Chapter 13

Open innovation in value networks

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1. Introduction

New technologies such as ICT, biotechnology or new materials are becoming an increasing powerful driving force generating competitive advantages and commercial success for companies in a wide range of industries. The complexity of new technologies often goes beyond the capabilities of individual companies (Hagedoorn and Duysters, 2002) and forces innovating companies to cooperate with other firms and organizations to reduce the inherent uncertainties associated with novel product-markets. Simard and West (chapter 11) have analyzed the role of different types of networks in Open Innovation. In the previous chapter Maula et al. have shown that central firms have to take the role of a network orchestrator in the case of the development of systemic innovations. In this chapter we focus on the role of inter-organizational networks in the *commercialization* of new product offerings based on the technological breakthroughs in the agricultural biotech (or agbiotech)[1].

Have a look at Figure 2 in chapter 1. Insourcing of externally developed technologies is crucial for the innovativeness of a company. The funnel in Figure 2 might give the impression that inter-organizational networks only play a role in the research and early development phases. This chapter shows that innovating companies also have to set up and manage inter-organizational networks to commercialize their innovations successfully. These networks are different from the networks that firms establish to tap into external technology sources in the early stages of the funnel[2]. They have received

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1 Agricultural biotech is that part of the biotechnology that is dedicated to develop genetically modified (GM) plants.

2 This is of course only true for radical or disruptive innovations (Christensen and Raynor, 2003).

less attention than the R&D networks in the academic literature, but are nevertheless important because they are directly responsible for the market success and profitability of new technologies.

We take the commercialization of new products based on agricultural biotechnology as an illustration. To deal with business opportunities that are enabled by technological developments in agbiotech, economic actors with different assets and competencies have to be linked together into inter-organizational networks to create jointly value for targeted customer groups (Brandenburger and Nalebuff, 1996; Normann and Ramirez, 1993; Normann, 2001; Parolini, 1999).

We call these networks "value constellations" following Normann and Ramirez (1993): they are interorganizational networks linking firms with different assets and competencies together in response to or in anticipation of new market opportunities. Value constellations create value for a target customer group by means of a business model translating technological developments in agbiotech into new, commercially viable products. A central firm sets up a value constellation through acquisitions, licensing agreements, non-equity alliances, joint ventures, contracting and other types of relations that go beyond arm's-length relations. Partners in the network are biotech firms, seed producers, chemical companies, farmers, but also manufacturing companies, retailers, etc... depending on the end application. Such constellations, however, bring with them significant strategic and organizational challenges, about which there is very little prior knowledge.

Interorganizational networks have many links with the idea of Open Innovation. One reason why firms are teaming up with each other is technological complexity.

Chesbrough (2003a, p. 53) argues that: “The cascade of knowledge flowing from biotechnology ... is far too complex for any one company to handle alone ...so companies have to identify and build connections to excellent science in other labs”. These are networks that are established to absorb externally developed knowledge, they can be situated in the left side of Figure 2 in chapter 1. Interorganizational networks are also established when the innovating company is not capable to reap the business opportunities stemming from agbiotech on its own. New business models that are radically different those underlying existing (or competing) product offerings force the innovating firm to set up a value constellation with different partners to successfully launch the new product. These networks are situated at the right side of Figure 2.

Value constellations are also interesting from a theoretical point of view. When networks of companies become crucial in understanding how value is created and captured, different theoretical perspectives have to be brought together to understand this phenomenon. First, value constellations have a lot in common with the relational view of the firm (Dyer and Singh, 1998) and the maximization of transaction value (Dyer, 1997; Zajac and Olson, 1993). Value constellations challenge us to rethink value creation not from a single firm's point of view but as the outcome of the interplay of the network partners. Moreover, value appropriation can no longer be analyzed in terms of the negotiation power of individual firms as too much fighting among the participants for a share of the pie reduces the volume of the pie. There is also a clear link to the resource based view of the firm since organizations have to combine their internal resources with those of their partners to generate value. Value constellations are a particular type of inter-organizational networks, where value creation and distribution, external resource or

knowledge sourcing, interorganizational ties and network governance call for an integration of various frameworks (Amit and Zott, 2001; Gomes-Casseres, 2003).

The paper is structured in the following way. First, we explore some evolutions in the agricultural biotech and analyze how companies establish different value constellations that are enabled by the agricultural biotechnology. The third section explains how value constellations create value. When firms launch radically new products based on new technologies (e.g. agbiotech) they use (new types of) business models that determine how value will be created and appropriated, how external resources have to be sourced by establishing different interorganizational ties with different partners. We also focus on the external management tasks of the central firm ensuring that the potential value of the network is maximized. Next, in the fourth section, we examine how value constellations can improve our understanding of Open Innovation. Three topics are analyzed. First, we analyze how central firms choose between different governance modes when they establish relations with partners. Second, value constellations are a nexus for the integration of different theoretical perspectives since they are a nexus where value creation, non arm's-length transactions, external resource sourcing and inter-organizational networking are welded together. Third, we suggest that Open Innovation has to be analyzed at different levels of analysis and that inter-organizational networks are important to improve our understanding of Open Innovation. The chapter concludes with some final observations and possible avenues for further research.

2. Agricultural biotechnology and new business opportunities

In this section we describe how companies are profiting from new business opportunities that emerge in the wake of the technological breakthroughs in the agricultural biotech (or agbiotech). We show how the same technology - genetically modified crops – leads to completely different ways to create value depending on the business model and targeted customers.

Before the advent of agricultural biotechnology, agriculture was a mature and slowly growing business, characterized by a standardized production of commodity-like food and feed based on arm's length transactions between different players in the value creating system. Competition was based on price and economies of scale were crucial.

The first generation of GM crops was designed *to reduce farm production costs or improve crop yields.* The most popular examples are pest resistant and herbicide tolerant crops. Pest resistant crops (example: Bt corn[3]) generally lower insecticide use and require fewer trips across the field. The advantages for farmers are time and cost savings (both on pesticides and energy) and using less pesticide is beneficial for the environment. These GM-crops are a challenge for chemical companies producing pesticides: sales of traditional pesticides drop sharply and price competition intensifies as a result of the recurring introduction of new pest resistant crops. Entering the business of insect resistant crops is one way to substitute for the reduced insecticide sales.

