OWNERSHIP STRUCTURE IN AGRIFOOD CHAINS: THE MARKETING COOPERATIVE

GEORGE W.J. HENDRIKSE AND S.J.J. (JOS) BIJMAN

ERIM REPORT SERIES *RESEARCH IN MANAGEMENT*	
ERIM Report Series reference number	ERS-2000-15-ORG
Publication status / version	draft / version March 2000
Number of pages	22
Email address first author	ghendrikse@fbk.eur.nl
Address	Erasmus Research Institute of Management (ERIM) Rotterdam School of Management / Faculteit Bedrijfskunde Erasmus Universiteit Rotterdam PoBox 1738 3000 DR Rotterdam, The Netherlands Phone: # 31-(0) 10-408 1182 Fax: # 31-(0) 10-408 9020 Email: info@erim.eur.nl Internet: www.erim.eur.nl

Bibliographic data and classifications of all the ERIM reports are also available on the ERIM website:
www.erim.eur.nl

ERASMUS **R**ESEARCH **I**NSTITUTE OF **M**ANAGEMENT

REPORT SERIES
RESEARCH IN MANAGEMENT

BIBLIOGRAPHIC DATA AND CLASSIFICATIONS		
Abstract	This article analyses the impact of ownership structure on investments in a three-party supply chain from an incomplete contracting perspective. Circumstances are determined in which a marketing cooperative is the unique first-best ownership structure.	
Library of Congress Classification (LCC)	5001-6182	Business
	5546-5548.6	Office Organization and Management
	HD 1483	Cooperative agricultural societies
Journal of Economic Literature (JEL)	M	Business Administration and Business Economics
	M 10 L 2	Business Administration: general Firm Objectives, Organization and Behaviour
	D 2	Production and organization
European Business Schools Library Group (EBSLG)	85 A	Business General
	100B 240 B	Organization Theory (general) Information Systems Management
	100 D	Design, structuring of organization
Gemeenschappelijke Onderwerpsontsluiting (GOO)		
Classification GOO	85.00	Bedrijfskunde, Organisatiekunde: algemeen
	85.05	Management organisatie: algemeen
	85.05	Management organisatie
Keywords GOO	Bedrijfskunde / Bedrijfseconomie	
	Organisatieleer	
	Cooperaties, Marketing, Agribusiness	
Free keywords	Marketing cooperatives; chains; incomplete contracts	
Other information		

Ownership Structure in Agrifood Chains: The Marketing Cooperative

George W.J. Hendrikse
Erasmus University Rotterdam, Rotterdam School of Management,
Office F3-51, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands,
Phone: +31-10-4088660, Fax: +31-10-4089016, E-mail: ghendrikse@fac.fbk.eur.nl.
and
W.J.J. (Jos) Bijman
Agricultural Economics Research Institute,
P.O. Box 29703, 2502 LS The Hague, The Netherlands,
Phone: +31-70-3358218, Fax: +31-70-3615624, E-mail: w.j.j.bijman@lei.wag-ur.nl.

Abstract
This article analyses the impact of ownership structure on investments in a three-party supply chain from an incomplete contracting perspective. Circumstances are determined in which a marketing cooperative is the unique first-best ownership structure.

Ownership Structure in Agrifood Chains: The Marketing Cooperative

1. Introduction

In recent years, vertical co-ordination or integrated supply chain management has received much attention of economists and management scholars studying the agrifood sector Changes in the market for agrifood products, in farm support policies, in consumer demand and in technological development require more collaboration in the agrifood supply chain (Downey). Contract-regulated production and trade are replacing spot market transactions (Martinez and Reed). More co-ordination and collaboration may lead to improved efficiency in the production and distribution channel and to more product and market innovations (Galizzi and Venturini). These vertical relationships can take many forms, like strategic alliances, long-term contracts, licensing, subcontracting, joint ventures and franchising (Mahoney and Crank).

Increasing vertical co-ordination of production, distribution and marketing among firms in a supply chain may have an impact on the investment decisions of each firm individually. Investments by a firm in one stage of the chain must be co-ordinated with investments by firms in other stages in order to obtain optimal chain performance. As there are complementarities among the activities of different chain participants, the investments are of a relationship-specific kind. In other words, vertical co-ordination may increase asset specificity. The central question of this paper is how different ownership structures affect the investment incentives of firms participating in specific agrifood supply chains. In addressing this question, we apply incomplete contract theory as developed by Grossman and Hart and Hart and Moore.

The main contributions of this paper are twofold. First, we present a conceptualisation of a three party supply chain. Where incomplete contract models have mainly been developed on the basis of two parties engaged in a vertical or lateral relationship, in this paper we develop a model with three parties. Second, the three-party model is used to analyse the efficiency of ownership structures in the agrifood sector, particularly the farmer-owned marketing cooperative.

The paper consists of eight sections. Section 2 gives a stylized example of the type of agrifood chain we are studying and the investment decisions of its participants. Section 3 briefly presents the incomplete contract theory of the firm. Section 4 introduces the model for analysing efficient ownership structures. Section 5 presents the model for two parties. while section 6 develops the model for the three-party agrifood chain. In section 7 comparative statics results are formulated. Section 8 provides conclusions.

2. A stylized example

An example of an agrifood chain with complementarities in the activities of the chain participants can be found in the production and marketing of organic food. Consider three parties – grower, processor and retailer – agreeing on an exclusive relationship to produce organic tomato salad. The grower decides to produce organic tomatoes, to be processed into tomato salad by the processor, and to be sold by the retailer. Before he can harvest the first tomato, the grower has to make a significant investment in shifting from conventional to organic farming. Most of this investment is in obtaining appropriate knowledge. His newly acquired knowledge is related to the land he owns and is worthless if he has no access to the land.

The grower's products will be processed in separate processing lines and will be sold through separate marketing initiatives. Thus, the special activities of the processor and the retailer lead to the highest total (i.e. chain) surplus. Assuming that the grower will receive part of the revenues generated in the processing and retail stages of this chain, he will invest more if he is part of this specific chain than if he is part of some generic chain. Thus, the investment by the grower is (at least partially) chain-specific.

The chain-specific nature of the grower's investment means that his investment will yield a significantly lower return if the processor and/or the retailer renege on the contract. Thus, a kind of dependency has been created between the grower on the one hand and the processor and retailer on the other hand. An opportunistic contract party may take advantage of this dependency relationship, for instance if market conditions have changed. Once the farmer has done his (sunk) investment, the processor or retailer may demand a larger part of the total chain surplus under the threat of discontinuing the contract alltogether. Such opportunistic behaviour is always possible as no contract can cover all future contingencies. Particularly in situations of great uncertainty and market volatility, opportunities for contract reneging increase.

This uncertainty about the future behaviour of his contract partners may induce the grower to lower his investment or to take precautionary measures to prevent ending up in a situation that other parties can appropriate a large part of the surplus of his investment. For instance, he may decide to do the processing of tomatoes into tomato salad himself, and he may even sell the tomato salad himself. What this really means is that the grower may set up or acquire processing and retailing assets. Farmer co-operatives are an example of such investments by agricultural producers in processing and marketing stages of the agrifood chain.

In this paper we do not only look at the chain-specific investment by the grower, but also by the processor and retailer. A processor can make a chain-specific investment, for instance in R&D that yields a special processing technology for organic produce (e.g. low energy use in processing). This technology is related to the equipment or a patent that the processor already owns. From this investment, too, complementarities (or positive externalities) in the chain may arise. For instance, the new processing technology yields a higher return if the grower coordinates his harvesting activities with the processing activities. Finally, the retailer may invest in setting up a marketing campaign that attracts customers willing to pay a higher price for organic tomato salad. The marketing campaign is related to the company name and its image. This investment, too, is chain-specific, because it generates a higher total surplus if the farmer and the processor guarantee the continuous supply of organic tomato salad.

Before we introduce our model for analysing the relationship between ownership structure and efficient investment decisions, we will briefly introduce incomplete contract theory. Our paper builds upon the ideas developed in this strain of economic organisation theory.

3. Incomplete Contract Theory

The incomplete contract theory starts from the basic idea that it is often difficult to write enforceable comprehensive contracts. Real world contracts are almost always incomplete in the sense that there are inevitably circumstances or contingencies left out of the contract, because they were either unforeseen or simply too expensive to enumerate in sufficient detail. As contracts are incomplete, actions and payments must often be determined *ex post*, either unilaterally or through negotiation. Consequently, contracting parties should be concerned *ex ante* with the threat of opportunistic behaviour and the results of possible renegotiation. This is particularly problematic if *ex ante* specific investments have to be made. These investments create the opportunity for hold up, i.e. *ex post* appropriation of quasi-surplus (i.e. specific investment costs plus surplus) by the non-investing contract party. As a result, incomplete contracts may lead to under-investment in the economic relationship. Klein et al. and Williamson (1979, 1985) have suggested that vertical integration may solve this inefficiency problem.

