Coordination and Differentiation of Strategies: The Impact on Farm Growth of Strategic Interaction on the Rental Market for Land

Die Koordinierung und Differenzierung von Strategien: Betriebsgrößenwachstum und strategische Interaktion auf dem Bodenpachtmarkt

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Abstract

Among the family farms in Western Germany, regional differences in farm-development strategies can be observed. The land market has been identified in the literature as crucial for farm growth. In various studies, developments are driven by assumptions about the effects of scale and the initial heterogeneity of farms. In contrast, the present paper focuses on the potential role of opportunistic and future behaviour for the development of different farm strategies. In order to demonstrate the potentially crucial role of strategic behaviour, we introduce a thought experiment and focus on the theoretical case of identical farms. In the light of ideas from theories about oligopolistic markets, two central problems of decision-making are identified: the coordination problem of farm exits and the problem of strategic choices made by the remaining farms. This paper supplements explanations that argue on the basis of farms' heterogeneity in that it offers an approach to the question of why farms might not overcome their short-term constraints in order to realise strategic advantages in competition.

Key words

structural change; land market; oligopolistic competition; strategic complements; strategic substitutes

Zusammenfassung

Regionale Unterschiede in den Betriebsentwicklungsstrategien der landwirtschaftlichen Familienbetriebe der westlichen Bundesländer Deutschlands sind beobachtbar. Der Bodenmarkt wurde in der Literatur als zentraler Faktor für das Wachstum landwirtschaftlicher Betriebe identifiziert. Normalerweise wird die Entwicklung in entsprechenden Studien durch Annahmen über Skaleneffekte und die anfängliche Heterogenität der Betriebe bestimmt. Im Gegensatz dazu steht im vorliegenden Papier die Rolle zukunftsgerichteten und opportunistischen Verhaltens für die Entwicklung unterschiedlicher Betriebsstrategien im Vordergrund. Um die möglicherweise zentrale Rolle strategischen Verhaltens zu verdeutlichen, wird in einem Gedankenexperiment der theoretische Grenzfall identischer Betriebe untersucht. Im Lichte von Ideen aus Theorien zum oligopolistischen Wettbewerb werden so zwei zentrale Entscheidungsprobleme ausgemacht: Das Koordinierungsproblem der Betriebsaufgabe und das Problem der Strategiewahl der verbleibenden Betriebe. Der Beitrag ergänzt die Erklärungen, die von betrieblicher Heterogenität ausgehen, indem ein Erklärungsansatz dafür angeboten wird, warum Betriebe nicht ihre kurzfristigen Restriktionen überwinden, um sich so einen strategischen Vorteil im Wettbewerb zu sichern.

Schlüsselwörter

Strukturwandel; Bodenmarkt; oligopolistischer Wettbewerb; strategische Komplementarität; strategische Substitutivität

1 Introduction: Motivation and Research Question

The western federal states of Germany are characterised by a traditional family-farm structure. Due to productivity growth on the one hand and declining prices on the other, full-time farms have to expand (COCHRANE, 1958). However, due to the linkage of agricultural production to land, some farms cannot grow unless other farms shrink or exit (e.g., BALMANN et al., 2006). In western countries a delay in this structural change, resulting in manifestly suboptimal farm sizes, has been frequently detected (BALMANN, 1997;

BOEHLJE, 1992). Numerous studies attempt to explain structural change in terms of delayed growth of single farms. Generally speaking, the argument in these studies revolves round different kinds of rent of the status quo. The reduced growth of some farms is explained by hysteresis (HINRICHS et al., 2006), sunk costs and insecurity of future expectations (CHAVAS, 1994), non-tradable utility components (z-values; KEY and ROBERTS, 2009) or the farm-household model (HENNING, 1994). Two problems exist concerning these types of explanation. One is the question of why not some farms overcome the "tyranny of the status-quo" (DIXIT, 1992). If they did, they would, for example, gain a competitive advantage on the land market and crowd out those farms, which do not overcome the problem of transaction costs associated with change. The other problem is why the willingness or ability to change does seem to be much higher in some regions, and why the remaining competitive farms do not expand into regions with delayed structural change.

The differences of mobility in certain farm types can be illustrated by the development of the share of small, medium, and large farms in different types of region as illustrated in figure 1. It shows the mean development of the groups of small, medium-size, and large farms between 1979 and 2003 for different types of district. 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.[1] Specifically, in regions with initially large farms we observe a decline in the share of medium-size farms accompanied by relative stability in 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 initially characterised by smaller farms, the share of medium-size farms grows or remains stable, while the share of small

Figure 1. **Development of the Mean Share of Farms by Size Classes in all Farms and by Initial Structural Situation and Regional Characteristic Types of Production**
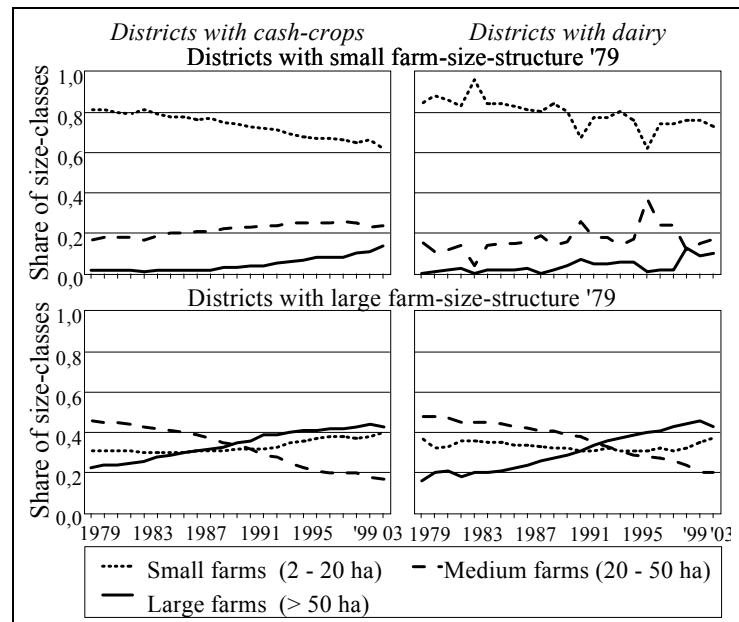
Source: own figure based on agricultural census 1979-2003

farms declines. Accordingly, medium-size farms are characterised by a higher mobility in regions dominated by large farms. Consequently, the developments do not converge towards identical structures in the medium term.[2] Regional differences in the mobility of farms have been detected in transition probabilities calculated from micro data, too (HUETTEL and MARGARIAN, 2009). They are an expression of regionally differing growth strategies. Strategies are understood as action plans to achieve a particular goal. If rents of the status quo are connected with the existence of a farm, the goal might be the stabilisation of the farm in order to realise future rents (MARGARIAN, in press). In order to guarantee future stability, one possible strategy could be the maximisation of technical and allocational efficiency and of competitiveness on relevant markets. Another possible strategy could be the minimisation of opportunity costs in the presence of imperfect markets.[3]

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[1] We have not presented an alternative differentiation according to the regions' general economic situation. Differences in those cases were even less pronounced than in differentiation by production type.