In conventional weed control, farmers used pre-plant herbicides before or at planting combined with the use of selective post emergence herbicides to fight weeds. The introduction of herbicide-tolerant seeds – resistant to a particular, firm specific, and

[3] Bt Corn stands for genetically-altered hybrids that contain a naturally-occuring soil bacterium, Bacillus thuringiensis, that kills the European corn borers. New GM-seeds that resist other pests will be introduced during the next years.

patented herbicide – provides broad spectrum weed control[4] with one herbicide that can be applied over the crop at any stage of growth. Farmers can spray crops with a single herbicide during a much longer period with productivity increases as a result. They also profit from time and cost savings because herbicide tolerant crops require no more tillage or at least less than in conventional weed control. Herbicide tolerant crops are particularly interesting to chemical companies because it allows them to offer seeds and herbicides as a bundled good to farmers.

These enhancements of the agronomic traits did however not change the commodity nature of crops like corn, canola and others. It affected only a small part of the existing value creating system, and the business model stayed strictly focused on commodity like agricultural products. For farmers, competition is still based on price and efficiency gains remained the most important competitive driver. As a result , the introduction of the first generation of agricultural related biotech products was intended to strengthen the position of agricultural firms by productivity gains but without restructuring their business model. Agrochemical companies and seed companies were the only ones that have to revisit their business model to some extent.

Contrary to the first generation of biotechnology products, many of the innovations under development in the agricultural biotechnology focus *on value-enhanced or output traits*. These GM-crops are designed for specific needs of end-users in different industries. Some are focusing on agriculture related industries (mainly processing industries), but some applications are targeting turnarounds in industries that

[4] Roundup was already introduced in the seventies as a burndown treatment, used to kill all existing vegetation before planting (Carpenter and Gianessi, 1999).

were previously not related to the agriculture industry. We first discuss the GM-crops focusing on agriculture related industries.

Different GM-crops under development are delivering better or healthier food and feed. Corn, canola and soybeans are genetically modified to improve quality, digestibility and taste. Some GM-tomatoes remain firm longer and retain pectin during processing into tomato paste, which generates advantages throughout the entire value-chain; the farmer can get a better tomato to the factory, the processor can reduce waste (less rotten tomatoes) and he has lower energy costs (less need for evaporation) during puree production, and the end-consumer is offered quality at cost savings. Another example is the improvement of the fiber quality of cotton, such as polyester-type traits to make the fabrics sturdier and produce fibers with superior insulating qualities. Some companies envision making wrinkle-resistant or fire-retardant qualities of cotton. These developments will eventually have a major impact on the processing of cotton and the textile industry.

Biotech also transforms the agricultural industry into an important upstream industry for many industrial sectors that were previously not related to agriculture. Biotechnology has the potential to make major inroads in industries in which agricultural products have previously been absent. Nutraceuticals for instance are foods or food components that reduce risk of certain health problems. Other examples – just to name a few ones - are edible vaccines, cheap drug development, biodegradable polymers or new energy sources.

These examples illustrate that agricultural biotechnology enables companies *to set up new value creating systems* in *different industries*. The initial primary target of plant

biotechnology was to improving the production of plant-derived food. Biotechnology however enabled agriculture to shift from the production of commodity-like food and feed to high-priced, specialized plant-derived products that can be applied in a wide range of industries. Agricultural biotechnology is introducing a broad range of new products that not only redefine today's key agricultural markets, but also create business linkages to other previously non-related markets and industries including pharmaceuticals, animal health, chemicals, and a broad range of industrial markets (Shimoda, 1998; Enriquez and Goldberg, 2000).

Consequently, agriculture and the entire agribusiness have entered a period where the pace of biotechnology innovations intensify speed up change and where new business models challenge existing ones.

3. Value constellations: organizing for value creation and distribution

Innovation can be defined as the conception of an idea up to the introduction of an invention into the market (Ernst, 2001). Technology has no value as long it is not commercialized in some way. To create and extract economic value from new technological developments each firm needs a suitable business model, which operates as a mediator between technology development on the input side and economic value creation on the output side (Chesbrough and Rosenbloom, 2002).

A business model can be defined as "...the set of which activities a firm performs, how it performs them, when it performs them as it uses its resources to perform activities, given its industry, to create superior customer value ... and put itself in a position to appropriate value" (Afuah, 2004, p.9). Creating and capturing value from early stage

technologies can in most cases only be realized if the innovating company links other parties like customers, suppliers, complementors and competitors to the commercialization process. Establishing a "value network" with partners to market a new technology, "...shapes the role that suppliers, customers and other parties play in influencing the value captured from commercialization of an innovation" (Chesbrough and Rosenbloom, 2002, p. 534).

We will argue in this section that the value constellation concept offers a coherent framework to understand the formation of the current inter-organizational networks and merger and acquisition wave in the agribusiness. Following figure 13.1, we will first focus on how value is created in value constellations. Next, we analyze how different players can capture part of the value created in the value constellation. Third, we analyze how a central firm has to set up and manage value constellation to realize the potential business opportunities. Both value creation and value capturing can only be realized if a central company acts as an orchestrator and manages the 'value constellation' (Iansiti and Levien, 2004a). Fourth, we discuss briefly set-up strategies for value constellations. Finally, we focus briefly on the role of governments.

Insert here Figure 13.1

3.1 Value creation in value constellations

The examples of new product offerings generated by agricultural biotechnology illustrate that new technologies provide opportunities to set up value constellations to introduce new product offerings based on new business models and to compete against

existing ones with new business models. New technologies can be disruptive (Christensen 1997; Christensen and Raynor, 2003) but it is not the technology itself but the business model behind the application of that technology that gives it its disruptive power. Similarly, Ramirez and Wallin (2000) and Normann (2001) argue that value migration from incumbents to new entrants occurs when the latter enter the market deploying a business model that imposes new rules for competition. Hence, not the technology as such but the business model grafted upon technological innovations opens up new business opportunities (Chesbrough, 2003a; Chesbrough and Rosenbloom (2002).

In this section we enter two topics related to the value creation in value constellations. First, we give a brief overview of the value drivers that play a role as sources of value creation in the establishment and organization of value constellation. Next, we analyse how a central company can create value from combining its capabilities with that of its constellation partners.