Grossman and Hart have argued that vertical integration brings costs as well as benefits. To understand what is changing when two firms merge, Grossman and Hart and Hart and Moore have developed a property rights theory of the firm. A firm is identified with a collection of non-human assets under common ownership, where ownership means holding residual rights of control. Residual rights are all rights to an asset that are not expressly assigned to another party (including the state). The allocation of residual rights of control has effect on the bargaining position of parties to a contract after they have made relationship-specific investments. In the absence of comprehensive contracts, property rights largely determine which ex post bargaining position will prevail. A party owning assets that are essential for value creation in the relationship is in a position to reap at least some of the benefits from the relationship, which were not explicitly allocated in the contract, by threatening to withhold the assets otherwise. Thus, a shift of ownership affects the ex ante investment incentives of contract parties.[1]

4. The model: structure

The standard model of incomplete contract theory consists of a three stage non-co-operative game. The first stage consists of the choice of ownership structure, where each ownership structure is associated with a specific distribution of bargaining power. The second stage consists of the specific investment decision(s). The third stage consists of the choice of the non-investor between honouring the contract and renegotiating it.

This game is solved by the method of backward induction. We start therefore with the third stage. Two parties, for instance a farmer and a food procesor, may sign a contract before investment by the farmer takes place. A contract may specify ex ante, i.e. before the investment decision, that each party receives ex post, i.e. after the investment decision, half of the surplus. The problem with this contract is that situations may arise for which the contract does not specify anything, e.g. consumer demand is lower than expected. The (opportunistic) processor will argue that the quasi-surplus instead of the surplus has to be divided in such situations. The specificity of assets has weakened the ex post bargaining position of the farmer to such an extent that he will accept these new terms regarding the exchange. The subgame perfect equilibrium strategy in the third stage is therefore to renegotiate the ex ante contract.

The investment decision in the second stage of the game determines the bargaining positions in the third stage. The specificity of the investment puts the investor in a weak bargaining

[1] The main Grossman/Hart/Moore conclusions on optimal asset ownership in a two party vertical relationship (i.e. buyer-seller relationship) are the following. (1) A party with an important investment (in human capital) should have ownership rights over the asset for which the investment is required. (2) If investments by party A become relatively more important than investments by party B, A should own more assets. (3) Highly complementary assets should be under common ownership. (4) Independent assets should be separately owned. (5) Important assets should not by owned by a third party.

position regarding the division of the surplus in the third stage. However, the investor anticipates that the other party may take advantage of the incompleteness by claiming a larger share of the ex post surplus than initially agreed upon. This fear of ex post opportunistic behaviour results in underinvestment. This is the hold-up problem (Klein et al., 1978).

In the first stage of the game, the choice of ownership structure is chosen. It is assumed in the incomplete contracting theory that an ownership stucture is chosen efficient. Every ownership structure is associated with a particular distribution of bargaining power. In order to capture bargaining power, we adopt the game theoretic solution concept Shapley value (Shapley), just like the seminal article by Hart and Moore (1990).

5. The model: two parties

There are two parties (1 and 2), two assets (A_1 and A_2) and two investment decisions (x_1 and x_2). For simplicity, x_i can only take the value 0 or 1. Each party represents a specific stage of production. For instance, party 1 is a farmer and party 2 is a processing firm. The assets are, for instance, land and factory. The investment is done by a person and cannot be done by another person, thus the investment is (at least partially) in human capital. The investment is related to a specific non-human asset, i.e. the investment does not generate any surplus if the investing party is denied access to the asset. For instance, the farmer invests in enhancing land productivity and the processor invests in improving processing technology.

The model consists of two steps: an ownership structure step and an investment step. We make the following assumptions about investment (x). Investments are made simultaneously and non-cooperatively (i.e. each party invests without taking into account the choices of the other parties). Investments are observable but not verifiable. This means that no contract can be written about the precise investments, but that parties can observe each other's investments once they have been made. The observability implies that bargaining at T_1 takes place under symmetric information about the T_0 investments. No contracts are possible about cost sharing at T_0 or benefit sharing at T_1. As contracts at date T_0 about the division of value generated by the investments are necessarily incomplete, the division of value at date T_1 depends on the bargaining power of the parties.

We assume complementarities in asset use. An investment by party 1 generates a higher value if not only asset A_1 but also A_2 is used. Similarly for an investment by party 2: it generates a higher value if more assets are used.

As the generation of maximum value depends on the use of assets belonging to another stage of the chain, the investments are chain-specific. The value generated by a specific investment is the quasi-surplus (q), being the surplus plus that part of the investment that is sunk in the relationship. The actual value of q depends on who invests and which assets are used. We assume that party 1 generates a quasi-surplus of t when A_1 is used and 2t when both assets are used. Similarly, we assume that party 2 generates a quasi-surplus of f when A_2 is used and 2f when both assets are used. The quasi-surplus for various investment decisions and various assets used is shown in table 1. The full quasi-surplus of each investment will be generated only when all assets are used.

Table 1. Quasi-surplus for two investment decisions and various assets involved

assets involved	investment decision	q
A_1	$x_1=1$	t
A_1 A_2	$x_1=1$	2t
A_2	$x_2=1$	f
A_1 A_2	$x_2=1$	2f

Various divisions of asset ownership are possible. We have distinguished 3 different ownership structures. Figure 1 shows for each of the three ownership structures the assets that each party owns. Ownership structure I represents market exchange. Forward integration is captured by ownership structure II. It is an expression of the agricultural marketing cooperative, where farmers own the processing or trading company at the second stage of the chain. Thus, in a marketing cooperative party 1 owns A_1 and A_2. Finally, ownership structure III represents backward integration.

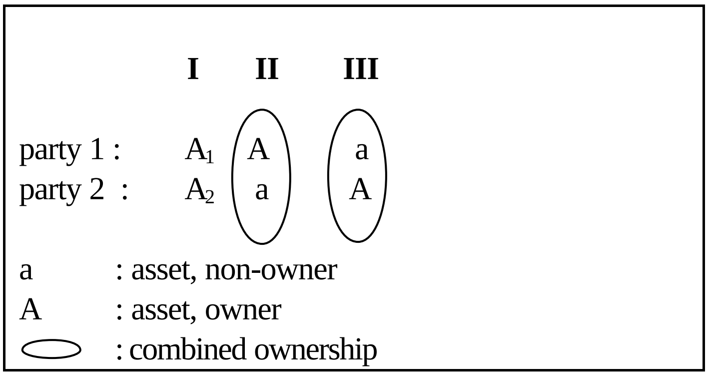


Figure 1. Three owhership structures

The bargaining power of each party in the supply chain under the various ownership structures is captured by its Shapley value. The Shapley value is computed for each ownership structure and each investment by using the characteristic function. A characteristic function v assigns a number to every coalition S, given a particular ownership structure G and given investment choices x. Formally, v (S | G, x). This number is the total value generated by the parties in the coalition S without any help from the parties outside of S; S is the coalition of parties (with $S \subseteq \underline{S}$; $\underline{S}$ being the set of all parties). G is the ownership structure, i.e. the allocation of asset ownership. Table 2 presents the characteristic function and the corresponding Shapley value (SV) for each investment decision and all ownership structures. This entails 6 cases.

Table 2. Characteristic functions and Shapley values

G	x_1	x_2	v(f)	v(1)	v(2)	v(12)	SV_1	SV_2
I	1	0	0	t	0	2t	1.5t	0.5t
II	1	0	0	2t	0	2t	2t	0
III	1	0	0	0	0	2t	t	t
I	0	1	0	0	f	2f	0.5f	1.5f
II	0	1	0	0	0	2f	f	f
III	0	1	0	0	2f	2f	0	2f

The Shapley value is a measure of power in the ex post bargaining process.[2] It specifies for each party the size of the quasi-surplus that this party will receive in the bargaining process. Therefore, the Shapley value determines the maximum costs of investment the party is willing to make. If we denote the sunk cost (or specific) part of the investment as 'k', then the (investment) participation constraint[3] for party 1 under ownership structure I is

$$k_1 \leq 1.5t.$$

Efficient ownership structures (with two parties)

An ownership structure is first-best efficient if both parties invest and each investment generates surplus, i.e. if x = (1,1) and $k_i \leq q_i$, for i = 1,2. To find out whether a particular combination of investments will yield the first-best, we use the participation constraints of the two parties, i.e. $k_1 \leq SV_1$, and $k_2 \leq SV_2$.

