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The regional specifity of structural change in agriculture

An assessment of the role of farmers' strategic behaviour on the land market

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The regional specifity of structural change in agriculture: An assessment of the role of farmers' strategic behaviour on the land market

Die regionale Spezifität des Agrarstrukturwandels: Eine Analyse der Bedeutung strategischen Verhaltens von Landwirten auf dem Bodenmarkt

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Abstract

Among the family-farms in western Germany, significant regional differences are observable. They exist not only with respect to present farm-structure but also with respect to patterns of structural change. In the present paper, the different farm-development-strategies that cause these regional patterns are explained economically. As a central cause for their stability in a competitive environment, the relatedness of agricultural production to the non-renewable factor land is identified. Moreover, the coordination of the different strategies, which results in regional clusters, is shown to evolve endogenously in a model of strategic interaction on the land-market. It is demonstrated that due to the existence of rents of the status quo and resulting non-linearity in farmers' reaction-curves, coordination-failures and multiple equilibria are possible. The theoretically derived results confirm the notion that not only farmers' decisions determine structural development but also the initial structural situation heavily influences upon farmers' decisions. The interdependence between structure and behaviour is reinforced by the important role of expectation concerning competitors' behaviour in strategic interaction, because these expectations are coined by experience.

Keywords: Market Structure, Firm Behaviour, Equilibria, Rationality, Farming, Complementarity, Competition, Disequilibrium Dynamics, Agriculture

Zusammenfassung

Die landwirtschaftlichen Familienbetriebe der westlichen Bundesländer Deutschlands weisen deutliche regionale Unterschiede mit Blick auf ihre aktuelle Struktur aber auch auf deren Entwicklung auf. In der vorliegenden Studie werden die unterschiedlichen Betriebsentwicklungsstrategien, die diesen regionalen Entwicklungsmustern zugrunde liegen, ökonomisch erklärt. Als zentral für die Stabilität der unterschiedlichen Strategien in einer wettbewerbsorientierten Umwelt wird die Bindung der landwirtschaftlichen Produktion an die nicht erneuerbare Ressource „Boden“ identifiziert. Die Koordination der unterschiedlichen Strategien, die zu den regionalen Entwicklungsclustern führt, erfolgt endogen durch strategische Interaktion der Betriebsleiter auf dem Bodenmarkt. Aufgrund von Renten des Status quo und sich ergebenden Nicht-Linearitäten in den Reaktionskurven, die auch zu Informationsproblemen führen, entsteht die Möglichkeit von Koordinationsfehlern und multiplen Gleichgewichten. Diese theoretischen Ergebnisse bestätigen, dass nicht nur die Entscheidungen der Landwirte den Strukturwandel beeinflussen, sondern auch andersherum die Entscheidungen der Landwirte vom bisherigen Verlauf des Strukturwandels abhängen. Diese Interdependenz zwischen Struktur und Verhalten wird durch die zentrale Rolle der Erwartungsbildung mit Blick auf das Verhalten der Konkurrenten verstärkt, da Erwartungen durch zurückliegende Erfahrungen geprägt sind.

Schlüsselwörter: Marktstruktur, Unternehmensziele, Gleichgewichte, Ungleichgewichtige Dynamik, Rationalität, Landwirtschaft, Komplementarität, Wettbewerb

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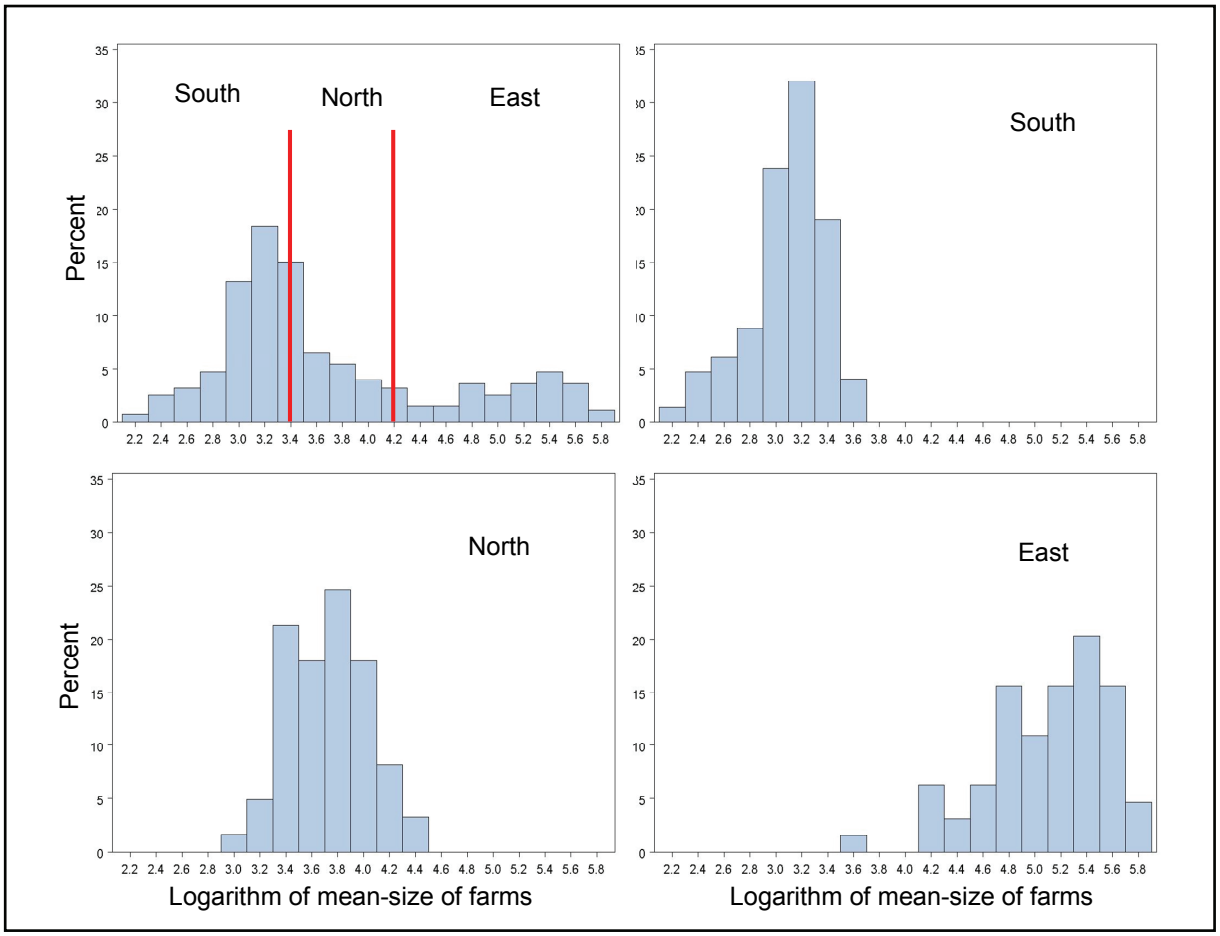
1 Introduction: Motivation and research question

