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Dynamics of Common Learning in Learning Alliances

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Abstract
The paper proposes a System Dynamics model that gives deeper insights into the dynamics of common learning in learning alliances. Although current research widely recognizes alliances as an important strategic option to achieve strategic goals, feedback perspectives are often neglected. A feedback perspective can be helpful to explain certain unanticipated long-term effects such as insufficient learning outcomes in learning alliances. I transfer findings from recent learning alliance literature into a System Dynamics model that consists of three major and four minor feedback loops which I discuss in detail. Then, different scenarios offer insights into the dynamics of common learning, perceived benefits, associated resource allocations and the development of trust in a learning alliance under the consideration of varying parent companies' expected benefits. I introduce a model that supports decision-makers to understand how expectations of learning outcomes may affect success or failure of learning alliances.

Keywods
Interorganizational Learning, Learning Alliances, Relative Scope, Common Benefits, Common Learning, Resource Expenditures, Knowledge, Trust

1. Introduction

During the past decade, the formation of alliances and joint ventures has become a common element of firms' strategies in all kinds of different sectors to achieve competitive advantage (Aloysius, 2002; Lane, Salk, and Lyles, 2001; Zahn, 2001; Inkpen, 2000a; Child and Faulkner, 1998; Doz and Hamel, 1998; Gulati, 1995; Ring and Van de Veen, 1992). This trend is evidenced by the fact that more than 20,000 alliances have been reported world-wide over a period of only two years (Kale, Dyer, and Singh, 2002; Anand and Khanna, 2000). Besides various motives for founding alliances, interorganizational learning is of increasing importance for realizing strategic goals (Lane, Salk, and Lyles, 2001: 1139). Even though alliances are widely discussed in the literature, only a few articles include a dynamic approach to study the development of alliances over time. However, they often tend to neglect a feedback perspective which may lead to a short-term analysis. In order to show the long-term effects of today's decisions, it is valuable to consider feedback loops. They show accumulations, time delays, and non-linearities and hence exhibit the long-term effects of decisions. This makes it possible to explain specific behaviors and effects and to unfold the dynamics of phenomena over time. Feedback loops are essential for defining a dynamic

hypothesis and to show, model, and illustrate dynamic behavior. System Dynamics provides such a simulation approach on the basis of feedback loops (Sterman, 2002; Sterman, 2000; Forrester, 1961). In this paper, a System Dynamics model is designed to gain deeper insights into the dynamics of common learning in a learning alliance that is founded by two parent companies.

2. Background and Literature Review

In this section I discuss the theoretical background of learning alliances. I first define the term learning alliances. Then I introduce the concept of relative scope.

2.1 Learning Alliances

Alliances and joint ventures can be understood as interorganizational cooperations of at least two companies that are legally and – under certain conditions with some constraints – economically independent for the duration of the cooperation (Bea and Haas, 2001: 419). This means that these interorganizational forms mingle both hierarchical and market-oriented aspects of coordination.

The founding parent companies agree upon certain restrictions regarding their freedom of choice in order to implement common objectives within determined areas of mutual interest (Pausenberger, 1989: 621).[i] The motives for companies to form or enter alliances are widely situated, e.g., in risk reduction, in the achievement of economies of scale and/or rationalization (Child and Faulkner, 1998: 32), in the reduction of transaction costs (Picot and Dietl, 1990: 178), in the development and conquest of new markets as well as in the concentration of core competencies, in the concentration of market power, or in the acquisition of knowledge (Lane et al., 2001: 1139; Child, 2001: 657; Zahn, 2001: 11; Prange, 1996: 164; Hamel, 1991: 83).

The focus of this paper lies on the latter, knowledge acquisition through interorganizational learning. Lately, there has been an increasing body of both theoretical research (see, for example, Carlile, 2002; Goussevskaja and Kidd, 2002; Inkpen, 2000a; Khanna, Gulati and Nohria, 1998; Kumar and Nti, 1998; Larsson, Bengtsson, Henriksson, and Sparks, 1998; Grossman and Shapiro, 1987) and empirical studies (see, for example, Amburgey, Dacin, and Singh, 2000; Beckman and Haunschild, 2002; Tsang, 2002; Lane and Lubatkin, 1998; Inkpen and Crossan, 1995; Hamel, 1991) focusing on the issue of learning in the interorganizational context. An increase of knowledge through employees' learning can create new business opportunities and hence build up sustainable sources of competitive advantage (Spender and Grant, 1996: 5; Penrose, 1959: 24). These days, the sources of competitive advantage are more frequently breakthrough innovations that increasingly rely upon interdisciplinary and interindustry research and lie beyond the research capabilities of just one single firm (Lubatkin, Florin, and Lane, 2001: 1353).

2.2 Concept of Private and Common Benefits

Even though learning alliances have been subject to recent research, most studies focus on specific questions in the field of interorganizational learning (e.g., Belderbos, 2003; Larsen et al., 1998; Doz, 1996; Ring and Van de Ven, 1992). Only some imply a dynamic approach (like e.g., Lane, Salk, and Lyles, 2001; Khanna et al., 1998; Khanna, 1998; Kumar, Nti, 1998; Doz, 1996). Khanna et al. (1998) and Khanna (1998) address the question of how a learning

alliance develops over time on the basis of the concept of the relative scope (Khanna et al., 1998: 193; Khanna, 1998: 350).

The nucleus of the relative scope lies in the parent companies' choice of alliance scope that considerably affects the character of benefits that the parent companies may reap (Khanna, 1998: 340). The parent companies themselves focus on a certain set of activities called the firm's scope. Generally speaking, the alliance scope typically refers to some subset of markets in which the partner firms are involved (Khanna, 1998: 344; Inkpen, 2000b: 776). The overlap between the scope of the alliance and the total market scope of each partner is called the relative scope (Khanna et al., 1998: 195).

The overlap between the alliance scope and parent 1's scope can be much bigger than parent 2's overlap. In conclusion, one could assume that both parent companies have different goals in this particular alliance. This observation leads to the concept of private and common benefits. The relative scope determines each parents' expected private and common benefits that accrue to the parent companies from an alliance (Khanna et al., 1998: 195; Khanna, 1998: 341). Private benefits can be defined as those kinds of benefits that a parent firm can earn unilaterally by picking up skills from its alliance partner and applying them to its own operations in fields unrelated to the alliance activities (Khanna et al., 1998: 195).

Common benefits can be understood as those kinds of benefits that "accrue to the alliance parent from the collective application of the learning that both firms go through as a consequence of being part of the alliance; these are obtained from operations in areas of the firm that are related to the alliance" (Khanna et al., 1998: 195). The common benefits earned by the parent companies need not be equal for both parents.

The relative scope provides the basis for understanding the parent companies' resource allocation patterns. Different relative scopes lead to different resource allocation behaviors as the parent companies are driven by different needs or interests. For the purpose of unveiling the dynamics of learning alliances the concept of the relative scope is helpful. It covers the tension between competitive and cooperative behavior. So it can be stated that it features a dynamic perspective on alliance development (Inkpen, 2000b: 775; Khanna et al., 1998: 193). As the dynamics of learning and resource allocation are the main focus of this paper, I employ this concept.

In this paper, I analyze the dynamics of a partnership where only common benefits can accrue by using a System Dynamics modeling approach. I examine how different expectations of common benefits, in a learning alliance with only two parent companies, determine the alliance's duration of existence.

3. Hypothesis

In this section, I present the hypothesis of this paper on the basis of the theoretical concepts described above. he focus is only on the alliance itself, with the parent companies being left out. Still, narrowing the focus on just the alliance, the approach of Khanna et al. (1998), further enhanced by learning alliance literature, delivers interesting implications regarding the behavior of the parent companies' engagement, e.g. in terms of resource allocations to the alliance.

For the model it is assumed that two parent companies have founded a learning alliance. They have different backgrounds and relative scopes; i.e., one company has knowledge on the market whereas the other has knowledge on products or processes. This implies that they might also have differing expectations of the common benefits that may result from joint learning. Higher expectations might be due to the fact that there is a greater overlap of the alliance scope with the firm scope. Consequently, the parent company is very concerned about successful learning outcomes as the alliance covers a great scope of the own market. This means that the parent is interested in a long-term existence of the alliance with high common learning outcome. A partner who has only little overlap of the scopes would not be that interested in a long-term existence which might be a cause for early termination of the alliance. Hence,

> *Hypothesis: common alliance learning can only be successful if the alliance is equally important for both parent companies, meaning that they both have the same expectations of the accruing common benefits.*

4. Development of a Dynamic Model for Common Learning

Here, I first present the method I used to develop my model. Further, I talk about the model boundary, followed by the presentation of a reference mode and a detailed description of the stock and flow diagram. This is done by explaining the different loops I discovered. Finally, I explicate the baserun and the different scenarios I produced.

4.1 System Dynamics Method

As stated above, even though learning alliances have been subject to recent research, only some imply a dynamic approach. The models being designed often concentrate on specific building blocks of the field of research on learning alliances and/or neglect a feedback-loop point of view (Kapmeier, 2002: 2). Therefore, a dynamic approach provides an ideal tool for analyzing the dynamics of learning alliances. It would be able to capture the behavior that develops over time by simulating the behavior of interrelated variables. System Dynamics (Sterman, 2000; Forrester, 1961) offers such a simulation method on the basis of feedback processes with stock and flow variables.

The possibility to run different scenarios shows decision-makers long-term effects of decisions instantaneously. As shown below, these might refer to the resource allocation in terms of whether or not to continue a learning alliance.

The model is based upon the findings of carefully reviewing relevant learning alliance literature. It is designed with the Vensim software.

4.2 Model Boundary

In the following sections, I present the model that I developed to test my hypothesis. I determine the model boundary and exhibit the assumptions that I made.

In the model, a reciprocal learning alliance (Lane et al., 2001) is being considered. It is founded by two parent companies. Only common benefits (Khanna et al., 1998; Khanna, 1998) can arise. It is assumed that the common benefits that arise built up upon each other. In other words, one common benefit has to occur before a second can occur. The alliance is set

up to work on a specific task, i.e. a project limited to a certain time-span that demands resources. Its aim is to create new knowledge through a blending of knowledge, co-learning and joint discovery (Lane et al., 2001: 1363). Social similarity of the alliance parents or interfirm diversity (Dengel and Milling, 2002; McAllister, 1995; Zucker, 1986), knowledge relatedness (Lane et al., 2001), knowledge tacitness or explicitness (Spender, 1996; Polanyi, 1966), dominant logic (Bettis and Prahalad, 1995) and dynamic capabilities (Eisenhardt and Martin, 2000; Hagedorn, Link, and Vonortas, 2000; Teece, Pisano, and Shuen, 1997; Teece and Pisano, 1994) are keywords and concepts often discussed in the alliance literature. They are indeed valuable for alliance research. However, to keep the model simple, abstractions are necessary. Therefore, these by no means unimportant ideas are not taken into consideration and hence lie outside the scope of the model.

The alliance knowledge base is the focus of the model. It is decreased by unlearning and increased by learning (Zahn and Tilebein, 2000: 122; Prange, 1996: 172; Luhmann, 1994: 448). It is assumed that the alliance can only realize single-loop learning (Argyris and Schön, 1978). This means that it is not possible to leave the knowledge path and leap onto another one. Moreover, resource expenditures by both parents are taken into consideration. It is assumed that resource expenditures only include human resources. This way, expenditures of other resources like money are subtly included as people require offices, laboratories or other infrastructure to work on their task. Also, it is also assumed that only the parent companies provide the alliance with people. These resource allocations are not limited. Hence, there is no overall budget for the project that the alliance works on. Consequently, the parent companies allocate more resources to the alliance when they perceive progress (Grossman and Shapiro, 1986: 592).[ii] When they perceive progress, the expected value of completing the project increases. The higher the expected value of completing the project, the more resources the parents allocate to the alliance. Transparency between the parent companies is also assumed. This implies that both parent companies are aware of how much resources the partner spends on the alliance and how far they are in achieving their expected benefits.

In addition, the parent companies follow an equilibrium strategy that is based on stability, optimality, and rationality. Subsequently, the partners follow the Nash equilibrium, indicating that both parent companies believe that they are doing the best they possibly can, given the actions of the partner (Ho and Weigelt, 1997: 132).

It is further assumed that resource expenditures are made on the bases of the individual parent company's expected and perceived common benefits (Khanna et al., 1998; Khanna, 1998). The parent companies' expected common benefits are determined by the parent companies' relative scopes. In the model, the relative scopes are seen as exogenous. Nevertheless, inputs into this exogenous variable can indeed vary. This implies that the parent companies' relative scopes also vary. For example, the firm scope would increase if a parent company conquered new markets outside of the alliance scope. Hence, this company's relative scope would decrease.

Moreover, trust on the group level is being considered (Curral and Inkpen, 2002). It is assumed that an existing positive atmosphere on the firm level that might be due to previous ties between the parents (Gulati, 1995), can be shifted onto the group level. Trust encourages the people involved in the alliance to interact more frequently and communicate with each other.

Absorptive capacity (Cohen and Levinthal, 1990) and information redundancy (Nonaka and Takeuchi, 1997) are also being considered in the model. Redundancy is operationalized via

the variable ‘assessment of new knowledge’. With high redundancy, the assessment of new knowledge is low. This means that, by intuition, the ‘absorptive capacity’ is highest in a situation where the ‘assessment of new knowledge’ is lowest. Consequently, people understand quickly what they learn – but what is newly learnt is only little value to them. Both ‘absorptive capacity’ and ‘assessment of new knowledge’ influence the learning aptitude of the people who work in the alliance.