---

[2] In our model we have assumed that a specific farmer is trading with a specific processor, and that each investment is specific to this trade relationship, in the sense it generates a higher surplus in this particular relationship than in trade with a third party. However, substitutability of farmers and processors can be easily incorporated in the model. We will outline this for the non-investor as well as the investor. Substitutability of a particular party reduces its Shapley value in two ways when the party is a non-investor. First, an increasing number of substitutes for a particular party reduces the Shapley value of all these substitutes jointly. The reason is that the probability increases that a particular order of the grand coalition has the feature that one of these non-investors is earlier than the investor. The value added by a non-investor in such an order is zero, whereas the value added by the investor and the non-investor together is assigned to the investor. Second, one of the four axioms underlying the Shapley value requires that identical players have to have identical Shapley values. So, the decreasing share of the surplus going to the non-investor has to be split equally between an increasing number of substitutes. If the party is an investor, then it is obvious that its incentives to invest are diminished when identical rivals benefit from the positive externality of the investment. This is the classic public good problem.

[3] The participation constraint formulates the circumstances under which the investor invests. It is an inequality which states that the revenues of the investment for the investor are not smaller than the costs of investment (k). The revenues of the investment of the investor are equal to the Shapley value of the investor in our model.

Table 2 implies a ranking regarding the suitability of the various ownership structures with respect to the specific investments.[4] The ranking of maximum possible investment outlays by party 1 for the various ownership structures is:

III < I < II.

Ownership structure II is always first-best efficient regarding the specific investment of party 1, i.e. every surplus generating investment by party 1 will be implemented under ownership structure II, regardless of the value of k_1. The reason is that all benefits of the investment accrue to party 1.

The ranking of maximum possible outlays regarding the investment k_2 by party 2 for the various ownership structures is:

II < I < III.

The ranking of efficient ownership structures for party 1 and party 2 is presented in figure 2. It shows which ownership structures are first best efficient as a function of the sunk costs of each party. The smaller the specificity of investment, the more ownership structures yield the first best efficient outcome. With higher levels of investment, fewer ownership structures are efficient. For instance, if $f<k_2\leq 1{,}5f$ and $t<k_1\leq 1{,}5t$, then only I is first best efficient. The general result is that a first best ownership structure assigns more power to a party when its sunk costs / quasi-surplus ratio increases, ceteris paribus.[5]

---

[4] The ordinal ranking of the ownership structures is to be interpreted as a ‘reduced form’ of an underlying model (Williamson, 1991). The reduced form is to be seen as a way to deal with the early stage of the development of the theory of the firm (cf. Holmstrom and Roberts). The empirical importance of ordinal rankings is that they formulate some constraints with respect to the data. To be more specific, various changes in the choice of ownership structure as a function of the level of asset specificity are predicted not to happen. If they occur anyway in reality, then this will cast serious doubts on the relevance of the model.

[5] The choice of ownership structure is in our model driven by efficiency considerations only. However, considerations of equity may prevent that the first best ownership structure will be chosen. A possible solution is to accompany the choice of ownership structure with a lump sum transfer scheme.

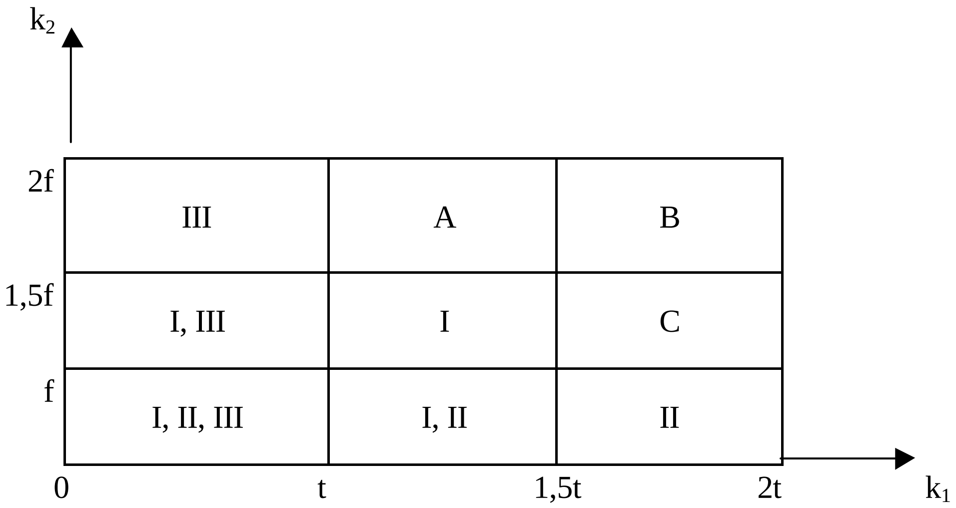


Figure 2. First-best efficient ownership structures

In the area in the upper right corner of the figure no first best efficient combination of investments is possible. If investments of 1 and 2 fall in the area A, B or C only second best efficient ownership structures are possible. This means that only one of the two parties will invest. The second best ownership structure choice in region A is III when $2f-k_2 \geq 1.5t-k_1$ and I or II otherwise. Similarly, the second best ownership structure choice in region C is II when $2t-k_1 \geq 1.5f-k_2$ and I or III otherwise. Finally, the second best ownership structure choice in region B is II when $2t-k_1 \geq 2f-k_2$ and III otherwise. The general result is that the second best ownership structure assigns more power to a party when the surplus of its investment increases, ceteris paribus.

6. The model: three parties

Now we will present the model for the three party chain. There are three parties (1, 2 and 3), three assets (A_1, A_2 and A_3) and three investment decisions (x_1, x_2 and x_3). For simplicity, x_i can only take the value 0 or 1. The three parties together make up an agrifood supply chain; they each represent a specific stage in this chain. For instance, party 1 is a farmer, party 2 is a processing firm and party 3 is a retail firm. The assets are, for instance, land, factory and shop.

Once again, we assume complementarities in asset use. An investment by party 1 generates a higher value if not only asset A_1 but also A_2 and A_3 are used. The notion of a chain entails that there is a difference between being in the middle or at the end of the chain. We capture this by assuming that the value generated by the investment will be higher if two adjacent assets are used than if two non-adjacent assets are used. In the three-party agrifood chain this means that the positive externalities of the investment of the farmer (party 1) is higher for the processing company (party 2) than for the retailer (party 3). The quasi-surplus for various investment decisions and various assets used is shown in table 3, where the difference between adjacent and non-adjacent assets is captured by $\alpha < 1$ and $\beta < 1$.

Table 3. Quasi-surplus for three investment decisions and various assets involved

assets involved	investment decision	q
A_1	x_1=1	t
A_1 A_2	x_1=1	2t
A_1 A_3	x_1=1	$(1 + \alpha)t$
A_1 A_2 A_3	x_1=1	$(2 + \alpha)t$
A_2	x_2=1	f
A_1 A_2	x_2=1	2f
A_2 A_3	x_2=1	2f
A_1 A_2 A_3	x_2=1	3f
A_3	x_3=1	h
A_1 A_3	x_3=1	$(1 + \beta)h$
A_2 A_3	x_3=1	2h
A_1 A_2 A_3	x_3=1	$(2 + \beta)h$

The full quasi-surplus of each investment will be generated when all assets in the chain are used. Various divisions of asset ownership are possible. We have distinguished 10 different ownership structures. Figure 3 shows for each of the ten ownership structures the assets that each party owns. For instance, ownership structure V holds if asset A_2 and A_3 are both owned by party 3 and asset A_1 is separately owned by party 1. Ownership structure II is an expression of the agricultural marketing cooperative, where farmers own the processing company at the second stage of the chain. Thus, in a marketing cooperative party 1 owns A_1 and A_2, while party 3 owns A_3.

