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Orientation in Diversification Behavior of Cooperatives: An Agent-Based Approach

George Hendrikse, Ruud Smit, and Mark de la Vieter[1]

Abstract. There are significant differences between the diversification behavior of investor-owned enterprises and cooperatives (Van Oijen and Hendrikse 2002). However, the origin of these differences is not well understood. The impact of the orientation of decision-makers on the evolution of the diversification portfolio is analyzed with agent-based simulations.

Keywords. Diversification, corporate coherence, cooperatives, agent-based approach

> '... presumption that most farmers cannot see any further than the farm gate and that directors of agricultural co-operatives, unless the executive or outside expertise are co-opted onto the board, are production, rather than market, orientated.' *(LeVay 1983, 20)*

1 Introduction

An important governance structure in the agrifood industry is the producer co-operative[2]. It is an association of many independent growers who jointly own a downstream processor / retailer (Sexton 1986). Cooperatives are not listed on stock markets, and have distinguishing features (Commission of the European Communities 2001, 12) like 'an orientation to provide benefits to members and satisfy their needs, democratic goal setting and decision-making methods, special rules for dealing with capital and profit, and general interest objectives (in some cases)'. A number of these features will feature prominently.

Agricultural and horticultural cooperatives operate nowadays in a rapidly changing environment. Two broad developments can be distinguished. First, a different product assortment is required in order to be successful in a market chang-

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[2] The labels marketing co-operative and agricultural co-operative are also used.

ing from a sellers to a buyers market. Second, many agricultural markets have become more competitive due to their increase in size, e.g. the emergence of the internal market in Europe and the worldwide trend towards globalization. This results in many merger activities (Dobson et al. 2003).

These developments raise a number of issues regarding the composition of product portfolios and the direction of merger activities of the involved enterprises. First, Teece et al. (1994) studies the coherence of the multiproduct business firm.[3] Relatedness between products in diversification portfolios of enterprises is established and summarized in a number of stylized facts (pp. 3–4):

- the sequence is generally for firms to begin as single product and subsequently become multi-product, rather than the other way around;
- firms maintain a constant level of coherence between neighboring activities;
- firms not only add businesses, they also commonly divest;

Corporate coherence entails that the corporation has to be taken into account. One way to do this is to take various corporate forms/governance structures into account. However, the relationship between governance structure and the direction of the evolution in diversification portfolios is not addressed by Teece et al. Our interest is in how the orientation of decision makers and corporate form determines the directionality of corporate coherence, while capturing the above stylized facts.

Second, the relationship between governance structure and diversification policy has to be addressed. Kamshad (1994) did not find a statistically significant difference between the diversification policy of investor owned firms and labor-managed firms. Similarly, Demsetz and Villalonga (2001) find no statistically significant relation between ownership structure and firm performance. However, Van Oijen and Hendrikse (2002) did find a statistical significant difference between the diversification portfolios of investor owned firms and agricultural cooperatives. It provides support for the now widely accepted view that institutions matter. They establish empirically relatedness and direction in the diversification policy of investor owned firms and marketing cooperatives. Investor owned firms diversify in related products, while cooperatives have a tendency to diversify in unrelated products. The debate has therefore progressed from the question of whether institutions matter to the analysis of how specific sets of institutions matter and under what circumstances.

Third, an important difference between cooperatives and investor owned firms is that the providers of input own the enterprise in a cooperative, while the providers of capital own the enterprise in an investor owned firm (Hansmann 1996). Various explanations for corporate diversification have been advanced (e.g., Hoskisson and Hitt 1990; Montgomery 1994; Ramanujam and Varadarajan 1989). These perspectives are rooted in different theories or paradigms, notably agency

[3] Huseyin and Venkatraman (2005) stress also the importance of relatedness.

theory (Jensen 1986), industrial organization (Palepu 1985), institutional theory (Scott 2001), the resource-based view of the firm (Penrose 1959), strategic contingency theory (Venkatraman 1989), and transaction cost economics (Williamson 1975). We will address briefly the resource-based view, institutional theory, and agency theory.