I have left out the concept of relative absorptive capacity (Lane and Lubatkin, 1998) as it focuses on the knowledge bases of different organizations. Even though the people who work in the alliance come from two different companies, they work on the same task – there is no student-teacher learning involved in this situation. This would be the case where knowledge is transferred from the alliance to the parents’ knowledge bases. However, accruing private benefits is out of the model’s scope.

Most of the variables within the model boundary are qualitative and therefore difficult to quantify. However, they are essential for understanding the structure that determines the dynamics of interorganizational learning. Therefore, “leaving such variables out of models just because they lack of hard numerical data is certainly less ‘scientific’ than including them and making them reasonable estimates of their values” (Sterman, 1991: 12; see also: Sterman, 2002: 523).

4.3 Reference Mode

In this section I present the reference mode that the model refers to (Sterman, 2000: 90). Here, the dynamics of resource spendings over time are looked at closely.

As stated above, it is assumed that the alliance can only generate common benefits. Thus, it is a situation of pure cooperation. As the partners follow the Nash-equilibrium, resource allocation decisions are best made together. Both parent companies come to an agreement on the amount of resources needed to be allocated depending on the progress of the project. They act as one single firm. (Khanna et al., 1998: 197; Grossman and Shapiro, 1987: 378).

Following Grossman and Shapiro (1987) and Khanna et al. (1998), the resource allocation of the parent companies would look like depicted in the Figure 1. It can be seen from the figure that the project requires the completion of two milestones. As long as the learning alliance still works on milestone 1, resource allocations stay constant at a certain level. Once the first milestone is finished, the alliance works on milestone 2. As the expected value of the project increases at this moment, resource allocation by the parents is increased until the project is finished. Even though the reference mode indicates milestones, there are no milestones being considered in the model. It is assumed that resource allocations are made constantly.

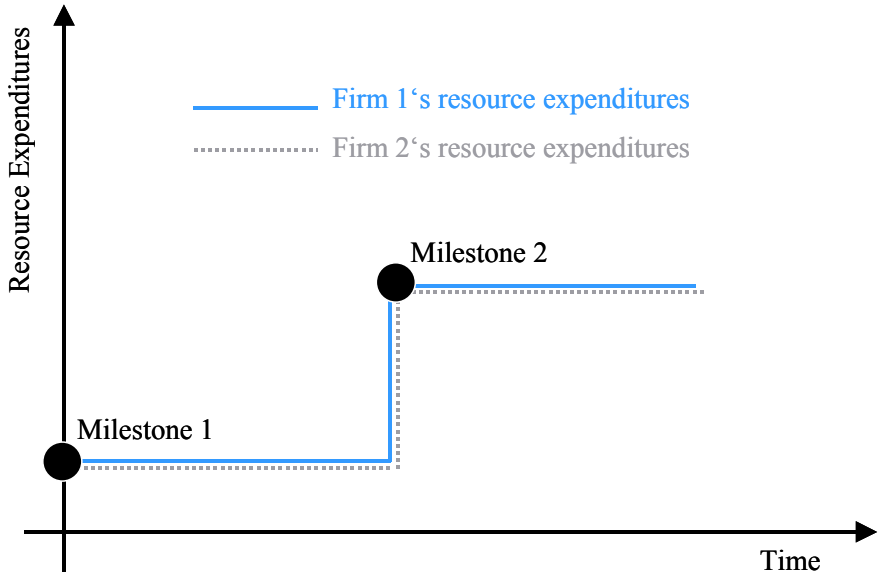

Figure 1: Reference mode: Resource spending in a situation of only common benefits. Source: following Grossman and Shapiro, 1987: 374.

4.4 Stock and Flow Diagram

In this section, the stock and flow diagram and the baserun as well as different scenarios will be presented.

4.4.1 Loop Descriptions

The model designed consists of three major and four minor feedback loops. First, there are two major balancing feedback loops, called ‘reaching the goals’ (Kapmeier, 2002: 4) whose structure is identical. Each refers to reaching the goals of the two parent companies. Second, a reinforcing loop shows that ‘trust enhances learning’ (Kapmeier, 2002: 3). Third, a reinforcing loop illustrates that a larger knowledge base ‘enhances absorptive capacity’ (reinforcing loop). But, fouth, at the same time, ‘information gets redundant’ (balancing loop). Finally, two structurally identical balancing loops called ‘spending regulative’ monitor and control the resource allocation ensuring the two parents’ resource spendings even out.

4.4.1.1 B1a and B1b - Reaching the Goals

Both B1a and B1b – Reaching the goals are identical feedback loops that are intertwined. For better understanding, I will first explain B1a. The loop regulates the optimal resource allocation in proportion to the expected value of the project. There are four accumulations, or stocks (see Figure 2).

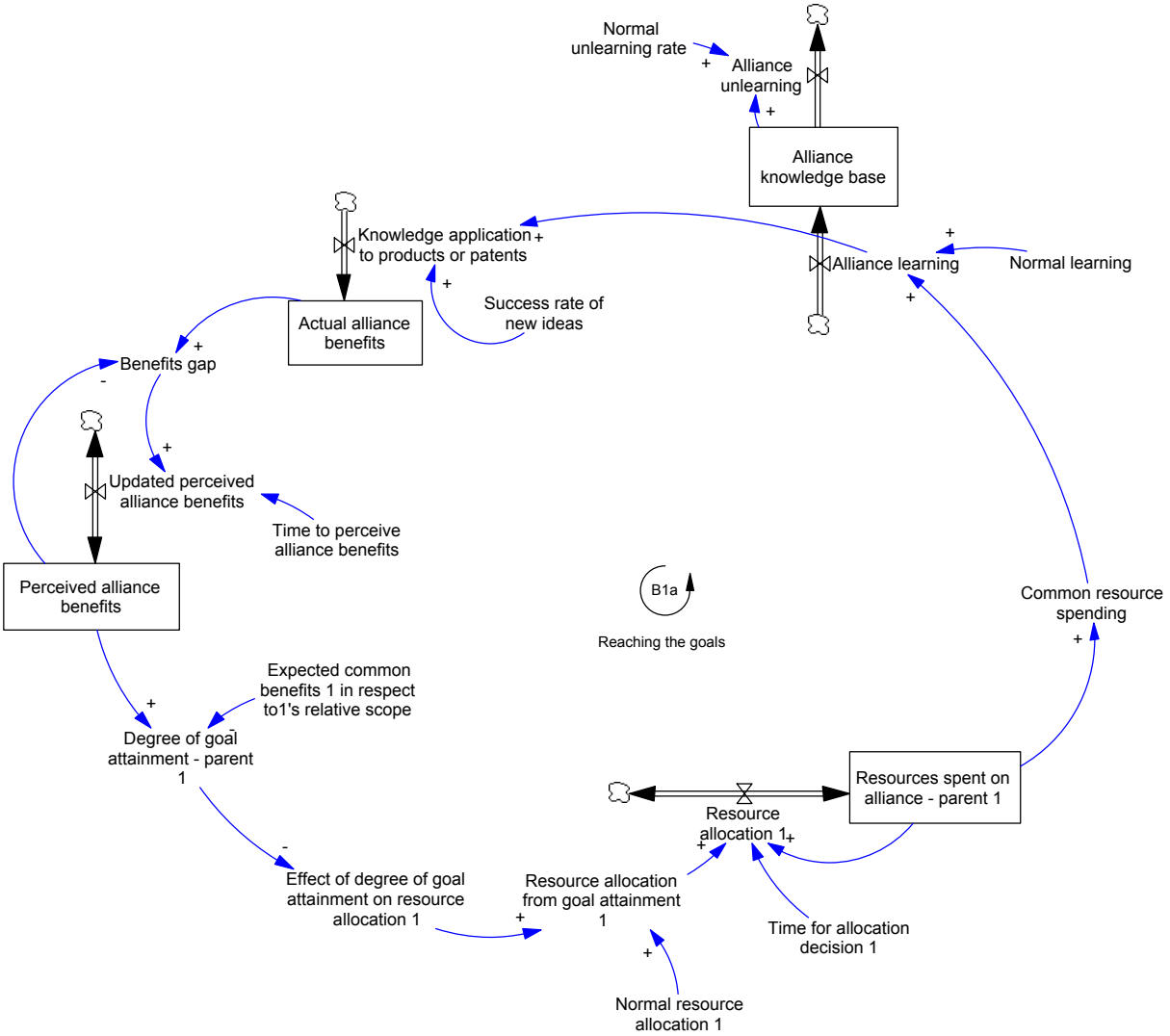

Figure 2: B1 – Reaching the goals

The stock ‘alliance knowledge base’ (measured in knowledge points) indicates how much accumulated knowledge the alliance has. It is initialized at 2 knowledge points, which stands for a common basic understanding of the project to work on. The ‘alliance knowledge base’ increases by ‘alliance learning’ and decreases by ‘alliance unlearning’ (knowledge points per week). ‘Alliance unlearning’ (Güldenberg, 1996; Bettis and Prahalad, 1994; Hedberg, 1981) is on the one hand determined by the size of the stock. The more people know, the more they unlearn. On the other hand, ‘unlearning’ is influenced by a ‘normal unlearning rate’ (1/ week). This variable refers to the phenomenon that people forget things over a certain period of time. Here, it is assumed that the employees working in the alliance forget 1% of their knowledge per week. The ‘alliance knowledge base’ is increased by ‘alliance learning’. This flow variable is determined by the ‘resources spent on the alliance’ (people) and ‘normal learning’ (knowledge points per people and week). ‘Normal learning’ is a constant that provides information about the people’s learning efficiency. It is assumed that one person can learn 0.5 knowledge points per week under normal learning conditions.

A firm does not necessarily benefit from the acquisition of knowledge unless the knowledge is actually applied (Child and Faulkner, 1998: 283). The more people learn, the more new patents can be registered (Inkpen and Crossan, 1995; March, 1991; Lyles and Salk, 1996; Argyris and Schön, 1978). However, not everything newly learnt is useful for the development of new products or suitable for a patent registration. This is covered by the

constant ‘success rate of new ideas’ (benefit points per knowledge point). The flow ‘knowledge application to products or patents’ (benefit points per week) increases the stock ‘actual alliance benefits’ (benefits points).

As it takes ‘time to measure and perceive the alliance benefits’ (weeks), an information delay is included in the model (Sterman, 2000: 411). This smoothing structure includes the ‘perceived alliance benefits’ (benefit points), the ‘benefits gap’ (benefit points) which computes the difference between the ‘actual alliance benefits’ and the ‘perceived alliance benefits’, and the flow ‘updated perceived alliance benefits’ (benefit points per week) that is intended to close the ‘benefits gap’.

The parent company decides to join the reciprocal learning alliance to realize three patents, for example. It does so considering its relative scope. It is assumed that the expected alliance benefits increase with an increase of the overlap between the alliance scope and the firm scope. This is captured in the exogenous variable ‘expected common benefits of the parent company in respect to the parent company’s relative scope’. In the baserun it is constant with three benefit points and it varies in the scenarios.

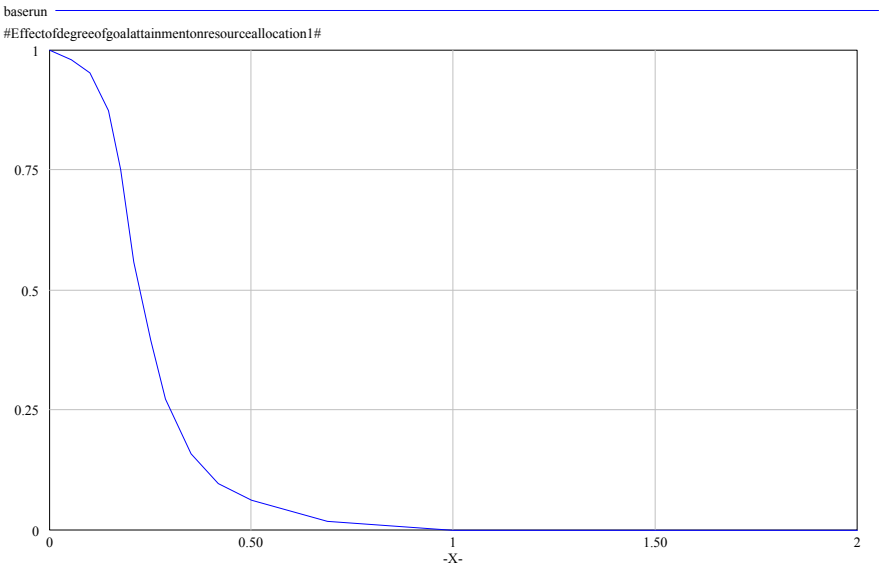

Figure 3: Nonlinear relationship for ‘effect of degree of goal attainment on resource allocation’

There is a nonlinear relationship between the goal attainment and the resource allocation that is captured in a robust table function (Sterman, 2000: 553; see Figure 3). When the goal has almost been reached (the ‘degree of goal attainment on resource allocation’ is small), the parent company only allocates few additional resources to the alliance. However, when the goal is still far off (large ‘degree of goal attainment on resource allocation’), the parent company allocates more resources to the alliance in order to reach the goal faster (Grossman and Shapiro, 1987: 378).