3.1.1 Value drivers

A new business model has to identity different *sources of value creation* or 'value drivers'. We identified four different types of value drivers that enhance the value-creation potential of agbiotech[5]. The first value driver which is prominently present in agricultural biotechnology is *efficiency*. The first applications of 'agbiotech' focused on efficiency gains for farmers. Both insect resistant and herbicide tolerant seeds are

[5] The four taxonomy of the value drivers is adapted from Amit and Zott (2001) who analyzed the value drivers in e-business. Although the categories have the similar labels, value drivers in agbiotech differ significantly from those in e-business. These differences are an interesting topic for future research because they have a strong impact on the way value constellations are structured.

developed to improve farm productivity. GM seeds are bought at a premium price *vis-à-vis* the traditional seeds but a farmer also saves on fuel and insecticides, and profits from time savings because of reduced tillage, spraying, etc. Farm productivity also improves because operational risk can be reduced (e.g. less damage by insects or fungi; strawberries that resist frost). Productivity enhancements can of course also be realized in the processing industry: e.g. GM-tomatoes that retain longer their pectin save on wastage and energy consumption for the processor. Finally, cost efficiency is also dramatically reduce capital costs to produce different drug in previously unthinkable ways.

Efficiency enhancements should be considered *relative* to the traditional ways of breeding and producing agricultural products (see bow in top left-upper corner of Figure 13.1). Competing offerings are always the benchmark to evaluate new offerings, but it is a moving target as companies in the traditional value creating system can retaliate or change strategy. Pesticide and herbicide prices dropped sharply as a reaction to the plummeting sales following the introduction of GM-crops with agronomic traits. Retaliation and strategic moves of companies that are part of a competing value creating system, should always be taking into account. As a result, companies considering setting up a new business model should not consider the *actual* behavior of competitors but their *potential reactions* of incumbents and new entrants vis-à-vis the new business model. Focusing on niche applications to avoid head to head competition with incumbents may be one strategy to avoid retaliation (Yoffie and Cusumano, 1999).

A second type of value drivers is *convenience*. Edible vaccines based on GM-crops can be administered in a more convenient and cost efficient way than traditional

vaccines. Insect resistant and herbicide tolerant crops also increase convenience for farmers as they reduce the need for tillage and spraying.

Agricultural biotechnology's most important value driver is its *'enabling'* property. It enables targeted customers to do things that they were not able to do before (Normann, 2001 p. 74). Especially the value-enhanced crops offer lots of possibilities. Agricultural biotechnology is developing nutraceuticals reducing the risk of particular health problems. It may develop new drugs that are too expensive to make by traditional production methods. Textile fabrics may become better insulated or sturdier without additional manufacturing processes. New types of plastics that were not accessible by standard chemistry may be produced by GM-plants and polymers may become fully biodegradable[6].

Finally, agricultural biotechnology creates value by bundling complementary goods - Amit and Zott (2001) call it *'complementarities'*. GM-crops 'bundle' into seeds complementary goods that have previously been offered separately: pesticides and seeds are now bought as a one stop purchase of insect resistant seeds, herbicide and GM-seeds purchase are necessarily two sides of the same coin, etc… Customers value 'bundled' complementary goods when their costs are lower than when they are delivered separately or when the performance of the 'bundle' is better than when customers have to bundle the products themselves.

[6] Sustainability of the competitive advantage is not guaranteed as long as strategic countermoves of actors in competing value creating systems are possible. Companies considering to developing crop-based, biodegradable polymers should know for instance that Du Pont already developed fully hydro/biodegradable polymers based on the oil-based polyethylene terephthalate (PET) polyester technology: being biodegradable is not a sales argument that is unique for plastics generated in bacteria or plants.

In sum, companies have a broad range of sources to create value from agbiotech. In de next paragraphs we analyze how companies create value in value constellations.

3.1.2. Value creation

Innovation based value creation for a targeted customer group is at the center of open innovation in general and value constellations in particular. However, value creation is also at the center of business strategy. Porter (1985, 1996) has argued that value is created by a "value creating system" – a vertical chain extending from suppliers in upstream industries to buyers of products or services: “Gaining and sustaining competitive advantage depends on understanding not only a firm’s value chain but how the firm fits in the overall value system” (Porter, 1985, p. 34). However, the value system is not crucial in the further analysis to understand the competitive positions of companies. In a value system every company occupies a particular position within the value system and adds value to the inputs before passing them to the next actor in the chain. Relationships between firms (suppliers, distribution channels, substitutes, etc…) are usually restricted to arm's-length transactions where price negotiations play an important role. The value system can therefore be decomposed into bilateral transactions between companies[7]. In other words, analyzing the whole value system does not offer any additional insights: it is only the outcome of the bilateral transactions between firms in the value system.

The "value constellation"-concept (Normann and Ramirez, 1993) is related to the value system in that they both are focused on delivering value for the targeted customer

[7] The traditional value system approach has already been challenged in the past by several authors (Brandenburger and Stuart, 1996; Ramirez, 1999, Ramirez and Wallin, 2000; Stabell and Fjeldstad, 1998).

group. However, the value constellation approach offers a different view of how value is created by the participating firms. First, within value constellations not the individual companies but different products or services compete for the time, attention and money of the customers. Gomes-Casseres (2003) calls this collective competition: competition is at the level of product offerings that the participating firms are producing together. Second, actors in the value-creating system produce value together through rethinking their roles and interrelationships. Therefore, value creation is not just adding value step after step but reinventing it by means of a reconfiguration of the roles and relationships. among actors of the value creating system (Ramirez and Wallin, 2000). Competitive advantage of a constellation is not only based upon the resources of its participants but also how they are assembled, structured and managed within the constellation. Finally, within this logic, networking and the overall structure of the constellation become central to explain how companies gain and sustain competitive advantages[8].

Within collective competition – i.e. competition between value constellations - the competitiveness of the product offering is determined by the firm-level resources and competencies that are aggregated at the constellation level. These group-level resources determine the relative value of the constellation's products vis-à-vis other products in the market. The value of product offerings has to be expressed in relative terms because the price customers want to pay is also affected by the price of competing products. Moreover, one should also take competitive dynamics into account because competitors could retaliate or develope substitutes with a better price-performance ratio.

[8] The configuring of roles of different economic players within new, technology based value creating networks has not received substantial attention from scholars. Notable exceptions are Amit and Zott, 2001; Bamford et al. 2003; Brynjolfsson and Urban, 2001; Chesbrough, 2003a; Gomes-Casseres, 1996, 2003; Taylor and Terhune, 2000.