According to the resource-based view, firms can have excess capacity in resources (Penrose 1959). The resources can be redeployed in new businesses, which implies product diversification. Several types of resources can be used for diversification (Chatterjee and Wernerfelt 1991). A priori, no differences with respect to physical and intangible assets can be expected, but, in general, cooperatives have less financial resources than corporations. Specifically, cooperatives can only generate additional equity by retaining earnings and obtaining extra funds from the limited pool of members. In contrast, corporations can retain earnings and raise extra equity in the stock market from any investor who is willing to take the risk. Consequently, cooperatives may have fewer means to diversify than corporations.

Institutional theory (Davis et al. 1994; Kogut et al. 2002) investigates the influence of institutional factors on diversification behavior. Various institutional factors are mentioned, such as government regulation, interfirm networks, and ownership (e.g., Kogut et al. 2002). For our purposes, the institutional factor that D'Aunno, Succi, and Alexander (2000) refer to as norms about property rights seems particularly relevant, since it differs between corporations and cooperatives. The owners of a corporation have the right to use the assets in a way that maximizes the value of the firm. They are less concerned about meeting the corporation's original mission than they are about generation of profits. Faced with market pressures, they are likely to abandon traditional goals and commitments and exercise their right to use assets for other business opportunities (D'Aunno et al. 2000). In contrast, cooperatives are primarily founded in a specific industry to protect the interests of many small members against a monopolistic supplier or customer (Milgrom and Roberts 1992). The members are less likely to abandon the original mission and use the assets to seize business opportunities in industries they are not active in. As a consequence, diversification into new industries is more probable for corporations than it is for cooperatives.

Agency theory suggests that firms diversify because their managers have personal motives to do so. Managers do not return free cash flows to shareholders, but spend them on diversification projects, because of motives like empire building, pay increases, and reduction of employment risk (Ahimud and Lev 1981; Jensen 1986). This is not in the interest of the shareholders, for instance, because they can diversify risks themselves by building an efficient stock portfolio. However, in a corporation, the interests of shareholders and managers can be aligned, for instance by granting stock options to managers, which could help to eliminate diversification projects that destroy value. This instrument is not available in a cooperative. In addition, risk reduction through product diversification might actually be

in the interest of the members of the cooperative, since a large portion of their wealth is often tied to the cooperative (Hendrikse and Veerman 2001).

This article develops one argument to address the question why the diversification profiles of cooperatives and corporations differ. We will focus on the relationship between the orientation (perspective, cognition, and province of meaning (Arbnor and Bjerke 1997)) of the agents in different governance structures and the evolution of the diversification portfolio.[4]

Orientation reflects that the world is far too complex to be comprehended. The limited cognition / bounded rationality of individuals and organizations inevitably entails that only a few aspects of the world can be grasped, while many others are ignored. Heiner (1983) defines bounded rationality as the gap between the cognitive capabilities of the decision-maker and the complexity of the problem. This can be made specific in various ways, like specifying probabilities of making mistakes (Sah and Stiglitz 1986), adopting incomplete rather than complete contracts (Grossman and Hart 1986), or partitioning the states of the world (Rubinstein 1993; Bajari and Tadelis 2001). We adopt a partitioning approach in an agent based simulation environment, using the methodology of cellular automata (Schelling 1978; Hegselmann and Flache 1998), in order to capture by the notion of orientation the stylized facts formulated by Teece et al. (1994).

The methodology of Agent Based Modeling is a promising technique to study '... macro effects [as] dynamic consequences of decisions and mechanisms operating only at the micro level.' (Hegselmann and Flache 1998). Two important features of Agent Based Modeling are locality, i.e. agents basing their decisions on their own state and the local environment, and emergence of macrostructures, i.e. the evolution of the system as the outcome of the interactions between the agents. The importance of these concepts is already present in the writings of well-known scholars. For example, the classic article by Coase (1937) acknowledges the prominence of the local environment in the decision-making of enterprises. Coase (1937, 389) writes:

> *'Each factory ... plays his part as a single cell in a larger organism, mainly unconscious of the wider role he fills.'*

This citation expresses the idea of a world consisting of firms interacting with each other in local environments, unaware of the collective outcome of their individual decisions and actions following from them. Another example is Simon (1991, 27), characterizing societies by organizations and markets. In his account of the observations of a mythical visitor from Mars, organizations are characterized by 'lines of authority' and an important role is assigned to transitions in the boundaries of enterprises.

[4] A recent study by Ang et al. (2005) shows the background of CEOs has an impact on their divestiture decisions.

