappa^a_{i,t}$, γ^c=0,05, δ=0,15, α=1

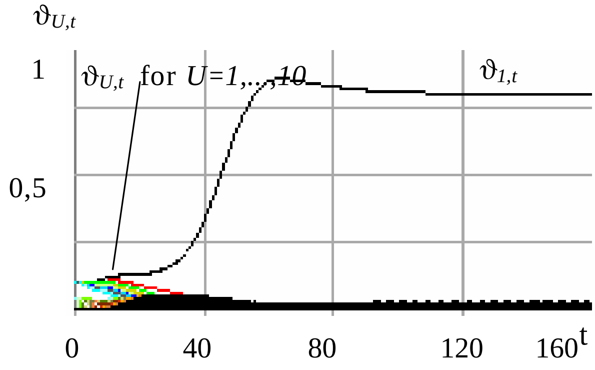


Figure 7 Market share $\vartheta_{U,t}$ U=1,...,n for g=10, σ=50, $\kappa^a_{i,t}$, γ^c=0,05, δ=0,15, α=3

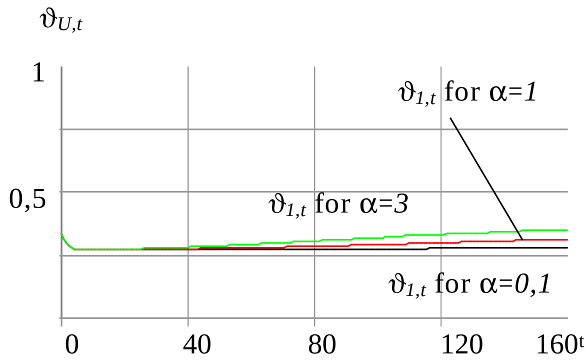


Figure 8 Market share $\vartheta_{U,t}$, U=1 for g=3, σ=50, $\kappa^b_{i,t}$, γ^a=0,00, δ=0,08, α=0,1;1;3

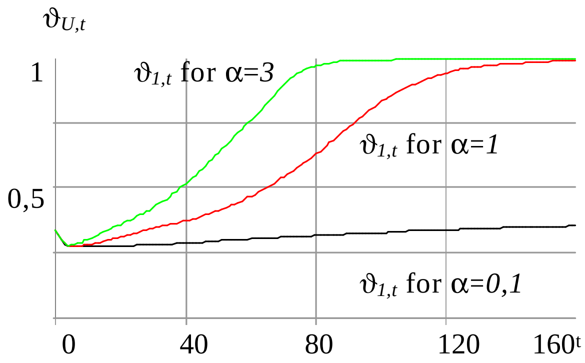


Figure 9 Market share $\vartheta_{U,t}$, U=1 for g=3, σ=50, $\kappa^a_{i,t}=1/f_{i,t}$, γ^a=0,00, δ=0,08, α=0,1;1;3

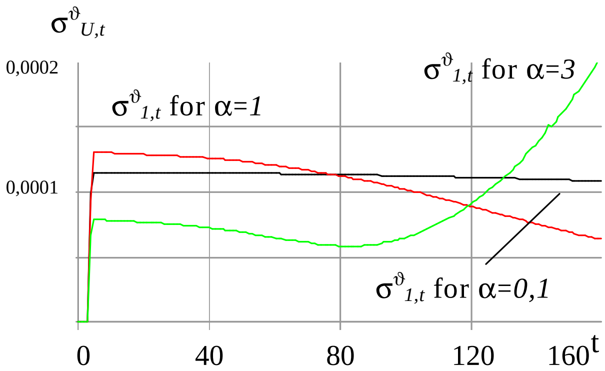


Figure 10 Standard deviation of the market share development $\sigma^{\vartheta}_{U,t}$, U= 1 for g=3, σ=50, $\kappa^b_{i,t}$, γ^a=0,00, δ=0,08, α=0,1;1;3

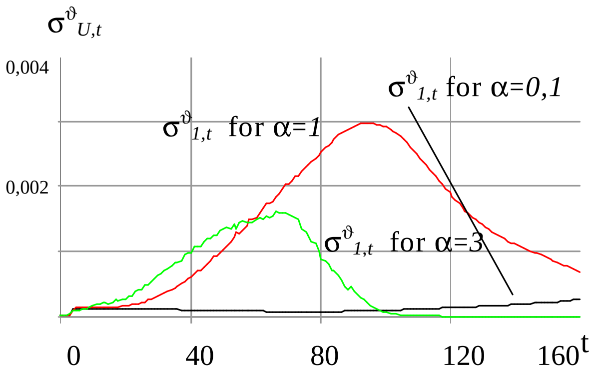


Figure 11 Standard deviation of the market share development $\sigma^{\vartheta}_{U,t}$, U=1 for g=3, σ=50, $\kappa^a_{i,t}$, γ^a=0,00, δ=0,08, α=0,1;1;3