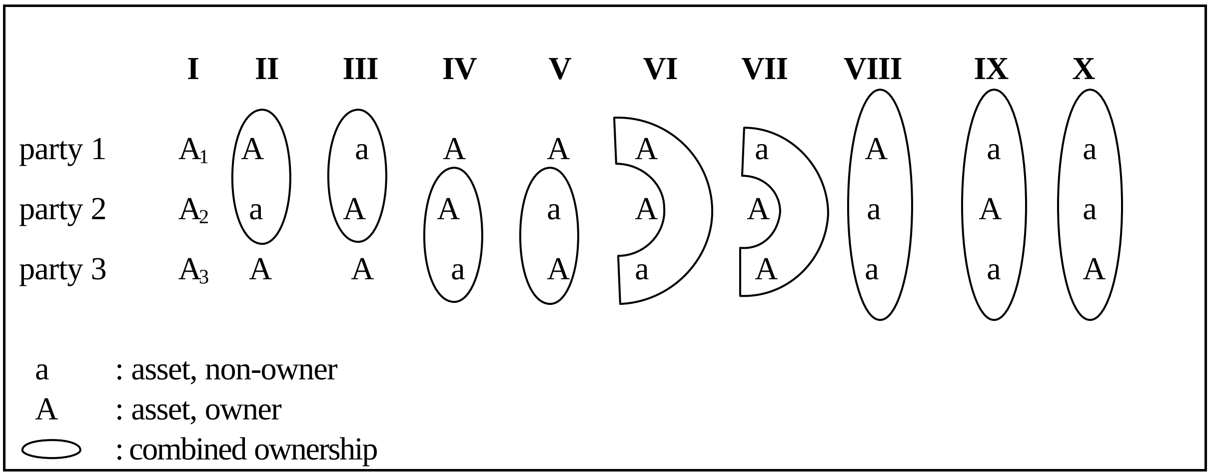


Figure 3. Ten ownership structure

The bargaining power of each party in the supply chain under the various ownership structures is captured by its Shapley value. The Shapley value is computed for each ownership structures and each investment by using the characteristic function. An example will illustrate this. Suppose party 1 invests (i.e. x_1 = 1) and the choice of ownership structure is I (G = I). The characteristic func-

tion is:
$N = \{1,2,3\}$
$v(\varnothing \mid I, (1,0,0)) = 0$
$v(1 \mid I, (1,0,0)) = t$
$v(2 \mid I, (1,0,0)) = 0$
$v(3 \mid I, (1,0,0)) = 0$
$v(12 \mid I, (1,0,0)) = 2t$
$v(13 \mid I, (1,0,0)) = (1+\alpha)t$
$v(23 \mid I, (1,0,0)) = 0$
$v(123 \mid I, (1,0,0)) = (2+\alpha)t$

Table 4 presents the computation of the Shapley values for ownership structure I and investment by party 1. The Shapley value is an allocation of payoffs to each player. The payoff assigned to a player is equal to the average marginal contribution he makes to each coalition to which he could belong, where all coalitions are regarded as equally likely. The incentive to invest is equal to the Shapley value divided by the total surplus which can be generated. We illustrate the numbers in table 4 by elaborating on two possible orders in which the grand coalition of all players can be formed. Consider first the order 123. The marginal value added by player 1 is $v(1 \mid I, (1,0,0)) - v(\varnothing \mid I, (1,0,0)) = t - 0 = t$. The marginal value added by player 2 is $v(12 \mid I, (1,0,0)) - v(1 \mid I, (1,0,0)) = 2t - t = t$. The marginal value added by player 3 is $v(123 \mid I, (1,0,0)) - v(12 \mid I, (1,0,0)) = (2+\alpha)t - 2t = \alpha t$. The marginal contribution of each player in order 312 is computed similarly. The marginal value added by player 3 is $v(3 \mid I, (1,0,0)) - v(\varnothing \mid I, (1,0,0)) = 0 - 0 = 0$. The marginal value added by player 1 is $v(13 \mid I, (1,0,0)) - v(3 \mid I, (1,0,0)) = (1+\alpha)t - 0 = (1+\alpha)t$. The marginal value added by player 2 is $v(123 \mid I, (1,0,0)) - v(13 \mid I, (1,0,0)) = (2+\alpha)t - (1+\alpha)t = t$.

Table 4. Shapley values for ownership structure I and investment by party 1

order in coalition S	party 1	party 2	party 3	total
(123)	t	t	αt	$(2+\alpha)t$
(132)	t	t	αt	$(2+\alpha)t$
(213)	$2t$	0	αt	$(2+\alpha)t$
(231)	$(2+\alpha)t$	0	0	$(2+\alpha)t$
(312)	$(1+\alpha)t$	t	0	$(2+\alpha)t$
(321)	$(2+\alpha)t$	0	0	$(2+\alpha)t$
sum of marginal contributions	$(9+3\alpha)t$	$3t$	$3\alpha t$	$(12+6\alpha)t$
Shapley value	$(9+3\alpha)t/6$	$t/2$	$\alpha t/2$	$(2+\alpha)t$
Incentive to invest	$(9+3\alpha)/(12+6\alpha)$	$3/(12+6\alpha)$	$3\alpha/(12+6\alpha)$	1

Similarly we can compute the Shapley values for the other ownership structures as well as for other investing parties. As we have assumed non-cooperative investment decisions, only the Shapley value of the investing party is relevant for its investment decision. Appendix A provides all characteristic functions and the corresponding Shapley values for each investment decisions and all ownership structures. This entails 30 cases. The (investment) participation constraint for party 1 under ownership structure I is

$$k_1 \leq (9+3\alpha)t/6 = (1.5 + 0.5\alpha)t.$$

Table 5 gives the maximum costs of investment of each investing party under the 10 different ownership structures. It follows immediately from table A-2 in appendix A**.**

Table 5. Maximum investment levels under various ownership structures

ownership structure	**max. investment by party 1**	**max. investment by party 2**	**max investment by party 3**
I	$(1.5 + 0.5\alpha)t$	2f	$(1.5 + 0.5\beta)h$
II	$(2 + 0.5\alpha)t$	4/3f	$(1.5 + 0.5\beta)h$
III	$(1 + 1/3\alpha)t$	2.5f	$(1.5 + 0.5\beta)h$
IV	$(1.5 + 0.5\alpha)t$	2.5f	$(1 + 1/3\beta)h$
V	$(1.5 + 0.5\alpha)t$	4/3f	$(2 + 0.5\beta)h$
VI	$(1.5 + \alpha)t$	2f	$(5/6 + 0.5\beta)h$
VII	$5/6 + 0.5\alpha)t$	2f	$(1.5 + \beta)h$
VIII	$(2 + \alpha)t$	1.5f	$1 + 0.5\beta)h$
IX	$(1 + 0.5\alpha)t$	3f	$1 + 0.5\beta)h$
X	$(1 + 0.5\alpha)t$	1.5f	$(2 + \beta)h$

Efficient ownership structures in a chain

An ownership structure is first-best efficient if all three parties invest and each investment generates surplus, i.e. if x = (1,1,1) and $k_i \leq q_i$, for i = 1,2,3. To find out whether a particular combination of investments will yield the first-best, we use the participation constraints of the three parties, i.e. $k_1 \leq SV_1$, $k_2 \leq SV_2$ and $k_3 \leq SV_3$.

Table 5 implies a ranking regarding the suitability of the various ownership structures with respect to the specific investments. The ranking of maximum possible investment outlays by party 1 for the various ownership structures is:

VII < III < IX/X < I/IV/V < VI < II < VIII.

Ownership structure VIII is always first-best efficient regarding the specific investment of party 1, i.e. every surplus generating investment by party 1 will be implemented under ownership structure VIII regardless of the value of k_1. The reason is that all benefits of the investment accrue to party 1.

Because the positive externalities of investment are not fully taken into account when the investing party makes its investment decision, under-investment may result. For example, party 1 will invest under ownership structure II when $k_1 \in [0, (2+0.5\alpha)t]$, but not when $k_1 \in ((2+0.5\alpha)t, \infty)$. Ownership structure II is inefficient for high levels of k_1, i.e. $k_1 \in ((2+0.5\alpha)t, (2+\alpha)t)$, because party 1 does not take the full positive externality of investment for party 3 into account in its investment decision. Ownership structure VI is less efficient than ownership structure II. The difference between these two ownership structures is that party 1 owns the assets at stage 1 and 2 under ownership structure II, whereas ownership structure VI entails ownership of the assets at stage 1 and 3 by party 1 (see figure 3). Investment by party 1 generates more value in stage 2 than in stage 3, therefore ownership structure II is superior to ownership structure VI with respect to investment by party 1. Ownership structures I, IV, and V are identical and dominated by ownership structure VI from the viewpoint of the investment by party 1 because in I, IV and V party 1 only owns the asset at the first stage of the chain. Ownership structure IX and X are identical with respect to investment incentives for party 1: party 1 is indispensable because it makes the investment, while the other party, i.e. party 2 in IX and party 3 in X, is indispensable because it owns the assets in all stages. Ownership structure III is less efficient than ownership structures IX and X because here party 1 has to negotiate with two other parties instead of one other party under IX and X. Finally, ownership structure VII is the least efficient with respect to the investment incentives for party 1. It is even less efficient than ownership structure III because the combination of parties 1 and 2 in ownership structure III generate more surplus than the combination of 1 and 3 in ownership structure VII.