> Suppose that it <a mythical visitor from Mars> ... approaches the Earth from space, equipped with a telescope that reveals social structures. The firms reveal themselves, say, as solid green areas with faint interior contours marking our divisions and departments. Market transactions show as red lines connecting firms, forming a network in the spaces between them. Within firms (and even between them) the approaching visitor also sees pale blue lines, the lines of authority connecting bosses with various levels of workers. As our visitor looked more carefully at the scene beneath, it might see one of the green masses divide, as a firm divested itself of one of its divisions. Or it might see one green object gobble up another.'

We will analyse the evolution of the diversification portfolio of enterprises. The notion of orientation is introduced to study the evolution and directionality of the product portfolio of an enterprise. It determines to a certain extent which new product will be selected. The article is organized as follows. Section 2 presents the model. Section 3 formulates the results of orientation on the coherence of the multiproduct firm. They capture the first two stylized facts of Teece et al. (1994). Section 4 concludes.

2 Agent Based Model

Agent-based modeling is a methodology to investigate social dynamics. Agent Based Modeling is an extension of cellular automata. Basic features of cellular automata are the assumption of discrete space and locality. The world is modeled as a grid, the cells of which adopt a state from a finite set of states. The state of a cell changes according to transition rules. Agent based models extend the cellular automata model by adding the feature of a set of agents occupying the cells. These agents interact within well-defined spatial neighborhoods. Thus, the set of agents share a common habitat and at the same time, act autonomously based on information they receive from their local environment and their direct neighbors.

The two main ingredients of an agent-based model are the model of the agent and the transition rule(s) governing the actions of the agent. Each agent is characterized by a state, while decisions of agents are captured by transition rules. These transition rules produce a new state for each agent as a function of the current state of the agent and the state of each agent in the neighborhood of this agent.

Notice that there is no central authority that possesses an overview over the whole habitat and its inhabitants, nor is there an agent who in any way is capable of, or responsible for, the coordination of the actions of the individual agents. Manipulation of the macro level outcome may only be achieved by the careful and crafty influencing of the behavior of the individual agents and their way of influencing each other, i.e. by redefining the transition rules. For this to be successful, it is important to gain insight into the mechanisms responsible for the emergent outcomes of the social dynamics we are investigating, i.e. the diversification be-

havior of Ltd's and cooperatives. In this way the implications of the micro foundation of the agent for the macro behavior of the system of all agents has to be studied. Or in the words of Epstein and Axtell (1996):

> 'What constitutes an explanation of an observed phenomenon? [...] Artificial society modeling allows us to "grow" social structures *in silico* demonstrating that certain sets of microspecifications are *sufficient to generate* the macro phenomena of interest.'

In this paper we will develop the agent model, consisting of the definition of the states the agent can be in, and the transition rule that governs the evolution of its state during a simulation run. Our ultimate aim is to investigate the dynamics of agents developing their product portfolio in a competitive environment with other agents. However, before we can hope to be able to interpret the complexities that will emanate from such a simulation, we need to have a clear picture of how the behavior of an individual agent evolves independent of the behavior of other agents. Therefore the model in this paper contains only a basic form of an agent-based simulation. At t=0, there is only one agent at grid point (0,0), which is allowed to diversify (i.e. add a new product to its portfolio) according to a predetermined transition rule (micro-motive).

2.1 Agent

Agents are characterized by their product portfolio and their orientation. A *product portfolio* consists of a set of products. Each product is represented as a cell in a two-dimensional grid. The distance between cells represents the similarity between products. Similarity between products exists along two dimensions, related diversification (horizontal dimension) and unrelated diversification (vertical dimension). The state of an agent is its product portfolio.[5]

The direction of an agents' diversification will be called its *orientation*. The orientation of an agent is defined as a subset of the Moore environment of each product cell. Only products in this subset have a positive probability to be added to the product portfolio. Fig. 1 presents the two possible orientations of an agent, where the agent is oriented on the shaded cells. The Moore neighborhood on the

[5] There are two major differences between Schelling (1978) and this paper. First, his model has a fixed number of agents of various types, the type of an agent does not change, and the state of each agent is modelled as a location. Our model has one agent, being one of two possible types / orientations. The state of an agent is formulated as an agent and all its descendants. (Hendrikse and Muijen (1998) present a model where the state of the agent is to a certain extent determined by the agents in the local neighbourhood of the agent.) Second, Schelling studies population dynamics, i.e. the interaction between agents, by having agents move to different locations when the number of foreigners in the local environment is above a certain threshold. We study the direction and evolution of the diversification portfolio of an enterprise.