The western counties of Germany are characterised by a traditional family-farm-structure. Here a delay of structural change, resulting in apparently suboptimal farm-sizes, has been detected frequently. The severity of this phenomenon of sustainably reduced growth of farms is higher in some regions, especially in Germany's south, than in others. In the past 60 years within the socio-economic system of a market-economy, in Germany most sectors became structurally similar across regions with only minor deviations. This process goes on as "globalisation" with economic structures becoming more and more alike even across countries due to the growing access to international markets. The liberalisation of trade, though restricted politically, is also observable for agricultural commodities but the historically overcome structural differences of agricultural production between Germany's south, north and east remain in place (Figure 1).

Figure 1: Distribution of the logarithmical mean farm-sizes in Germany's districts by region in 1999



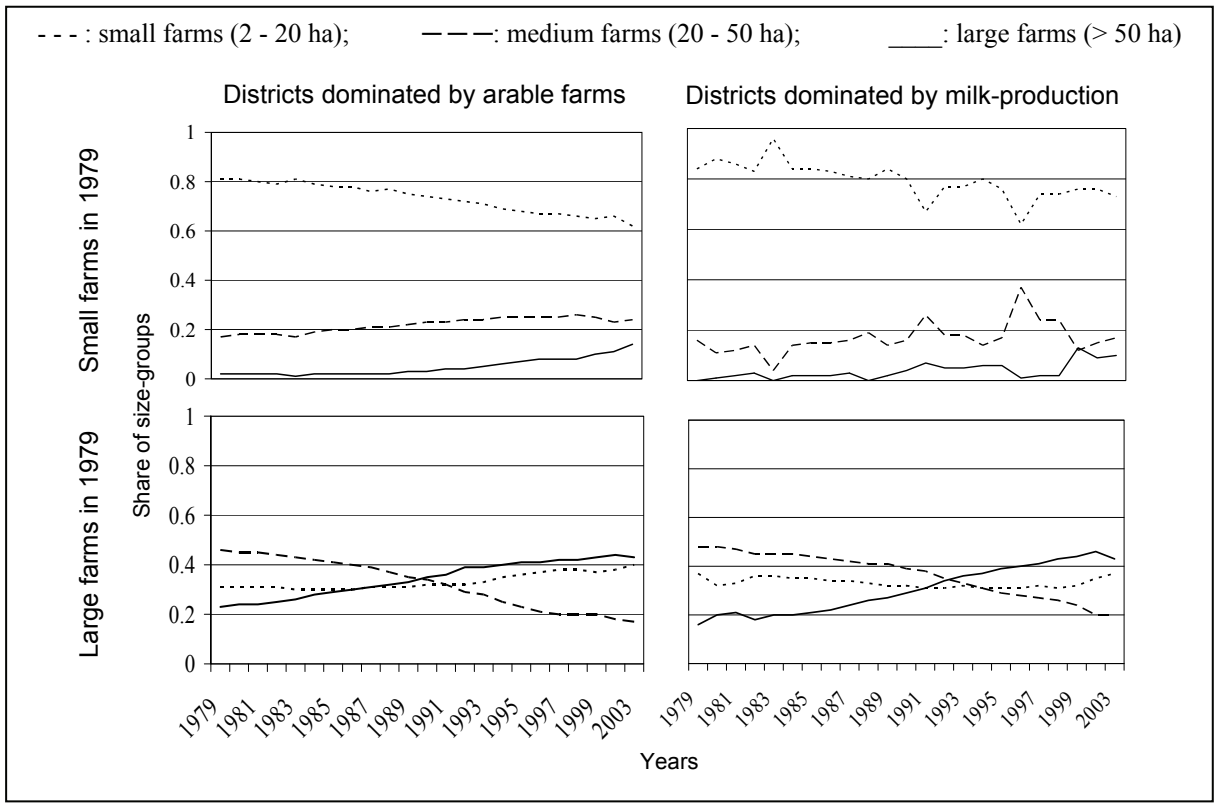
Remark: City-counties are excluded. „South" includes the following non-transformation-counties: Hesse, Rhineland palatinate, Baden-Württemberg and Bavaria. „North" includes the remaining non-transformation-counties except Saarland while „East" includes all transformation-counties (former eastern Germany).

Source: Own figure based on FDZ (1999).

Moreover, while in the years of transformation of the eastern former socialist economy a high mobility of farmers from the west, who invested in farmland in the east, could be observed, a comparable mobility across regions does not exist in the reversed direction or within the west. This regional specifity of structural change remains a puzzle for agricultural economists (SCHMITT, 1992; HAGEDORN, 1996).

Most of the attempts to explain structural change of agriculture argue on the single-farm-level. The reduced growth of some farms is being explained by hysteresis (HINRICHS et al., 2006), sunk costs and insecurity of future expectations (CHAVAS, 1994) or the farm-household-model (HENNING, 1994). The latter motivated many empirical investigations of the causes of structural change conducted on a single-farm-level (e.g., WEISS, 1999) or on an aggregated regional level (e.g., GLAUBEN et al., 2006). The specifity of single-farm-characteristics, like age of the manager, management-capability, number of household-members etc., is not capable theoretically, though, to explain systematic regional differences of structural change. Even if significant correlations are detected among single-farm-characteristics, the question remains open, of why sustainably significant regional differences in single-farm-characteristics exist in a competitive environment. Moreover, the detection of different farm-characteristics does not suffice in order to explain observable differences in the pattern of structural change (figure 2).

Figure 2: Development of the mean share of farms by size-classes in all farms by initial structural situation and regional characteristic type of production



Source: Own figure based on agricultural census 1979-2003

The figure shows the mean development of the groups of small, medium-size and large farms between 1979 and 2003 for different types of districts. The rows differentiate the regions by their farm-size-structure in 1979 while the columns divide districts that are characterised by arable farms from districts dominated by grassland and milk-production. As can be seen, the main difference in the pattern of development exists between regions of different farm-size structure; much less pronounced differences exist among regions characterized by different types of production. Specifically, in regions dominated by larger farms we observe a decline in the share of medium-size farms accompanied by relative stability of the share of small farms in the years under consideration, the so-called phenomenon of the disappearing middle (WEISS, 1999). In contrast, in the regions characterised by smaller farms, the share of medium-size farms grows or remains stable, while the share of small farms declines. Accordingly, medium-size farms are characterised by a higher mobility in regions dominated by large farms; their development-strategies differ from those of medium-size farms in regions characterised by small farms.