The actual number of resources allocated to the alliance is calculated by multiplying the ‘effect of goal attainment on resource allocation’ (dimensionless) with the ‘normal resource allocation’ (people). The latter variable states that the parent companies allocate 10 people under normal conditions. Now, depending on the ‘degree of goal attainment’, the actual resource allocation might be smaller. The number computed is called ‘resource allocation from goal attainment’ (people). The higher the ‘resource allocation from goal attainment’, the more people will be allocated to the alliance the next period via the variable ‘resource

allocation' (people per week). 'Resource allocation' is a biflow that can either increase or decrease the stock 'resources spent on the alliance' (people). As another variable ('resource allocation from allocation difference') from Loop B1b determines the biflow, the underlying policy will be discussed later. In any case, the 'resources spent on the alliance' influence how much people learn in the alliance, considering 'normal learning'.

The second balancing loop, B1b – Reaching the goals, refers to the second parent company's resource allocation structure. From Figure 4 it can be seen that it is structurally identical to B1a described above. B1b connects to B1a at three variables, 'perceived alliance benefits', 'common resource spending', and 'resource allocation'. As with parent company 1, parent company 2 also measures up the 'perceived alliance benefits' against its 'expected common benefits'. The 'resources spent on the alliance' from both parent companies add up at 'common resource spending'.

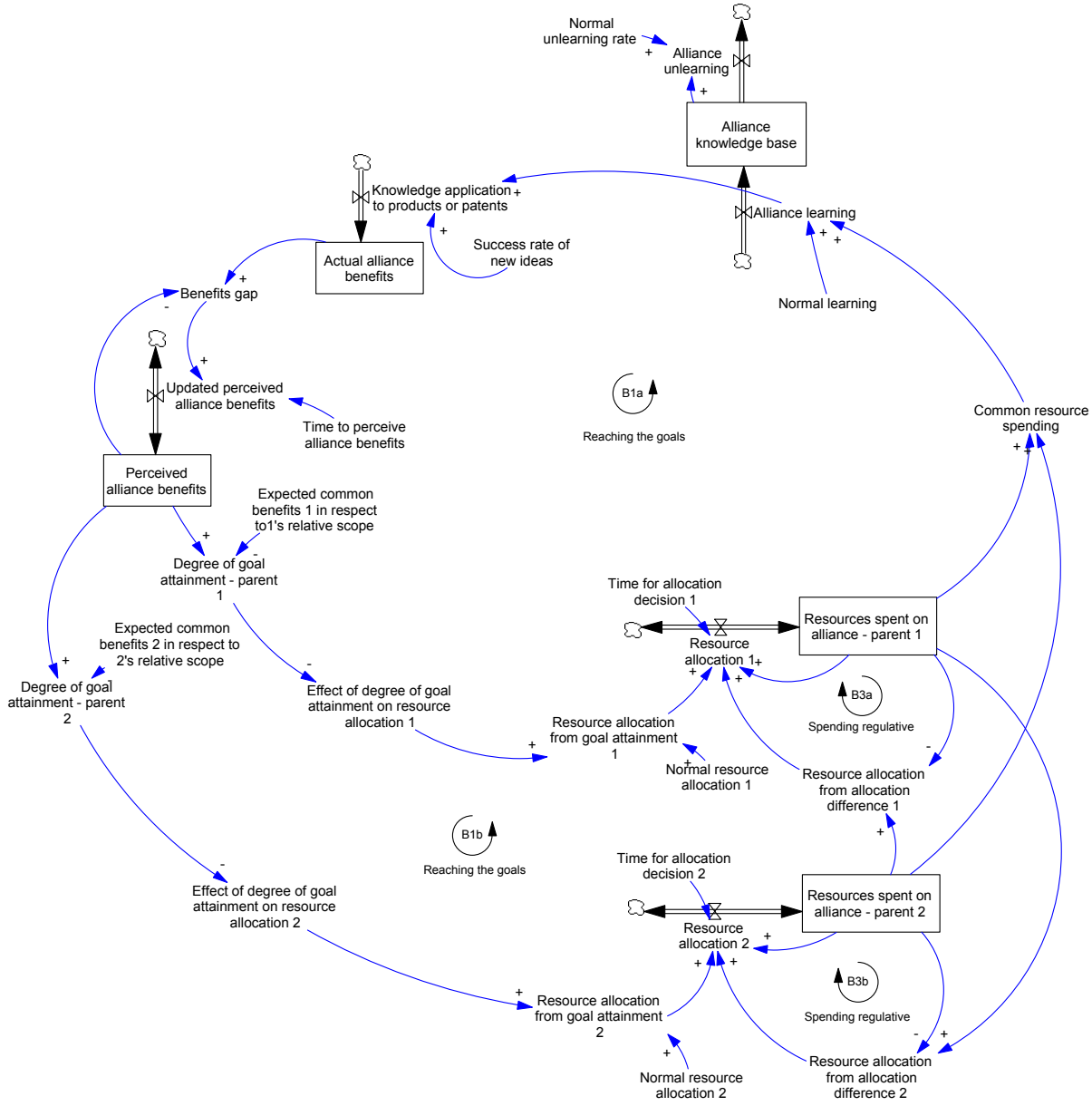

Figure 4: B1a and B1b – Reaching the goals, parent 1 and parent 2

4.4.1.2 B3a and B3b - Spending Regulative

Both parent companies' resource allocations influence each other. As stated above, in a situation of pure common benefits, the two parent companies act as one single firm (Khanna et al., 1998: 197). This indicates a structural regulative ensuring that both companies always spend roughly the same amount of resources on the alliance. This is captured by the two balancing loops B3a and B3b – Spending regulative. Any resource allocation differences of the two parents are registered in the two separate variables 'resource allocation from allocation difference' (number of people). Now, the parent companies' resource allocations depend on two variables, 'resource allocation from allocation difference' (people) and 'resource allocation from degree of goal attainment' (people). From the underlying policies, six different policies might occur (see Table 1).

In any case, if the 'degree of goal attainment' indicates that the expected common benefits are achieved, the task of the alliance is accomplished. Consequently, the parent decides to withdraw its resources from the alliance. If the goal has not yet been accomplished, the parent might either further increase the resources considering that the 'resource allocation from allocation difference' indicates that the partner spends the same amount of resources or more. Or, if the partner invests less, resources are withdrawn in order to get equal again with the partner.

	Resource allocation from allocation difference = 0	**Resource allocation from allocation difference > 0 (Partner invests more)**	**Resource allocation from allocation difference < 0 (Partner invests less)**
Resource allocation from degree of goal attainment = 0	**Withdrawal of resources** (Resource allocation from gap policy).	**Withdrawal of resources** (Resource allocation from gap policy).	**Withdrawal of resources** (Resource allocation from gap policy).
Resource allocation from degree of goal attainment > 0	**Increase resources** (Resource allocation from gap policy).	**Increase resources** (Resource allocation from gap policy + Resource allocation from allocation difference policy).	**Smooth withdrawal of resources even though the firm has not reached its goals yet** (Resource allocation from allocation difference policy).

Table 1: Resource allocation policies

If resource allocations are increased, a third order delay is involved in the process as it takes time to perceive the need to increase the resources, or to choose the right people or what you have, for instance. This 'time for the allocation decision' (weeks) is constant at four weeks. If resources are withdrawn from the alliance, there is no delay involved. The moment the goal is achieved, resources are withdrawn immediately. It is assumed that there is no smooth transition from putting people into the alliance to withdrawing them from it.

4.4.1.3 R1 - Trust Enhances Learning

The reinforcing loop R1 – Trust enhances learning describes the relationships between performance, trust, learning, and, again, performance. The loop connects to the balancing loops B1a and B1b – Reaching the goals at 'perceived alliance benefits'.

The people in the alliance measure up the perceived alliance benefits with their own expectations. The higher the 'degree of goal achievement' (again, this variable is dimensionless as this is the input for another nonlinear relationship, thus the table can be considered robust), the more the people believe in the success of the alliance (see Figure 5). This means that they feel attached to the alliance, which can be interpreted as intergroup trust (Currall and Inkpen, 2002: 488).

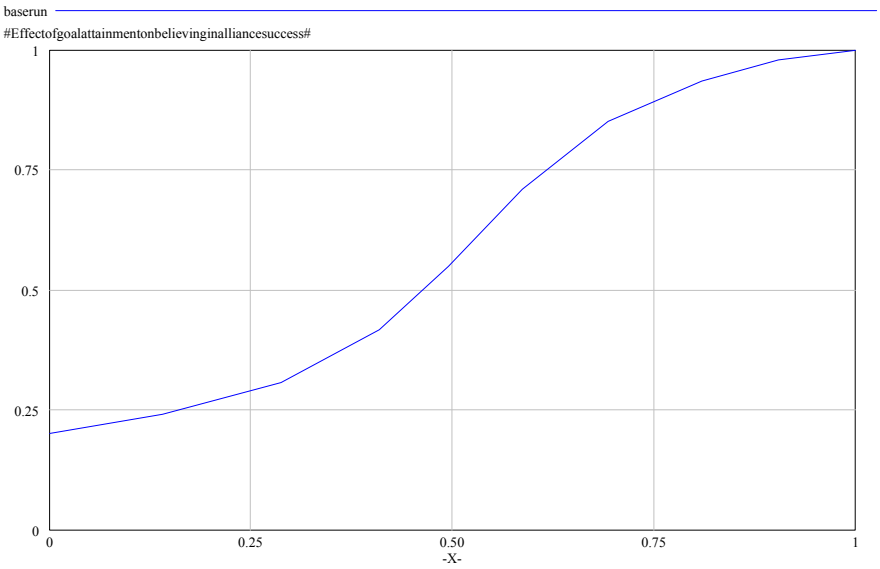

Figure 5: Nonlinear relationship for 'effect of goal attainment on belief in alliance success'

As can be seen from the Figure 5, a certain trust threshold or initial trust exists even when there is only little or no goal attainment. This is due to the observation that "there is an element of trust in every transaction" (Ring and Van de Ven, 1992: 488). The curve in Figure 5 is s-shaped which indicates that trust develops slowly when just little progress is observed, though, when the goal is achieved, it reaches a limit. In any case, the trust being generated is multiplicated by a normalizing factor, 'normal belief' (belief points). The stock 'intergroup belief in alliance success' (belief points) is a fragment of a smoothed-information structure (see also the structure of 'perceived alliance benefits'). There is a biflow 'change in belief' (belief points per week) that can either increase or decrease the stock.

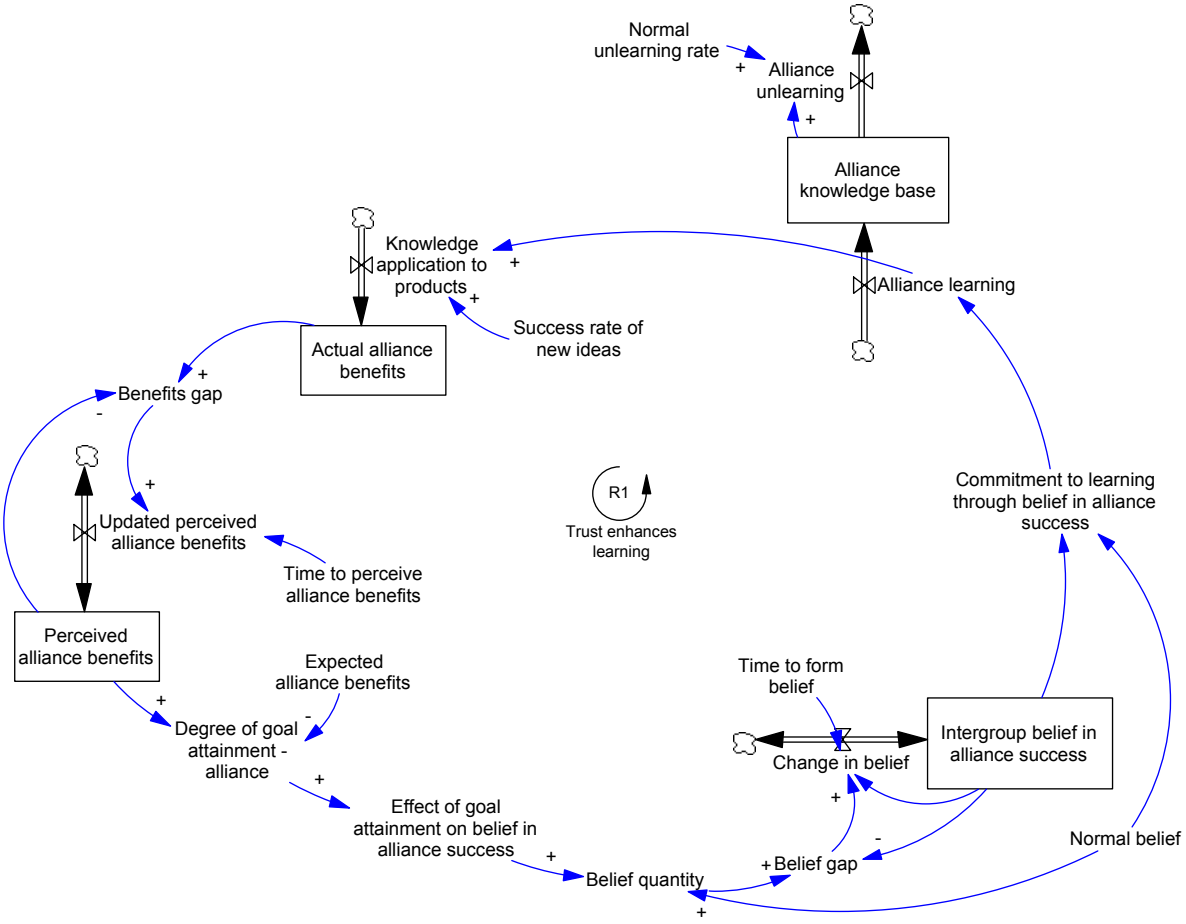

Figure 6: R1 – Trust enhances learning

'Intergroup belief in alliance success' describes the people's attachment to each other. The attachment is purely formed through the perceived alliance benefits. This means that perceived progress strengthens the people's dedication to their work. The parent companies' 'expected common benefits in respect to their relative scope' do not influence the 'intergroup belief in the alliance success'. It is assumed that the people working in the alliance only dedicate their time and energy to their research findings and not to coordinating the degree of their parent companies' goal attainment. The moment one parent withdraws its people from the alliance, intergroup belief diminishes quickly.[iii] Further, the more the people trust each other, the more they are willing to share information, the more open they are, and the more they communicate and interact with each other as they commit to their task and to the alliance (Inkpen, 2000b: 1028; Kumar and Nti, 1998: 360). Hence, they learn together and generate alliance benefits.

