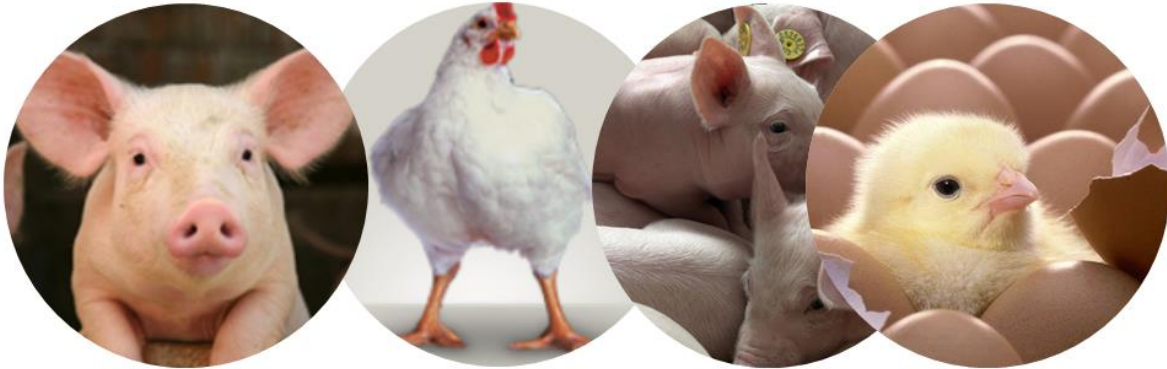


Organization of the Dutch broiler meat and pig meat supply chain



Frans van den Brink
February 2013

Preface

In front of you there is a report regarding the organization of the Dutch broiler meat and pig meat supply chain. It is clear that the pig meat supply chain and broiler meat supply chain are differently organized. The broiler meat supply chain applies contract farming while transactions in the pig meat supply chain are organized as a spot market. However, it is unclear why both supply chains are organized in the way they are. This research is carried out to obtain more knowledge about the reasons why both supply chains are organized in the way they are. This is done by comparing both supply chains and analyzing the differences between both supply chains that could lead to differences in organization according to theory.

I have carried out this research as minor master thesis for the master Management, Economics and Consumer Studies at Wageningen University. I was supervised by dr. ir. Jack Peerlings from the Agricultural Economics and Rural Policy chair group.

This thesis is an additional thesis besides the general master graduation thesis. I have chosen to do an additional thesis for two reasons. Firstly, besides my focus on agricultural business economics, I have focused on general agricultural economics during the past few years. Therefore I wanted to write a thesis on a general agricultural economics topic. Secondly, because of my great interests in intensive livestock production, especially in poultry production, I wanted to do some additional practical work on this topic.

During this research I have interviewed four experts to get more information about the organization of both supply chains. Firstly I would like to thank ir. Peter van Horne, poultry economist, and ing. Robert Hoste, pig production economist, at LEI Wageningen UR. They have provided me with a lot of useful information about the organization of both supply chains. Secondly I would like to thank Wim van der Vegte, CEO from hatchery and broiler integration Lagerwey. He provided me with a lot of practical information and details about the organization of the broiler meat supply chain and relationships within that chain. That information helped me to fine-tune my research. Thirdly I would like to thank Erlend Beltman, sector manager broilers of feed company Agrifirm, for providing me information about the relationship between broiler (breeder) farmers and feed companies. Finally I would like to thank dr. ir. Jack Peerlings for his supervision. His critical reflections of my work helped me a lot. Especially when linking the gathered practical knowledge with the used theory.

Frans van den Brink

Content

- Summary 1
- 1 Introduction..... 3
 - Background..... 3
 - Problem definition 4
 - Research objective 4
 - Structure of the research 5
- 2 Theory..... 6
 - 2.1 Structure-Conduct-Performance..... 6
 - 2.1.1 General theory..... 6
 - 2.1.2 SCP indicators 7
 - 2.2 Transaction Cost Economics theory 8
 - 2.2.1 General theory..... 8
 - 2.2.2 TCE indicators 10
- 3 Pig meat supply chain..... 11
 - 3.1 General information 11
 - 3.2 Breeding organizations..... 11
 - 3.3 Sow (breeding) farms 12
 - 3.4 Pig trading companies 13
 - 3.5 Porker farms 13
 - 3.6 Slaughter companies and retail..... 14
 - 3.7 Feed companies..... 15
- 4 Broiler meat supply chain..... 17
 - 4.1 General information 17
 - 4.2 Breeding organizations..... 17
 - 4.3 Broiler breeder (rearing) farms 18
 - 4.4 Broiler hatcheries 20
 - 4.5 Broiler farms..... 21
 - 4.6 Slaughter, meat processing and feed companies 23
- 5 Results 25
 - 5.1 Results SCP 25
 - 5.1.1 Concentration ratios..... 25
 - 5.1.2 Entry barriers 28
 - 5.1.3 Attitude of the actors 30