[2] In the long term, only large farms will remain, no matter what the underlying model is. However, as KEYNES put it: "In the long run we are all dead" (1923: 80).

[3] Concerning the relation of imperfect markets and a possible multiplicity of strategies, refer to the concept of "thin markets" and "thick markets" of MAKOWSKI and OSTROY (1995).

For German farms, numerous sociological studies have 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 often not analysed. OHE (1985), in concluding his exploratory study of farmers' strategies, puts forward the hypothesis, though, that farm income as motivation to keep on farming differs regionally. Some economic studies exist that hint at regional differences in farm-development strategies. An example is ROEDER et al. (2006), who discover regionally differing shadow prices for labour on farms. GOETZ and DEBERTIN (2001) report regional differences in the decision to work off-farm, and WEISS (1999) reports regional differences in the decision to expand. TIETJE (2004) analyses young farmers' decisions to continue farming and reports differences in the attitudes of German and Austrian farmers. Additionally, these regional differences represent common knowledge expressed, for example, in non-scientific articles on farmers' strategies[4] or in discussion among experts. Economic causes of regionally differing strategies of farmers have not so far been analysed in a systematic manner.

In a competitive environment, there are two general ways of explaining these regional differences in farm strategy. The first is the existence of regionally differing rents of the status quo and the second is an endogenous development due to specific interactions among farmers. The idea of regionally differing rents of the status quo was the motivation for many empirical investigations of the causes of structural change conducted at a single-farm level (e.g., WEISS, 1999) or at an aggregated regional level (e.g., GLAUBEN et al., 2006). These studies often refer to the farm-household model. Here, regional differences in the growth of farms are explained by differing household characteristics and exogenous differences in the social and economic regional environments. However, the empirically detected impacts of variables like unemployment are often unexpected or ambiguous. (BREUSTEDT and GLAUBEN, 2007; GLAUBEN et al., 2006; GOETZ and DEBERTIN, 2001; MARGARIAN, 2007).

Therefore, since exogenous differences do not seem to explain fully the observed coordination of farmers' strategies, the second approach of endogenous coordination, i.e., of regional interaction of farmers, is being followed in the present paper. Regional

economic interaction among farmers occurs foremost on the rental market for land. The possible role of the land market for differing strategies of farmers is going to be explored in a thought experiment. In section 2, a short overview is given of studies that explore the relation between structural change and the land market. Section 3 outlines the characteristics of the interacting homogenous farms in the thought experiment and sketches a very basic model of structural change. Section 4 extends the model in order to incorporate strategic interaction on the land market. Section 4.1 describes the coordination problem that results from the simultaneous decision on exit and growth of farms. Section 4.2 analyses the decision problem of potentially stable farms with respect to the desired degree of growth. Conclusions and an outlook on future work are given in section 5.

2 Literature Review: The Role of the Land Market

The central relevance of the land market for agriculture is stressed by BALMANN (1995: 37). He argues that the availability of labour and capital is practically unlimited for the small agricultural sector. Due to its scarcity, land is the limiting factor for agricultural production. Therefore, as BALMANN explains, a farm's size may be expressed in terms of land as long as one assumes that labour and capital are allocated in an optimal fashion. On the other hand, this means that land scarcity determines the optimal allocation of labour and capital on a farm and therefore the intensity of production. Accordingly, the link of growth of agricultural production to the factor land causes a strong interrelation between farms' growth strategies. Given this scenario, conditions on the rental market for land have received surprisingly little attention in the literature on structural change in agriculture. Nevertheless, some studies do exist that explain the differentiated farm-development strategies of farmers with reference to the land market.

LEATHERS (1992) states that "if a land price is to be observed, there must be trade of land; if the aggregate supply is fixed, those trades must occur among farmers (rather than sales from an input supply industry to farmers); if all farmers were identical, no trade would occur in equilibrium". Nevertheless, due to the macro-economically motivated ongoing structural change, we do not observe this equilibrium. In the process of structural change, though, farmers should be expected to realise that if none of them moved, all

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4   See for example dlz 2/2007: 147; FAZ 126/2007: 15; SZ 135/2006: V2/4.

of them would lose their viability as full-time farms. Anticipating this danger, some of the identical farms would prefer to exit or shrink and others to grow. Homogeneity of farms would not prohibit the development but would cause a coordination problem, which hinders the prediction of a unique equilibrium[5]. Assuming heterogeneity, LEATHERS (1992) shows in a theoretical model how the farms' reactions to political interventions due to the restrictions of local land markets depend on the regional farm structure.

Another example of the recognition of the significance of land markets for structural change is VRANKEN and SWINNEN (2004: 308). They show the more powerful effects of capital-market imperfections that result from heterogeneous farms' direct interaction on the leasing market for land: "More credit market constraints will reduce the likelihood that a household will rent in land. It makes it more likely that it rents out land. There is a secondary effect that reinforces this. Credit market constraints will also reduce labour use on the farm. More credit market constraints will result in less farm labour use. This will, in turn, cause a decline in the marginal productivity of land, and consequently, further reduce renting in of land and increase renting out of land." VRANKEN and SWINNEN (2004) show that in their research area the land market may be distorted due to the extreme heterogeneity of a few very large farms and many unstable small farms. Nevertheless, due to this setting, farm structure remains largely exogenous to the development.

ROBERTS and KEY (2002) also consider the impact of capital-market imperfections, taking into account the interrelatedness of farms. They argue that, due to liquidity constraints, farms that have restricted access to credit have to quit production earlier in times of negative developments in the sector. Therefore, farms with good credit-market access would grow even more in these times of negative development. ROBERTS and KEY deduce structural consequences from the assumption that it is mainly small farms that have restricted access to the credit market.