4.4.1.4 R2 - Enhancing Absorptive Capacity

In this and the following section, I describe the loops R2 – Enhancing absorptive capacity and B2 – Information redundancy (see Figure 7). The 'alliance knowledge base' (knowledge points) needs to be normalized for determining both the 'absorptive capacity' and the 'assessment of knowledge value'. As no real quantity can grow forever (Sterman, 2000: 295), it is put in relation to an assumed 'maximum knowledge base' (knowledge points). Thus, the resulting 'relative knowledge base' is a dimensionless variable.

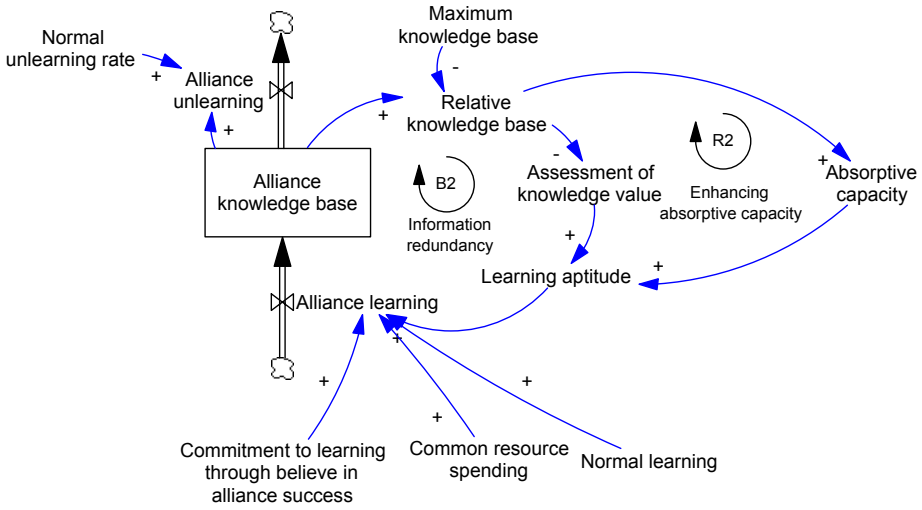

Figure 7: R2 – Enhancing absorptive capacity and B2 – Information redundancy

The ability to recognize, learn and use new knowledge is included in the 'absorptive capacity' (dimensionless) (Cohen and Levinthal, 1990). Here, it is assumed that the absorptive capacity increases in an s-shaped way. Accordingly, the higher the 'relative knowledge base', the higher the capacity to absorb new knowledge (see Figure 8).

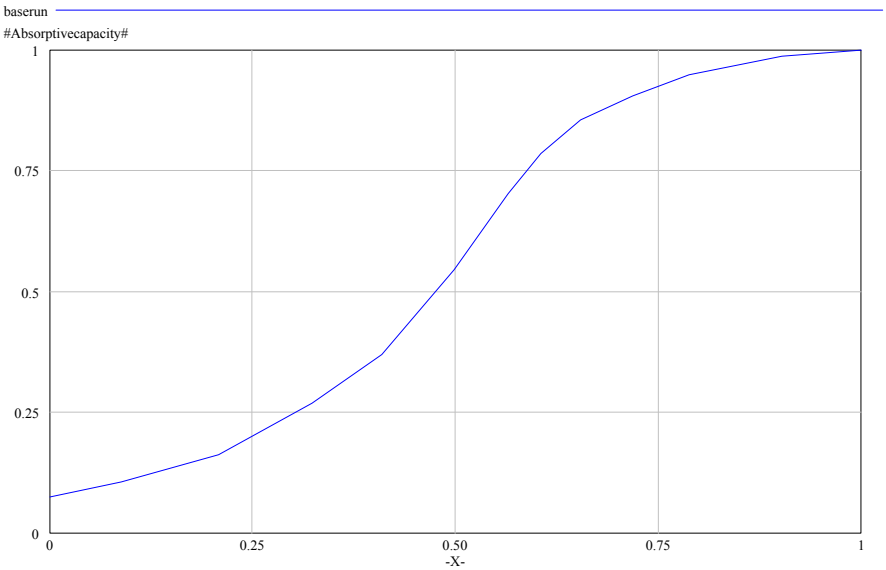

Figure 8: Nonlinear relationship for 'absorptive capacity'

Thus, the absorptive capacity increases with an increasing knowledge base. This means that the people understand their task better the more they know. However, as can be seen from Figure 8, the people working in the alliance cannot perform double-loop learning (Argyris and Schön, 1978) as there are no learning leaps.

4.4.1.5 B2 - Information Redundancy

At the same time, however, the more the people know, the less new information they actually receive (Nonaka, Toyama, and Byosière, 2001; Lane and Lubatkin, 1998; Nonaka and Takeuchi, 1997). This means that the assessment of knowledge value is decreasing. It decreases slowly in the beginning, then faster and finally more slowly again, which leads to an inversed s-shaped curve (see Figure 9).

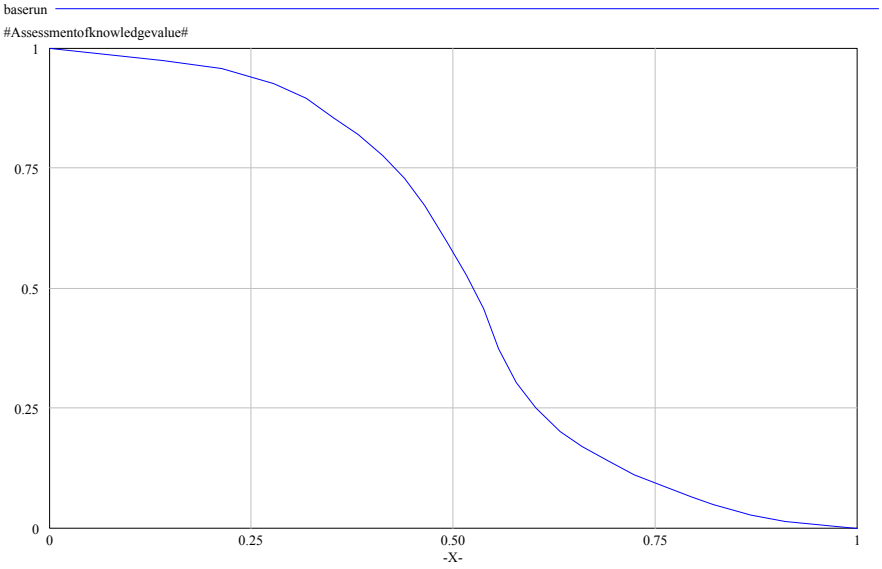

Figure 9: Nonlinear relationship for ‘assessment of knowledge value’

The loops explained above are now put together into one single stock and flow diagram (see Figure 10). This model structure provides the basis for the dynamic analysis of alliance learning. I present the different runs in the next section.

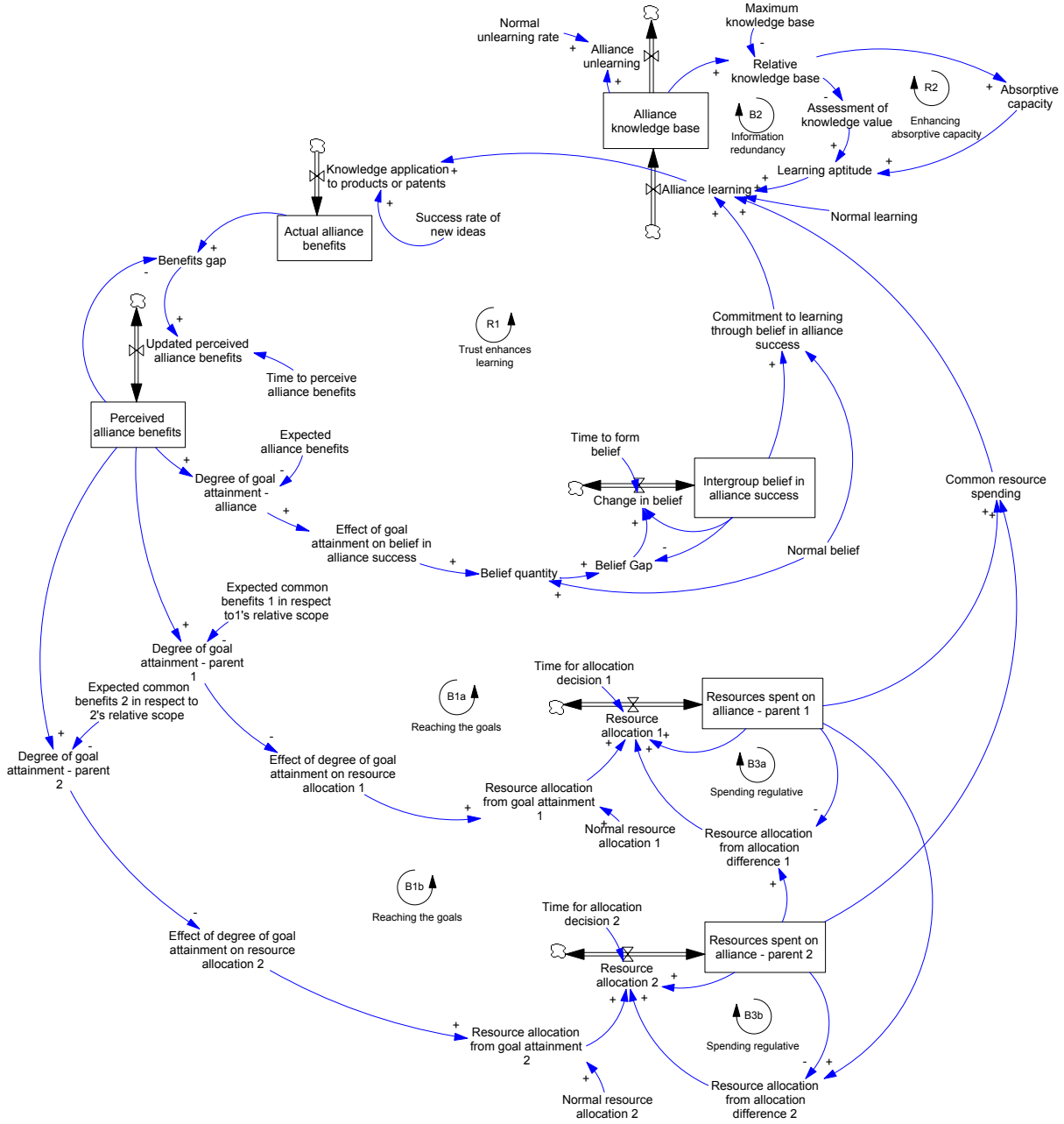

Figure 10: Stock and flow diagram of common learning

4.4.2 Findings from the Dynamics of the Model

4.4.2.1 Baserun: Both Companies have the Same Expectations of the Alliance's Common Benefits

In the baserun, it is assumed that both companies expect the alliance to accrue the same common benefits which is constant at three benefit points. Figure 11 shows the behavior of 'resources spent on the alliance' by both parents, 'degree of goal attainment' and both 'actual' and 'perceived alliance benefits' over a period of 50 weeks. As can be seen from the figure, the resource spending patterns of both parent companies are identical. They first increase progressively (here, until roughly week 15) and then at a diminishing rate until they reach a peak (week 20). This is the moment when the goals are achieved. Structurally, when both parents invest the same amount of resources, the allocation difference is zero at all times. Hence, the resource allocations only rely on the degree of goal attainment that follows an s-

shaped curve, the slope depending on the ‘perceived alliance benefits’. As discussed above, the ‘perceived alliance benefits’ lag behind the ‘actual alliance benefits’ due to time delays. Therefore, the alliance still keeps on working on the task even though the actual goals have been attained (here, after week 17). Due to the delayed benefit perception, time passes by until benefits continue occuring. Therefore, the degree of goal attainment becomes larger than one. Once the ‘perceived alliance benefits’ equal out to the expected common benefits (week 20), the parent companies finally perceive that the alliance’s goals are achieved. Consequently, the parents are satisfied and thus withdraw their resources immediately from the alliance.