Aggregating resources of firms into a value constellation is however not sufficient to explain the potential of a constellation to create joint value. Resources have to be effectively combined and governed effectively at the constellation level. Gomes-Casseres (2003) discusses four factors that are crucial to ensure that constellations are effectively governed. "A unifying vision is important to bring disparate partners together. A corollary of this is that competition among members erodes the cohesion of the constellation (Hwang and Burgers, 1997). Leadership is important in making collective decisions and in disciplining constellation members. Group size is a self-evident factor: the larger the group, the harder it is to manage, all else being equal" (Gomes-Casseres, 2003, p. 331).

In sum, value creation in constellations is determined by the (1) the resources it assembles, (2) the way how it can combine and govern them[9], and (3) the value of competing products and the competitive reactions of other competing firms and constellations.

3.2 *Value appropriation by different actors in value constellations*

In the previous section we have analyzed how value constellations create value. That value also has to be distributed among the different participants (including the targeted customers). According to Brandenburger and Nalebuff (1996) the total value created in a value creating system equals the sum of values appropriated by the different actors. Amit and Zott (2001, p. 515) extend this approach "…by positing that total value created through a business model equals the sum of values appropriated by all the

[9] We come back on the constellation leadership in section 3.3.

participants in a business model, over all transactions that the business models enables". However, the total value that can be captured by the participants of the value constellation does not tell us anything yet about the distribution of that value among the participants.

Brandenburger and Stuart (1996) argue that value appropriation by the different players depends on their bargaining power. Gomes-Casseres, (2003) explores two different sources of bargaining power. One strand of literature emphasizes the role of the position of firms in the network as an important determinant of their power – crucial concepts are network centrality, structural holes and participation in multiple networks (clique overlap) (Nohria and Garcia Pont, 1991; Burt, 1992; Lorenzoni and Baden-Fuller, 1995). Others underline the role of scarce resources that companies bring to the value constellation (Pfeffer and Salancik, 1978; Brandenburger and Nalebuff, 1996; Ghemawat et al., 1999). Future research has to analyze how important those factors are in companies' ability to extract profits from the constellation.

The bargaining power of the individual companies can however only partially explain how value is extracted from value constellations. Value appropriation in a value constellation has to be *considered jointly* with the value creating strategy at the constellation level because the quality of the collaboration of the participants and the value-sharing among them both determine how much value the constellation as a whole can create. Moreover, all participants should profit from its participation in a value constellation. The strength of the value constellation is determined by (1) the extra value created in comparison with competing value systems and (2) the commitment of the different partners in the value constellation. The latter is in turn the result of the

(financial) benefits each one can reap compared to alternative value systems (e.g. farmers will not purchase insect-resistant seeds when they are better off with traditional seeds and a cheap herbicide). Hence, it will be necessary to calculate the benefits along the value constellation and to ensure *that each part of the constellation gets a return so that every participant stays committed*.

Therefore, life-science companies, - although they might have monopoly power thanks to their IPR-protected innovations - share the value created in the value constellation with the other economic players in order to ensure that GM-plants gain rapid market penetration. Traxler and Falck-Zepeda (1999 p. 95) calculated for the use of Bt Cotton that in the period 1996-1997 "…US farmers received the largest single share of benefits ranging from 42% to 59% of total surplus generated. The combined share of Monsanto and the seed firms ranged from 26% to 44%. The main conclusion of our study is that even under monopoly conditions, the innovator is only able to extract a portion of the surplus it creates. The monopolist must provide farmers with an adoption incentive by setting a price that makes the new input more profitable than existing options". These findings are in line with previous studies (Griliches, 1957; Teece 1986).

'Fair' value distribution in a value constellation is important, because some actors are automatically better off in the new constellation compared to the old value creating system, but others might be worse off and have to be compensated to get / stay committed to the value constellation. In a value constellation there are always customers that are explicitly targeted as groups that potentially can benefit from agricultural biotechnology. These target groups differ from application to application. New GM-crops and derived products may be beneficial for farmers (e.g. herbicide tolerant crops), downstream

industries (e.g. oil processing industry) or the end-customer (e.g. fresh tomato market). However, focusing on those players that can directly benefit from a new GM-crop is not enough. A value constellation can only be successfully established if *all* players that are necessary for a smooth working of the value constellation are better off than in competing business systems.

Most 'agbiotech' innovations are designed to affect only part of the value creating system: a nice example is the 'agronomic trait'-crops that, in monetary terms, only affect agrochemical companies, seed companies and the farmers' community. In this case it is tempting to leave downstream sectors and end customers out of scope. However, the public opposition to transgenic plants (especially in Europe) indicates that (perceived) value is a concept with many more dimensions than the 'economic value' that can be measured as cost reductions, quality improvements or other product characteristics for which the end customer wants to pay a premium price. Agronomic trait crops created benefits for agro-chemical companies, seed companies and farmers but they have not provided end customers with food that is significantly cheaper, safer and tastier. End customers have become critical because they do not benefit from agricultural biotechnology and are confronted anyway with their potential (but unproven) environmental and health hazards. Escalating public opposition has a serious economic impact on the GM-crops; some of them are nowadays sold at a discount because exports to Europe cannot be guaranteed. As a result, farmers and downstream industries have little incentive to grow and process them[10]. In short, this story about public opposition shows that *all* actors, who might be affected one way or another by the value

[10] This situation is likely to change when value-enhanced crops with direct benefits for end-consumers will be introduced in the coming years.

constellation, should be committed to it. Focal firms in agricultural biotechnology have ignored their critics or have been too defensive in the past; nowadays they are beginning to engage in public dialogue and to teach the public[11].

This is only one example illustrating the rule that all actors have to be better off in the new value constellation compared to the existing value creating system(s). Value-enhanced crops pose new and increasingly difficult challenges compared to agronomic trait crops. First, the number of actors is larger as life-science companies target downstream industries and even the final-customer (e.g. the fresh tomato market). As a result, many different actors – or even the whole value creating system from upstream industries to end customers – are affected by the new business model and they all have to be convinced to get committed to the value constellation. The higher the number of actors, the more difficult it becomes to distribute the value created and to manage the value constellation. Second, value-enhanced crops require huge adjustments from a number of key players. End-customers have to learn how to appreciate and take advantage of these crops. This, in turn requires that retail business has to introduce new types of branded products. Processors must learn how the leverage quality enhancements. Elevators must learn how to effectively segregate output trait crops and how to optimize identity preserved supply chains. Hence, the larger the adjustments and investments required for the commercialization of value-enhanced-crops, the tougher the management challenges will be to compensate companies that might be worse off in a new business system compared to the old ones.