CHAVAS (1994) argues that from the interplay of insecure knowledge and sunk costs strategies with reduced long-term investments result. This effect depends on expectations concerning the future stability of the farm. Obviously, present decisions impact upon future expectations. Nevertheless, the possibility that farms anticipate the development of neighbouring

farms and act strategically is not explicitly taken into consideration. FEINERMAN and PEERLINGS (2005) are more explicit regarding the role of expectations concerning the stability of neighbouring farms in their study on the role of future land availability for the growth of Dutch dairy farmers: "Buying or renting land is often not possible for specific farmers because they require land close to their farm and the only possibility to buy or rent land is when their neighbour quits farming. Whether and when the neighbour will quit is unknown to them, but they have a-priori expectations about the likelihood of these events. Uncertainty about the possibility of buying land is therefore, in some cases (land intensive sectors), greater and more relevant than the uncertainty with respect to prices, policies and technology." The authors show in a simulation study that present investment should be higher the higher the probability that land will become available in the near future. However, they do not take into account the possibility of strategic investment. Rather, they view availability of land as exogenously given. Moreover, farmers would not only have to anticipate future land availability but also their neighbours' future demand for land.

Mainly in agent-based models, attempts have been made to approach the problem of endogenous farm-structure development via simulations (BALMANN et al., 2006; LAUBER, 2006). Nevertheless, even in these models, the theoretical and empirical basis of agents' interaction on the land market is rather weak (KELLERMANN et al., 2008). Usually, the agents' actions are guided by short-term considerations concerning the marginal profitability of growth. In such a setting, path dependency may be generated by certain assumptions concerning local and global optima in the size of farms (BALMANN, 1995). According to this argument, if additional to the global optimum in farm size a second local optimum exists, there is no guarantee that the global optimum will be reached if most farms start out with a smaller farm size than the local optimum. As KUMBHAKAR (1993) states, though, "[…] in a perfectly competitive market situation a farm subject to increasing returns to scale will go bankrupt eventually". Why some small farms do not take off in the direction of the global equilibrium does indeed require further explanation. Moreover, empirical investigations find either an L-shaped form of scale effects (HALLAM, 1991) or constant returns to scale (VLASTUIN et al., 1982; PETERSON, 1997). According to the latter, the assessment of scale effects seems to depend on the assessment of opportunity costs. Actually, imperfect markets might create rents of the

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[5] Concerning the lack of unique equilibria in coordination games, see for example HARGREAVES HEAP and VAROUFAKIS (2004: 68 et seq).

status quo and thereby forces that contribute to local optima (BALMANN, 1995). Nevertheless, due to the ambiguity of results concerning empirical scale effects and the insecurity concerning the stability of local optima if farmers act strategically and with future-orientation, further elaboration of the argument seems necessary.

Consequently, the forces that hinder the transition from local to global optima are still awaiting an explanation. HURRELMANN (2005) analyses Polish land markets empirically. She identifies several formal and informal institutions that regulate transactions on the land market on a local scale. Rules appropriate to the local situation exist because of the welfare aspects that concern the whole group of existing farmers. The possibility of strategic and opportunistic behaviour and their effect on the stability of the observed equilibria is not the focus of her work. Therefore, we are left with the interesting question regarding which special conditions on the land market might contribute to the stability of coordinated competition.

In summary, the studies show the potential relevance of the land market for the diversity of farmers' strategies. Their main limitation regarding the question of the stability of regionally differing strategies lies in the assumption of short-term optimising behaviour of farmers. The aim of the following is to analyse under what circumstances different farm strategies may co-exist if farmers act strategically and with rational long-term expectations. Due to the immobility of land we might well expect strategic behaviour. It forces farmers to interact repeatedly with a limited number of competitors. Strategic behaviour is characterised by reciprocal anticipation of the competitors' behaviour.

3 A Simple Model of Farm Growth and Land

It is well known that full-time farms have to grow in order to maintain their viability[6]. The main reasons are ongoing technical progress and the growing productivity of labour in agricultural production on one hand and a continuing decline in prices for agricultural products on the other (COCHRANE, 1958; DENNIS and ISCAN, 2007). Since agricultural produc-

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[6] In 1972, KÖHNE calculated roughly for West Germany that a farm would have to grow by about 2-3 hectares in order to stabilise farm income in real terms. He concluded that such growth did not seem to be realistic in the light of the much lower observed mobility of land.

tion is linked to the non-renewable factor land, for some farms to grow others have to decline. If the heterogeneity and differences in marginal productivity are high, this share of declining farms will be relatively large (HUETTEL et al., 2010). With heterogeneous farms, assumptions concerning effects of scale may alone drive the development. The strategic problem that farmers face in their decision on growth may be clarified better with initially homogenous farms.

This situation is set up in the following as a thought experiment. It serves the purpose of clarifying potentially crucial problems in the imperfect land market. In a static model, we assess a single decision situation experienced by identical farms. Initially, in t-1, land (L_i), labour (l_i) and durable capital (C_i) are fixed:

$$(1) \quad \begin{aligned} \Pi_i(\bar{L}_i, \bar{l}_i, \bar{C}_i, x_i \mid t-1) &= R_i(\bar{l}_i) \\ &+ \pi_i(t-1)o_i(x_i \mid \bar{L}_i, \bar{l}_i, \bar{C}_i) \\ &- c_i(x_i \mid \bar{L}_i, \bar{l}_i, \bar{C}_i) \end{aligned}.$$

Here, Π_i is the profit of farm i. Initially, durable production factors C_i are sunk. Farms own their initial land endowment L_i. Variable production factors x_i may include non-family labour. The farms' output o_i and variable costs c_i depend on fixed and variable inputs. Commodity prices π_i decline over time. R_i describes certain rents of the full-time farm that exist independently of production. The simplifying assumption is that these rents are lost, once the family labour employed on the farm is reduced and the full-time farm turns into a part-time farm. Given the durable production factors labour, land and capital in t-1, we observe declining marginal productivity of variable inputs in t-1: $\dfrac{\pi\delta^2 o_i}{\delta x_i^2} < 0$ and $\dfrac{\delta^2 c_i}{\delta x_i^2} > 0$.

The farms maximize profits initially:

$$(2) \quad \frac{\delta\Pi_{i,t-1}}{\delta x_i} = \frac{\pi\delta o_i}{\delta x_i} - \frac{\delta c_i}{\delta x_i} = 0.$$

The farms are also efficient in terms of allocation initially:

$$(3) \quad \frac{\delta\Pi_{i,t-1}}{\delta L_i} = \frac{\delta\Pi_{i,t-1}}{\delta l_i} = \frac{\delta\Pi_{i,t-1}}{\delta C_i}.$$

Nevertheless, commodity prices decline over time and with them profits decline, and in period t we observe $\dfrac{\pi\delta o_i}{\delta x_i} < \dfrac{\delta c_i}{\delta x_i}$. If production intensity is reduced as a consequence, sufficient payment of family labour is no longer guaranteed. The farm would have to decline

in terms of family labour and land. According to our assumption, though, it loses its special rents as a full-time farm as soon as family labour declines. The alternative is to realise the potential created by technical progress. Investment in certain fixed capital facilitates the exploitation of more land with the same amount of family labour and compensates for declining commodity prices. In order to gain these advantages, the farm has to make long-term investments and it has to expand its land area. We adhere to the assumption that the supply of capital for the small sector of agricultural production may be perfectly elastic (BALMANN, 1995). Land is conceptualised as the restrictive factor. Accordingly, decisions on investments in durable production factors are determined by the expected availability of land.