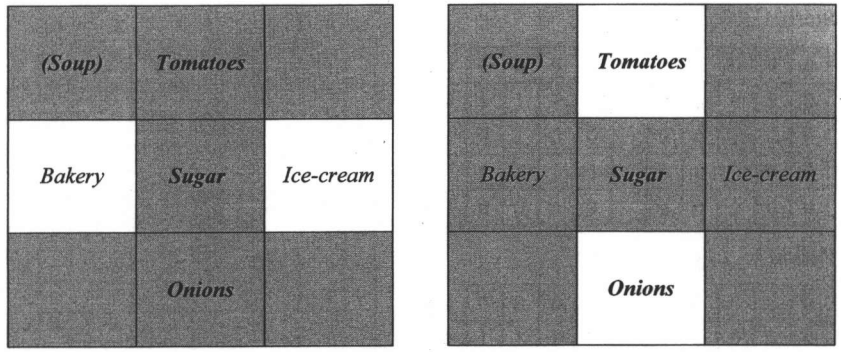

Fig. 1. Vertical direction / Unrelated diversification (Cooperative) versus Horizontal direction / Related diversification (Ltd)

left-hand side represents the vertical orientation of a Cooperative. Only two of the nine products in this square have probability 0 of being chosen in the next period. Products east or west of the cell in the center, i.e. horizontal, cannot be chosen. Similarly, the Moore neighborhood on the right-hand side represents the horizontal orientation of a Ltd. Only two of the nine products in this square have probability 0 of being chosen in the next period. Products north or south of the cell in the center, i.e. vertical, cannot be chosen.

2.2 Transition Rule

A *transition rule* produces a new state for each agent as a function of the current state of the agent and the state of each agent in the neighborhood of this agent. The new state consists of the portfolio of products in the previous period plus an additional product. This additional product is chosen out of the set of products covered by the orientation of all the products in the previous period. The actual choice is determined according a weighted probability distribution, where the weights are determined by how often a cell is covered by the orientation of each product in the portfolio. The mathematical formulation of this probability distribution is provided in the appendix.

Fig. 2 illustrates two periods of a simulation with an agent with a vertical orientation. In the grids on the left-hand side the development of the portfolio is shown. The grids on the right hand side show the weighed probability distribution determining the chance that a product is chosen in the next period. At the start of a simulation the portfolio of an enterprise consists of one single product. Diversification occurs by picking one of the products within the orientation of the current product portfolio. In the first period this amounts to choosing randomly between the seven products covered by the orientation of the agent in Fig. 1. Each cell within the orientation of the single product in the portfolio has an probability 1/7

Start:

0	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	0	0	0	0
0	0	0	0	0

0	0	0	0	0
0	1	1	1	0
0	0	1	0	0
0	1	1	1	0
0	0	0	0	0

Period 1:

0	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	0	1	0	0
0	0	0	0	0

0	0	0	0	0
0	1	1	1	0
0	1	2	1	0
0	1	2	1	0
0	1	1	1	0

Period 2

0	0	0	0	0
0	0	0	0	0
0	0	1	0	0
0	0	2	0	0
0	0	0	0	0

0	0	0	0	0
0	1	1	1	0
0	2	3	2	0
0	1	3	1	0
0	2	2	2	0

Fig. 2. An evolution of the product portfolio of a Cooperative during two periods

to be picked. Note that the product in the current portfolio is also contained in the set of possible new products. The reason for choosing a product that is already in the portfolio is that the production capacity for that product will be augmented by one unit. Suppose that the product south of the product in the starting portfolio is chosen at the beginning of the first period. In the right hand part of Fig. 2 we see that the choice set now contains 12 products. Two of these products are within the orientation of both products in the current portfolio. Therefore their chance to be picked is twice the chance of the other products. Suppose that in the second period the same product is chosen as in the first period. The bottom two grids show the portfolio and the weighed probability distribution at the end of the second period.