[11] Starting the public dialogue and teaching the public are examples of 'value constellation'-management activities (see section 3.3)

3.3 Value constellation management

Creating and capturing value from life-science applications neither happens spontaneously nor is it the result of an adaptation process of firms to changes in the business environment. It requires a central firm that explores the potential of life-sciences to create value for customers in radically new ways and shapes the external environment accordingly (Normann, 2001, Iansiti and Levien, 2004a). Take the Flavr-Savr tomato as an example to understand what actions the central firm has to take to launch a new GM-crop on the market. This GM-tomato developed by Calgene more than a decade ago had a better flavor and targeted the fresh tomato market[12]. Its commercialization required that different actors in the value system joined Calgene in its efforts to launch the new tomato: the central firm had to manage carefully its relations with seed companies, farmers, packers, retailers and end consumers. These other players own complementary assets that are crucial for the commercialization process. Typical examples are complementary R&D, manufacturing processes, logistics and distribution channels.

Arm's-length transactions between the innovation firm and the other actors are in most cases not a viable option because investments the partners have to make are sometimes (co-)specialized and thus transaction specific (Teece, 1986).Vertical integration (or ownership of assets) is one possible way to overcome transaction cost problems. However, vertical integration is only applicable to very specific transactions since the commercialization of GM-crops may affect whole value creating systems (see Flavr-Savr example) including companies that are many times larger than the innovating

[12] This example is based on the Flavr Savr tomato described in Goldberg and Gourville (2002).

company[13]. As a result, market transactions and asset ownership (integration) are not appropriate to commercialize radical innovations that require the redesign of value creating systems.[14] The central firm has to control and make the most of critical capabilities that reside in other firms by establishing a value constellation. In a value constellation the central firm brings together players with disparate assets and competences (Normann 2001; Gomes-Casseres, 2003). This implies that the company has to set up an inter-organizational network and manage the constellation by means of mergers and acquisitions, strategic alliances, licensing agreements, contracting and other types of relations that go beyond arm's-length contracts. This "critical capability sourcing" is not unique for the commercialization of new technology applications but has also been explored within the context of "strategic sourcing" (Iansiti and Levien, 2004a; Gottfredson et al., 2005).

Value constellations imply that interdependency becomes crucial in business: the performance of the innovating company is increasingly dependent on the influence it has over assets outside its own boundaries. Although value constellations are important in current business practice, there is yet no comprehensive framework that provides a general guideline how to manage it successfully. Following Iansity and Levien (2004) there are in our opinion two important issues for a central firm to manage a value constellation First, it has to structure and manage the constellation so that the potential of the constellation to create joint value is maximized. Second, it has to make agreements with other participants to *share this jointly created value*.

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[13] Vertical integration is valuable in very specific circumstances (e.g. acquisition of seed companies) as we will see in section 4.1

[14] This is in sharp contrast with incremental innovations or sustaining innovations (Christensen and Raynor, 2003) where a company can rely on existing relations with suppliers, channels and end-consumers.

How much value there will be created depends on the design of the constellation. Gomes-Casseres (1996, 2003) has shown that the collective competitiveness of the participants depends on the size of the constellation, its technological capabilities, market reach, unifying vision, leadership at the core, and absence of internal competition among the participants. These different factors all have an impact on the competitive strength and growth potential of a value constellation. In that regard, Iansiti and Levien (2004a) also emphasize that the central firm actively has to nurture the constellation to manage potential tensions between participants and to discourage competitors to match the strength of the value constellation.

Second, the focal firm has to make a number of arrangements with other participants in the value constellation so that *everyone is better off* compared to competing offerings (see also section 3.1.2). Companies will only join and stay in the constellation if participation offers a higher expected net return compared to competing offerings. This implies that the firm has to share the added value with others to spur adaptation of the GM-crops. But it also implies substantial *support for and compensation of* actors that have to invest in new (transaction specific) assets when they intend to join the value constellation.

We take the elevators (logistics systems) as an illustration. Segregation or identity-preservation is necessary to deliver value-added crops to downstream industries but they also imply extra logistical costs. Identity preservation for example is crucial in the production and distribution of nutraceuticals and agriceuticals because health and environmental hazards require a fully separated and dedicated logistics system. In line with the traditional commodity crops, elevators' asset configuration and logistics of

commodity grain handling have been based upon volume based shipping and mingling of grains. Logistical redesign focusing on segregation and identity-preservation is necessary and will lead to additional direct expenses and considerable long-term investments. Maltsbarger and Kalaitzandonakes (2000) found that operational costs and switching costs for elevators are not trivial. Moreover, segregation becomes prohibitively expensive for very low threshold levels of contamination. Therefore, a logistic system based upon segregation is one of the potentially 'weak' links in the value constellation. The focal firm has to strengthen this 'weak link' by supporting elevators in their efforts to come up with logistic systems that can ensure segregation or identity preservation.

Finally, there are a number of set up strategies (see fourth block in Figure 1) that have to be performed by the focal company. A recurring problem during the initial phase of a new value constellation is the 'thin market' problem: buyers – downstream industries – may be discouraged by an erratic or insufficient supply while farmers face a market that is too thin to support large enough premiums (when they risk to have excess supply). In that case, guaranteeing pull through demand and contracting to mitigate farmers' risk may be a convenient way to get through the initial phase of the value constellation. Pull through demand may require that the focal firm integrates vertically into some downstream industries.

In the case of agricultural biotechnology the central firm is likely to be a large corporation with deep pockets because of the considerable investments both in tangible and intangible assets necessary to set up a value constellation[15]. Usually they have a stake

[15] Focal companies are not necessarily large companies with deep pockets. Amit and Zott (2001) indicate that a number of start-up companies have successfully entered the e-business 'industry'. Normann and Ramirez (1993), Slywotsky et al. (2001), Ramirez and Wallin (2000) and Parolini (1999) focus on new value constellations that emerge from a bright business idea that is usually not

in a particular industry that might be affected by 'agbiotech'. These companies might be incumbents, defending their traditional turf such as agrochemical companies, or they may be new entrants in those industries, taking the biotechnology as an enabler to enforce an entry strategy and changing the strategic game in a particular industry.