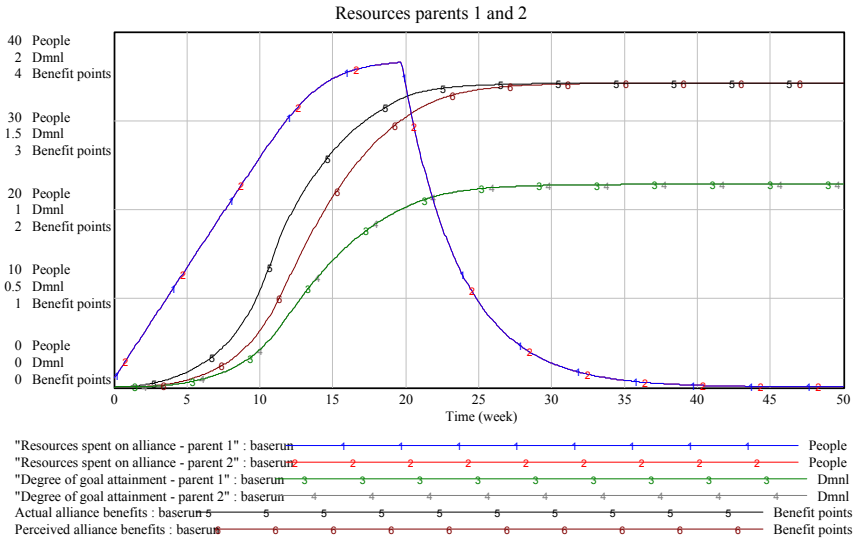

Figure 11: Resource spendings - baserun

At first sight, the graphs for resource allocation in the baserun (Figure 11) and the reference mode (see Figure 1) look different. This might be an indication that the model does not reproduce the behavior that serves as the reference mode. Grossman and Shapiro (1987) follow a more discrete development approach of dynamics with resource allocations only occurring at the end of a certain event (Grossman and Shapiro, 1987: 374). System dynamics, however, follows continuous integration with smooth developments and transitions over time. Both behavioral modes show increasing resource allocations with the alliance progressing towards the goals. Therefore, both representations over time can be seen as similar.

It is stated above that the benefits arise through the applying what has been learnt in the alliance to products or patents. As is shown in the Figure 12, the ‘alliance knowledge base’ accumulates in an s-shaped curve and reaches a peak (at roughly week 20). The ‘alliance knowledge base’ is determined by ‘alliance learning’, the flow to build up the knowledge accumulation. The stock first increases exponentially, then asymptotically towards a goal. This behavior is determined by the flow that first increases, peaks during the knowledge base’s transition phase and then drops nearly exponentially.

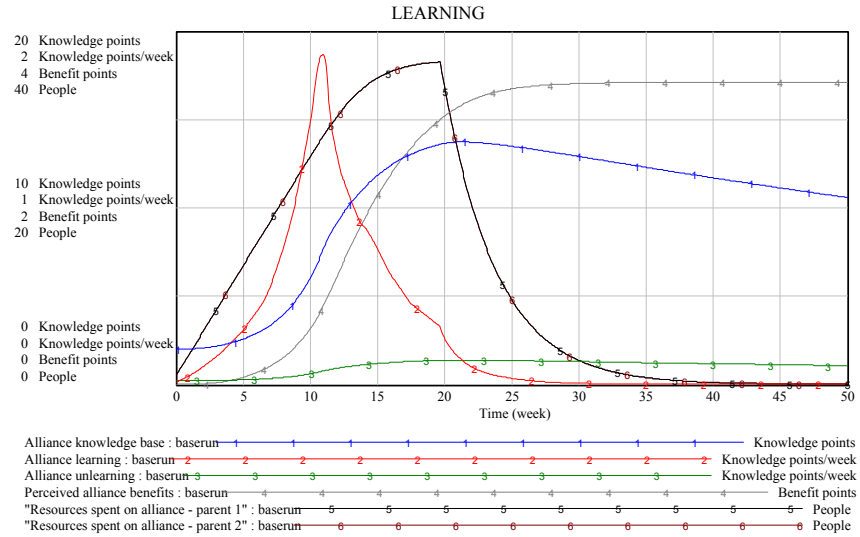

Figure 12: Learning and knowledge base - baserun

The bumpy and rough slope of ‘alliance learning’ in the declining phase is due to the different variables determining it (see Figure 13). When the ‘learning aptitude’ decreases, the commitment to the alliance and the resource expenditures still increase. In other words, even though the ability to learn declines, the parents spend even more resources on the alliance (here, after week 11).

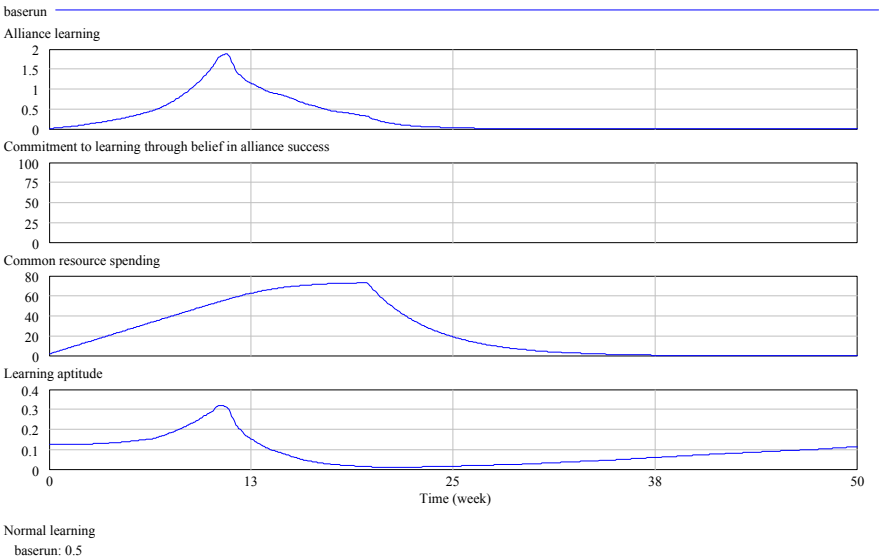

Figure 13: Alliance learning - baserun

Figure 14 illustrates the behavior of ‘learning aptitude’ in greater detail. With an increasing knowledge base, the ‘absorptive capacity’ increases exponentially whereas the ‘assessment of new knowledge’ declines exponentially. However, the net increase of both multipliers is positive. Consequently, the ‘learning aptitude’ grows. Growth slows down when the net increase diminishes and it peaks when the net rate is zero. Afterwards, the ‘learning aptitude’ decreases as the ‘assessment of new knowledge’ becomes smaller. The ‘assessment of new knowledge’ increases again because the ‘alliance knowledge base’ drops (here, after week 25). So, there would be things to (re-)learn again. According to Figure 12, ‘unlearning’ slightly increases due to an increasing ‘alliance knowledge base’ until approximately week 16 and then almost flattens and reduces the knowledge base constantly.

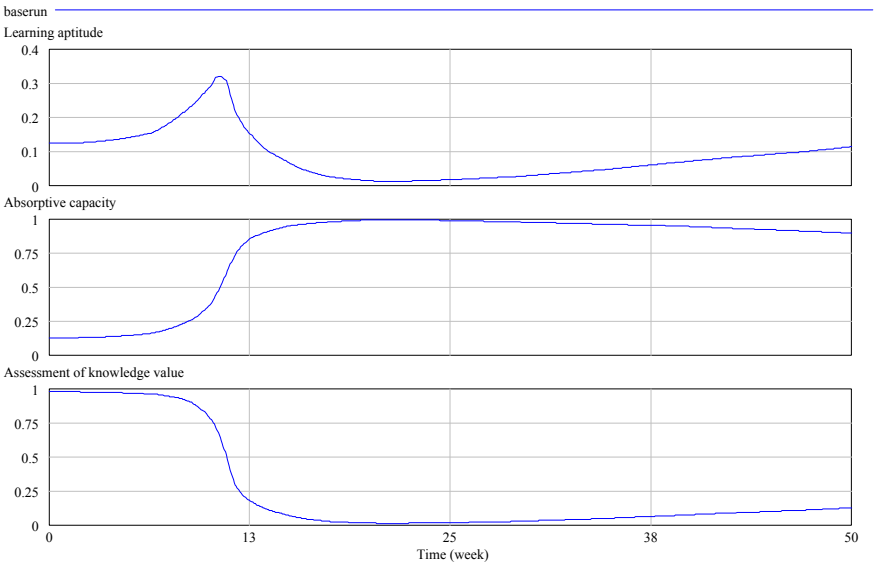

Figure 14: Learning aptitude - baserun

In the beginning of the alliance's existence 'interfirm belief in the alliance success' or trust drops slightly (see Figure 15). Even though there are both enthusiasm among the people working in the alliance and belief in the alliance's success, there are no outcomes being generated. Thus intergroup trust slowly diminishes.

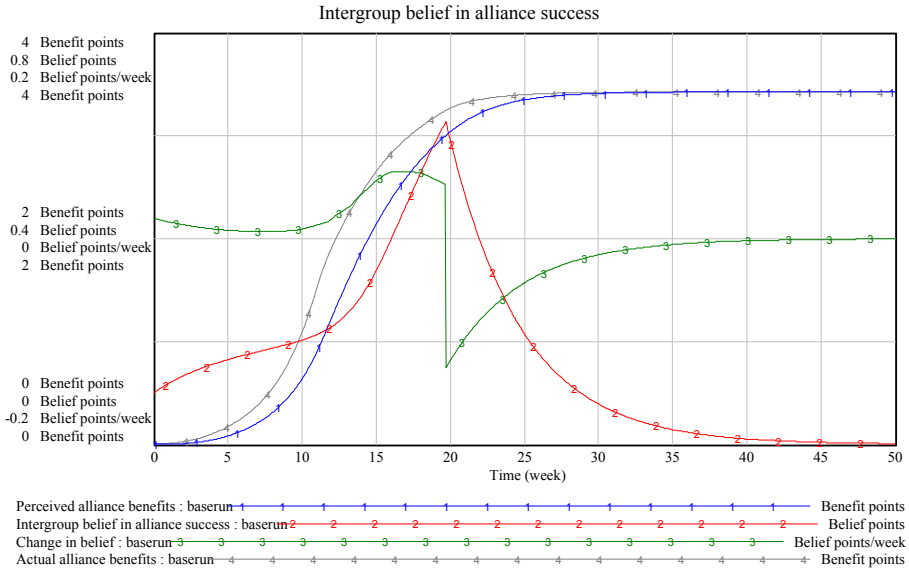

Figure 15: Intergroup belief in alliance success - baserun

As soon as the alliance actually generates benefits, people recognize that they are on the right track with their work. With growing certainty in the alliance's purpose, 'change in belief' (net rate) rises and hence, 'interfirm belief in alliance success' builds up. The latter increases until the parents decide to withdraw the resources. Trust diminishes exponentially after this decision has been made. The alliance goals have been achieved, and further success is not possible. Both parents are satisfied with the alliance's outcomes. They have worked together successfully. If they decide to work on another task together in the future, it is conceivable that initial 'interfirm trust' will be greater than in the baserun due to this cooperatively well accomplished task. This might be different in the other scenarios that are discussed subsequently.

4.4.2.2 First Scenario: On the way, Parent 2 Finds the Alliance More Attractive Than Originally Thought

In the first scenario, it is assumed that both companies start out with the same expectations of the alliance outcomes. However, in week 7, parent 2 suddenly realizes that the alliance is of greater importance than it had originally thought. This may be due to a change of the parent's relative scope, i.e., through the parent's decision to expand the markets covered by the alliance. As a result, the parent increases its 'expected common benefits in respect to its relative scope' by more than 300% (modeled via a step function: 3+STEP (8, 7)). This is entailed in Figure 16 by the sudden drop of parent 2's 'degree of goal attainment' in week 7.

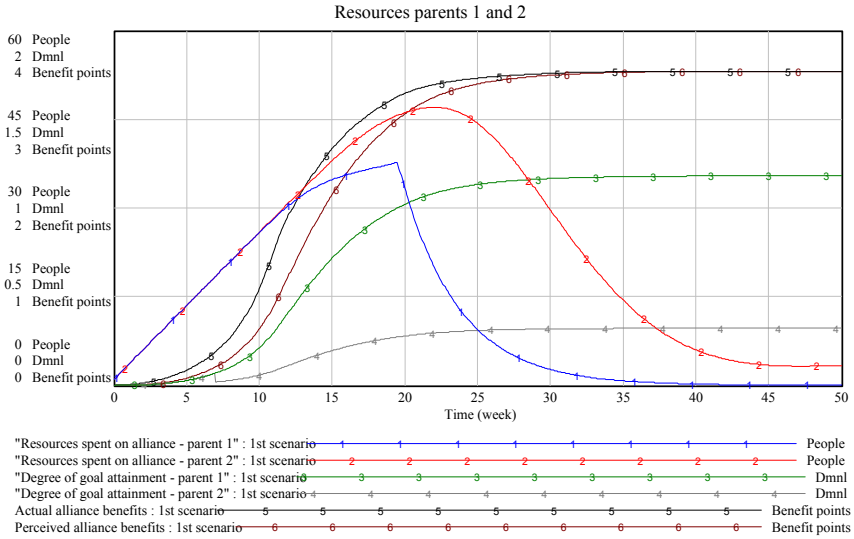

Figure 16: Resource spending – 1st scenario

According to parent 2's resource allocation policy, more people should be working in the alliance after week 7. Yet, there is no sudden increase in 'resources spent on alliance – parent 2' as people must be recruited for working on the task. As stated in section 4.4.1.2, this delay lasts 4 weeks. It can be seen from the Figure 17 that after week 11 (= 7 + 4), parent 2 further increases its resource expenditures on the alliance (see Figure 17).