3 Results

In a first series of simulation runs we investigated whether the orientation of an agent has an impact on the final "shape" of its evolving product portfolio. Orientation of a diversification pattern can be determined by taking the average angle with the x-axis of all activities. An average angle of above 45% indicates a vertical

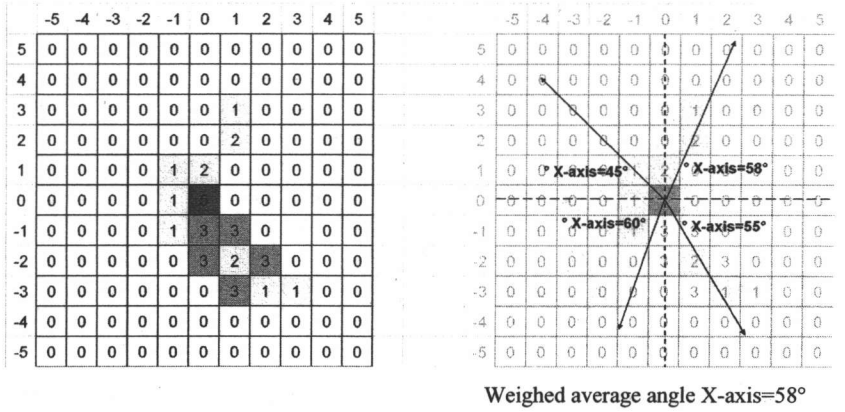

Fig. 3. Diversification profile of a Cooperative-orientation (1 run, 30 periods/run)

orientation, while an average angle of below 45% indicates a horizontal orientation. Finally, an angle of exactly 45% means that there is no specific orientation in the activities. A graphical representation of this idea is given in the right hand side of Fig. 3. The left-hand part of the figure presents a product portfolio / diversification pattern, the result of one run and 30 diversification periods. A summary statistic of the final shape of this portfolio is the Weighed Average Angle with the X-axis of the portfolio. This value is calculated by taking the average angle of the current activities in each 4 quadrants. Next, one calculates the weighed average value of these 4 values (more activities in a quadrant lead to more weight in the total number). The procedure is shown graphically in the right hand part of the figure.

The pattern in Fig. 3 is the result of one simulation. The shape is clearly vertical, which is in line with the vertical orientation of the agent. However it is also skewed downwards. This can be explained by the relative importance of the first diversification step. In this case this step was straight downward, which gives the profile a tendency towards the bottom. Averaging across a number of simulation runs shows a more stylized pattern, like Fig. 4.

The different diversification profiles of Cooperatives and Ltd can be clearly distinguished. Compared to an indifferent orientation, which has a weighed average angle with the X-axis of 45°, the Cooperative has an angle of 45+7°, while the Ltd has an orientation of 45-7°. These results are in line with the different micromotives of the Cooperative and Ltd. However, if one increases the number of periods per run, the average angle with the X-axis slowly tends towards the 45°. This is caused by the increasing influence of "back leaping". This phenomenon is illustrated in Fig. 5 and can be described as follows. A Cooperative has a tendency to diversify upwards and downwards, compared to an Ltd. If the number of periods is limited, a relatively large number of products is generated above and below the origin. However, this tendency is reversed when the number of periods increases. An increasing number of periods decreases the expected vertical tendency.

	-5	-4	-3	-2	-1	0	1	2	3	4	5
5	0	1	0	1	1	0	0	0	0	0	0
4	0	1	2	6	3	2	4	0	0	0	0
3	1	0	3	13	14	16	11	6	0	0	0
2	0	2	6	16	33	41	39	14	1	1	0
1	0	1	8	17	67	79	88	29	11	0	0
0	0	1	4	32	53	197	58	44	3	3	0
-1	0	0	2	18	96	88	81	29	13	1	1
-2	0	0	1	17	42	66	33	23	7	4	0
-3	0	1	6	5	19	11	21	14	8	1	0
-4	0	1	1	1	2	3	4	8	1	0	0
-5	0	1	0	0	0	0	0	0	1	0	0