3..4. The role of the government

Biotechnological innovations have always been tested intensively by regulatory agencies before they could be commercialized. The government is an important player within this context and it has the power to decide about the fate of new value constellations that are enabled by 'agbiotech'-innovations.

In Europe, governments have been preoccupied with the regulatory hurdles accompanying GM-labeling. This preoccupation to protect the end-consumer is legitimized as GM-crops with agronomic traits mainly benefit farmers and agrochemical industry. The commercialization of value-enhanced crops may fundamentally change the role of governments. Benefits for end consumers will become tangible: nutraceuticals reduce the risks for particular diseases, drugs will become more effective and cheaper, and new industrial applications will become available. In defending end customers' interest, the governments 'regulatory' task may become a highly complex one.

Similarly the government can embrace 'agbiotech'-innovations as a strong tool in realizing environment protection targets. Bio-fuel, clean energy sources, biodegradable plastics, etc… are innovations that can be stimulated by tax-initiatives differentiating between the prices of traditional, polluting products and those offered by means of GM-

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linked to technological innovations. They argue (and illustrate with a series of case studies) that small companies have the potential to change the rules of the game into their advantage.

crops (or biotechnology in general). Hence, the role of the government can chance from a cautious and defensive regulator into a more pro-active initiator of initiatives that are designed to reach higher consumer-surplus and to realize policy targets in the realm of health care and environmental protection.

4. Using value constellation to improve our understanding of Open Innovation

Value constellations have a number of possibilities to better understand Open Innovation. We chose three topics to explore. First, the choice of the central firm for a particular governance mode for the relations with its partners. Second, value constellations as a nexus to combine and integrate different theories of the firm. Third, the need to analyze Open Innovation at different (but nested) levels of analysis. We only make a quick exploration of these topics and providing some interesting research questions for future research.

4.1. Choice between governance modes in value constellations

Moving from a business model in the midst of well-defined, mature businesses to one that tries to capture the potential of the life-science sector does not happen spontaneously. First, it requires new business model architectures developed by key companies (Normann and Ramirez, 1993; Normann, 2001). Next, the development of agbiotech based business models requires that economic actors with different assets and competencies are tied together into a value constellation. Finally, a central firm has to choose the appropriate governance mode for its relations with each constellation partner. In theory, coordination between the partners can be accomplished by choosing any of the

options ranging from external market-based contracts to the vertical integration of complementarities within the firm, and any collaborative arrangement in between.

The choice for an appropriate governance mode in value constellations has not yet been analyzed in a comprehensive framework. Nonetheless, it is at the core of Open Innovation since the shaping of these external relations will determine the success of the commercialization of new technologies. Chesbrough and Teece (1996), Chesbrough (2003a) and Pisano (1990) describe how user firms have different options when they want to source externally developed technologies. The question how to shape the relations with partners to commercialize the innovation is not within the scope of their research.

Some researchers have analyzed how companies choose between different governance modes to shape the relations with partners to commercialize an innovation. However, almost all publications focus on dyadic relations with one partner (see a.o.Almeida et al., 2002; Dyer et al, 2004; Grant and BadenFuller 2002, 2004; Hoffman and Schaper-Rinkel, 2001; Pisano, 1991; Roberts and Lui, 2001). In addition, these publications have focused on make-buy-ally decisions from a transaction cost perspective. Barney (1999) takes a different perspective and states that a firm's internal capabilities affect its boundary decisions. Recently, Jacobides and Winter (2005) argue that transaction costs and capabilities should not be considered separately but are intertwined in the determination of the vertical scope of the firm. We suggest from the analysis of the value constellation that the choice for a particular governance mode (including integration) cannot be analyzed from one theoretical perspective and is determined by the role of the different partners in the constellation.

Seed firms provide a nice illustration. Seeds were previously little noticed commodities, but they changed into highly valued, strategic assets with the coming of agricultural biotechnology because they incorporate the intellectual capital of biotech companies (Bjornson, 1998). As a result, in the second half of the nineties seed companies were acquired at extravagant price earning ratios by agricultural, chemical and pharmaceutical companies. Those companies controlled large biotech research budgets and had promising technology applications in the pipeline, but they lacked access to the seeds that could incorporate their patented know-how and the seed distribution systems that could give them the possibility to reach the highly fragmented agriculture sector.

Coordination modes between the partners also vary depending on the level of control and coordination that is required to ensure that quality, technological specs and product specifications can be delivered to the targeted customer. In the case of nutraceuticals and drugs tight controls from farmer to end-user are of utmost importance because of the quality control of the product and the potential health (and environmental) hazards. Similarly, value-enhanced products also involve serious producer risks for farmers: to mitigate that risk specific contracts between life-science companies and farmers will become more fashionable.

In short, we believe that the choice of the governance mode of the inter-organizational ties in the value network should be analyzed from their role in the value constellation. These choices have maximize the joint value created by the network partners and assure that the created value is shared among them so that each of them is better off than when they would leave the constellation. Hence, the analysis of the

determinants of these make-buy-ally decisions in value constellations is in our opinion an interesting topic for future research.

4.2 Value constellations as a nexus for the integration of different theoretical perspectives

Value constellations are also interesting from a theoretical perspective. They are established to create and extract value, they consist of a set of transactions, they combine resources and capabilities of different partners and are by definition a specific class of inter-organizational networks. Value creation, transactions, resources and networking are the four constituent dimensions of value constellations. Moreover, they have to be considered *jointly* to understand how firms can create and appropriate value within constellations. Consequently, the role of value constellations cannot be sufficiently addressed by "one-dimensional" theoretical frameworks that emphasize the role of only one of these dimensions[16].

How value constellations can be analyzed along the value chain analysis (Porter, 1985) the transaction cost view (Williamson, 1975, 1985), the resource based view (i.e. Wernerfelt, 1984; Barney, 1986, 1991) or the relational view (Dyer and Singh, 1998) goes beyond the scope of this chapter and is obviously an interesting topic for future research. However, we can point to some of the limitations of these theoretical frameworks arguing that they offer only a partial explanation of value constellations and that we are in need of an integrative theoretical framework.

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[16] The need for a multidimensional approach is echoed in Amit and Zott (2001) and Gomes-Casseres (2003).