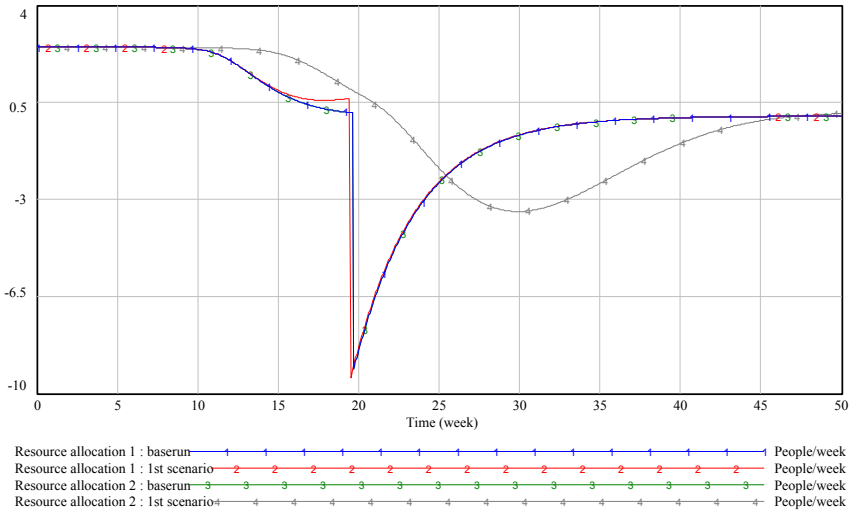

Figure 17: Resource allocation parent companies 1 and 2 – baserun and 1st scenario

While the ‘perceived alliance benefits’ approach parent 1’s expected common benefits, parent 1 slows down the increase of resource allocations according to the policies presented in Table 1. It can be seen from the Figure 17 that parent 1 increases its resources much more slowly (here, from week 11 to week 20) than in the baserun. Parent 1 withdraws its resources after it has reached its goals (week 19) slightly earlier as in the baserun as more people have worked on the task, whereas parent 2’s resource allocation is still positive as it has only met approximately 50% of its expectations. Nevertheless, even though the task has not been yet accomplished, parent 2 also pulls out its resources (after the 22nd week). There is no longer a partner with whom to learn.

The behaviors of ‘alliance learning’, ‘alliance unlearning’, and ‘alliance knowledge base’ resemble those of the baserun (see Figure 18). The same holds for ‘interpartner belief in alliance success’ (see Figure 19). Both the ‘alliance knowledge base’ and the ‘actual alliance benefits’ are insignificantly higher in the first scenario than in the baserun.

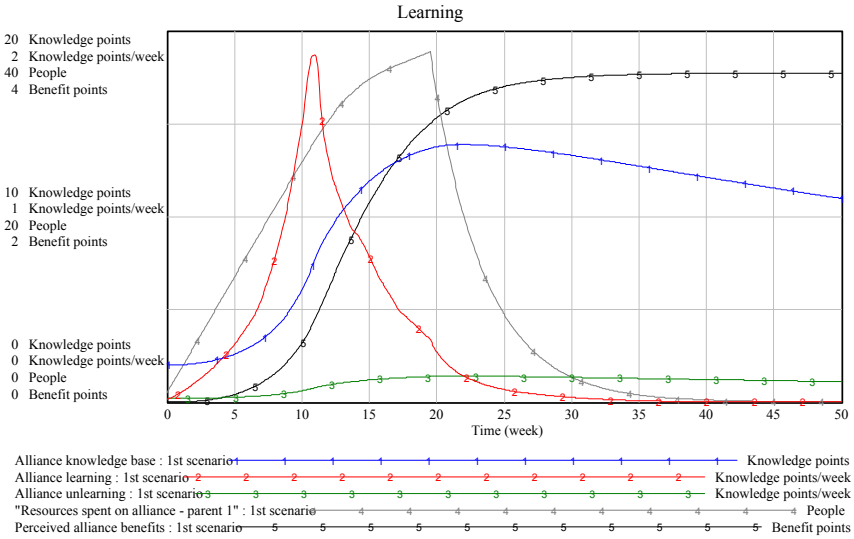

Figure 18: Learning – 1st scenario

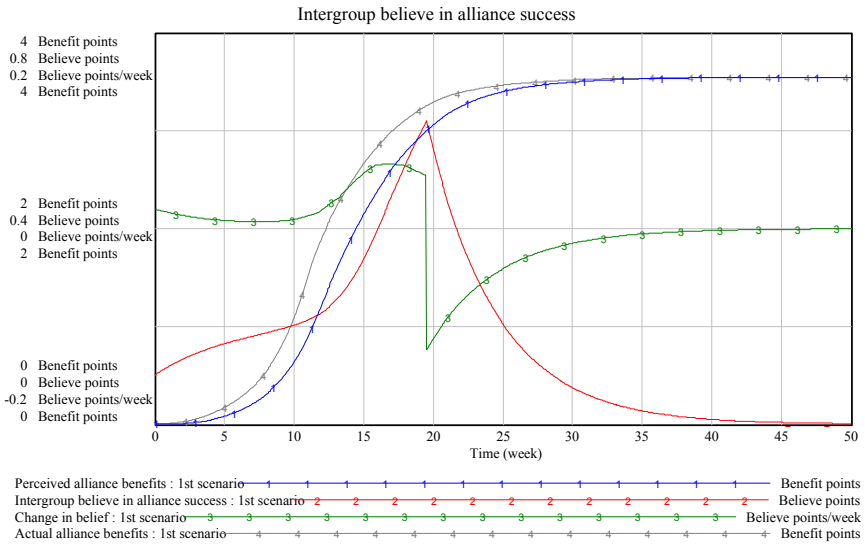

Figure 19: Interfirm belief in alliance success – 1st scenario

Even though there are no considerable differences concerning the interfirm belief or the learning process in the alliance between the baserun and the first scenario, it can be stated that

the change in the alliance's importance for parent 2 is significant. Only 50% of its expectations were accomplished – the outcome is unpleasant. Parent 1, however, is satisfied as it has achieved more than originally expected.

4.4.2.3 Second Scenario: Parent 2 has Higher Expectations of Alliance Benefits Than Parent 1

For the second scenario it is assumed that parent company 2 has a larger overlap of its firm's scope with that of the alliance from the founding of the alliance. Hence, parent 2's relative scope is larger than parent 1's. So, the alliance's success is of higher importance for this company as the alliance covers a larger area of the company's field of interest. It is assumed that parent 2's expected common benefits are twice as high as in the baserun. Consequently, the 'normal resource allocation' is twice as high.

As can be seen from the Figure 20, parent 2 spends a lot more resources on the alliance right from the beginning compared to the other runs. Due to this intensive resource spending parent 2 forces parent 1 also to spend more resources than in the other runs (see Figure 21).

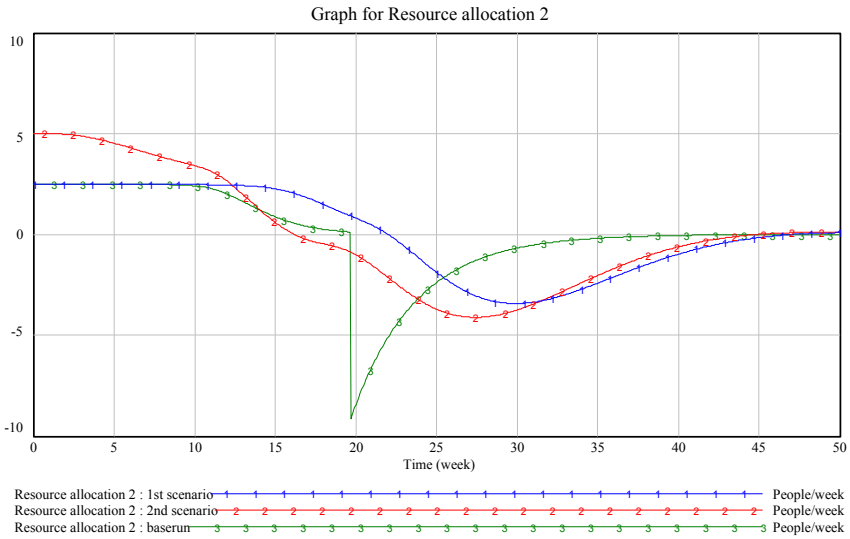

Figure 20: Resource allocation, parent 2 – 2nd scenario

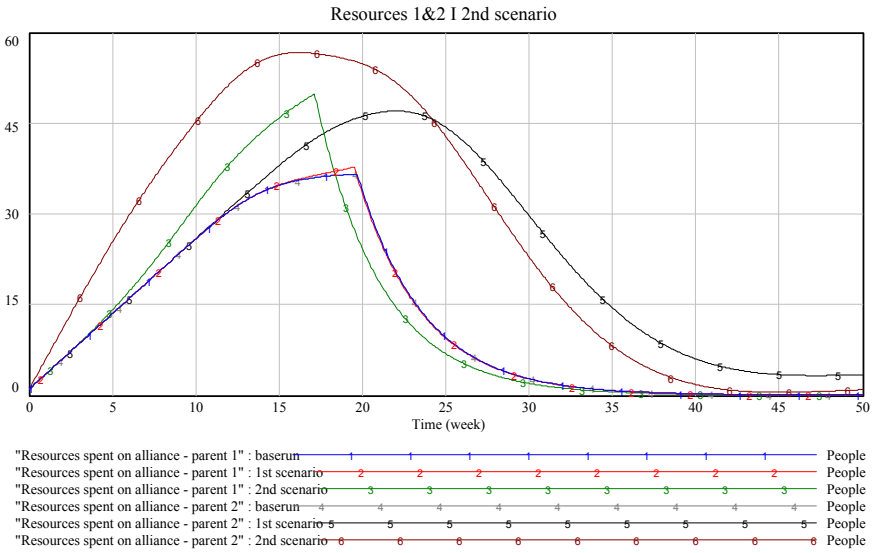

Figure 21: Resources spent on alliance, parents 1&2 – baserun, 1st and 2nd scenario

As there are far more people working on the alliance task, learning occurs faster. Hence, the alliance generates benefits more quickly (see Figures 21 and 23). In the early phase, though, as the benefits occur faster than in the other runs, 'interfirm belief in alliance success' builds up faster than in the baserun and in the first scenario (see Figure 21). However, trust decreases exponentially when parent 1 quits the alliance.

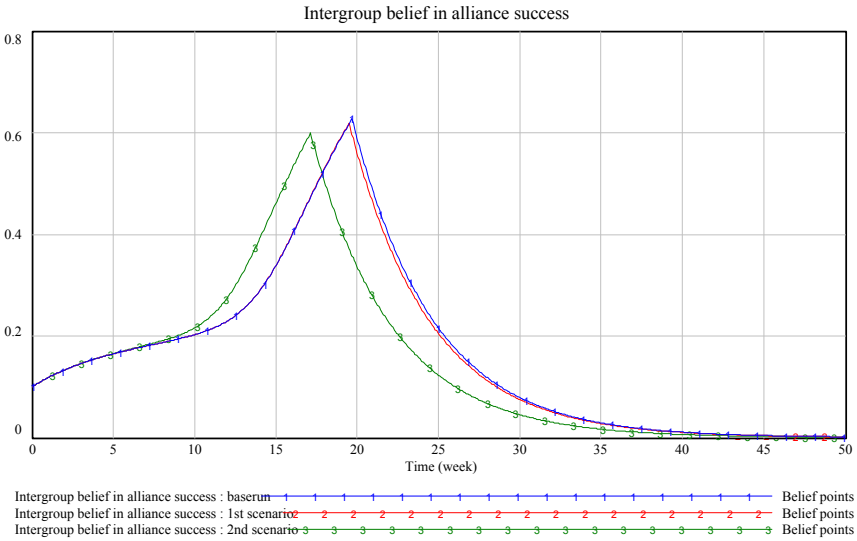

Figure 22: Intergroup belief in alliance success – baserun, 1st and 2nd scenario

As parent 1's goals are accomplished (roughly week 17; see Figure 23), it withdraws its resources immediately. By this time, parent 2 – due to its higher expectations – has only quite achieved 50% of its expected benefits. However, as there are still people working in the alliance (mostly from parent 2), they keep on researching and learning and therefore still generate benefits. Due to the fading 'intergroup belief in alliance success' further learning is limited. Until the end of the alliance, further benefits will still be generated. The final degree of goal attainment is roughly 60%. Consequently, parent 1 would call the alliance as a success whereas parent 2 thinks of it as failed and unsuccessful.