The ranking of maximum possible outlays regarding the investment k_2 by party 2for the various ownership structures is:

II/V < VIII/X < I/VI/VII < III/IV < IX.

Similarly, the ranking of maximum possible outlays regarding the investment k_3 by party 3for the various ownership structures is:

VI < IV < VIII/IX < I/II/III < VII < V < X.

The explanation of these rankings is similar to that of party 1 and will therefore not be presented.

These three rankings can be put in a three dimensional diagram with k_1, k_2, k_3 on the axes. This diagram represents first-best efficient ownership structures. For reasons of simplicity it is sliced into six two-dimensional figures, with each figure representing a range of values of k_2. In figure 4 we have set the investment by party 2 at $k_2 \leq 1.33f$. At this level party 2 will always invest.

k_3 \ k_1	$(5/6+0.5\alpha)t$	$(1+1/3\alpha)t$	$(1+0.5\alpha)t$	$(1.5+0.5\alpha)t$	$(1.5+\alpha)t$	$(2+0.5\alpha)t$	$(2+\alpha)t$
$(2+\beta)h$	X	X	X				
$(2+0.5\beta)h$	V, X	V, X	V, X	V			
$(1.5+\beta)h$	VII, V, X	V, X	V, X	V			
$(1.5+0.5\beta)h$	I, II, III, V, VII, X	I, II, III, V, X	I, II, V, X	I, II, V	II	II	
$(1+0.5\beta)h$	I, II, III, V, VII, VIII, IX, X	I, II, III, V, VII, VIII, IX, X	I, II, V, VIII, IX, X	I, II, V, VIII	II, VIII	II, VIII	VIII
$(1+1/3\beta)h$	I, II, III, IV, VI, VII, VIII, IX, X	I, II, III, IV, V, VII, VIII, IX, X	I, II, IV, V, VIII, IX, X	I, II, IV, V, VIII	II, VIII	II, VIII	VIII
$(5/6+0.5\beta)h$	I, II, III, IV, V, VI, VII, VIII, IX, X	I, II, III, IV, V, VI, VII, VIII, IX, X	I, II, IV, V, VI, VIII, IX, X	I, II, IV, V, VI, VIII	II, VI, VIII	II, VIII	VIII

Figure 4. First-best efficient ownership structures for k_2 £ 1.33f

The next step is finding first-best efficient ownership structures for a higher investment by party 2: $1.33f < k_2 \leq 1.5f$. Figure 5 presents this slice. Now ownership structures II and V are no longer first-best efficient. Additional figures, shown in appendix B, show that:

- if $1.5f < k_2 \leq 2f$, then VIII and X are no longer first-best efficient;
- if $2f < k_2 \leq 2.5f$, then I, VI and VII are no longer first-best efficient;
- if $2.5f < k_2 \leq 3f$, then III and IV are no longer first-best efficient;
- if $k_2 > 3f$, then no ownership structure is first-best efficient.

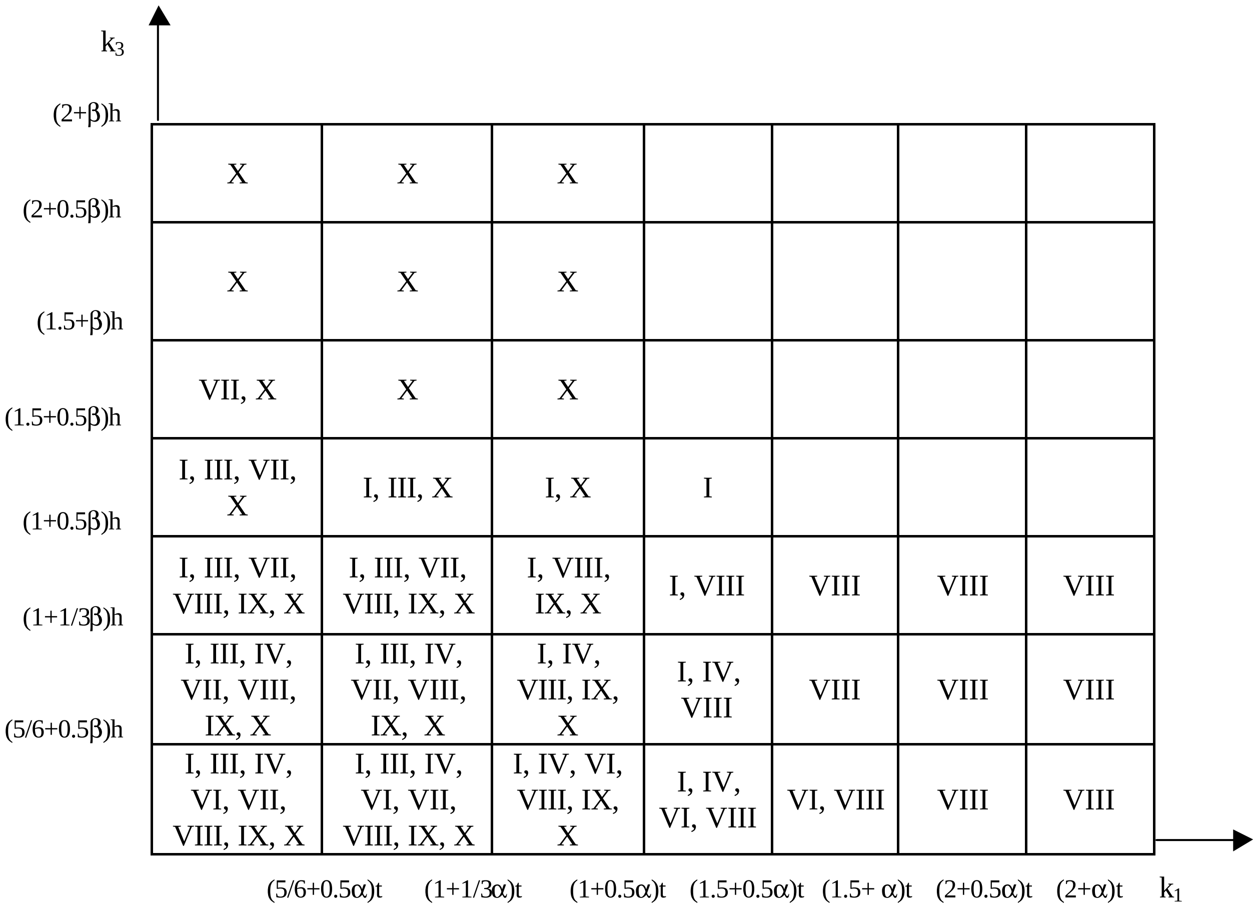


Figure 5. First-best efficient ownership structures for 1.33f < k_2 £ 1.5f

It follows from figures 4 and 5 (and the ones in appendix B) that each possible ownership structure can be uniquely first-best efficient. The ordering of efficient ownership structures for each investing party shows that a change in ownership structure at the same time makes investing more attractive for one party and less attractive for other parties. If a shift in ownership structure strengthens party i's bargaining position then it will weaken party j's bargaining position. Certain combinations of investment decisions of the three parties are only viable under a specific ownership structure.

An interesting case is ownership structure II: the farmer owns both the land and the factory, and the retailer owns the shop. An example of this structure could be a farmer-owned marketing cooperative (MC) producing special (organic) dairy products and selling to an independent retailer. Each party in this supply chain is making specific investments, but the relative sizes of these investments differ. Figures 4 and 5 show that ownership structure II is the only first-best efficient structure if and only if $(1.5+0.5\alpha)t < k_1 \leq (2+0.5\alpha)t$, $0 < k_2 \leq 1.33f$, and $(1+0.5\beta)h < k_3 \leq (1.5+0.5\beta)h$. Here the farmer's specific investment is relatively large compared to the investments by the processor and the retailer (i.e. $k_1/q_1 > k_2/q_2$ and $k_1/q_1 > k_3/q_3$). If the farmer's investment is smaller, then also I and V are first-best efficient. With ownership structure I each party owns an asset, and with ownership structure V the processing plant and the shop are both owned by the retailer. If the investment by the retailer is smaller, i.e. $k_3 \leq (1+0.5\beta)h$, then also VIII becomes first-best efficient. Ownership structure VIII means that the farmer owns all three assets. This situation of full chain integration will only yield the social optimum if the specific investments by the processor and retailer are much smaller than the investment by the farmer.