The value chain analysis (Porter, 1985) analyzes value creation and appropriation at the *firm level* and is very valuable in examining value constellations and Open Innovation. However, in constellations value creation is determined by the cohesion and internal structure of the value constellation as a whole, not by the performance of the individual participants. Competitive advantage and competition are no longer determined at the firm but at the constellation level (Gomes-Casseres, 1994). Future research will have to take the complex interplay between competition and co-operation into account to explain value creation in value constellation (see also Brandenburger and Nalebuff, 1996).

The resource based view (RBV) postulates that a unique bundle of resources and capabilities may lead to value creation and sustainable competitive advantage. We have mentioned before that value constellations bring together and integrate resources and capabilities that reside in different partners. A central firm may/should have some control over these resources but it owns only part of them, since most resources are owned by the partners in the value constellation. Iansiti and Levien (2004a, 2004b) call this a keystone strategy: "By carefully managing the widely distributed assets your company rely on ... you can capitalize on the entire ecosystem's ability to generate ... innovative responses to disruptions in the environment" (Iansity and Levien, 2004, 74). The RBV is thus crucial in our understanding of Open Innovation because it emphasises the bundling of unique resources. However, in value constellations the innovation firm should have control over the required resources but should not necessarily internalize them.

In constellations value is created through sequences of transactions between the participation companies. Transaction costs economics is concerned with the choice of the

most efficient governance form for a particular transaction. As we have seen, the choice for the appropriate governance mode of the relations between constellation partners is crucial for the optimal functioning of the constellation. However, are transactions in value constellations optimized by minimizing transaction costs?

Some scholars emphasize the importance of maximizing transaction value rather than minimizing transaction costs (Dyer 1997; Madhok, 1997; Ring and van de Ven, 1992; Zajac and Olson,1993). This is an interesting approach because the structural form of a transaction is derived from the value that can be created within the broader context (of a value constellation). Because both the transaction value analysis and value constellations are focusing on joint value maximization and on the process of value creation and distribution, there is a good match between both approaches. However, value constellations differ from the transactional value approach in that value constellations bring the resources of many partners together while transaction value has been analyzed mainly on the dyad level.

The relational view of the firm (Dyer and Singh, 1998) offers another theoretical angle to analyze value constellations. This approach recognizes that a firm's critical resources may extend beyond its boundaries and that the economic performance of an individual firm is often linked to the network of relations in which it is embedded. There is a link between the configuration of interorganizational networks and value creation "...and the locus value creation may be in the network rather than in the firm" Amit and Zott (2001, 513). It is obvious that the relational view of the firm is an interesting theoretical framework to explain value constellations, but most publications about interorganizational networks have tried to explain competitive success by network

positions of network members and structural properties of networks (see amongst others Gulati, 1998; Powell, Koput, and Smith-Doerr, 1996; Rowley, Behrens, and Krackhardt, 2000; Stuart, 2000; Stuart and Podolny, 1996). Others explain rent generation by the scarce resources networks bundle (Brandenburger and Nalebuff, 1996; Eisenhardt and Schoonhoven, 1996; Gulati, 1999; Tsai and Ghoshal, 1998). Hence, if research about interorganizational networks intends to capture the logic behind value constellations it has to integrate value creation and appropriation, resource bundling and network structure as different dimensions of one and the same strategy.

We conclude that value chain analysis, transaction costs economics, network theory and resource based view are certainly useful in explaining value constellations but a quick analysis shows that we need an integration of these various frameworks to come up with a complete picture. Interorganizational networks that create value by means of transaction based bundling of resources and competencies can only be understood when different approaches are integrated (Madhok and Tallman, 1998), Hence, value constellations and Open Innovation may become a nexus to combine these different theoretical perspectives in the future. We are not the only ones that point at the need to integrate theoretical frameworks. Amit and Zott (2001) come to the same conclusion in there study about e-business models and Gomes-Casseres (2003) concludes that there is no comprehensive framework explaining the competitive advantage in alliance constellations.

4.3. Open Innovation research at different levels of analysis

Our study of the value constellations indicates that Open Innovation has to be investigated at different layers that are nested. Figure 13.2 gives an overview of these layers.

Insert figure 13.2 here

In the past Open Innovation has been analyzed at the firm level and in particular from the technology user point of view (Chesbrough, 2003a). The analysis of interorganizational networks (this section of the book) suggests that an approach with different levels of analysis can deepen our understanding of Open Innovation. The first level is that of the individuals who set up informal intra- and inter-organizational networks. This approach has been explored in chapter 11 and bridge chapter 10, but has not received much attention in previous Open Innovation research. The next level is the firm level which has been analyzed in the first section of this book.

Next, one can consider Open Innovation from the dyad level, i.e. the perspective of two companies that are tied to each other through equity or non-equity alliances, corporate venturing investments, etc. The dyad perspective takes into account the perspective of the two organizations that are involved in an Open Innovation relationship. As Open Innovation is basically about non arm's-length relations between companies it can take advantage from a dyad level perspective analysis of strategic alliances (Bamford et al, 2003 ; Lynch, 1993) and external corporate venturing (Keil, 2002). Typical research questions at this level of analysis are how to select partners, how to assess the return and

risks of an alliance or external venture, how to evaluate the fit between potential partners and how to structure the cooperative agreement and manage it over time.

The next level of analysis refers to inter-organizational networks. The different chapters of this section of the book contain three main messages in our opinion. First, a network perspective is necessary as a complementary approach of Open Innovations. Key innovating companies do not profit from Open Innovation only by deliberately in- and outsourcing intellectual property with different external partners. Key innovators have also to set up and manage interorganizational networks both to develop new technologies (chapter 12) and to exploit technology based business opportunities (this chapter). External network management becomes crucial when Open Innovation moves beyond bilateral insourcing of externally developed technologies. Key players in Open Innovation have to orchestrate the network of partners that are crucial to develop or to exploit particular innovations. They have to look for interesting partners, lead and nurture the network, minimize tensions between partners and instill a unifying vision.

Second, when Open Innovation is realized through extensive collaborative networks competition is no longer between individual firms but between groups of firms. Group based competition is different from firm based competition (Gomes-Casseres, 1994; Brandenburger and Nalebuff, 1996 ; Bamford et al., 2003).

Third, external networks are likely to change substantially when a new venture shifts from the idea generation phase to the commercialization. Chapter 12 explores the need for external networks when a company is involved in the development of systemic innovations (left-hand side of figure 1.2). This chapter focuses on value constellations

that are necessary to commercialize innovation (right-hand side of figure 1.2). The dynamics of these networks have to our knowledge never been studied in depth.