5.1.4	Overview results SCP	31
5.2	Results TCE	31
5.2.1	Asset specificity	31
5.2.2	Uncertainty and complexity	32
5.2.3	Frequency	35
5.2.4	Overview results TCE	35
6	Conclusions and discussion	37
6.1	Conclusions.....	37
6.2	Discussion	39
	References.....	40
	Appendices	46

Summary

This research analyzed the organization, the so-called governance structure, of the Dutch broiler meat supply chain and pig meat supply chain from an economic viewpoint. First, both supply chains are described. Second, the Structure-Conduct-Performance paradigm (SCP) and Transaction-Cost Economics theory (TCE) are applied to analyze why both supply chains are organized in the way they are. Besides literature, expert interviews are used to gather necessary information.

Both the pig meat and broiler meat supply chain are characterized by farmers who produce the animals and industrialized companies who process the meat and deliver farm inputs (feed) to the farmers. In both supply chains there is a large number of farmers compared to the amount of processing firms and input delivering firms.

The broiler meat supply chain is characterized by some vertical integration. Marketing contracts are applied between broiler (breeder) farmers and hatcheries, slaughter companies and feed companies. The duration of those contracts is equal to one year in most cases. The pig meat supply chain is organized as a spot market. There are no contractual agreements between firms within this supply chain like in the broiler meat supply chain.

Although both supply chains consist of a lot of farmers and a few processing and input delivering firms, the supply chains are differently organized. Besides that, pig farmers have had on average a lower and more often negative income than broiler farmers during the past ten years. Although pig farmers have had a lower and more negative income than broiler farmers for years, there are still no contractual agreements or other types of vertical integration between firms of different levels within the pig supply chain in the Netherlands. The pig meat supply chain remains organized as a spot market. The objective of this research is to explain the difference in organization between the Dutch broiler meat and pig meat supply chains.

The applied SCP paradigm states that the performance of an industry or supply chain depends on the conduct (behavior) of the actors in a supply chain. The conduct of the actors in a supply chain depends on the structure of the supply chain. However performance can also affect conduct and conduct can affect the structure of a supply chain.

The used measures to describe the supply chain structure are concentration ratios and entry barriers. A high concentration could lead to firms with market power. Firms with market power in the pig meat supply chain could have less need to ensure supply by contracts because they can ensure supply by using their market power. The analysis of concentration ratios in combination with expert interviews shows that there are currently no firms with market power in both supply chains.

Entry barriers can lead to better supply chain performance. The analysis shows that the contracts in the broiler meat supply chain can act as entry barrier. Therefore it could be that contracts lead to better supply chain performance. This is underlined by the fact that the incomes of broiler farmers were higher than that of porker farmers between 2001 and 2011. But it does not explain why contracts are not applied in the pig meat supply chain.

The attitude of the farmers in both supply chains is also analyzed. It shows that both broiler (breeder) farmers and pig farmers do not want to do business with an integrator based on production contracts. So they do not want to produce broilers, hatching eggs or pigs for a fixed compensation. That is not in line with their idea of entrepreneurship. In contrast to the Netherlands, production contracts are widely applied in the United States broiler meat supply chain.

The applied TCE theory states that a supply chain will be organized as a spot market when there is a low level of asset specificity, uncertainty, complexity and a high frequency of the transactions. A supply chain becomes more vertically integrated when asset specificity, uncertainty and complexity go up and when frequency goes down. Contract farming is a way of vertical integration, although it is not complete vertical integration of a supply chain.

In the broiler meat supply chain there is a higher level of site specificity and temporal asset specificity than in the pig meat supply chain, because pigs can be transported over larger distances and because pigs can be slaughtered in a wider age range than broilers. These differences in asset specificity can explain the difference in governance structure between both supply chains according to TCE. It is assumed that all other types of asset specificity have a high and equal level in both supply chains. The high procedural asset specificity leads to a lock-in problem. Therefore it is very difficult and costly to change the governance structure of both supply chains.

Broiler farmers without a contract face much more price risk than porker farmers. So there is more uncertainty involved in the broiler meat supply chain, which can explain why there is more vertical integration in the broiler meat supply chain.

In the broiler meat supply chain it is less easy to equal supply and demand than in the pig meat supply chain, because the slaughter date of broilers can be shifted fewer days than the slaughter date of porkers. Besides that there is an all-in, all-out system applied on broiler farms. Due to that system each broiler farm delivers a large amount of broilers to a slaughter company every seven to eight weeks which makes it difficult to match the supply of broilers with the demand. In the pig meat supply chain this is less difficult, because each porker farmer weekly delivers smaller amounts of porkers to a slaughter company. So there is more complexity involved in the broiler meat supply chain, which can explain why contracts are applied in the broiler meat supply chain while the pig meat supply chain is organized as a spot market.