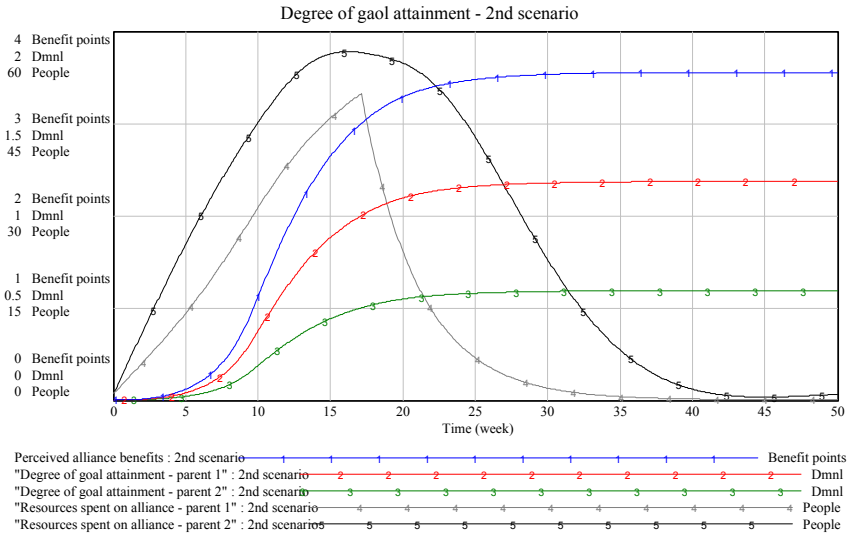

Figure 23: Degree of goal attainment and resources spent on alliance, both parents – 2nd scenario

4.4.2.4 Third Scenario: Both Companies Increase their Common Expected Benefits at the Same Time

The situation looks different if both parents change similarly regarding the expected common benefits. In the third scenario, for example, both parent companies increase their expected common benefits by less than 100% in week 5 (STEP function: 3+STEP(2, 5)). This joint decision may be a consequence of coordination efforts initiated by either one or both parents and it may result from an enhancement of the alliance's scope. As can be seen from the Figure 24, resource expenditures are made jointly with each parent spending more people on the alliance (here more than 60 people). The mode of behavior is similar to those described above. Yet the time horizon is much broader as there are more benefits to accrue. The expected common benefits are attained, when the 'degree of goal attainment' reaches 1 (roughly week 60). This leads to the termination of the alliance, with both parents being satisfied and reassured that the alliance was a good means to reach their common goals.

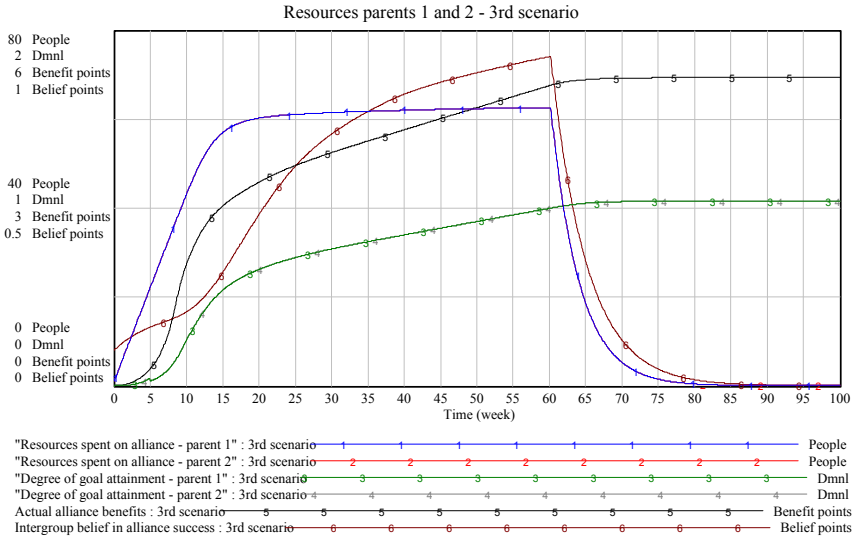

Figure 24: Resources spent on alliance and degree of goal attainment – 3rd scenario

In this scenario, the graph for 'intergroup belief in alliance success' is worth mentioning. It can be seen from the Figure 25 that 'intergroup belief in alliance success' builds up in an s-shaped curve until it nearly reaches full belief. Due to the fact that the people work together successfully over such a long period, they trust each other increasingly over time. As in the runs described above, after the alliance goals have been reached and the resources withdrawn, 'intergroup belief' also declines. However, the good experience would be a good basis for further cooperation.

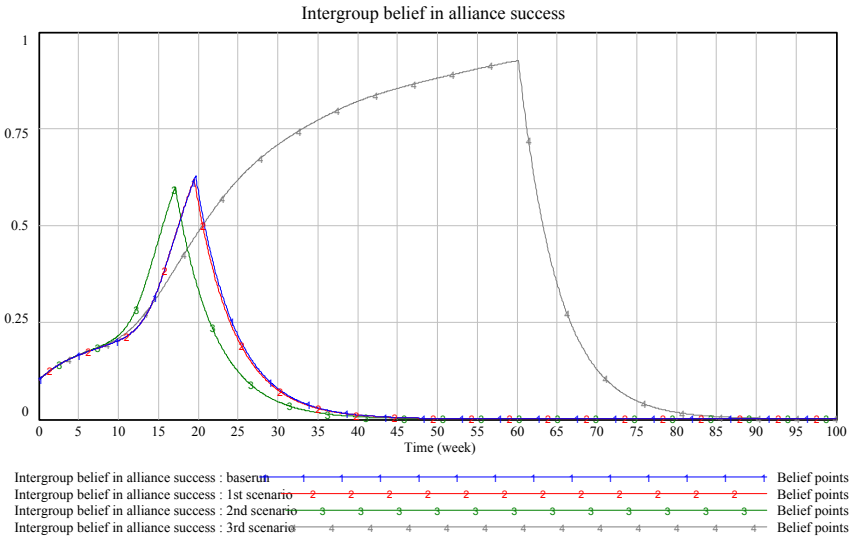

Figure 25: Intergroup belief – baserun, 1st, 2nd, and 3rd scenario

Compared to the first and second scenarios, it was of great advantage for the parents to act cooperatively and convince the partner to continue with the alliance and also increase the expectations at the same time. This way, they both ensure that the alliance is equally important to both of them.

5. Concluding Discussion

The paper begins with a definition of learning alliances that stand in the focus of the investigation. I reviewed the relevant learning alliance literature for examining the dynamics of common learning in learning alliances. Then I described System Dynamics as the method used to conduct the investigation. Afterwards I presented a specific System Dynamics model that investigates the dynamics of common learning. In this section I discuss the implications of the results obtained using the System Dynamics model on learning alliances described in the previous section.

Regarding the influence of the evaluation of the importance of the alliance for the parent companies the following can be stated.

In the baserun both parent companies' expected common benefits are identical from the founding of the alliance. This implies that they both see the alliance as equally important to them. The parents terminate the alliance at the same time, namely, when their expected common benefits are attained. Both parents are satisfied with the outcome of the alliance. As the joint learning went well it can be assumed that they would be open to enter another learning alliance with each other.

In the first scenario both parents start out with the same expectations of common alliance benefits. The learning alliance progresses in a way that is rewarding for both parents. Suddenly the second parent increases its expectations. This leads to unbalanced expectations: the alliance becomes more important for the second parent than for the fist. As there are less expectations for the first parent, its expectations are met first during the course of the alliance. There are no more incentives for it to stay in the alliance and thus, it withdraws its resources from the alliance. As a result, the second parent is only able to realize a small portion of its expectations. Therefore, even though the parent has drawn so much attention to the alliance its outcome can be regarded as disappointing.

In the second scenario, the imbalance of the parent companies' expected common benefits exists from the very beginning of the learning alliance's existence. One parent has higher expectations of common benefits than its partner and therefore, it evaluates the alliance as more important. This might be due to a larger overlap of the alliance scope with the firm scope. Like in the first scenario, the parent with the lower expectations of common benefits terminates the learning alliance before the other parent achieves its common benefits. Again, the alliance was useful for the parent with less expectations. Hence, if the parents' expected alliance benefits differ from each other, the parent more interested in the alliance success might be disappointed with the overall outcome.

Khanna et al. (1998) point out that there are no incentives for a partner to stay in the alliance when there are no more private benefits to accrue (Khanna et al., 1998: 198). However, from the first and the second scenario it can be stated that also in a situation of only common benefits there is no incentive for a parent to stay in the alliance once its expected common benefits are achieved. So, the parent terminates the alliance before the other parent company has finished common learning.

In the third scenario, it is assumed that both parent companies start out with the same expectations and then increase them at the same time about the same quantity. This means that both parents evaluate the alliance as more important on the course of the alliance's existence. In this scenario it is shown that both parent companies continue to work jointly on the task until they both meet their expectations. The coordination of the expectations is of significant value for the common alliance success.

Overall, it can be summarized that both parent companies have to evaluate the learning alliance equally important for it to be successful for both of them. If the parents consider the learning alliance unequally important the alliance turns out to be unsatisfactory and disappointing for at least one of the parents. So, when engaging in a learning alliance, a company should firstly ensure that the partner's expectations are neither significantly higher nor lower than its own. Secondly, it is essential for the alliance success that the parent companies communicate permanently during the lifetime of the alliance in order to continuously balance the each other's expectations.

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7. Appendix

Model

(01) Absorptive capacity= WITH LOOKUP (Relative knowledge base,
([(0,0)-(1,1)],(0,0.07456),(0.08869,0.1053),(0.208,0.1623),(0.3242,0.2675),(0.4098,0.3684),(0.4985,0.5439),(0.5657,0.7018),(0.605505,0.785088),(0.654434,0.855263),(0.718654,0.903509),(0.789,0.9474),(0.902141,0.986842),(1,1)))
Units: Dmnl
Absorptive capacity is the ability to recognize, learn and use new external knowledge (Cohan, Levinthal 1990). It is assumed that the absorptive capacity increases in an s-shaped way (table function). The higher the Relative knowledge base, the higher the capacity to absorp new knowledge.\!Relative knowledge base (dimensionless)\!

(02) Actual alliance benefits= INTEG (Knowledge application to products or patents,0)
Units: Benefit points
The alliance benefits are accumulated and have no outflow. It is measured in benefit points. The alliance benefits are the benefits that are being generated through the alliance itself. Its initial value is 1.

(03) Alliance knowledge base= INTEG (Alliance learning-Alliance unlearning,2)
Units: Knowledge points
The employees' knowledge base is measured in knowledge points. The initial value of the stock is 2. The stock is increased by learning, called alliance learning. The stock is decreased by the outflow called alliance unlearning.

(04) Alliance learning=
Commitment to learning through belief in alliance success*Learning aptitude *Common resource spending*Normal learning
Units: Knowledge points / week
Alliance learning increases the stock Alliance knowledge base. It is determined by the Resources spent on the alliance times the Learning commitment, and the Additional learning aptitude. So, when people and money are involved, people learn on the alliance tasks. If not, people have other things to do and do research on different things next to the alliance. Alliance learning - not the Alliance knowledge base is important for the Knowledge application to products. This is due to the fact that this new knowledge is being generated on the basis of the old knowledge. So, new knowledge levers to new products. (patent application)

(05) Alliance unlearning=Alliance knowledge base*Normal unlearning rate
Units: Knowledge points / week
This rate decreases the stock Alliance knowledge base. (old patents that are not useful anymore)

(06) Assessment of knowledge value= WITH LOOKUP (Relative knowledge base,
([(0,0)-(1,1)],(0,1),(0.140673,0.973684),(0.214067,0.95614),(0.278287,0.925439),(0.318043,0.894737),(0.351682,0.855263),(0.382263,0.820175),(0.412844,0.776316),(0.440367,0.72807),(0.464832,0.671053),(0.492355,0.596491),(0.51682,0.526316),(0.538226,0.45614),(0.556575,0.372807),(0.577982,0.302632),(0.602446,0.25),(0.633027,0.2),(0.66055,0.17),(0.691131,0.14),(0.724771,0.11),(0.761468,0.0877193),(0.795107,0.0657895),(0.82263,0.0482456),(0.868502,0.0263158),(

0.911315,0.0131579),(1,0)))
Units: Dmnl
The assessment of knowledge value is a table-function (look-up)
that states that, the more I know, the less I can learn in addition to what I already know in a specific context. The graph looks like s-shaped decline.\!\!\!

(07) Belief Gap=Belief quantity-Intergroup belief in alliance success
Units: Belief points
The Gap computes the difference between the Believing quantity and the Intergroup believe in alliance success.

(08) Belief quantity=Effect of goal attainment on belief in alliance success*Normal belief
Units: Belief points
The Believing quantity is the result of the multiplication of the dimensionless variable Effect of goal attainment on believing in alliance success and the Normal believing.

(09) Benefits gap=Actual alliance benefits-Perceived alliance benefits
Units: Benefit points
The Gap computes the difference between the Perceived alliance benefits and the Actual alliance benefits.

(10) Change in belief=IF THEN ELSE("Degree of goal attainment - parent 1">1, -Intergroup belief in alliance success
/Time to form belief, Belief Gap/Time to form belief)
Units: Belief points/week
The biflow Change in believe increases or decreases the stock Intergroup believe in alliance success. It increases the stock according to the Updated perceived alliance benefits. The higher the benefits, the higher the change in believe. Once one company has reached its goals and withdraws its resources from the alliance, trust between the groups diminishes.

(11) Commitment to learning through belief in alliance success=
Intergroup belief in alliance success/Normal belief
Units: Dmnl
Learning commitment is a variable that results from the multiplication of the Normal learning and the Relative believe in alliance success. (in German: Wollen-lernen)

(12) Common resource spending=
"Resources spent on alliance - parent 1"+"Resources spent on alliance - parent 2"
Units: People
Common resource spending is a variable that counts together the Resources spent on the alliance from both partner 1 and 2.

(13) "Degree of goal attainment - alliance"= Perceived alliance benefits/Expected alliance benefits
Units: Dmnl

(14) "Degree of goal attainment - parent 1"=
Perceived alliance benefits/Expected common benefits 1 in respect to1's relative scope
Units: Dmnl
As more stages of the research and development project are completed, less effort is needed to finish the stages and earn the same benefits. The firm steps up its allocation every period

on the way to close the gap. Khanna et al. (1998), p. 198. The more milestones have been reached, the less resources are being allocated on the way to close the gap.\!Zielerreichungsgrad\!