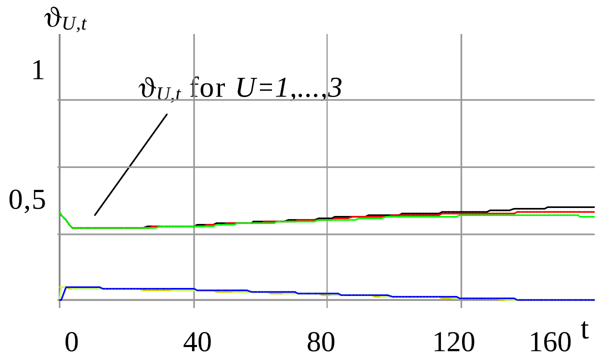


Figure 12 Market share $\vartheta_{U,t}$, $U=1$ for $g=3$, $\sigma=50$, $\kappa^{b}_{i,t}$, $\gamma^{a}=0{,}00$, $\delta=0{,}08$, $\alpha=3$

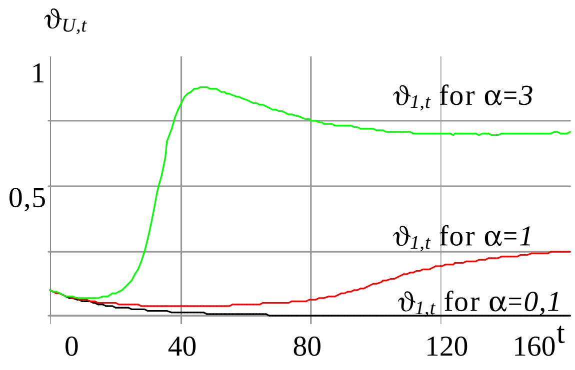


Figure 13 Market share $\vartheta_{U,t}$, $U=1$ for $g=10$, $\sigma=50$, $\kappa^{a}_{i,t}$, $\gamma^{d}=1/t$, $\delta=0{,}03$, $\alpha=0{,}1;1;3$

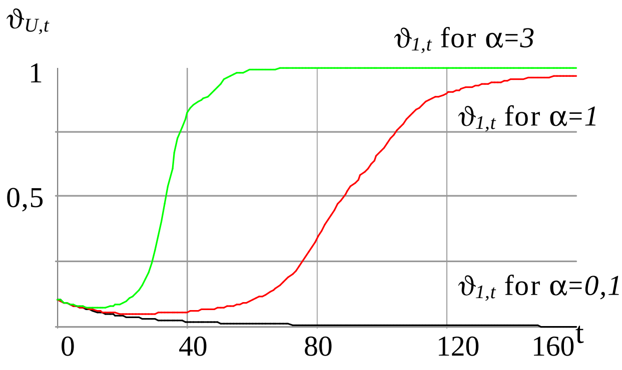


Figure 14 Market share $\vartheta_{U,t}$, $U=1$ for $g=10$, $\sigma=50$, $\kappa^{a}_{i,t}$, $\gamma^{d}=1/t$, $\delta=0{,}15$, $\alpha=0{,}1;1;3$

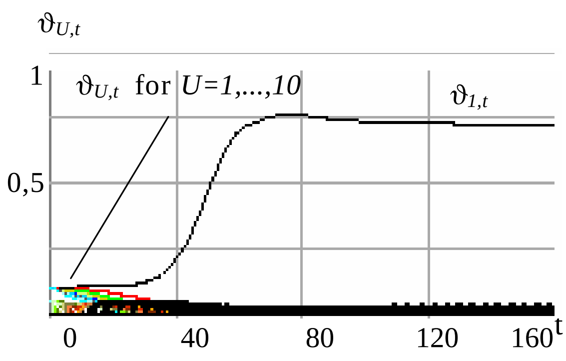


Figure 15 Market share $\vartheta_{U,t}$, $U=1,\ldots,n$ for $g=10$, $\sigma=50$, $\kappa^{a}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=3$