For German farms, numerous sociological studies identified differing farm-development-strategies (e.g., PATRICK et al. (1983), SINKWITZ (2001), HERRMANN (1993), HILDENBRAND et al. (1992)). In these studies, the economic background of observed strategies and possible regional differences are usually not analysed. OHE (1985) in concluding his explorative study on farmers' behaviour puts forward the hypothesis, though, that farm-income as a motivation for keeping up farming differs regionally. Some economic studies exist that hint on regional differences in farm-development strategies. ROEDER et al. (2006) who discover regionally differing shadow prices for labour on farms have recognised them for example. GOETZ and DEBERTIN (2001) report regional differences in the decision to work off-farm and WEISS (1999) reports regional differences in the decision to grow. TIETJE (2004) analyses young farmers' decisions to continue farming and reports differences in the attitudes of German and Austrian farmers. Additionally, these regional behavioural differences represent common knowledge expressed for example within non-scientific articles on farmers' strategies[1] or in discussion among experts. Economic causes of regionally differing strategies of farmers have not been analysed in a systematic manner so far.

The central question therefore is why farmers show persistent individual and regional differences in their farm-development-strategies and why several competing strategies exist simultaneously over extended periods. It is the aim of the presented work to explain the observed regional differences in farmers' behaviours and especially their persistence in the presence of competition economically. Therefore, the existing attempts for the explanation of the differentiated structural change in agriculture are integrated within a theoretic extension of the existing theories.

The theoretic extension rests on the argument that the central characteristic of the agricultural sector is its inevitable link to land and this factor's immobility and scarceness. This characteristic has been recognised by agricultural economics, but has seldom been analysed

[1] See for example dlz 2/2007, S. 147; FAZ 126/2007, S. 15; SZ 135/2006, S. V2/4.

with respect to its consequences theoretically (an example is BALMANN et al., 2006) or empirically (a rare example is HURRELMANN, 2005). The link to land forces farmers to interact repeatedly with a restricted number of competitors. In the presence of rents of the status-quo, which result from the single-farm-restrictions on growth mentioned above, we expect to observe strategic behaviour on the market for land. Strategic behaviour is characterised by reciprocal anticipation of the competitors' behaviour. Thereby the regionally restricted interaction of farms has the potential to cause covariances in the decisions (GLAESER et al., 1996) of farmers. Systematic regional differences in farmers' behaviours are observable.

The following paper explains the theoretic considerations that shall explain regional differences in farm-development-strategies in more detail. Empirically testable hypotheses are going to be derived. The paper's structure is as follows: The main section of the paper (*chapter 2*) deals with the theoretic relationship of imperfect markets, strategic interaction and the observable multiplicity of farmers' strategies. The formal argument starts in *section 2.1* with a game-theoretic analysis of the potential for stabilisation of non-competitive behaviour in large populations. If interactions among agents are restricted, cooperative behaviour might actually be able to stabilise under certain circumstances. This finding justifies the analysis of the market for land in the framework of oligopoly theory of industrial organisation. Within this framework in *section 2.2*, the possibility of strategic competition among farmers is analysed. *Section 2.2.1* shows how, by the idea of competition on quantities rather than on prices, stabilising non-competitive behaviour of farmers might be justified economically. *Section 2.2.2* on the contrary analyses under what circumstances a rapid differentiation among farm-sizes can be expected. Finally, in *section 2.3* it is worked out that due to the situation on the land-market, where potential demanders for land are also potential suppliers of land, adverse price-reactions towards coordinated rising demand of competitive farms might be provoked. This situation causes the possibility of coordination-failures and thereby of multiple potential equilibria of the development. In *section 2.3.1,* the adverse price-effect is treated as a social complementarity, making it straight forward to apply a model of social interaction (as in contrast to a typical market-model). *Section 2.3.2* works out the conditions for stable and non-stable equilibria in the distribution of competitive and non-competitive strategies among farms. The paper concludes in *chapter 3* with an assessment of the theoretic framework's restrictions and potentials, of possible consequences of the theoretic considerations for the further modelling of structural change and with an outlook on the empirical assessment of the derived hypotheses.

2 Imperfect markets, the multiplicity of strategies and strategic interaction

Imperfect markets might cause local price-information and price-externalities. According to MAKOWSKI und OSTROY (1995) the resulting uncertainty with respect to the behaviour of others might cause "thin markets" in which no single optimal strategy exists but the rational agents rather construct "a myriad of individual byways of their own construction" (p. 811). Under these circumstances, the observable market does not necessarily represent the only possible market; from this fact results the possibility of coordination-failures.

Rents of the status-quo, which are due to imperfect markets, result in local price-information and cause thereby imperfect information and uncertainty. In the present work, building upon MAKOWSKI and OSTROY (1995), such rents are considered a necessary condition in order to explain the differing farm-development-strategies economically. Rents of the status-quo might result among others from sunk costs, insecurity concerning the future development of markets, imperfect labour markets, and political rents, from transaction-costs of various kinds or from an intrinsic value of the concerned activity. These factors have been discussed in the literature in the attempt to explain structural change on a single-farm-basis (see chapter 1). Therefore, the following theoretical considerations represent an extension of existing theories. The theoretic extension rests on the existence of rents of the status-quo, the resulting endogenous insecurity concerning the decisions and willingness to pay of competitors and the subsequent importance of expectations concerning the actions of competitors. Lasting coordination-failures, i.e. locked-in situations, might result because passed experiences determine these expectations.

These expectations are relevant within an environment of strategic interaction, which is characterised by reciprocal anticipation of expected decisions of competitors in the course of decision-making. Strategic behaviour of this kind is only possible, though, within restricted markets characterised by imperfect competition.

2.1 The significance of direct interaction

The present chapter serves the purpose to set forth why, even though farmers are numerous, structural change might depend on the direct interaction of subgroups of farmers. Principally, game-theoretic analyses often have demonstrated that in large groups coordinated interaction will not evolve as a stable phenomenon (e.g., HEAP and VAROUFAKIS, 2004). The respective models often build on the pay-off-matrix of a game of prisoners' dilemma (figure 3).