The last level of analysis (see figure 13.2) consists of the national innovation systems. This level has been discussed in chapter 11 and goes beyond the scope of this paper. It is however important to mention that the establishment and management of interorganizational networks can be spurred or hampered by the innovation system in which it is embedded.

In sum, we suggest that a multilevel perspective can deepen our understanding of Open innovation and that inter-organizational networks play an important but yet under-researched role in explaining Open Innovations. In our opinion, there are ample opportunities for future research in combining Open Innovation with external network management, collective competition and the dynamics of networks that accompany an innovation in its journey from idea generation to a profitable business.

5. Conclusions and suggestions for future research

In this chapter we have shown that market-based transactions within the agricultural industry are increasingly replaced by an increasingly complex network of relations between the relevant economic players. Moving from a business model that is appropriate for mature businesses to one that tries to capture the business opportunities related to the emergence of the life-science does not happen spontaneously. It requires a purposeful rethinking and shaping of the business model by a central firm (Normann, 2001) and economic actors with different assets and competencies have to be tied together into a value constellation. Not only the competencies of the participating firms

but also the way how the constellations is structured and managed determines the collective competitiveness of the latter.

What did we learn from this chapter about Open innovation? In our opinion there are five ideas to take away. First, agricultural biotechnology is interesting as technology field to test whether Open Innovation can be generalized. Open innovation has been studied predominantly within the context of the information and communication technologies (Chesbrough, 2003a). Although agbiotech provides a complete different setting, Open Innovation is also applicable to this technology field. Future research has to examine whether Open Innovation also applies in others contexts. Our findings about agbiotech indicate that Open Innovation should not be confined to ICT as Graham and Mowery propose.

Second, we have focused on value constellations, i.e. interorganizational networks that are established to create and capture value based on new business models. They could be considered as a mirror image of the innovation networks establish to insource externally developed technologies. Innovation networks (the example of systemic innovation networks has been discussed in chapter 12) are situated at the left-hand side and value constellations at the right-hand side of Figure 1.2. Value constellations are different from 'early-stage' innovations networks: they are established to commercialize an innovation together with partners that own critical resources and are tightly linked to the underlying business. Emphasizing the commercialization stage is interesting because most Open Innovation research has been focused on external technology sourcing and networking with technology providers and innovative, upstream companies. Value constellations are to a large extent oriented towards customers and other downstream

players. The study of value constellations shows that the 'openness' of Open Innovation also applies to the commercialization phase. This is not a new idea (see Gomes-Casseres, 1994; Normann and Ramirez, 1993) but it has not yet been integrated it into the broader 'Open Innovation'-picture.

Third, innovation networks and value constellations could be considered as two snapshots that obscures the truly dynamic nature of 'Open Innovation'-networks. Firms continuously change these networks depending on the development stage of the venture. Understanding these dynamics is important both from a theoretical and managerial point of view. We hope future research will explore the dynamics of these networks.

Fourth, value constellations are from a theoretical point of view interesting constructs. They are built to create and capture value and thus have a lot in common with the value chain analysis. They are also related to transaction cost economics because the central firm has to choose the appropriate governance mode for the relations with its partners. Next, value constellations bring together critical resources that are owned by different companies and have therefore a lot in common with the resource based view of the firm. Finally, value constellations can be analyzed in terms of the relational view of the firm. As a result, value constellations are a nexus for the integration of different theoretical perspectives.

Finally, the analysis of interorganizational networks in general and value constellations in particular reveals that research about Open Innovation should be multi-layered. Open Innovation from the (user) firm perspective only provides a partial view. Figure 13.2 shows that there are at least five possible layers. Each dimension opens a new perspective on Open Innovation. Since the different layers are nested Open Innovation

has to be explored simultaneously at different levels. Therefore we hope that future research will explore Open Innovation at the individual or unit level on the one hand and at the network and innovation system level on the other hand.

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Figure 13.1: Analyzing value constellations

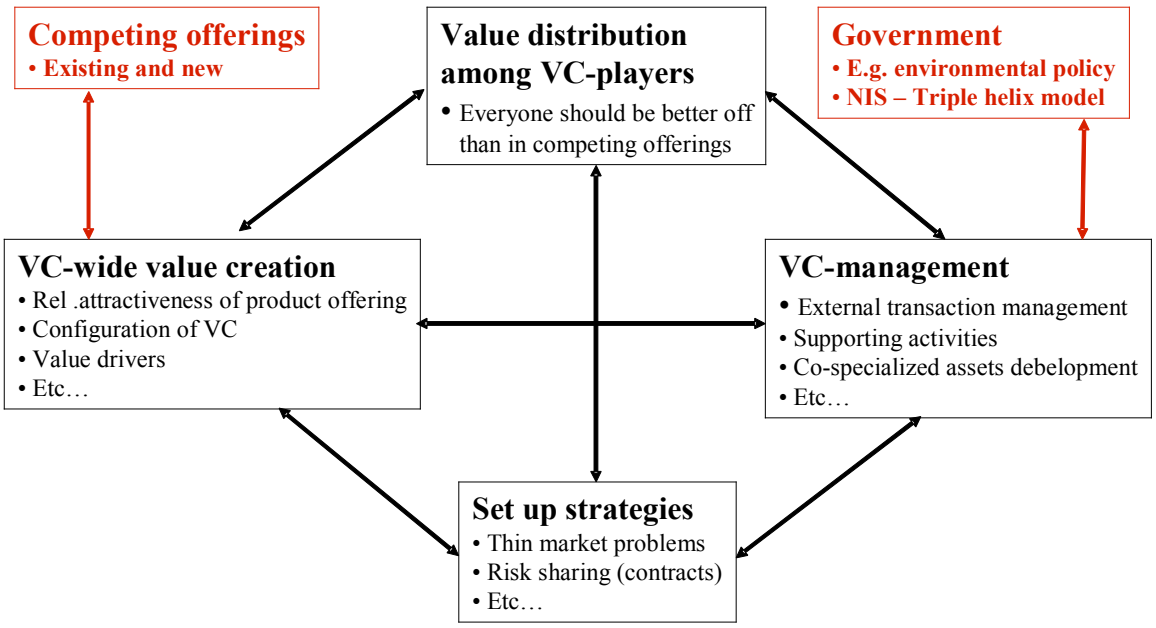

Figure 13.2: Analyzing Open Innovation at different units of analysis