Ownership structure II does not show up anymore in figure 5, indicating that an increase in k_2 will reduce the attractiveness of an MC as a ownership structure. When the specific investment by party 2 increases relative to the investments by parties 1 and 3, an MC can no longer deal with the hold-up problem, thus leading to inefficiency. Because an MC is geared towards the interests of the farmer (party 1), expressed by farmer-ownership of the processing firm, investments by party 2 face the threat of hold up by the farmers. The conclusion is that if a cooperatively owned processing firm needs relatively high specific investments, for instance to enhance or to maintain its competitiveness, a shift from MC to another ownership structure may be necessary. The recent restructuring of MCs into the incorporation of non-farmers as providers of equity capital, can be understood from this point of view.

7. Comparative statics results

A number of comparative statics results can be derived from this model. First, the set of efficient ownership structures shrinks when k/q increases, i.e. when the specific costs of investment increases relative to the surplus it generates. When k/q increases, the ownership structure has to be more fine-tuned in order to prevent hold-up problems. Another way of formulating this result is that an increase in the value of q, given the level of k, will increase the set of efficient ownership structures. The increase in the share of the surplus in the quasi-surplus provides more leeway in the choice of ownership structure such that both parties feel secure that their investments will be recouped. In the cells in the upper right corner of figure 4 and 5 there is no first-best ownership structure, i.e. there is no ownership structure that is able to obtain the first-best when k_1 as well as k_3 have a high value (relative to the size of q).[6]

Second, many agricultural markets are nowadays surplus instead of shortage markets. The response of more product differentiation and more vertical coordination entails a higher level of asset specificity, thus increasing k/q.. Third, the globalization of markets entails more competition, i.e. the surplus is reduced and therefore k/q is increased. This makes it more difficult to establish the first best outcome. Finally, what happens if α or β increases, i.e. if the complementarities of the chain increase? A higher value of α means that the specific investment by party 1 generates a higher quasi-surplus. This results in a shift to the right of the borderlines between the cells in figures 1 and 2. This implies that with given investment levels for parties 1, 2 and 3 more ownership structures are now first-best efficient (also showing that less integrated structures become efficient for party 1). A similar argument is valid for the value of β. In general we see that a higher quasi-surplus of a given investment makes more ownership structures efficient.

8. Conclusions

[6] Which ownership structures are second best efficient depends on the relative size of the parties' investment decisions.

Incomplete contract theory predicts that asset ownership has effect on parties' incentives to invest. This effect is due to the impossibility to write comprehensive contingent contracts for relationship-specific investments and the resulting potential for opportunistic behaviour and ex post renegotiation over the trade benefits. This risk of hold up leads to under-investments. Changing the allocation of asset ownership between the trading parties may solve (part of) the hold up problem.

Our model shows that optimal asset ownership is determined by the specific investment cost/quasi-surplus ratio for party A compared to the specific investment cost/quasi-surplus ratio for party B when first best efficiency is attainable. If this ratio is higher for party A then for party B, than party A should own most of the assets that are used in generating the quasi-surplus. In other words, if the specific investment by A generates a smaller surplus (relative to the investment) than the specific investment by party B does, A should own more assets in order to obtain the efficient investment decisions. The second best ownership structure choice assigns most power to the party generating the highest surplus.

The model has been presented as a chain consisting of three parties, e.g. a farmer, a processor and a retailer. A three party chain consisting of a plant breeder, a farmer and a retailer can be analyzed in the same way. The same results will of course hold, but the MC is in such a chain represented by ownership structure IV instead of ownership structure II.

Vertical co-ordination in the agrifood sector often requires aligning activities of more than two parties. In this paper we have applied the incomplete contract model to a three-party supply chain. Each party can make chain-specific investments, meaning that the investments yield higher benefits within this specific supply chain than outside the chain. Whether parties are actually willing to make those chain-specific investments depends on the division of value in case of ex post renegotiation. The bargaining power in this renegotiation process is determined by the ownership of assets that are essential for the investment (i.e. without access to these assets the investment will generate no or lower value).

If changes in technology or changes in agrifood markets shift the relative importance of the individual investments by different chain partners, e.g. if retailer investment becomes more important than farmer investment, it may be necessary to change the allocation of ownership of essential assets to induce parties to make those investments that generate the chain optimum. In other words, it may be necessary to change the ownership structure of agrifood chains to obtain that combination of investment decisions that yields the first-best. The model we have presented may contribute to determine ownership structures that induce maximum value generating.

References

Downey, W.D., "The Challenge of Food and Agri Products Supply Chains', in: J.H. Trienekens and P.J.P. Zuurbier (eds.), *Proceedings of the 2nd International Conference on Chain Management in Agri- and Food Business*, Wageningen: Wageningen Agricultural University, Department of Management Studies, 1998.

Galizzi, G., and L. Venturini (eds.), *Vertical Relationships and Coordination in the Food System*, Heidelberg/New York: Physica-Verlag, 1999.

Grossman, S.J., and O.D. Hart, "The Costs and Benefits of Ownership; A Theory of Vertical and Lateral Integration", *Journal of Political Economy*, 94 (1986):691-719.

Hart, O., and J. Moore, "Property Rights and the Nature of the Firm', *Journal of Political Economy*, 98 (1990): 1119-1158.

Holmstrom, B. and J. Roberts, "The Boundaries of the Firm Revisited", *Journal of Economic Perspectives*, 12 (1998): 73-94.

Klein, B., R.G. Crawford and A.A. Alchian, "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process", *Journal of Law and Economics*, 21 (1978): 297-326.

Mahoney, J.T. and D.A. Crank, "Vertical Coordination: The Choice of Organizational Form", in: K.F. Coaldrake et al., (eds.), *New Industries and Strategic Alliances in Agriculture: Concepts and Cases*, Champaign, IL: Stipes, pp. 87-126, 1995.

Martinez, S.W., and A. Reed, *From Farmers to Consumers. Vertical Coordination in the Food Industry*, Washington, DC: USDA/ERS, 1996.

Shapley, L., "A Value for n-person Games', *Contributions to the Theory of Games Vol II, Annals of Mathematics Studies 28*, Princeton University Press, (1953): 307-317.

Williamson, O.E., "Transaction-Cost Economics: The Ownership of Contractual Relations", *Journal of Law and Economics*, 22 (1979): 233-261.

Williamson, O.E., *The economic institutions of capitalism*, New York: Free Press, 1985.

Williamson, O.E., "Comparative Economic Organization: the Analysis of Discrete Structural Alternatives", *Administrative Science Quarterly*, 36(1991): 269-296.

Appendix A. Characteristic functions and Shapley values

Table A-1. Characteristic functions

The incentive to invest is determined by the bargaining power of the investor in a particular ownership structure and the bargaining position which is implied by the level of investment. There are ten possible ownership structures and three types of investment. Thirty different characteristic functions have therefore to be analysed in order to determine the level of investment of each party and the efficient choice of ownership structure. Table A-1 presents the characteristic functions.

We will explain the numbers of the rows seven and eight, i.e. ownership structures VI and VII (see figure 3), of this table in order to illustrate its construction. Assume that player 1 invests. Coalitions without player 1 have value 0 because player 1 has to invest and is therefore essential. This implies v(2) = v(3) = v(23) = 0. If all players are in the coalition then the whole surplus is of course created by this coalition, i.e. v(123) = $(2+\alpha)t$. Compare ownership structure VI with ownership structure VII. Player 3 adds no value in ownership structure VI to a coalition of which player 1 is already a member because player 1 owns the assets at the third stage. This implies v(1) = v(13) and v(12) = v(123). The coalition of player 1 adds a value of $(1+\alpha)t$ because he owns the assets at stage 1 and 3, i.e. v(1) = $(1+\alpha)t$. The coalition of the players 1 and 2 generates the whole surplus because together they own all the assets, i.e. v(12) = $(2+\alpha)t$. The players 1 and 3 are both essential in ownership structure VII because player 1 invests and player 3 owns the assets at stage 1. This implies v(1) = 0 and v(12) = 0. Player 2 is essential for the players 1 and 3 for generating the value with his asset, i.e. v(13) = $(1+\alpha)t$.