With respect to farmers' strategies in structural change "aggressive" behaviour in the present work is equated with the growth-oriented "competitive" strategy, while "cooperative" behaviour is equated with farm-stabilising (risk-minimising) strategies of reduced farm-growth. According to figure 3, a growth-oriented farmer, who comes up against a farm-stabilising farmer realises the highest pay-off. In this situation, the growth-oriented farmer realises maximal growth without high prices, which would result from strong competition. Strong competition occurs if two growth-oriented farmers meet each other: Due to ruinous competition, none of them realises a positive pay-off (rent). Expected (joined) profit might be maximised, though, if both farmers realise a strategy of reduced growth, because under these conditions each of them receives half of available land for a low price, resulting from reduced competition. The well-known dilemma of the game stems from the fact that the optimal reaction of every farmer towards whatever his competitor does is the realisation of a growth-oriented strategy. Therefore, the only Nash-stable equilibrium shows general growth-orientation of all actors.

Figure 3: Pay-off-Matrix of the prisoners' dilemma

	C	A
C	b-c	-c
A	b	0

C = Cooperation / farm-stabilisation
A = Aggression / growth-oriented, competitive

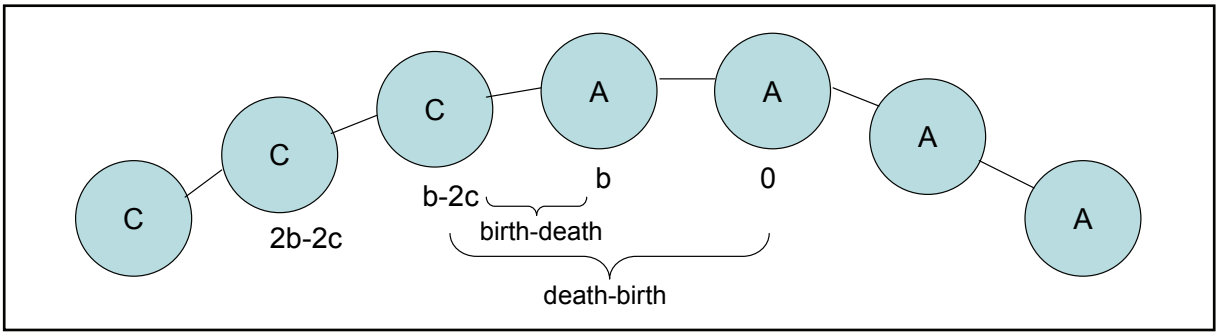
b = benefit of cooperation
c = costs of cooperation
b > c

Remark: In this case of homogeneous players and symmetric pay-offs the simplified version of the pay-off-matrix in the figure shows only the pay-offs of the row-player in each respective situation.

Source: Adopted from OHTSUKI et al. (2006; in „Supplementary information")

Since farmers are numerous and principally are free to interact within the borders of a nation, their economic behaviour has traditionally been analysed within this paradigm of uncoordinated interaction respectively of perfect competition[2]. With respect to competition for land, though, competition is restricted in space, due to the factor's immobility. Farmers interact in a direct manner only with a restricted group of competitors; interaction with all other farmers occurs in an indirect manner, via interaction of their neighbours and the neighbours of their neighbours. NOWAK (2006) has shown that restricted interaction might stabilise coordinated behaviour even in large groups. While the respective results can be generalised to interactions on a two-dimensional grid and even towards rather irregular restricted interactions within the concept of "games on graphs" (ibid.), their intuition is most easily demonstrated within the one-dimensional frame of a circle[3] (figure 4).

Figure 4: Pay-offs of the cooperative and aggressive strategy in the prisoners' dilemma on a circle



Remark: C = Cooperative strategy; A = Aggressive strategy

Source: Adopted from OHTSUKI et al. (2006).

[2] Another possibility would be to view the land-market as monopolistic with single suppliers who set the price. The rental market for land, though, does rather have the character of an auction (and it has usually been modelled in this manner, especially in multiple-agents models, see for example HAPPE et al., 2004). Here the oligopsonistic setting that is going to be justified in the present chapter applies.

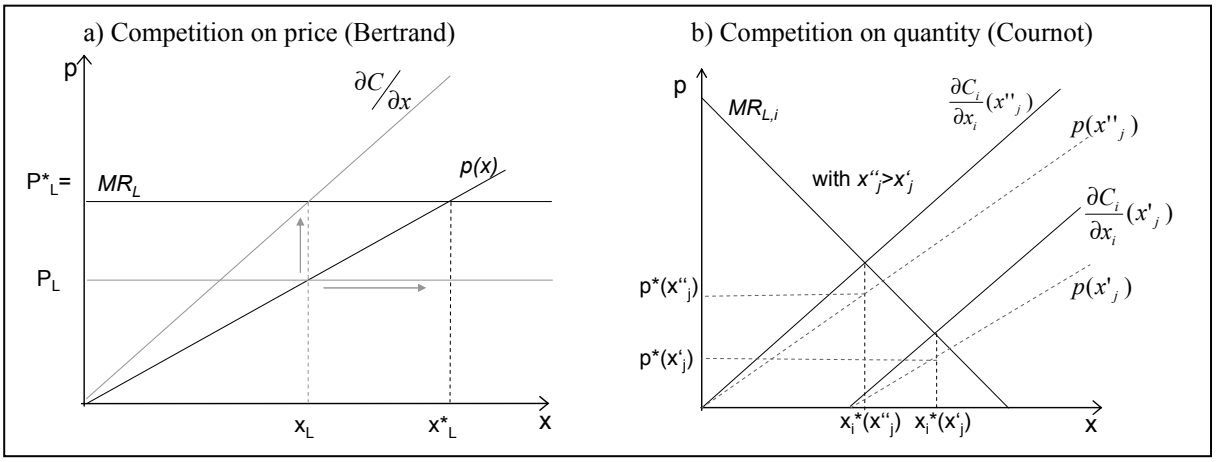
[3] BERGSTROM and STARK (1993) explicitly model the behaviour of farmers situated around a lake in much the same way.

On the circle, a group of growth-oriented and a group of stabilising farmers face each other. Direct interaction, though, occurs always only between two of them. The pay-offs noted in figure 4 correspond to the pay-offs in the matrix of the prisoners' dilemma (figure 3). OHTSUKI et al. (2006) differentiate two possible processes; in the birth-death-process, a new actor (enterprise) enters the game first and afterwards it is decided depending on the players' pay-off-situations, who will be replaced. In this case, the growth-oriented farmer survives generally and the only stable equilibrium of the two-player-game of the prisoners' dilemma is replicated. In agriculture, though, the release of land of one farm is a precondition for the growth of another. This corresponds to the death-birth-process (figure 4). In this process, farmers, who have not coexisted in direct competition so far, interact in the competition for given up land. In this case, the pay-off of the stabilising farmer exceeds the pay-off of the growth-oriented farmer if $b/c > 2$, and the strategy of reduced growth is stabilised. This rational justifies the judgement that the dependence of farming on land might be one of the central peculiarities, which differentiates structural change in agriculture from that observed in other sectors. Due to this dependence on the immobile and non-renewable factor land, it might be adequate to consider the possibility of strategic interaction among farmers.