Therefore, in period t, the farms face the decision either to decline or to extend their land area. If they take no action, due to declining commodity prices, losses caused by the inefficient use of family labour will finally outweigh the rents connected with the full-time farm. Consequently, if no farm responds, eventually all of them will lose the status of a full-time farm with related rents. If farms anticipate this danger, they might be willing to decline if they are compensated for the loss of expected discounted future rents $R_i^{\exp}$. These are

$$(4) \quad R_i^{\exp} = \sum_T \frac{1}{(1+r)^T} R_{i,T}$$

with r as the interest rate and T the expected time of realisation of rents. The interest rate depends on security of the future flow of rents. We assume perfect labour markets. Family labour will be employed outside agriculture with at least the same wage as that achieved within agriculture. Therefore, the focal market is the land market. The farms will be willing to rent out land if the rental price not only compensates for the land's marginal production value but also for the expected future rents that the declining farms lose:

$$(5) \quad \frac{\delta \Pi_i}{\delta x_i} \le p \implies R_i^{\exp} + \frac{\pi(t)\delta o_i}{\delta x_i} - \frac{\delta c}{\delta x_i} \le p .$$

Here p is the rental price of land. $R_i^{\exp}$ represents the expected discounted flow of all present and future rents dependent on the stability of current farm organisation. While marginal productivity of land for all the identical farms will be identical too, the value of $R_i^{\exp}$ depends on the farms' expectations. Those farms that decide to decline calculate with a reference sce-

nario of total immobility and, therefore, with a short period T for the realisation of future rents (equation 4). Those farms that decide to grow expect that others will exit and supply land. They calculate with a longer period T and, therefore, with higher expected rents due to their own ability to grow. Expanding farms are, therefore, willing to compensate exiting farms, because they are able to realise higher discounted expected future rents with their growth than exiting farms lose.

Due to the fixed character of lost rents, farms in our thought experiment are assumed to exit subsequently rather than to shrink simultaneously. Thereby, no matter how much a farm declines, the mean price for an exiting farm's land is lower, the higher the share of rented-out land. Therefore, compensation is facilitated if a large share of a farm's land is rented out. Accordingly, farms have to decide whether they plan to exit or to grow. If they decide to grow, they have to make decisions on investment in capital and in land. In their decisions, all farms have to anticipate the decisions of other farms. Since the future viability of all current full-time farms depends on current decisions on investment, the decision situation of the farms may be judged as an entry game as described in the Industrial Organisation literature. Thus the thought experiment with homogenous farms makes it clear that farms inevitably have to act strategically in order to optimise their decisions. This will be outlined further in the next section.

4 Strategic Competition on the Land Market

Typically, each farm interacts on the rental market for land with a restricted number of competitors (GIULIANI, 2002).[7] This allows for strategic interaction, which is defined by WOECKENER (2007) as a decision, which directly and noticeably depends on the decisions of others. WOECKENER explains that, in order to make such an interdependent decision, one has to

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[7] We ignore here the problem of overlapping competition and analyse farmers in isolated farms. It has been shown, though, that due to restricted interaction, clusters of non-competitive behaviour might be able to stabilise, even though many agents interact with each other indirectly (NOWAK, 2006). BERGSTROM and STARK (1993) explicitly model the behaviour of farmers situated around a lake in much the same way and show stable strategies that are only locally optimal. For more elaboration on this point, see MARGARIAN (2009).

anticipate the decisions of other people. Moreover, one has to consider that the others, too, will try to anticipate one's own decision. Due to the restricted number of direct competitors on the land market, the single demander possibly exerts a noticeable influence on the price.

Classical oligopoly[8] theory (e.g., VARIAN, 1992; WOECKENER, 2007)[9] differentiates two possible modes of competition: price competition and quantity competition, Bertrand models and Cournot models respectively (CHURCH and WARE, 2000). Referring to the land market, price competition would be expected if the farms' growth potential was unrestricted, i.e. if the marginal value of additional land remained constant. Given a certain initial supply, a marginal rise in the willingness to pay on the part of the single farmer compared to the bids of competitors would result in only a marginal price effect. At the same time, the marginally higher bid guarantees that the overbidding farmer gets all the land available. Accordingly, stabilising strategies cannot be expected to evolve in this case; instead, severe competition results, with the only stable equilibrium being at that point where the marginal value of land equals its price.

However, agricultural production is capital intensive and family farms are often characterised by low organisational flexibility. Therefore, the farms' ability to exploit additional land usually depends on preceding decisions concerning, for example, investment in stables and technology or the employment of non-family labour. Consequently, a declining marginal value of land in the short and medium term can be assumed. 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. This may rationalise competition on quantities rather than on prices. Oligopolistic competition on quantities among homogenous farms might result in a symmetric Cournot equilibrium, with

each single farm growing less than in perfect competition but more than in a monopolistic situation (WOECKENER, 2007). Moreover, the decision on growth described in Section 3 actually represents a two-stage game with investments in stables and other factors in the first stage and competition on land in the second. KREPS and SCHEINKMAN (1983) have shown that such a case of "quantity precommitment" yields Cournot outcomes even if the second stage, i.e. the competition on land, is best characterised by a competition on prices. "One interpretation, then, of the Cournot model is that it is a reduced form or short-hand description of a more complicated two-stage game" (CHURCH and WARE, 2000). In the following, the model is applied in this sense. Therefore, by assuming strategic interaction on the land market, the observation of reduced growth of farms with reference to expected growth in perfect competition could be explained by a Cournot equilibrium. Consequently, we initially assume identical growth of expanding farms.