Weighed average angle X-axis=52,3°

	-5	-4	-3	-2	-1	0	1	2	3	4	5
5	0	0	0	0	0	0	0	0	1	0	1
4	0	0	0	0	0	0	1	1	0	1	0
3	0	0	2	3	8	4	5	2	4	1	0
2	0	4	6	15	28	42	21	15	7	1	2
1	0	3	11	40	89	73	81	33	21	6	0
0	2	3	19	50	97	173	79	70	15	3	3
-1	0	5	17	37	90	65	77	29	14	5	0
-2	0	2	7	23	28	31	18	19	6	2	0
-3	0	1	4	4	7	2	7	0	2	0	0
-4	0	0	0	0	0	1	0	1	0	0	0
-5	0	0	0	0	0	0	0	0	0	0	0

Weighed average angle X-axis=37,9°

Fig. 4. Diversification profiles of a Cooperative (left) and an Ltd (right) = (50 runs, **30** periods/run)

	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
6	0	0	0	0	1	0	1	3	0	2	0	0	0
5	0	0	0	0	6	6	6	6	4	1	0	0	0
4	0	3	2	11	14	25	27	22	19	8	8	1	0
3	0	1	23	20	34	48	64	45	50	25	8	4	0
2	0	3	19	35	78	111	145	100	69	27	20	1	1
1	0	5	9	44	105	226	217	199	112	85	7	6	0
0	0	2	17	35	135	185	338	184	144	40	14	1	3
-1	0	1	11	49	71	182	206	215	83	47	10	2	3
-2	0	2	10	20	71	104	124	108	90	30	9	1	0
-3	1	4	5	19	25	45	51	59	38	20	3	1	1
-4	1	0	1	8	14	17	10	14	20	5	3	1	0
-5	0	0	1	2	3	1	4	1	8	4	0	0	0
-6	0	0	0	0	1	0	1	4	0	2	0	0	0

Weighed average angle X-axis=43,3°

Fig. 5. Diversification profiles of a Cooperative-orientation (50 runs, 100 periods/run)

It is hard to identify a diversification profile in Fig. 5, which is caused by the blurring effect of many cycles per run. An extension of the model counteracting the influence of back leaping is the introduction of termination of an activity (product) after a certain number of cycles. This feature turns out to guarantee a clear distinction between a Cooperative-orientation and an Ltd-orientation at much higher numbers of periods, as shown in Fig. 6.

	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
6	0	0	0	1	0	1	0	4	5	1	0	0	0
5	0	0	1	4	3	5	12	3	9	1	0	0	1
4	0	0	0	5	8	11	14	21	10	8	1	1	0
3	0	0	2	9	12	19	34	25	19	10	3	0	1
2	0	2	8	19	18	39	46	41	31	13	3	1	0
1	1	4	8	14	33	61	56	59	35	20	9	3	3
0	1	1	10	20	31	50	76	77	37	18	7	1	2
-1	0	2	7	17	42	53	51	57	51	17	4	1	0
-2	1	1	6	15	20	39	52	49	30	19	3	2	4
-3	0	1	2	9	25	29	29	31	17	12	7	1	2
-4	0	3	4	10	7	19	13	12	4	8	1	0	2
-5	0	4	7	1	7	7	8	5	7	0	0	0	0
-6	0	1	0	2	7	3	2	3	0	0	0	0	0

Fig. 6. Diversification profile of a Cooperative-orientation (50 runs, 100 periods/run, activities are terminated after 50 cycles)

4 Conclusion

The contribution of this article is twofold. First, the notions of orientation and coherence are made operational with the agent-based methodology. A horizontal and a vertical direction in orientation are distinguished in order to be able to apply this concept in a diversification setting with related and unrelated products. Coherence between current and new products in a diversification portfolio is captured by having new products selected in the Moore-environment of the current products. The relationship between orientation and coherence is that orientation determines the likelihood of selecting new products in the (Moore) neighborhood of the current products. Second, the impact of orientation on the evolution of diversification portfolios is analyzed. Our specification of orientation with the agent-based methodology shows a significant impact of orientation on the directionality of a diversification portfolio.

The approach in this article is able to account for the stylized facts that firms begin as single product and subsequently become multiproduct and that they maintain a constant level of coherence between neighboring activities. The third stylized fact that firms not only add businesses, but that they also commonly divest, is not captured. However, this can be easily incorporated in the model. For example, a bound regarding the age of products can be incorporated, and motivated by idea of a life cycle of products. Another way to incorporate divestiture is that not only new products are born, but that existing products may also die due to either too much competition or being too isolated. Too much competition entails that a bound is introduced on the number of products in one location, whereas being too isolated from the ma-

jority of products in the diversification portfolio may be captured by having a larger Moore-neighborhood. Similar extensions can be formulated to incorporate stylized facts that we did not include in our summary of Teece et al. (1994), for example, that there often appears to be a degree of circularity to the fashion in which new businesses are added and subsequently divested, and that new product lines very often utilize capabilities common with existing product lines.