2.2 Strategic competition on the land-market

Classical oligopoly theory (e.g., VARIAN, 1992; WOECKENER, 2007) offers a fruitful starting point for the analysis of interaction among farms on the land market. With its help, the possible advance of farm-stabilising strategies shall be explained on a micro-economic basis in this chapter. Since the usual textbook examples of strategic competition deal with the markets for commodities (oligopoly), the respective arguments have to be reversed in order to represent competition in demand for the scarce resource land (oligopsony). Due to the restricted number of direct competitors on the land-market, the single demander possibly exerts a noticeable influence on the price. Therefore, prices for land and marginal costs of growth rise with the demand of the single farmer (Figure 5a).

Figure 5: Oligopsonistic equilibria with constant and deminishing returns on growth



Remarks: p_L = Price for unit land; x_L = demand for land; p(x) = function of price in dependence of demand; $\delta C/\delta x$ = Marginal cost of growth; MR_L = Marginal revenue of land; p* = equilibrium's price; x* = equilibrium's demand; subscript "i" marks deciding farm, "j" the competing farm.

Source: Own figures

The rise of marginal costs of growth $\partial C/\partial x$ exceeds the rise in prices per unit land, since the latter affects the total amount of traded land. If the single farmer could choose his optimal demand independently, he would follow the rule that marginal cost of land should equal marginal revenues of land (MR_L).

$$(1) \qquad MR_L \equiv \frac{\partial \pi}{\partial x} = \frac{\partial C}{\partial x} = p + \frac{\partial p}{\partial x} x$$

with π as revenues, C as costs of growth, x as demand for land and p as price for land. This holds true as long as the binding condition that marginal profits (P) fall with growth applies (WOECKENER, 2007):

$$(2) \qquad \frac{\partial^2 P_i}{\partial x_i^2} < 0 \text{ i.e. } \frac{\partial^2 C_1}{\partial x_i^2} > \frac{\partial^2 \pi_i}{\partial x_i^2},$$

which applies as long as the marginal value of land ($\frac{\partial^2 \pi_i}{\partial x_i^2}$) is constant or diminishes with growth while marginal cost of growth ($\frac{\partial^2 C_1}{\partial x_i^2}$) rises. Therefore, in order to maximise profits, the farmer would realise p_L and x_L in Figure 5a. If the farm's growth-potential is unrestricted, i.e. the marginal value of additional land remains constant, though, a marginal rise in the willingness to pay of the single farmer compared to the bids of competitors would result in an only marginal price-effect while at the same time it guarantees that the overbidding farmer gets all the land available. Accordingly, as has been demonstrated in the prisoners' dilemma game, stabilising behaviour cannot be expected to evolve in this case; rather ruinous competition results with the only stable equilibrium at that point, where the marginal value of land equals its price (p^*_L and x^*_L in figure 5a). This market-course has been named "Bertrand-competition" (VARIAN, 1992).

2.2.1 Stabilising behaviour in a Cournot-competition

A necessary condition for the evolution of an uncooperative market-coordination that prevents ruinous competition and results in restricted growth (stabilising strategies) of competitors is a declining marginal value of land in the short and medium-term. Under these circumstances, all of the farmers know that the other farmers' desire for growth is restricted. Rents of the status-quo generate diminishing returns to scale and therefore rents of the relinquishment of growth. In order to realise these rents, market-participants have to enter into strategic competition in which each single actor's decision depends on the anticipated decision of his competitors. In an oligopsonistic environment, this means that if a participant anticipates a rising demand for land of his competitor, he has to calculate with an upward shifted curve of marginal costs of growth (Figure 5b).

In the case of a diminishing marginal value of land, the incentive for overbidding the competitors is low due to the reduced potential quantity-effect, which does not compensate for the price-effect of rising demand. Therefore, each of the competitors will adopt his demand with respect to the anticipated demand of the competitor. In Figure 5a farmer i expected to grow by $x_i^*(x'_j)$ with the original lower demand x'_j of farmer j. After adjusting his expectations towards the anticipated higher growth x''_j of farmer j and the resulting expected rise in marginal costs of growth, though, farmer i reduces his own demand towards $x_i^*(x''_j)$ due to the higher expected price.

Equation 3 formally gives the development of marginal costs of growth due to the changing demand of a competitor j (adopted from WOECKENER, 2007, p. 13):

$$(3) \qquad \frac{\partial^2 C_i}{\partial x_i \partial x_j} = \frac{\partial p}{\partial x_j} + \frac{\partial^2 p}{\partial x_i \partial x_j} x_i \,.$$

Since all of the homogenous market-participants follow the same rational under symmetric expectations, a Nash-equilibrium results (WOECKENER, 2007, p. 16), which is characterised by reduced growth of all farmers as compared to the maximal growth of the "winning" farmer in the Bertrand-competition (Figure 5a). The new Cournot-competition in contrast results from competition on quantity rather than on prices. In structural change of agriculture, it is characterised by a slow but constant growth of a high share of farms. This Cournot-competition therefore results in a "regime of stabilisation" with many stable full-time farms. This regime is most probable in regions with an agricultural structure characterised by farms of homogeneous size. This regime might be even more stable in regions that are characterised by capital-intensive types of production due to sunk costs and, on the other hand in regions dominated by smaller arable farms. These latter farms have often been organised in a labour-extensive form as part-time farms. The transition towards the organisation of a full-time farm would effort rapid growth and therefore high transaction-costs. Due to sunk-costs and transaction costs the short- and medium effects of scale diminish more rapidly, resulting in a more elastic adjustment towards anticipated growth of others.

2.2.2 Differentiated strategies in the Stackelberg-case

Among heterogeneous farms, though, more competitive farms might exist, which are able to signal believably their strong will for accelerated growth. Irreversible investments within capital-intensive types of production are believable signals of this kind. If the signalled intention to grow of these quantity-leaders is anticipated by the less competitive quantity-followers, the latter will reduce their demand for land even further due to the expected high prices for land (see figure 5b). The quantity-leader (1) now faces a new decision-rule (compare equation (1)). This rule follows a sequential logic in that the leader anticipates the reaction of the quantity-followers (2) on their anticipation of his signalled plans for growth (adopted from WOECKENER, 2007, p. 22):

$$(4) \qquad \frac{\partial \pi_1}{\partial x_1} = \frac{\partial C_1}{\partial x_1} = p\left(x_1, x_2(x_1)\right) + \left(\frac{\partial p}{\partial x_1} + \frac{\partial p}{\partial x_2} \frac{\partial x_2}{\partial x_1} \right) x_1 \ .$$

The price rises due to the quantity-leader's higher demand. Its development also depends on the follower's reaction, though. Usually the followers lower their demand less than the leaders' rise in demand. They realise less growth than in the Cournot-equilibrium for a higher price. The so-called Stackelberg-equilibrium arises. This kind of differentiated development is expected to be observed in regions with heterogeneous farm-structure, especially in regions characterised by capital-intensive types of production.