4.1 The Coordination Problem of Farm Exits

The interdependence between two farms' decisions became apparent in the consideration at the end of section 3 of the necessity to grow in order to sustain efficient production in the current organisation. We describe the decision situation of the single farm regarding growth in land in a Cournot model by

$$(6) \quad \Pi_i(r_i) = R_i^{\exp}(r_i) + \pi_i(r_i) - p\left(\sum_{j=1}^{N} r_j\right) r_i$$

with r as the farm's growth in land and j as the total number of competitors on the rental market for land. The rental price for land is p. $R_i^{\exp}$ depends on the decision on growth of the single farm in two ways: first, sufficient growth will allow for the possibility of stabilising future rents for the consecutive period. Second, the stronger current growth is, the higher the probability that the farm's land will suffice to pay family labour in the future. Simplifying, we define the marginal return as $\pi_i(r_i) = \pi o_i(r_i) - c(r_i)$. We assume a linear contribution of land to the marginal return and a very simple price function for land

$$(7) \quad p = a + b\sum_{j=1}^{N} r_j .$$

We interpret the intercept a as the value of the single land unit for exiting farms. We derive

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[8] Another possibility would be to view the land market as monopolistic with single suppliers who set the price. However, the rental market for land is more akin to an auction (and it has usually been modelled in this manner, especially in multiple-agent models. See, for example, HAPPE et al., 2004). The oligopsonistic setting, that we justify in the present section, applies here.

[9] 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).

$$\Pi_i(r_i) = R_i^{\exp}(r_i) + \pi_i r_i - ar_i$$
$$(8) \qquad - br_i^{\,2} - br_i \sum_{j=1, j\neq i}^{N} r_j \quad .$$

Due to our interpretation of a it follows that $\pi_i r_i = ar_i$ and

$$(9) \quad \Pi_i(r_i) = R_i^{\exp}(r_i) - br_i^{\,2} - br_i \sum_{j=1, j\neq i}^{N} r_j \;.$$

We define p^{res} as the access price above marginal productivity:

$$(10) \quad p^{res} = b\sum_{j=1}^{N} r_j = bNr_j \;.$$

In order for trade to occur, farms must differentiate their expectations. Exiting farms anticipate rents for a short period of time ($R_{short}^{\exp}$) and growing farms for a long period of time with ($R_{long}^{\exp}$). This necessary endogenous coordination might cause coordination problems. Coordination problems have been discussed extensively in the context of participation or market-entry games (e.g., GOEREE and HOLT, 2002). Table 1 presents exemplary pay-offs of such a game in the left-hand matrix and expected pay-offs in the game of the land market in the right-hand matrix.

As we can see, in the game represented in the left matrix, there are two Nash-equilibria. If firm 2 decides to enter the market, it realises a pay-off of 100. Even though firm 1 realises a much lower pay-off of zero if it stays out, it would not be better off entering, given the other firm's decision to enter. The same holds true vice versa for a decision by firm 1 to enter and firm 2's reaction. If both firms stayed out, none of them would realise the advantage of market participation. If both firms entered, ruinous competition would cause losses for both of them. In the game of farm exits depicted in the right matrix, growing farms compensate exiting farms by $p^{res}r$. If both representative farms remain in production, both of them lose the

opportunity to realise rents for an expected long period of time. If both exit, neither of them is compensated for the loss of expected rents at all. The pay-offs need to fulfil the following conditions in order to constitute a coordination game:

(a) From the viewpoint of a farm that stays in

$$(11) \quad \begin{aligned} & R_{long} - p^{res}r > -R_{long} + R_{short} > -R_{long} \\ & \Rightarrow 2R_{long} > R_{short} + p^{res}r \end{aligned} ,$$

(b) from the viewpoint of an exiting farm

$$(12) \quad \begin{aligned} & -R_{long} < -R_{long} + R_{short} \leq -R_{long} + p^{res}r \\ & \Rightarrow R_{short} \leq p^{res}r \end{aligned}$$

and therefore

$$(13) \quad 2R_{long} - R_{short} > p^{res}r \geq R_{short} \;.$$

In fact, we can only expect trade to take place for

$$(14) \quad R_{long} \geq p^{res}r \geq R_{short} \;.$$

Therefore, the conditions of a coordination game are given. In our case and in most of the applications of market-entry games, the situation is further complicated because there are more than two players: "When there are too many potential competitors available to exploit a new market opportunity, the risk of multiple entry may discourage entry" (NTI, 2000). Other types of coordination problem have been discussed, too. In our thought experiment with initially identical farms, different paths of development could evolve in the repeated land market game, depending on initial coordination failures. DINDO and TUINSTRA (2006) apply a replicator-dynamic model with differing behavioural rules in order to analyse repeated n-player coordination games. They show that the stability of the unique mixed-strategy equilibria decreases with the number of players. They also observe autocorrelation in participation rates in a time series as well as underparticipation. Accordingly, coordination problems could represent one reason for the regionally differing composition of farm strategies.

Table 1.   The Coordination Game

		Firm 2	
		Stay Out	Enter
Firm 1	Stay Out	0,0	0,100
	Enter	100,0	-50,-50

		Farm 2	
		Stay In	Exit
Farm 1	Stay In	$-R_{long}+R_{short}$, $-R_{long}+R_{short}$	$R_{long}-p^{res}r$, $-R_{long}+p^{res}r$
	Exit	$-R_{long}+p^{res}r$, $R_{long}-p^{res}r$	$-R_{long}$, $-R_{long}$

Source: GOEREE and HOLT (2002) and own adaptation

The Number of Exiting Farms in a Nash Equilibrium

Nevertheless, empirical and theoretical evidence regarding expected outcomes remains weak. We continue to assume the realisation of an efficient Nash equilibrium. This Nash equilibrium evolves from Cournot competition per assumption (section 4). The decision rule of a single farm is derived from the first derivation of equation (9), since each expanding farm is going to grow until the marginal profit of growth equals zero:

$$(15) \quad R_i^{\exp'} = 2br_i + b \sum_{j=1, j \neq i}^{N} r_j .$$

The reaction function of the single farm is then

$$(16) \quad r_i = \frac{1}{2}\left(\frac{R'}{b} - \sum_{j=1, j \neq i}^{N} r_j \right).$$

The equilibrium growth per farm, considering the homogenous reactions of all farms, would be given by

$$(17) \quad r_i = \frac{R'}{2b} - \frac{N-1}{2}r_i \Rightarrow r_i = \frac{R'}{b}\frac{1}{N+1} .$$

This result resembles the well-known result from Cournot competition. Obviously, optimal growth depends on the number of competitors. Since we are interested in the optimal number of remaining farms, a non-trivial optimisation problem evolves. We assume that the last farm to grow in order to remain in production sustainably is the one that still achieves a non-negative profit (MANKIW and WHINSTON, 1986) while it is able to secure the necessary growth. We, therefore, derive the number of non-exiting farms by setting Π_i in equation (6) to zero and solving for N:

$$(18) \quad \Pi_i = 0 = R_i^{\exp} - bNr_i^2 \Rightarrow N = \frac{R_i^{\exp}}{br_i^2} .$$

Inserting the optimal farm-level growth given by equation (17), we get for the number of farms with growth in equilibrium

$$(19) \quad N = \frac{R_i^{\exp}}{b}\frac{b^2}{R'^2}(N+1)^2 \Rightarrow \frac{(N+1)^2}{N} = \frac{R'^2}{R^{\exp}b}$$

(compare the result of MANKIW and WHINSTON, 1986). Accordingly, if growing farms behave identically in Cournot competition, the number of farms in equilibrium is determined by expected rents to be secured by growth, the marginal contribution of growth to future security of rents and the impact of demand on the rental price of land. Therefore, without coordination failures, in our thought experiment with identical farms, there would be no reason for regionally differing growth. This result applies if the assumption of symmetric Cournot competition among growing farms is reasonable and the central parameters are identical. The possibility of asymmetric behaviour is analysed in the following.