x	G	v(1)	v(2)	v(3)	v(12)	v(13)	v(23)	v(123)
(1,0,0)	I	t	0	0	2t	$(1+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	II	2t	0	0	2t	$(2+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	III	0	0	0	2t	0	0	$(2+\alpha)t$
(1,0,0)	IV	t	0	0	$(2+\alpha)t$	t	0	$(2+\alpha)t$
(1,0,0)	V	t	0	0	t	$(2+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	VI	$(1+\alpha)t$	0	0	$(2+\alpha)t$	$(1+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	VII	0	0	0	0	$(1+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	VIII	$(2+\alpha)t$	0	0	$(2+\alpha)t$	$(2+\alpha)t$	0	$(2+\alpha)t$
(1,0,0)	IX	0	0	0	$(2+\alpha)t$	0	0	$(2+\alpha)t$
(1,0,0)	X	0	0	0	0	$(2+\alpha)t$	0	$(2+\alpha)t$
(0,1,0)	I	0	f	0	2f	0	2f	3f
(0,1,0)	II	0	0	0	2f	0	0	3f
(0,1,0)	III	0	2f	0	2f	0	3f	3f
(0,1,0)	IV	0	2f	0	3f	0	2f	3f
(0,1,0)	V	0	0	0	0	0	2f	3f
(0,1,0)	VI	0	f	0	3f	0	f	3f
(0,1,0)	VII	0	f	0	f	0	3f	3f
(0,1,0)	VIII	0	0	0	3f	0	0	3f
(0,1,0)	IX	0	3f	0	3f	0	3f	3f
(0,1,0)	X	0	0	0	0	0	3f	3f

(0,0,1)	I	0	0	h	0	(1+β)h	2h	(2+β)h
(0,0,1)	II	0	0	h	0	(2+β)h	h	(2+β)h
(0,0,1)	III	0	0	h	0	h	(2+β)h	(2+β)h
(0,0,1)	IV	0	0	0	0	0	2h	(2+β)h
(0,0,1)	V	0	0	2h	0	(2+β)h	2h	(2+β)h
(0,0,1)	VI	0	0	0	0	(1+β)h	0	(2+β)h
(0,0,1)	VII	0	0	(1+β)h	0	(1+β)h	(2+β)h	(2+β)h
(0,0,1)	VIII	0	0	0	0	(2+β)h	0	(2+β)h
(0,0,1)	IX	0	0	0	0	0	(2+β)h	(2+β)h
(0,0,1)	X	0	0	(2+β)h	0	(2+β)h	(2+β)h	(2+β)h

Table A-2. Shapley values

The Shapley value is used to determine the appropriation rate. First, it allocates the surplus which the investment of an investor generates between the three parties. Second, it is used to determine the incentive to invest, which is equal to the Shapley value divided by the quasi-surplus. Notice that for each particular case the Shapley value specifies an appropriation rate for all the three parties and of course only the incentive to invest of the investor.

x	G	Shapley value party 1	Shapley value party 2	Shapley value party 3
(1,0,0)	I	(1.5+0.5α)t	1/2t	0.5αt
(1,0,0)	II	(2+0.5α)t	0	0.5αt
(1,0,0)	III	(1+1/3α)t	(1+1/3α)t	1/3αt
(1,0,0)	IV	(1.5+0.5α)t	(0.5+0.5α)t	0
(1,0,0)	V	(1.5+0.5α)t	0	(0.5+0.5α)t
(1,0,0)	VI	(1.5+α)t	1/2t	0
(1,0,0)	VII	(5/6+0.5α)t	1/3t	(5/6+0.5α)t
(1,0,0)	VIII	(2+α)t	0	0
(1,0,0)	IX	(1+0.5α)t	(1+0.5α)t	0
(1,0,0)	X	(1+0.5α)t	0	(1+0.5α)t
(0,1,0)	I	1/2f	2f	1/2f
(0,1,0)	II	4/3f	4/3f	1/3f
(0,1,0)	III	0	2.5f	1/2f
(0,1,0)	IV	1/2f	2.5f	0
(0,1,0)	V	1/3f	4/3f	4/3f
(0,1,0)	VI	f	2f	0
(0,1,0)	VII	0	2f	f
(0,1,0)	VIII	1.5f	1.5f	0
(0,1,0)	IX	0	3f	0
(0,1,0)	X	0	1.5f	1.5f
(0,0,1)	I	0.5βh	0.5h	(1.5+0.5β)h
(0,0,1)	II	(0.5+0.5β)h	0	(1.5+0.5β)h
(0,0,1)	III	0	(0.5+0.5β)h	(1.5+0.5β)h
(0,0,1)	IV	1/3βh	(1+β/3)h	(1+β/3)h
(0,0,1)	V	0.5βh	0	(2+0.5β)h
(0,0,1)	VI	(5/6+0.5β)h	1/3h	(5/6+0.5β)h
(0,0,1)	VII	0	0.5h	(1.5+β)h
(0,0,1)	VIII	(1+0.5β)h	0	(1+0.5β)h
(0,0,1)	IX	0	(1+0.5β)h	(1+0.5β)h
(0,0,1)	X	0	0	(2+β)h

Appendix B.