2.3 The coordination problem

So far, the assumption of perfect information has not been violated, either because the assumption of homogenous farms with symmetric expectations has been met or because farms that are more competitive deliberately signalled their planned growth in order to provoke the well-known desired reaction. Technically, farms could be quite sure about their competitors' decisions due to the assumption of linear reaction-curves. The elasticity in the reaction towards rising demand of competitors might be very low in certain regions of the curve, though, due to rents of the status-quo of existing full-time farms. In order to secure the realisation of these rents in the long-term the necessity for a constant minimal level of growth exists. Farmers neglect this necessity only in cases, where they lost their face in their lasting competitiveness.

In this case, another non-linearity in the reaction arises due to the fact, that every potential demander of land at the same time is a potential supplier of land. Farmers who face a growing demand of their competitors and lose their face in future possibilities of growth might chose to exit or to shrink. In such cases, the supply of land rises and the price for land might even drop with rising demand of competitive farms. This adverse price-reaction arises if the second term on the right-hand side of equation 3 turns negative and starts to dominate the functional relationship[4]. The same holds true for the term $\frac{\partial p}{\partial x_2} \frac{\partial x_2}{\partial x_1}$ in the behavioural rule of quantity leaders (equation (4)): the sudden extreme drop in the demand of quantity-follower 2, i.e. his transformation into a supplier, could dominate the development of prices. The resulting adverse price-reaction would offset the equilibrium-condition (equation (2)), and unrestricted growth of quantity-leaders in this situation would be possible. Therefore, the potential quantity-leader might attempt to drive out his competitors deliberately.

The growth even of quantity-leaders, though, is restricted by the diminishing returns on growth in the short and medium term and the insecurity about the competitors' non-linear reaction-curve. These combined factors cause a non-manageable risk of unrestricted growth and prevent even quantity-leaders from expanding their demand sufficiently in order to drive

[4] While WOECKENER (2007) states that the sign of the respective term in equation (3) is not determined he assumes that usually, the direct effect of rising demand dominates the development of prices (p. 13f).

out less competitive farms from the market and provoke the desired rising supply of land. Usually, the transformation of a demander into a supplier of land is a reaction towards high aggregated demand of competitive farms. Therefore, among heterogeneous farms the reaction of one group of competitors might depend on the aggregated behaviour of another group of competitors resulting in possible problems of behavioural coordination.

2.3.1 The adverse price-effect of aggregated demand as social complementarity

Due to this problem of coordination, depending of the participants' expectations concerning their competitors' demand, multiple equilibria might be realised since the effect of a single actor's decision depends on the simultaneous and insecure decisions of other actors. The central question under the possibility of multiple equilibria is, which expectations the theoretic framework substantiates with respect to possible development-paths in different circumstances. Problems of this kind have been tackled in models of social interaction:

> „By social interactions, we refer to the idea that the utility or payoff an individual receives from a given action depends directly on the choices of others in that individual's reference group, *as opposed to the sort of dependence which occurs through the intermediation of markets*" (BROCK and DURLAUF, 2001A; emphasis added by AM).

The two preceding sections have demonstrated that in the presence of market-externalities the direct interdependence of pay-offs possibly exist within markets, too. In the following, the equivalence of the decision-rule for a group of potential quantity-leaders with the model of BROCK and DURLAUF (2001) for social interaction is demonstrated. The potential quantity-leaders have to decide upon whether they plan to grow within the restrictions of presently available land (stabilising strategy) or whether they attempt to drive out quantity-followers by their own unrestricted growth (competitive strategy). BROCK and DURLAUF conceptualise this as a binary decision problem with ω_i as the decision variable with the two possible realisations {-1,1}. The decision for unrestricted growth is 1, the decision against it is -1.

In this model the utility V of a decision ω_i is determined by (adopted from BROCK and DURLAUF, 2001)

$$V(\omega_i) = u(\omega_i) + S\left(\omega_i, \overline{m}_i^e\right). \tag{5}$$

Here $u(\omega_i)$ describes the direct utility of the own decision and $S\left(\omega_i, \overline{m}_i^e\right)$ describes the indirect effect on utility which results from aggregated behaviour. It depends on the own decision and the mean decision of other participants of the group ($\overline{m}_i^e$). Since utility in economic models per definition is equated with profit (P), the equivalence of equation (5) with the economic profit-function becomes obvious:

$$P(x_i) = \pi(x_i) - C\left(x_i, x_j\right). \tag{6}$$

The following equation describes the change of utility in dependence of the own decision and the competitors' reaction:

$$(7) \qquad \frac{\delta^2 V}{\delta\omega_i \delta\overline{m}_i^e} = \frac{\delta u}{\delta\omega_i} + \frac{\delta^2 S}{\delta\omega_i \delta\overline{m}_i^e}.$$

For the case of complementarity of decisions, that is if utility of decision 1 for one agent positive correlates with the same decision of other market participants, the interaction-parameter J (BROCK and DURLAUF, 2001) will be positive:

$$(8) \qquad \frac{\delta^2 S(\omega_i, \overline{m}_i^e)}{\delta\omega_i \delta\overline{m}_i^e} = J > 0$$

Taking into account the equivalence of (5) and (6) the equivalence of (7) with equation (3) from the model of strategic interaction can be demonstrated:

$$(9) \qquad \frac{\delta^2 V}{\delta\omega_i \delta\overline{m}_i^e} \equiv \frac{\delta^2 P}{\delta x_i \delta x_j} = \frac{\delta\pi}{\delta x_i} - \frac{\delta p}{\delta x_i} - \frac{\delta^2 p}{\delta x_i \delta x_j} x_i .$$

The interaction-parameter J from the model of social interaction might therefore be equated with the price-effect due to aggregated demand:

$$(10) \qquad -\frac{\delta^2 p x_i}{\delta x_i \delta x_j} \equiv \frac{\delta^2 S(\omega_i, \overline{m}_i^e)}{\delta\omega_i \delta\overline{m}_i^e} = J .$$

According to (8) complementarity in decisions might result if the second derivative of prices with respect to aggregated demand is negative that is if we observe a diminishing raising effect of demand on prices.