The frequency of the transaction between broiler farmers and slaughter companies is much lower than that between porker farmers and slaughter companies. That lower frequency can explain why the transaction between broiler farmers and slaughter companies is more vertically integrated than that between porker farmers and slaughter companies. The different lengths of the production cycles between both supply chains also explain why both supply chains are differently organized.

This research also shows that different countries apply different governance structures in both supply chains. In the United States (US) marketing contracts are applied in the pig meat supply chain and production contracts are applied in the broiler meat supply chain. These differences in governance structure between both countries are caused by different circumstances in both countries.

1 Introduction

This chapter consists of background information regarding the broiler meat and pig meat supply chain. Besides that the problem is defined and the research objective is described. Finally, an overview of the structure of this research is provided.

Background

This research will analyze the organization and structure, the so-called governance structure, of the Dutch broiler meat supply chain and pig meat supply chain from an economic viewpoint. At first, a description of both supply chains based on literature will be provided. Second, two economic theories will be applied to analyze the governance structure of both supply chains, namely Structure-Conduct-Performance paradigm (SCP) and Transaction-Cost Economics (TCE). Third, experts will be interviewed about the governance structure of the pig meat and broiler meat supply chain. Finally, a conclusion will be drawn based on the results of the three methods.

The gross domestic production of pig meat in the Netherlands was 1,852,000 tons in 2011 and the gross domestic production of broiler meat in the Netherlands was 710,300 tons in 2011 (PVE, 2012a; PPE, 2012). However only 691,000 tons of pig meat and 306,900 tons of broiler meat was consumed in the Netherlands in 2011 (PVE, 2012b; PPE, 2012). So the Netherlands was 268% self-sufficient in pig meat and 231% self-sufficient in broiler meat in 2011 which shows that a large part of the pig meat and broiler meat produced in the Netherlands is exported.

Both the pig meat and broiler meat supply chain are characterized by farmers who produce the animals and industrialized companies who process the meat and deliver farm inputs (feed) to the farmers. In both supply chains there is a large number of farmers compared to the amount of processing firms and input delivering firms (Bondt et al., 2003; CBS, 2012). The amount of farms in both supply chains has been declining in the past ten years, but the remaining farms increased their scale largely over the past ten years (CBS, 2012; De Bont et al., 2011).

The income of sow and porker farmers (pig farmers) was on average low between 2001 and 2011, namely €13,381.82 for sow farmers and €14,427.27 for porker farmers (LEI & CBS, 2011; De Bont et al., 2011). However, there were large differences between the different pig farmers (De Bont et al., 2011). Broiler farmers have had an average income of €33,000.- between 2001 and 2011 (LEI & CBS, 2011). Both the income of pig farmers and broiler farmers fluctuated a lot over the past ten years (figure 1.1; De Bont et al., 2011). But broiler farmers have had on average a much higher income than pig farmers, which resulted less often in a negative income for broiler farmers than for pig farmers (figure 1.1).