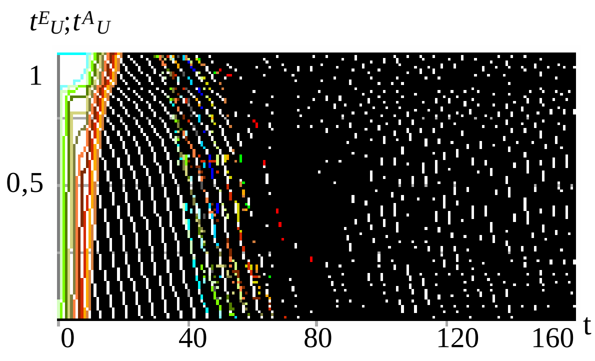


Figure 16 Lifetime for $U=1,\ldots,n$ for $g=10$, $\sigma=50$, $\kappa^{a}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=3$

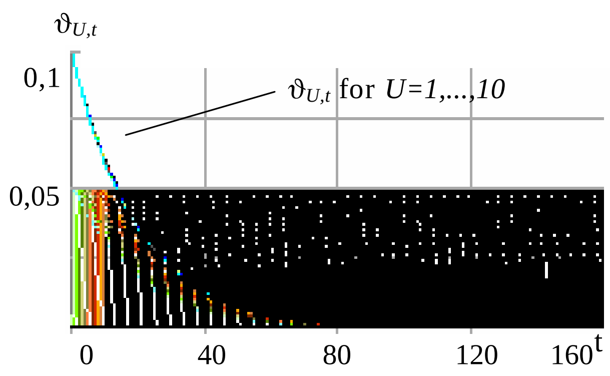
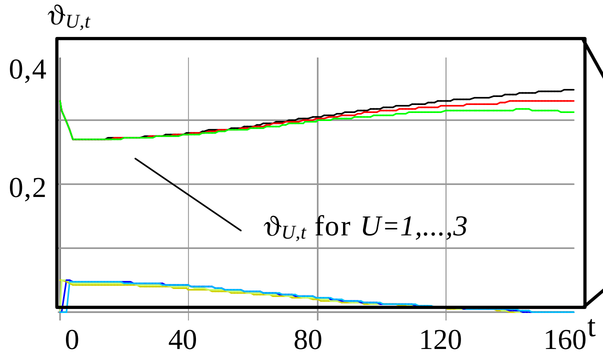


Figure 17 Market share $\vartheta_{U,t}$, $U=1,\ldots,n$ for $g=10$, $\sigma=50$, $\kappa^{a}_{i,t}$, $\gamma^{d}=1/t$, $\delta=0{,}03$, $\alpha=0{,}1$



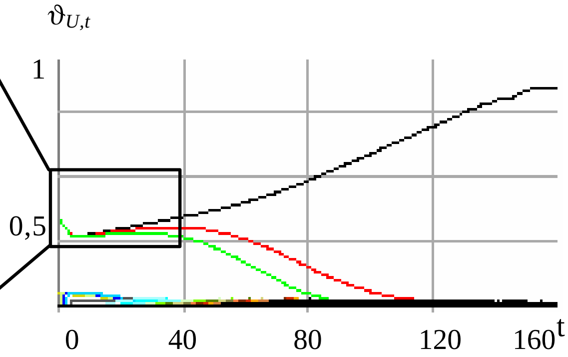
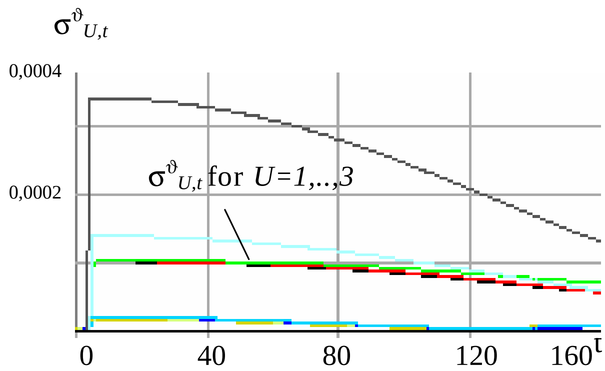


Figure 18 Market share $\vartheta_{U,t}$, $U=1,\ldots,n$ for $g=3$, $\sigma=10$, $\kappa^{b}_{i,t}$, $\gamma^{a}=0{,}00$, $\delta=0{,}08$, $\alpha=3$