The positive private effect of rising demand on utility (profit) ($\frac{\delta\pi}{\delta x_i} - \frac{\delta p}{\delta x_i}$) in (8) diminishes constantly. On the other hand, the negative effect of aggregated demand on utility per assumption diminishes, too. This marginal positive contribution of own demand on own profit-development might dominate the negative direct price-effect of own demand as soon as the case of adverse price-reaction on aggregated demand (chapter 2.2) occurs. A qualitative change in decision should be expected at this point due to the complementarity between competitive farms' decision on growth at this point of the curve.

2.3.2 Consequences of the complementarity for farmers' strategic decisions

BROCK and DURLAUF (2001A) suggest the following functional relation between the inter-action-effect, the own decision and the mean-decision of all agents on the one hand and the social utility on the other:

(11) $S(\omega_i, \overline{m}_i^e) = J\omega_i \overline{m}_i^e$.

Therefore, the diminishing effect of aggregated demand on the rising prices multiplicatively increases with aggregated decision for the strategy of growth. Consequently, the possibility to contribute to accelerated exit of farms of the single farms growth-decision rises significantly with other competitive farmers' decision for growth. The resulting utility-(profit)-function is

(12) $P(\omega_i) = \pi(\omega_i) - c(\omega_i) + J\omega_i \overline{m}_i^e$.

BROCK AND DURLAUF (2001A) simplify the profit-function with the parameter h, which is proportional to the deterministic private utility-difference of the two alternative choices with "-1" as the decision against a competitive strategy:

(13) $h = ½ (\pi(1) - c(1)) - (\pi(-1) - c(-1))$

leading to

(14) $P(1) = h + 1 * J\overline{m}_i^e$ and $P(-1) = -h - 1 * J\overline{m}_i^e$

The possibility that a participant decides in favour of the competitive strategy (1) depends on the relation of expected profits of both strategic options:

(15) $\Pr(1) = \Pr(P(1) > P(-1))$.

The probability of a single strategy to be realised can be calculated as

(16) $$\Pr(1_i) = \frac{\exp(P(1_i))}{\sum_{\omega_i \in \{-1,1\}} \exp(P(\omega_i))}.$$

The expectation concerning the populations decision may now be calculated via combining (14) and (16) as

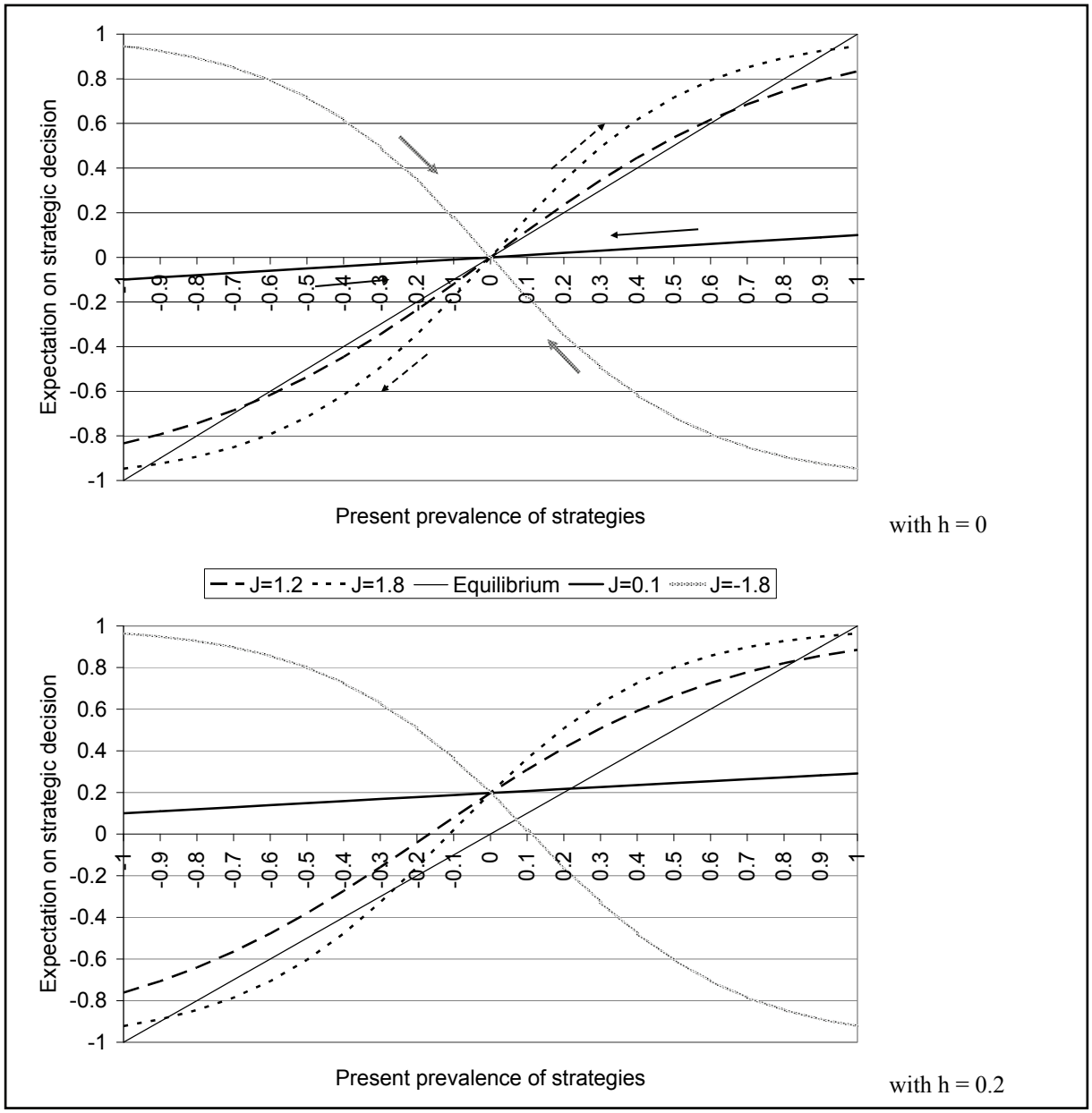
(17)
$$\begin{aligned} E(\omega_i) &= 1(\Pr(1) + (-1)(\Pr(-1)) \\ &= 1 \cdot \frac{\exp(P(1))}{\exp(P(1)) + \exp(P(-1))} - 1 \cdot \frac{\exp(P(-1))}{\exp(P(1)) + \exp(P(-1))} \\ &= \frac{\exp(P(1)) - \exp(P(-1))}{\exp(P(1)) + \exp(P(-1))} \\ &= \tanh(h + J\overline{m}_i^e) \end{aligned}$$

Assuming symmetric expectations and homogeneous agents with respect to h_i it follows the condition for possible equilibria:

(18) $m^* = \tanh(h + Jm^*)$.