4.2 The Problem of Strategy Choice by Growing Farms

The assumption of a symmetric Cournot equilibrium has been justified by the underlying two-step decision in the farms' decision problem and the need for quantity precommitment. Quantity precommitment has, however, further potential implications for possible strategies. Irreversible ex-ante investments could allow some farms to signal in a credible way an even stronger will for growth than in the other remaining farms. If the signalled intention of these growth-oriented farms to expand is anticipated by the less competitive farms, the latter might reduce their own demand in order to restrict the price effect and eventually turn into suppliers. This asymmetric oligopolistic strategy with quantity leaders on one hand and quantity followers on the other is described in the literature as Stackelberg competition (VARIAN, 1992).

We start from the Cournot equilibrium reached in the last section and take the respective supply of exiting farms as given. In this equilibrium, farms just grow enough in order to stabilise the full-time farms for the coming period. We deal with only these remaining farms in the following sections. The farms' demand is r_j^*, including land retention, i.e., the farm's need for the land it already owns. Due to our assumption of identical farms, all farms are subject to the same transaction costs of growth. We assume that even the growth of farms that strive for accelerated growth (growth-oriented farms) is restricted to an amount that is clearly below a single farm's initial capacity in land. Whether the strategy of accelerated growth is profitable depends on the reactions of other farms.

4.2.1 The Reaction of Single Farms to Accelerated Growth

Accelerated growth of some farms would only be possible if others were willing to decline, i.e. to reduce their land retention. The reaction of quantity followers is generally given by (WOECKENER, 2007: 15)

$$(20) \quad \frac{dr_j}{d\bar{r}} = -\frac{\dfrac{\delta^2 \Pi_j}{\delta r_j \delta \bar{r}}}{\dfrac{\delta^2 \Pi_j}{\delta r_j{}^2}}.$$

with $\bar{r} = \sum\limits_{j=1, j \neq i}^{N} r_j$. In normal applications, only the price depends on decisions of competitors. Then, usually, numerator and denominator have the same sign and the denominator is larger in absolute values. Demand (supply) of quantity followers decreases less than proportionally with growing demand (supply) of quantity leaders (WOECKENER, 2007). Nevertheless, in our case not only the price but also expected rents depend on aggregate demand in the population. Again (compare equation 8) each farm faces the profit function

$$(21) \quad \begin{aligned} \Pi_j(r_j) = R_j^{\exp}(r_j, \bar{r}) + \pi_j r_j - a r_j \\ - b r_j{}^2 - b r_j \bar{r} \end{aligned}.$$

Assuming $\pi_j r_j = a r_j$ (see Section 4.1) we derive as the first derivation by own growth r_j

$$(22) \quad \frac{\delta \Pi_j}{\delta r_j} = \frac{\delta R_j^{\exp}}{\delta r_j} - 2 b r_j - b \bar{r}.$$

The second derivation by own growth gives us

$$(23) \quad \frac{\delta^2 \Pi_j}{\delta r_j{}^2} = \frac{\delta^2 R_j^{\exp}}{\delta r_j{}^2} - 2b.$$

The cross derivation by the growth orientation in the population as a whole gives us

$$(24) \quad \frac{\delta^2 \Pi_j}{\delta r_j \delta \bar{r}} = \frac{\delta^2 R_j^{\exp}}{\delta r_j \delta \bar{r}} - b.$$

We know that rental prices for land generally rise with own and aggregate demand. Expected rents rise with own growth but decline with aggregate demand. We assume

$$(25) \quad R_j^{\exp} = c r_j{}^2 - d r_j \bar{r} - e \bar{r} \Rightarrow \frac{\delta R_j^{\exp}}{\delta r_j} = 2 c r_j - d \bar{r}.$$

This means that if the farm retains its land, expectations regarding the future flow of rents will increase. This applies if the farm holds on to all its land rather than giving up a certain share. Nevertheless, the stabilising effect of own demand on expected future rents is reduced if general demand in the population is high. As second derivative and cross-partial derivative we get

$$(26) \quad \frac{\delta^2 R_j^{\exp}}{\delta r_j{}^2} = 2c \text{ and } \frac{\delta^2 R_j^{\exp}}{\delta r_j \delta \bar{r}} = -d.$$

For the expected reaction of quantity followers, referring to equation (20), we get:

$$(27) \quad \frac{dr_j}{d\bar{r}} = -\frac{\dfrac{\delta^2 R_j^{\exp}}{\delta r_j \delta \bar{r}} - b}{\dfrac{\delta^2 R_j^{\exp}}{\delta r_j{}^2} - 2b}.$$

Since $\dfrac{\delta^2 R_j^{\exp}}{\delta r_j \delta \bar{r}}$ is negative ($-d$) and $\dfrac{\delta^2 R_j^{\exp}}{\delta r_j{}^2}$ is positive ($2c$), the numerator might be larger in absolute values than the denominator. In this case, the reaction of the remaining farms to higher population-level demand might be disproportionately high. This strongly negative effect of aggregate growth is due to the additional negative effect on expected future rents. Here it is assumed that the effect of own growth on the development of marginal expected future rents ($2c$) is not larger than the direct impact of own growth on the marginal increase of land price ($2b$).