Figure 19 Market share $\vartheta_{U,t}$, $U=1,\ldots,n$ for $g=3$, $\sigma=10$, $\kappa^{a}_{i,t}$, $\gamma^{b}=0{,}01$, $\delta=0{,}08$, $\alpha=1$



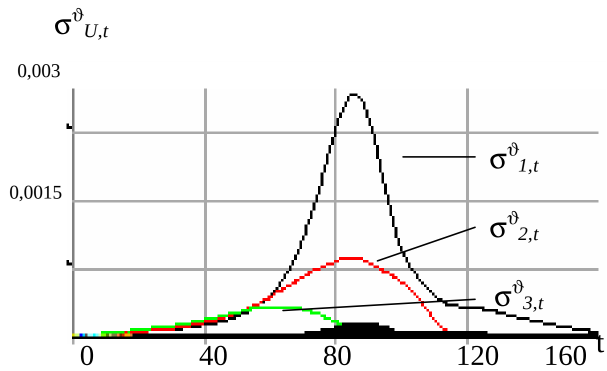
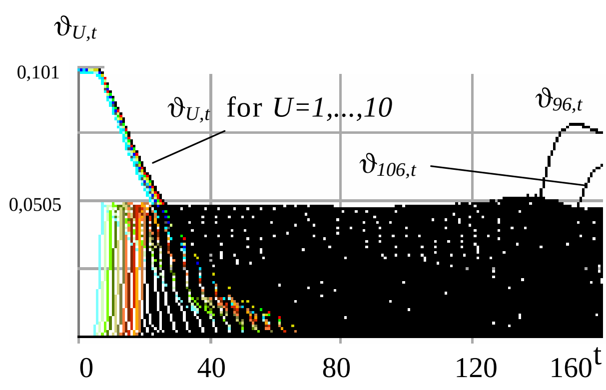


Figure 20 Standard deviation of the market share development $\sigma^{\vartheta}_{U,t}$, $U=1,\ldots,n$ for $g=3$, $\sigma=10$, $\kappa^{b}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=1$

Figure 21 Standard deviation of the market share development $\sigma^{\vartheta}_{U,t}$, $U=1,\ldots,n$ for $g=3$, $\sigma=10$, $\kappa^{a}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=1$



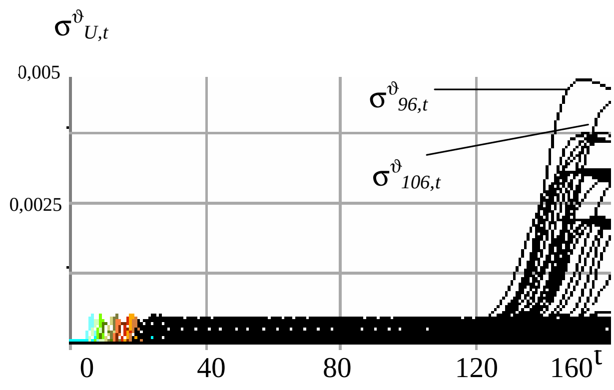


Figure 22 Market share $\vartheta_{U,t}$, $U=1,\ldots,n$ for $g=10$, $\sigma=10$, $\kappa^{a}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=1$

Figure 23 Standard deviation of the market share development $\sigma^{\vartheta}_{U,t}$, $U=1,\ldots,n$ for $g=10$, $\sigma=10$, $\kappa^{a}_{i,t}$, $\gamma^{c}=0{,}05$, $\delta=0{,}03$, $\alpha=1$

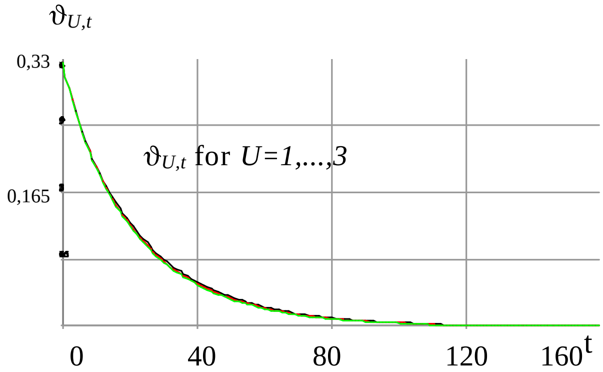


Figure 24 Market share $\vartheta_{U,t}$, U=1,...,3 for g=3, σ=50, $\kappa^a_{i,t}$, γ^c=0,05, δ=0,03, α=0,1