In accordance with the characteristics of the hyperbolic tangens under certain conditions, multiple possible equilibria are existent. The relationship of J and m^* at $h = 0$, i.e. without an intrinsic utility-difference between the two alternative choices, is depicted in the upper part of figure 6. We observe equilibrium if the expected probability of the strategy-choice (y-axis in figure 6) equals the distribution of realised strategies in the population (x-axis in figure 6). The diagonal represents all imaginable points of equilibrium.

Figure 6: Possible equilibria in strategy-choice depending on the initial situation and the price-effect of aggregated demand



Source: Own figure based on simulated data

The figure shows that multiple equilibria are only possible if $J > 1$, that is, if a negative development of prices with rising aggregated demand is possible. If aggregated demand only reduces the positive price-effect of rising individual demand ($J = 0.8$ in figure 6) a mixed-type equilibrium is predicted, where at a certain point of time only a fraction of all quantity-leaders realises the competitive strategy. The same expectation holds true if J is smaller than zero, that is, if aggregated demand exaggerates the positive effect of demand on price-development. The arrows in figure 6 point to the stable equilibria. While with $J > 1$ three equilibria exist principally, the mixed equilibrium is not stable. Minor exogenous influences cause the development to change towards a stronger predominance of the stabilising or the competitive strategy.

Moreover, the development is sensitive towards differences in profitability of growth in time or space. The bottom part of figure 6 shows the same curves for the case, that farmers do realise positive rents of growth considering only the direct price-effect of their demand ($h > 0$). The figure shows that in this case the existence of multiple equilibria depends on the relation of J and h. Only if the interaction effect is high ($J = 1.8$) three intersections with the diagonal can be observed. Otherwise, only the respective equilibrium with domination of growth-strategies (mean-strategy-value > 0) exists. This movement towards dominance of growth-strategies is much stronger, though, in regions with a positive interaction-effect than in regions, where no or little adaption of other farms' demand occurs. Therefore, it has to be expected that in regions with heterogeneous farms and potential quantity-leaders in times of favourable macro-economic conditions growth of competitive farms is accelerated particularly strong, resulting in an accelerated exiting of farms on the other hand. SCHEINKMAN (2008) calls this a multiplier-effect, which might be used in order to test the presence of social interaction-effects empirically.

The results are intuitively understandable: As long as farmers do not expect other competitive farms to raise their demand simultaneously, they will expect a normal price-reaction towards their own demand. Even quantity-leaders will only attempt restricted growth due to diminishing marginal revenues in the short- and medium-term. Despite of the existence of farms with superior competitiveness the differentiation between farms remains restricted and a stabilising regime with relatively few exiting farms results. Once farmers' expectations have changed, though, possibly due to external influences causing coordination in the rising demand of all competitive farms, the adverse price-reaction on the land-market can be anticipated causing coordinated growth within the group of potential quantity-leaders.

3 Outlook and conclusions

It was the aim of the present work to offer a theoretic approach for the economic explanation of observable regional differences in farmers' behaviour. In order for such clusters to evolve, a coordination of strategic variations in the course of structural change is necessary. In a first step, it was demonstrated that such coordination is possible theoretically within large populations even in a competitive environment. The necessary conditions of this result apply to agriculture: The interaction is (spatially) restricted and precondition for growth of one farm is the decline of another.

Then the theoretic framework of strategic competition was applied to the land-market. Thereby, a possible microeconomic reason for the evolution of stabilising non-competitive strategies was given: In the presence of rents of the status quo, competition is on quantities rather than on prices, and a Cournot-equilibrium with slow constant growth of a maximum number of farms evolves. The testable hypothesis was formulated that such a "conservative" development will predominate in regions characterised by farms of homogeneous size and either capital-intensive types of production or specialised arable-farms of small and medium-size.

It was also demonstrated that in strategic competition sunk costs due to highly specific assets enables more competitive farms to signal believably their will for growth. In the resulting Stackelberg-case, the quantity-followers anticipate these plans of the quantity-leader and reduce their own growth further. It is expected for the empirical test that the resulting further differentiation of farm-sizes predominates in regions characterised by heterogeneous farm-sizes and capital-intensive types of production.

Finally, within a model of social interaction the possibility of coordination-failures and multiple equilibria in structural change are demonstrated. Coordinated growth of potential quantity-leaders would result in strong competition on the land-market and might cause an adverse price-reaction due to the transformation of less competitive demanders into suppliers of land. This would cause a regime of growth with accelerated structural change. If no exogenous coordination of strategies occurred, though, the farms would remain within a stabilising regime. The empirical hypothesis is put forward that due to the coordination of the desire for growth a "multiplier-effect" arises in times of economic booms that causes temporarily a stronger differentiation among farm-sizes. Due to the central role of expectations in strategic competition, though, it is expected that, despite of these temporary changes in regimes, initial structural conditions keep up a lasting influence on future developments.

The presented work therefore shows that the sector's characteristics, especially its relatedness to land, can explain the observed peculiarity of structural change in agriculture. Due to market-imperfections, different farm-development-strategies exist and due to strategic interaction, different regional clusters of strategies evolve in a self-reinforcing manner. Due to the role of expectations, not only determines initial structure farmers' behaviour, but farmers' behaviour influences upon future structural development, too. Important consequences for the modelling of or intervention in structural change of agriculture exist. Especially, the development might not react as sensitive towards exogenous influences as a single-farm-based eco-

nomical model would predict. At the same time, in economic booms or with the adoption of growth-favouring political interventions, strong temporarily reactions may be observed in some regions. Generally, due to the strategic interaction of farms, political interventions might not support desired developments as effectively as expected, while unintended side effects could be stronger than anticipated in advance.

In the empirical continuation of this work, the derived hypotheses are tested within a panel-model of latent growth, which explains the stability of medium-size farms in the last 30 years. Additionally, observed strategies of farmers, which are revealed by a standardised and regionalised survey among farm-advisors, are related to structural conditions and can also be explained within the theoretical framework presented in this paper. Further theoretic work remains to be done in the explication of the specific games of strategic competition on the land market. Furthermore, the sketched model has to be fit in the existing schools of economic thought. Finally, it also should be clarified in future work, whether agriculture is a special exception or might serve as a paradigmatic example for the applicability of models of strategic interaction to markets that consist of numerous competitors.

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