4.2.2 The Decision on Accelerated Growth

In order to assess the decision problem of farms that decide in favour of the strategy of accelerated growth, given the other farms' reaction, the profit function in dependence on growth in land in equation (6) is further extended:

$$(28) \quad \begin{aligned} \Pi_i(\bar{r}, r_i) = R_i^{\exp}(r_i, \bar{r}) + \pi o_i r_i - c r_i \\ - p(\bar{r}(r_i), q(\bar{r}(r_i))) r_i \end{aligned}.$$

Desired growth is identical for all farms in the group of growth-oriented farms. Therefore, the relevant decision variable r_i is binary ($r_i = \{-1,1\}$), with the value of 1 expressing a decision in favour of accelerated growth and the value of -1 as a decision against accelerated growth. Output and costs of production depend on growth in land. Nevertheless, expected future rents and the cost of growth $p * r_i$ not only depend on the farms' own decision on growth but also on the decision of all other farms. The weight of growth-oriented farms that decide in favour of growth in the population is expressed as

$$(29) \quad \bar{r} = \frac{1}{n} \sum_n r_i .$$

Here n is the total number of farms interacting on the local rental market. The potential values of $\bar{r}$ range from -1 to 1. The demand of farms that decide against the growth-oriented strategy is described by q. Here, if a farm decides to keep its initial land endowment, this is judged to be positive "innate" demand[10]. If demand is below the farm's own endowment with land, it supplies land. Thereby, we avoid the problem of negative demand. Demand of non-growth-oriented farms depends on the prevalence of growth-oriented farms ($\bar{r}$).

Our price function is:

$$(30) \quad p = a + b\bar{r}(r_i) + bq(\bar{r}(r_i)) .$$

As before, we interpret the parameter a as the marginal productivity of land belonging to supplying farms. Inserting into equation (28) and calculating differences with respect to the farm's own decision gives us

$$(31) \quad \begin{aligned} \frac{\Delta \Pi_i}{\Delta r_i} &= R_i^{\exp}(\bar{r}) \frac{\Delta \bar{r}}{\Delta r_i} - b\bar{r}(r_i) - bq(\bar{r}(r_i)) \\ &\quad - b\frac{\Delta \bar{r}}{\Delta r_i} r_i - bq(\bar{r}) \frac{\Delta \bar{r}}{\Delta r_i} r_i \end{aligned} .$$

Expected rents increase with own growth. Since we start from a Cournot equilibrium, which guaranteed that each farm in the population has the potential to stabilise rents in the following period, we may assume that $R_i^{\exp}(\bar{r}) \frac{\Delta \bar{r}}{\Delta r_i} < b\bar{r}(r_i) - bq(\bar{r}(r_i))$ in equation (31).

The reference to equation (29) shows that the fewer competitors there are, the higher is the reaction of aggregate demand on a single farm's decision ($\frac{\Delta \bar{r}}{\Delta r_i}$).

Therefore the last two terms in equation (31) show that, with few local competitors on the rental market for land, the development of the rental price of land depends on the single farms' decision on growth. Usually, the first of the last two terms in equation (31) dominates and prices for land and marginal costs of growth rise with the demand of the single farmer. In order to assess the indirect effect of the single farm's decision due to the changing weight of growth-oriented farms in the population, we also have to differentiate with respect to $\bar{r}$:

$$(32) \quad \frac{\delta \Pi_i}{\delta \bar{r}} \frac{\Delta \Pi_i}{\Delta r_i} = \frac{\delta R_i^{\exp}}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i} - b - b\frac{\delta q}{\delta \bar{r}} - b\frac{\delta q}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i} r_i .$$

Obviously, with $\frac{\delta q}{\delta \bar{r}} + \frac{\delta q}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i} r_i < -1$ it becomes possible for the profitability of growth to increase with each farm that decides in favour of the strategy of accelerated growth. Equation (27) has demonstrated that $\frac{\delta q}{\delta \bar{r}} < -1$ may hold.

We would like to find potential equilibria in the share of strictly growth-oriented farms if the reaction of remaining farms to their demand grows with their weight in the population. For clarification of the problem, the concept of strategic complements and strategic substitutes is helpful. BULOW, GEANAKOPLOS and KLEMPERER (1985) define the concept: "We call x_2 a strategic substitute for x_1 if $\delta^2\pi_1/\delta x_2\delta x_1 < 0$ and a strategic complement if $\delta^2\pi_1/\delta x_2\delta x_1 > 0$. […] Producing more of a substitute reduces the total profit of an opponent […]. Producing more of a *strategic* substitute reduces an opponent's *marginal* profit […]." Due to equation (27), we posit that the decision for accelerated growth of one farm could be a strategic complement to the same decision of another farm. Nevertheless, due to the limited availability of land, a capacity effect restricts the share of farms with strong growth orientation. The next section assesses possible equilibria in strategy choice in the population given these non-linear reactions.

4.2.3 Expected Growth Strategies in Equilibrium

We tackle the problem with the help of an approach by BROCK and DURLAUF (2001). They named the central term $\frac{\delta q}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i}$ that is directly affected by the farms' decision r_i and by the mean decision in the population $\bar{r}$ an "interaction parameter (J)". The interaction parameter describes the effect of the combined decision on the utility of the relevant actors. In our case, since we observe costs instead of utility, J corresponds to the negative value of $\frac{\delta q}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i}$. Due to $\frac{\delta q}{\delta \bar{r}} \frac{\Delta \bar{r}}{\Delta r_i}$, the single farm's decision on growth also has a positive external effect on the other farms' decisions on growth. Multiple equilibria may only be observed if the parameter J, which measures strategic comple-

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[10] GIULIANI (2002) has used the German term "Eigennachfrage".

mentarity, is larger than one (MATSUYAMA, 2002). On the other hand, a natural restriction on the share of farms with accelerated growth exists due to the restricted capacity in land.

The expected effect of the different strategies on the profitability of growth (R'), depending on the share of growth-oriented farms, may be expressed as:

$$(33) \quad R'(r_i = 1) = J \cdot \bar{r} + \varepsilon \text{ and } R'(r_i = -1) = -J \cdot \bar{r} + \varepsilon$$

with ε as a random error term. In order to illustrate possible equilibria in the share of quantity leaders, we follow the approach of BROCK and DURLAUF (2001a). The probability (Pr) that a participant decides in favour of the competitive strategy ($r_i = 1$) depends on the relative impact on the development of costs of both strategic options:

$$(34) \quad \Pr(r_i = 1) = \Pr[(R' | r_i = 1) < (R' | r_i = -1)].$$

We apply the Logit assumption: ε is extreme-valued and independent across agents and alternatives. The probability of a single strategy to be realised by agent i can then be calculated (PHAN et al., 2004) as

$$(35) \quad \Pr(r_i = 1) = \frac{\exp(R' | r_i = 1)}{\sum_{r_i \in \{-1,1\}} \exp(R'(r_i))}.$$

The expectation concerning the population's decision may now be calculated by combining equation (33) and equation (35) as

$$
\begin{aligned}
E(\bar{r}_i) &= 1[\Pr(r_i = 1)] + (-1)[\Pr(r_i = -1)] \\
&= 1 \cdot \frac{\exp(R' | r_i = 1)}{\exp(R' | r_i = 1) + \exp(R' | r_i = -1)} \\
(36) \quad &\quad -1 \cdot \frac{\exp(R' | r_i = -1)}{\exp(R' | r_i = 1) + \exp(R' | r_i = -1)} \\
&= \frac{\exp(R' | r_i = 1) - \exp(R' | r_i = -1)}{\exp(R' | r_i = 1) + \exp(R' | r_i = -1)} \\
&= \tanh(J \cdot \bar{r})
\end{aligned}
$$

Inserting the strategy distribution in the population ($\bar{r}$) and the corresponding value of parameter J, the expected distribution of strategies in the population $E(\bar{r})$ can be calculated. Equilibria are realised with

$$(37) \quad E(\bar{r}) = \bar{r}.$$

In accordance with the characteristics of the hyperbolic tangent, under certain conditions multiple equilibria are possible. Equilibria are analysed graphically in figure 2. We observe an equilibrium if the expected probability of the strategy choice (y-axis in figure 2) equals the distribution of realised strategies in the population (x-axis in figure 2). The diagonal represents all imaginable points of equilibrium.