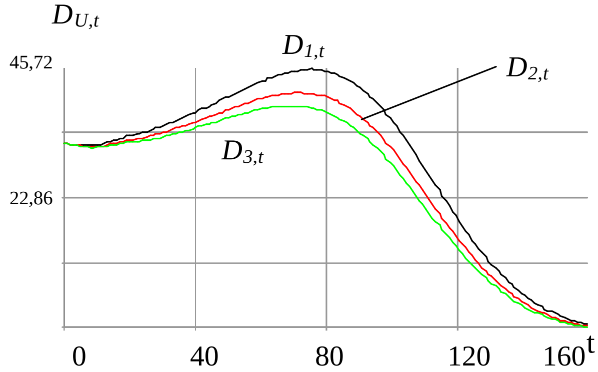


Figure 25 Demand numbers $D_{U,t}$, U=1,...,3 for g=3, δ=50, $\kappa^a_{i,t}$, γ^c=0,05, δ=0,03, α=0,1

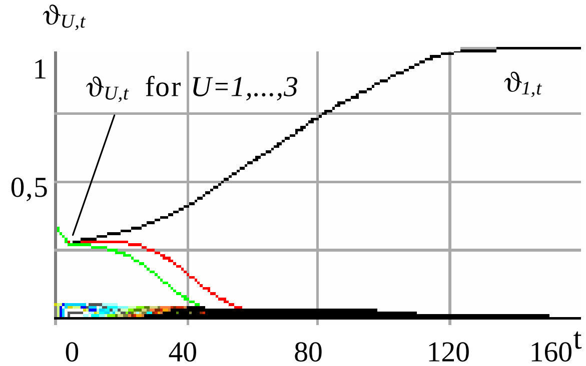


Figure 26 Market share $\vartheta_{U,t}$, U=1,...,n for g=3, σ=10, $\kappa^a_{i,t}$, γ^b=0,01, δ=0,08, α=3

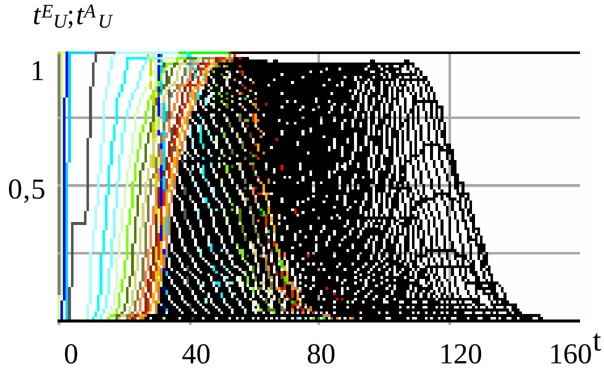


Figure 27 Lifetime for U=1,...,n for g=3, σ=10, $\kappa^a_{i,t}$, γ^b=0,01, δ=0,08, α=3

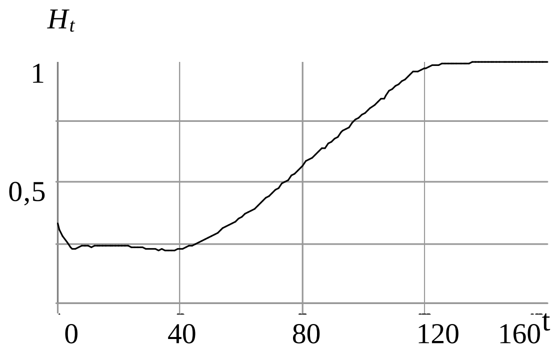


Figure 28 Herfindahl index H_t for g=3, σ=10, $\kappa^a_{i,t}$, γ^b=0,01, δ=0,08, α=3

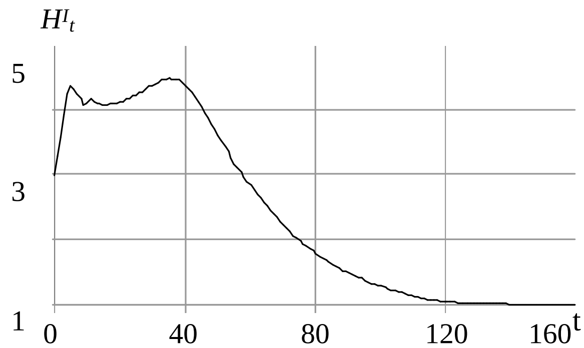


Figure 29 Inverse Herfindahl index H^I_t, for g=3, σ=10, $\kappa^a_{i,t}$, γ^b=0,01, δ=0,08, α=3

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