This article is inspired by the result of Van Oijen and Hendrikse (2002) that governance structure matters for the directionality of corporate coherence. The directionality of corporate coherence is addressed, but the driving force is not an aspect of the governance structure investor-owned enterprise or cooperative, but the orientation of agents in these governance structures. The next step is to highlight a feature of these governance structures causing different directionality by itself, independent of the orientation of the agents inhabiting these governance structures. One possibility is to introduce a distinct role for the society of members of a cooperative. For example, the current model selects a new product based on a weighted probability distribution, where the weights are determined by the orientation of all products. All products covered by at least one orientation have therefore a positive probability of being chosen in the next round. This seems to be closer to a corporation than a cooperative because products are relatively independent. A cooperative may be better represented by a truncated weighted probability distribution in order to reflect that some support from the society of members is needed for new activities. A subsequently step will be to study the impact of the interaction between orientation and governance structure on the direction of corporate coherence. These steps are to be viewed as an attempt to formulate a contribution to the field of behavioral governance structure choice.[6]

Another direction for future research is to incorporate the interaction between products as well as enterprises. The current model endows each product only with the feature of generating a new product in the next period. There is no interaction between the products in the portfolio of an enterprise and the portfolio of products is lacking the rivalry of another portfolio of products. This article presents therefore a model of an agent, i.e. a micro foundation for (the evolution of) the firm, rather than an agent-based model, i.e. an account of the outcome of many interacting agents. However, modeling the interaction between products, within and between enterprises, can be incorporated in the transition rules guiding the selection of new products. Extending the model in this direction allows for addressing the impact of competition between governance structures on the size and directionality of diversification portfolios. It will allow for studying the stylized fact that cooperatives and investor owned enterprises coexist in many agricultural and horticultural markets. The viability of this industry structure is poorly understood.

[6] Behavioral governance structure choice is viewed as part of the field of behavioral economics. Behavioral economics relaxes the standard assumptions of homo economicus by considering the impact of bounded rationality, bounded willpower, and bounded self-interest. Orientation, and how it is channeled by governance structure choice, is to be positioned in the realm of bounded rationality.

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Appendix: The Transition Rule of a Cooperative and a Ltd.

Every period one product is added to the product portfolio. The transition rule of each enterprise is characterized by a weighted probability distribution regarding the current product portfolio. It is therefore defined recursively. Define (i(k),j(k)) as the position of the new product in period k. The weighted probability distribution X(k,i,j)/7(k+1) determines (i(k),j(k)), where X(k,i,j) is the number of times cell (i,j) is 'hit' by the orientation of each product in the product portfolio at the end of period k-1. Define X(0,i,j)=0 for every i and j.

A1 The Transition Rule of a Cooperative

X(k+1,i,j) = X(k,i,j)+1, when (i,j)?{(i(k)-1,j(k)-1), (i(k)-1,j(k)+1), (i(k),j(k)-1), (i(k),j(k)), (i(k),j(k)+1), (i(k)+1,j(k)-1), (i(k)+1,j(k)+1)}, i.e. being hit by the orientation of the new product in the previous period adds 1 to X(k,i,j), where the orientation of a cooperative is characterized by the left-hand side of Fig. 1.

X(k+1,i,j) = X(k,i,j) otherwise, i.e. X(k,i,j) remains the same when cell (i,j) is not hit by the orientation of the product added in period k.

A2 The Transition Rule of a Ltd

X(k+1,i,j) = X(k,i,j)+1, when (i,j)?{(i(k)-1,j(k)-1), (i(k)-1,j(k)), (i(k)-1,j(k)+1), (i(k),j(k)), (i(k)+1,j(k)-1), (i(k)+1,j(k)), (i(k)+1,j(k)+1)}.

X(k+1,i,j) = X(k,i,j) otherwise.

A3 Evolution

Period 0: A product is positioned in the center of the grid.

Period k: A new product (i(k),j(k)) is selected based on the weighted probability distribution X(k,i,j)/7(k+1).