Figure B.1. First-best efficient ownership structures for $1.5f < k_2 \leq 2f$

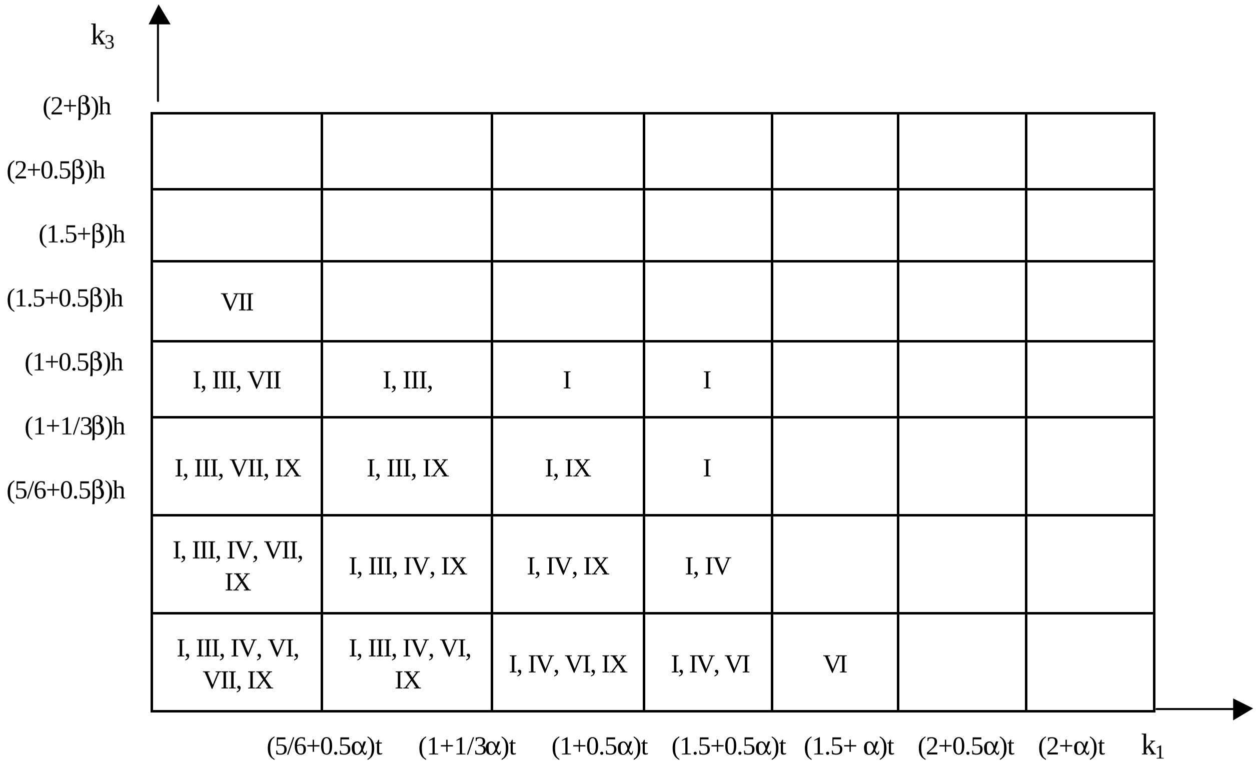


Figure B-2. First-best efficient ownership structures for $2f < k_2 \leq 2.5f$

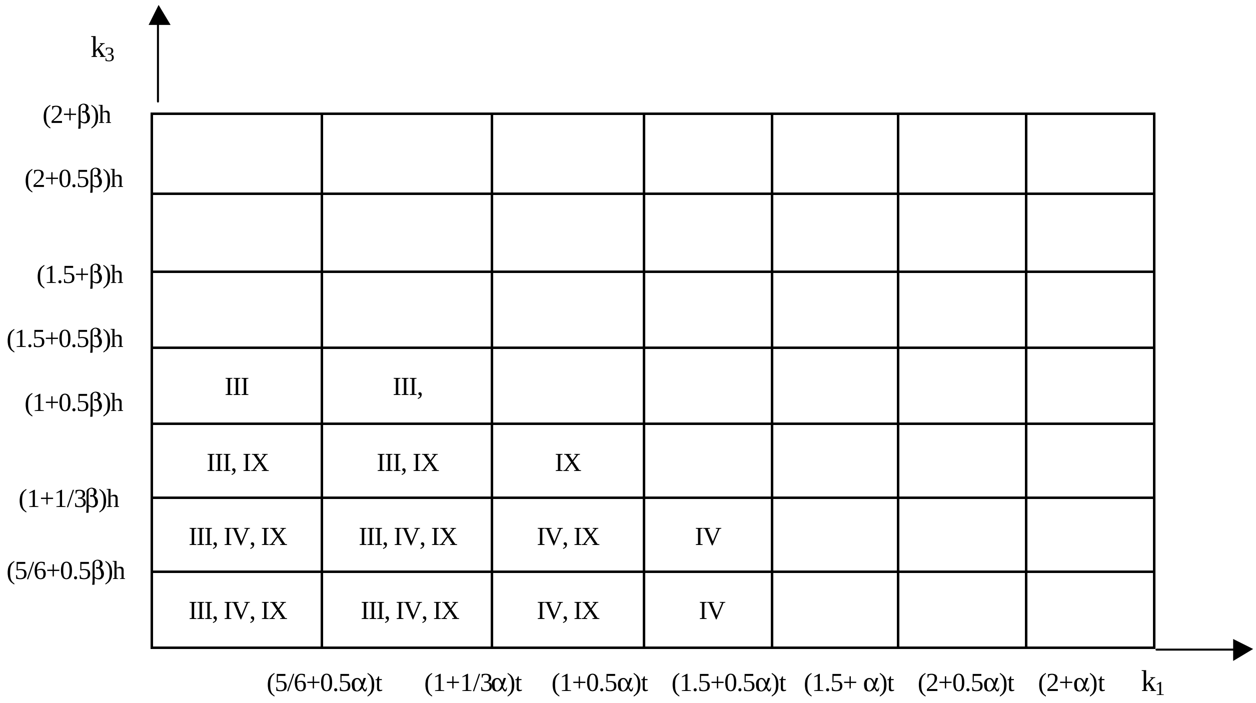
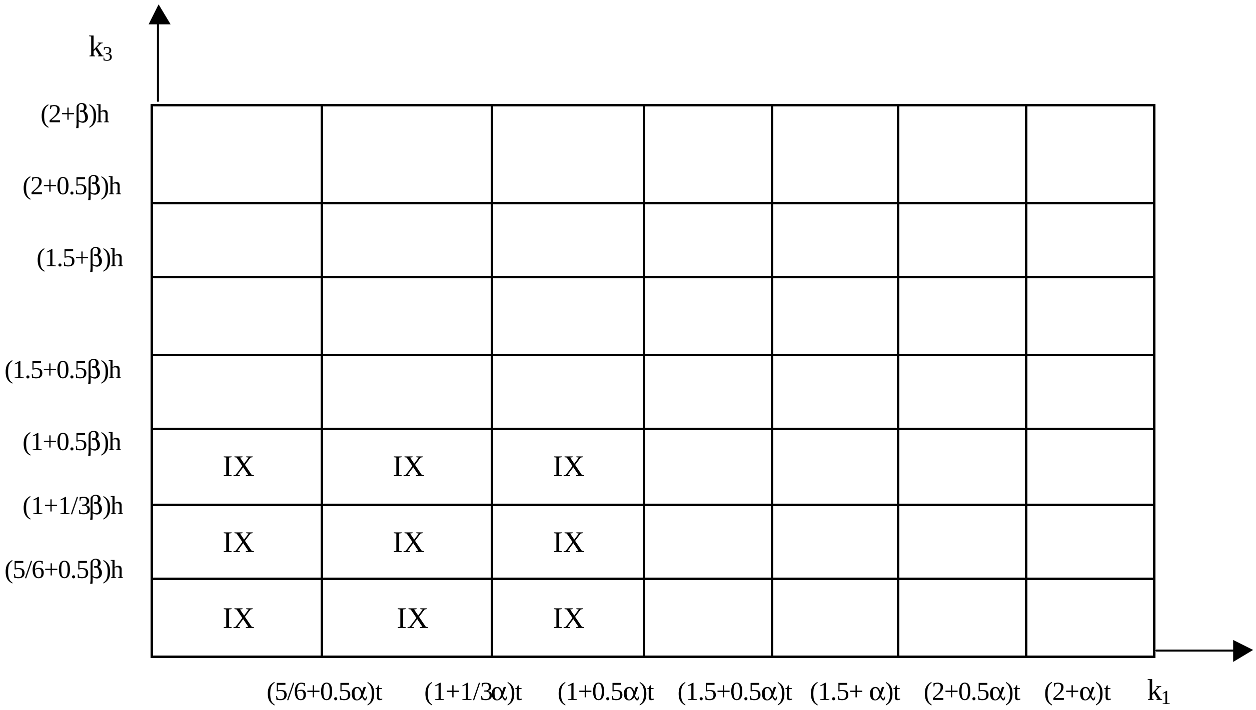


Figure B-3 First-best efficient ownership structures for $2.5f < k_2 \leq 3f$



There are no first-best efficient ownership structures for $k_2 > 3f$ because the investment is larger than the quasi-surplus.

ERASMUS **R**ESEARCH **I**NSTITUTE OF **M**ANAGEMENT

REPORT SERIES
RESEARCH IN MANAGEMENT

Publications in the Report Series Research[*] in Management

Impact of the Employee Communication and Perceived External Prestige on Organizational Identification
Ale Smidts, Cees B.M. van Riel & Ad Th.H. Pruyn
ERS-2000-01-MKT

Critical Complexities, from marginal paradigms to learning networks
Slawomir Magala
ERS-2000-02-ORG

Forecasting Market Shares from Models for Sales
Dennis Fok & Philip Hans Franses
ERS-2000-03-MKT

A Greedy Heuristic for a Three-Level Multi-Period Single-Sourcing Problem
H. Edwin Romeijn & Dolores Romero Morales
ERS-2000-04-LIS

Integer Constraints for Train Series Connections
Rob A. Zuidwijk & Leo G. Kroon
ERS-2000-05-LIS

Competitive Exception Learning Using Fuzzy Frequency Distribution
W-M. van den Bergh & J. van den Berg
ERS-2000-06-LIS

Start-Up Capital: Differences Between Male and Female Entrepreneurs, 'Does Gender Matter?'
Ingrid Verheul & Roy Thurik
ERS-2000-07-STR

The Effect of Relational Constructs on Relationship Performance: Does Duration Matter?
Peter C. Verhoef, Philip Hans Franses & Janny C. Hoekstra
ERS-2000-08-MKT

Marketing Cooperatives and Financial Structure: a Transaction Costs Economics Analysis
George W.J. Hendrikse & Cees P. Veerman
ERS-2000-09-ORG

---

[*] ERIM Research Programs:
LIS Business Processes, Logistics and Information Systems
ORG Organizing for Performance
MKT Decision Making in Marketing Management
F&A Financial Decision Making and Accounting
STR Strategic Renewal and the Dynamics of Firms, Networks and Industries

A Marketing Co-operative as a System of Attributes: A case study of VTN/The Greenery International BV,
Jos Bijman, George Hendrikse & Cees Veerman
ERS-2000-10-ORG

Evaluating Style Analysis
Frans A. De Roon, Theo E. Nijman & Jenke R. Ter Horst
ERS-2000-11-F&A

From Skews to a Skewed-t: Modelling option-implied returns by a skewed Student-t
Cyriel de Jong & Ronald Huisman
ERS-2000-12-F&A

Marketing Co-operatives: An Incomplete Contracting Perspective
George W.J. Hendrikse & Cees P. Veerman
ERS-2000-13– ORG

Models and Algorithms for Integration of Vehicle and Crew Scheduling
Richard Freling, Dennis Huisman & Albert P.M. Wagelmans
ERS-2000-14-LIS