Multiple equilibria are possible only if the strategic decisions are complements and if the interaction parameter shows values larger than one. In our case, the reaction to increasing demand by growth-oriented farms must be more than proportional. The left side of the figure shows such a situation with a reaction of non-growth-oriented farms to the decision of a single farm for accelerated growth slightly above 1. Some equilibria are possible in the lower part of the curve, because with a low weight of about -0.4 the expected value is also about -0.4. Another equilibrium exists with a larger weight of growth-oriented farms of about zero, but that equilibrium is not stable. Once the weight deviates slightly from the equilibrium, the development converges towards the lower equilibrium. We can see this provided we recognize that the expected weight of the growth-oriented strategy in the population is a little below the present weight of growth-oriented strategies in the neighbourhood of the unstable high equilibrium.

The right-hand side of figure 2 shows that with a higher initial value of the interaction parameter J of about two, two stable equilibria are possible, which lie far apart from each other. Either very few farms decide in favour of accelerated growth with a weight of growth-oriented farms of nearly minus one or, alternatively, close to the maximal number of farms are growth-oriented. Taking into account the capacity restriction, the weight of growth-oriented strategies within the population is then about 0.2. Which equilibrium is realised depends on the initial contingent distribution of strategies in the population. The crowding-out effect, that is captured by the interaction parameter, might therefore be a reason for regional differences in farms' growth strategies.

5 Conclusions and Outlook

The aim of this paper was to analyse whether the existence of different farm-development strategies could be rationalised from an economic angle and taking into account competition and possible future and strategic behaviour. Two possible reasons for regionally differing farm strategies in strategic competition have been identified: a coordination problem in the context of farm-exit decisions and the problem of choice of strategy by growth-oriented farms.

The assumption of the relevance of strategic interaction on the rental market for land has been justified

Figure 2. Possible Equilibria in Growth Strategies of Farms
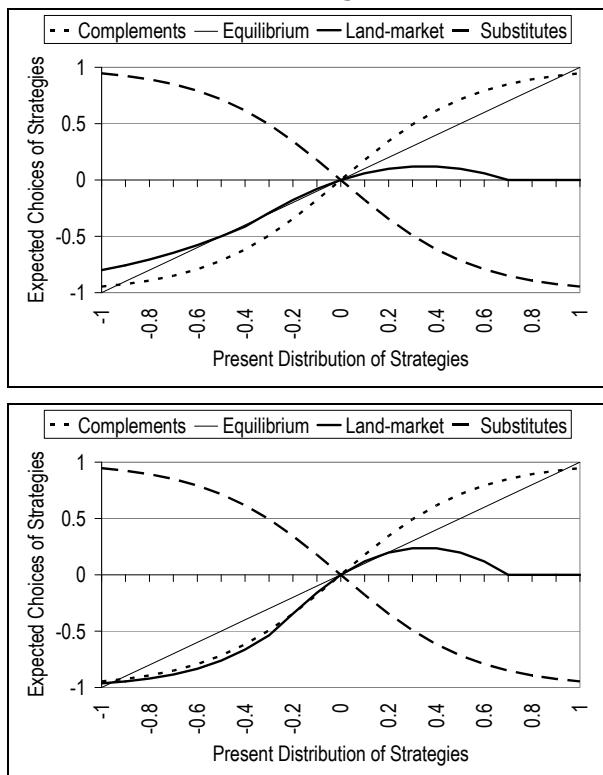
Source: own figure based on simulated data

by the restricted number of competitors on the one hand and by the existence of sunk costs and organisational inflexibility on the other. The latter could cause temporary rigidities in the growth of farms and the necessity for capacity precommitment. Thereby, the assumption that farms compete on quantities rather than on prices has been justified. Capacity precommitment also gives rise to strategic advantages of accelerated growth for some farms. Due to rents of the status quo and their dependence on future expectations, though, the reaction to demand by competitors is non-linear. Finally, due to a decrease in expected future rents on the one hand and an increasing price-effect on the other, a crowding-out effect might occur. Therefore, the profitability of the decision in favour of accelerated growth depends on the share of farms that decide to adopt this strategy. The possible equilibria that have been identified show that different equilibria in the distribution of strategies may evolve, depending on the initial situation and on idiosyncratic influences.

Even if all farms strive for the same growth, differences in strategy could be justified in view of prospective behaviour in the context of farm-exit decisions. The inevitable simultaneous decision of farms to exit or grow may be conceptualised by analogy to a market-entry game. Market-entry games are characterised by the necessity of endogenous differentiation of initially identical agents. Many potential equilibria as well as coordination problems are possible, especially if there are numerous agents.

The contribution of the land market with respect to observed patterns of structural change has previously been carefully analysed by other authors. These studies are usually based on certain implicit behavioural assumptions and on assumptions concerning farms' initial heterogeneity and scale effects. The present analysis complements these studies by showing that strategic behaviour could be crucial for the land market. At the same time, it offers an approach for explaining why farms might not overcome short-term constraints on growth in order to realise strategic advantages in competition.

Nevertheless, this study gives only a qualitative idea of possible problems in strategic decisions taken by farmers. The actual relevance of strategic interaction on the land market to structural change still needs to be tested empirically. An initial approach has been undertaken in HUETTEL and MARGARIAN (2009). In order to conduct empirical tests that are more rigorous, hypotheses of higher specificity concerning the impact of certain conditions on farmers' expected decisions regarding the land market have to be derived. Therefore, micro-economic models have to be developed with strategies evolving endogenously. HUETTEL et al. (2010) formulated a micro-economic model describing farmers' interaction on the land market that is mainly driven by assumptions concerning scale effects and initial heterogeneity. The integration of strategic decisions and endogenously evolving heterogeneity remains a major challenge.

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