(15) "Degree of goal attainment - parent 2"= Perceived alliance benefits/Expected common benefits 2 in respect to 2's relative scope
Units: Dmnl
As more stages of the research and development project are completed, less effort is needed to finish the stages and earn the same benefits. The firm steps up its allocation every period on the way to close the gap. Khanna et al. (1998), p. 198. The more milestones have been reached, the less resources are being allocated on the way to close the gap.\!Zielerreichungsgrad\!

(16) Effect of degree of goal attainment on resource allocation 1= WITH LOOKUP ("Degree of goal attainment - parent 1",([(0,0)-5,1)],(0,1),(0.0550459,0.97807),(0.100917,0.951754),(0.146789,0.872807),(0.17737,0.75),(0.211009,0.557018),(0.250765,0.394737),(0.287462,0.27193),(0.351682,0.157895),(0.41896,0.0964912),(0.501529,0.0614035),(0.688073,0.0175439),(1,0),(2,0),(5,0)))
Units: Dmnl
With a small Zielerreichungsgrad, the company spends lots of resources on the alliance in order to close the gap as fast as possible. The closer the company gets to the expected benefits, the less additional resources the company spends on the alliance. \!Zielerreichungsgrad\!

(17) Effect of degree of goal attainment on resource allocation 2= WITH LOOKUP ("Degree of goal attainment - parent 2",([(0,0)-(5,1)],(0,1),(0.0550459,0.97807),(0.100917,0.951754),(0.146789,0.872807),(0.17737,0.75),(0.211009,0.557018),(0.250765,0.394737),(0.287462,0.27193),(0.351682,0.157895),(0.41896,0.0964912),(0.501529,0.0614035),(0.688073,0.0175439),(1,0),(5,0)))
Units: Dmnl
With a small 'degree of goal attainment' the company spends more resources on the alliance in order to reach the goal as fast as possible. The closer the 'perceived benefits' get to the 'expected benefits', the less additional resources the parent spends on the alliance.

(18) Effect of goal attainment on belief in alliance success= WITH LOOKUP ("Degree of goal attainment - alliance", ([(0,0)-(1,1)],(0,0.2),(0.140673,0.241228),(0.287462,0.307018),(0.409786,0.416667),(0.495413,0.548246),(0.587156,0.710526),(0.69419,0.850877),(0.810398,0.934211),(0.905199,0.97807),(1,1)))
Units: Dmnl
With a small 'degree of goal attainment' the company spends more resources on the alliance in order to reach the goal as fast as possible. The closer the 'perceived benefits' get to the 'expected benefits', the less additional resources the parent spends on the alliance.\!Effect of goal attainment on believing in alliance success\!

(19) Expected alliance benefits=4
Units: Benefit points

(20) Expected common benefits 1 in respect to1's relative scope=3
Units: Benefit points
The expected common benefits is a parameter that is determined by the companie's relative scope. Common benefits are benefits from an alliance that a firm can apply to businesses within the scope of the alliance. They differ from alliance benefits that refer to the outcome that the alliance generates itself. The higher the expected common benefits, the more important the alliance is for the long-term success of the company. Here, the expected common benefits are constant at 15 benefit points.

(21) Expected common benefits 2 in respect to 2's relative scope=3
Units: Benefit points
The expected common benefits is a parameter that is determined by the companie's relative scope. Common benefits are benefits from an alliance that a firm can apply to businesses within the scope of the alliance. They differ from alliance benefits that refer to the outcome that the alliance generates itself. The higher the expected common benefits, the more important the alliance is for the long-term success of the company. In the baserun, the expected common benefits are constant at 15 benefit points.

(22) FINAL TIME = 50
Units: week
The final time for the simulation.

(23) INITIAL TIME = 0
Units: week
The initial time for the simulation.

(24) Intergroup belief in alliance success= INTEG (Change in belief,0.1)
Units: Belief points
The Intergroup believe in the alliance success is a biflow that can be either in- or decreased by the flow called 'change in believe'. Intergroup believe in alliance success describes the attachment of people who work in the alliance towards each other. The attachment is purely formed through the perceived alliance benefits. This means that perceived progress strengthens the people working in the alliance in terms of dedication to their work. The parent companies' expected alliance benefits in respect to their relative scope does not influence the intergroup believe in the alliance success. It is assumed that the people working in the alliance dedicate their time and energy only on their research findings and not on coordinating the degree of their parent companies' goal attainment.

(25) Knowledge application to products or patents=
MAX(Alliance learning*Success rate of new ideas, 0)
Units: Benefit points / week
What was learnt by the alliance (Alliance learning) is being applied to products developed by the alliance. Not all what is newly learnt is useful for the development of new products. Therefore, a transformer is needed to explain how many benefits (i.e. new patents or new products) are being generated (or:

successful). This flow increases the stock Actual alliance benefits.

(26) Learning aptitude=Assessment of knowledge value*Absorptive capacity
Units: Dmnl
The Learning aptitude is a multiplier of the Assessment of knowledge value and the Absorptive capacity. It is dimensionless and influences how well people in the alliance learn. (Können-lernen)

(27) Maximum knowledge base=15
Units: Knowledge points
As no quantity can grow forever there is an upper limit to the knowledge base. Here, it is appointed to 50 knowledge points.

(28) Normal belief=1
Units: Belief points
Normal believing is the maximum believing or trust in something. Here, it is assumed to be 1.

(29) Normal learning=0.5
Units: Knowledge points/People/week
Normal learning is a constant that tells us something about how well people learn. It is assumed that one person can generate 0.5 knowledge points per week.

(30) Normal resource allocation 1=10
Units: People
Under normal circumstances, which means when there is a mimimum Degree of goal attainment the parent allocates maximum resources. Here, the normal resource allocation is 10 people.

(31) Normal resource allocation 2=10
Units: People
Under normal circumstances, which means when there is a mimimum Degree of goal attainment the parent allocates maximum resources. Here, the normal resource allocation is 10 people.

(32) Normal unlearning rate=0.01
Units: 1/week
The parameter Normal unlearning rate refers to the phenomenon that people are forgetting things over a certain period of time. Here, it is assumed that people forget 1% of their knowledge per week.

(33) Perceived alliance benefits= INTEG (Updated perceived alliance benefits,0)
Units: Benefit points
The benefits being perceived are time lagged, either through delays in the perception itself or through the time needed a product is successful in the market. At any case, there is a certain time needed to perceive the Actual alliance benefits. The model construction equals a smooth. The stock can be increases and decreased by the flow Updated perceived alliance benefits. Its initial value is 1.

(34) Relative knowledge base=Alliance knowledge base/Maximum knowledge base

Units: Dmnl
The relative knowledge base is a normalizing variable. It is dimensionless and is calculated by dividing the actual Alliance knowledge base by the Maximum knowledge base.

(35) Resource allocation 1= IF THEN ELSE (Resource allocation from goal attainment 1=0, - "Resources spent on alliance - parent 1"
/Time for allocation decision 1
, DELAY3(((Resource allocation from goal attainment 1)+(Resource allocation from allocation difference 1
)/2)/Time for allocation decision 1
, Time for allocation decision 1))
Units: People/week
Resource allocation is a flow that increases the stock Resources spent on the alliance. It is determined by the Perceived gap divided by the Duration of the allocation decision times the People per Benefit point. There is a 3rd-order delay involved in this process. There is only people spent on the alliance if the Perceived gap is positive. If it is negative (overachievement of the expected benefits), there are no further resources spent on the alliance.

(36) Resource allocation 2=IF THEN ELSE (Resource allocation from goal attainment 2=0, - "Resources spent on alliance - parent 2"
/Time for allocation decision 2, DELAY3(((Resource allocation from goal attainment 2
)+(Resource allocation from allocation difference 2)/2)/Time for allocation decision 2
, Time for allocation decision 2))
Units: People/week
Resource allocation is a flow that increases the stock Resources spent on the alliance. It is determined by the Perceived gap divided by the Duration of the allocation decision times the People per Benefit point. There is a 3rd-order delay involved in this process. There is only people spent on the alliance if the Perceived gap is positive. If it is negative (overachievement of the expected benefits, there are no further resources spent on the alliance.

(37) Resource allocation from allocation difference 1="Resources spent on alliance - parent 2"- "Resources spent on alliance - parent 1"
Units: People
In a situation of pure common benefits, both partners act like if they were one firm concerning the resource allocation. This means that the partners looks how much the other one invests and depending on that varies the own resource allocation. (Khanna et al 1998)

(38) Resource allocation from allocation difference 2="Resources spent on alliance - parent 1"- "Resources spent on alliance - parent 2"
Units: People
In a situation of pure common benefits, both partners act like if they were one firm concerning the resource allocation. This means that the partners looks how much the other one invests and depending on that varies the own resource allocation. (Khanna et al 1998)

(39) Resource allocation from goal attainment 1=Effect of degree of goal attainment on resource allocation 1*Normal resource allocation 1
Units: People
A small effect of goal attainment allocates only little resources to the alliance. On the other hand, a large effect of goal attainment allocates more resources to the alliance. The effect of Zielerreichungsgrad (dimensionless) is multiplicated by the normal resource allocation (people).

(40) Resource allocation from goal attainment 2=Effect of degree of goal attainment on resource allocation 2*Normal resource allocation 2
Units: People
A small effect of Zielerreichungsgrad allocates only little resources to the alliance. On the other hand, a large effect of Zielerreichungsgrad allocates more resources to the alliance. The effect of Zielerreichungsgrad (dimensionless) is multiplicated by the normal resource allocation (people).

(41) "Resources spent on alliance - parent 1"= INTEG (Resource allocation 1,1)
Units: People
Resources in this context refer to both human and financial resources. When resources are spent on the alliance, it means that the resources acually work on the alliance tasks. After the withdrawal they don't work on the alliance tasks anymore. The initial value of this stock is 0.1 and the stock is increases by the inflow Resource allocation and decreases by the outflow Resource withdrawl.

(42) "Resources spent on alliance - parent 2"= INTEG (Resource allocation 2,1)
Units: People
Resources in this context refer to both human and financial resources. When resources are spent on the alliance, it means that the resources acually work on the alliance tasks. After the withdrawal they don't work on the alliance tasks anymore. The initial value of this stock is 0.1 and the stock is increases by the inflow Resource allocation and decreases by the outflow Resource withdrawl.

(43) SAVEPER = TIME STEP
Units: week [0,?]
The frequency with which output is stored.

(44) Success rate of new ideas=0.25
Units: Benefit points/Knowledge points
As not everything people learn is useful in terms of so-called benefits (or: successful). Here, 10 % of the new knowledge is useful and can be transformed into benefits.

(45) Time for allocation decision 1=4
Units: week
It takes the managers some time to think about the investment or deinvestment of resources. It takes the managers 5 weeks to decide on this topic on average.

(46) Time for allocation decision 2=4
Units: week

It takes the managers some time to think about the investment or deinvestment of resources. It takes the managers 5 weeks to decide on this topic on average.

(47) TIME STEP = 0.0625
Units: week [0,?]
The time step for the simulation.

(48) Time to form belief=5
Units: week
Some time is needed to form the believe into the alliance. It is assumed that the time to form a believe is constant at 10 weeks.

(49) Time to form expectations=10
Units: week

(50) Time to perceive alliance benefits=2
Units: week
The time to perceive the Actual alliance benefits is constant at 5 weeks.

(51) Updated perceived alliance benefits=Benefits gap/Time to perceive alliance benefits
Units: Benefit points/week
The variable Updated perceived alliance benefits is a biflow that may increase or decrease the stock Perceived alliance benefits. It is determined by the gap over the time to perceive alliance benefits.

Input for runs
Baserun:
Normal resource allocation 1 = 10
Units: People
Normal resource allocation 1 = 10
Units: People
Expected common benefits 1 in respect to1's relative scope = 3
Units: Benefit points
Expected common benefits 2 in respect to 2's relative scope = 3
Units: Benefit points
Expected alliance benefits = 4
Units: Benefit points

1st scenario:
Normal resource allocation 1 = 10
Units: People
Normal resource allocation 2 = 10
Units: People
Expected common benefits 1 in respect to1's relative scope = 3
Units: Benefit points
Expected common benefits 2 in respect to 2's relative scope = 3+STEP(8 , 7)
Units: Benefit points
Expected alliance benefits = 4
Units: Benefit points

2nd scenario:
Normal resource allocation 1 = 10

Units: People
Normal resource allocation 2 = 20
Units: People
Expected common benefits 1 in respect to1's relative scope = 3
Units: Benefit points
Expected common benefits 2 in respect to 2's relative scope = 6
Units: Benefit points
Expected alliance benefits = 4
Units: Benefit points

3rd scenario:
Normal resource allocation 1 = 17
Units: People
Normal resource allocation 1 = 17
Units: People
Expected common benefits 1 in respect to1's relative scope = 3+STEP(2, 5)
Units: Benefit points
Expected common benefits 2 in respect to 2's relative scope = 3+STEP(2, 5)
Units: Benefit points
Expected alliance benefits = 4+STEP(2, 5)
Units: Benefit points

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[i] In the following, due to reasons of simplification, I only refer to alliances even though the cited authors might refer to alliances or joint ventures.
[ii] Grossman and Shapiro (1987) state that different allocation patterns exist besides the pure progress effect. However, this pattern is the one that they observed most often (Grossman and Shapiro, 1987: 378).
[iii] In the model, it is assumed that parent 1 is always the parent who withdrawals its people from the alliance first. Therefore, in the scenarios, parent 2 is the parent whose expectations are being changed.

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