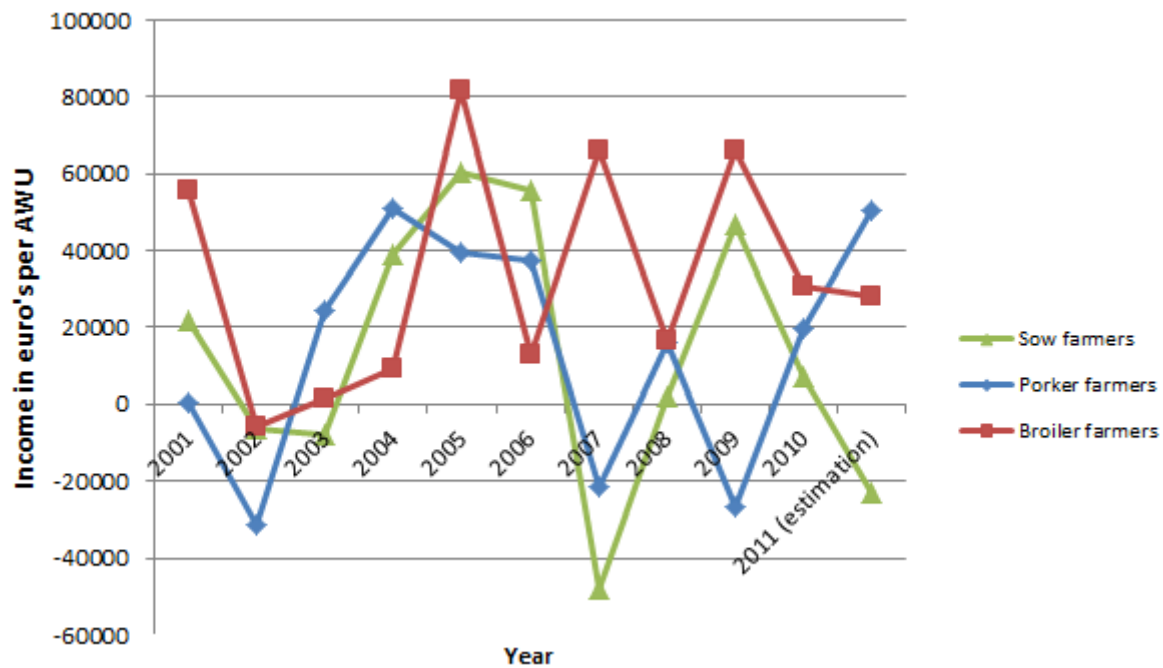


Figure 1.1: Income of pig farmers and broiler farmers (LEI & CBS, 2011).

The broiler meat supply chain is characterized by some vertical integration (De Bont et al., 2011). Broiler (breeder) farmers make contractual agreements with hatcheries, slaughter companies and feed companies (Van Horne et al., 2004; Van Horne, 2007; Karetso, 2009). The duration of those contracts is equal to one year in most cases (Karetso, 2009).

The pig meat supply chain is characterized by a spot market. There are no contractual agreements between firms within this supply chain like in the broiler meat supply chain (Backus et al., 2012; Janssens et al., 2012; Van Wagenberg, 2010). Porker farmers for example can shift easily between slaughter companies and to exporting finishing pigs (Van Wagenberg, 2010).

Problem definition

Although both supply chains produce meat and consist of relatively a lot of farmers and a few processing and input delivering firms, the supply chains are differently organized. It is also the case that pig farmers have had on average a lower and more often negative income than broiler farmers during the past ten years (LEI & CBS, 2011). Although pig farmers have had a lower and more often negative income than broiler farmers for years, there are still no contractual agreements or other types of vertical integration between firms of different levels within the pig supply chain in the Netherlands. The pig meat supply chain remains organized as a spot market.

Research objective

The objective of this research is to explain the difference in organization between the Dutch broiler meat and pig meat supply chains.

Three research questions are formulated to fulfill the research objective:

1. How are the broiler meat and pig meat supply chains organized and what kind of products are produced?
2. What factors determine the governance structure of a supply chain?

3. How can the governance structure of the broiler meat and pig meat supply chains be explained?

Structure of the research

This research consists of multiple chapters. In chapter 2 a description is given about the theory that is used in this research. In chapter 3 the pig meat supply chain is described and in chapter 4 the broiler meat supply chain is described in detail based on literature and expert interviews. This is done to analyze how both supply chains are organized and what kind of products are produced. Chapter 5 consists of an analysis of both supply chains based on two scientific theories, Structure-Conduct-Performance paradigm (SCP) and Transaction Cost Economics theory (TCE). This will be done to analyze what factors determine the governance structure of a supply chain and to analyze why both supply chains are organized in the way they are. Chapter 6, finally, consists of the conclusions and discussion.

2 Theory

This chapter describes the theory that is used within this research. In section 2.1 a description is given of the Structure-Conduct-Performance paradigm (SCP) and of the SCP indicators that might explain differences in governance structure between both supply chains. In section 2.2 the Transaction Cost Economics theory (TCE) and the TCE indicators that can be used to explain differences in governance structure are described.

2.1 Structure-Conduct-Performance

In section 2.1.1 the general theory behind SCP is described. Section 2.1.2 provides the indicators that are used in this research to explain why both supply chains are differently organized.

2.1.1 General theory

The SCP paradigm states that the performance of an industry or supply chain depends on the conduct (behavior) of the actors in a supply chain. The conduct of the actors in a supply chain depends on the structure of the supply chain (Perloff et al., 2007). However performance can also affect conduct and conduct can affect the structure of a supply chain (Douma & Schreuder, 2008).

A typical SCP study consists of two stages. At first, a measure of performance and measures of structure should be obtained. The second stage consists of relating the performance measure with the structure measures to explain differences in market performance across industries (Perloff et al., 2007).

Some typical measures of market structure are (Perloff et al., 2007):

- Firm size distribution: Concentration ratios ($C(q)$) can be used as a measure of firm size distribution, for example C_3 which indicates the total market share of the three largest firms;
- Barriers to entry.

Typical measures of market performance are measures that directly or indirectly reflect profit or the relationship of price to costs like (Perloff et al., 2007):

- Rate of return: Profit per euro of investment;
- Price-cost margin: The difference between price and marginal costs or average costs as a fraction of the price;
- Tobin's q : The ratio of the market value of a firm to its value based upon the replacement cost of its assets.

Firm size distribution can be used as structure measure in SCP research because it is expected that firms exercise more market power if there is only one or a few firms. Firms are also expected to exercise more market power if a small number of firms is very large relative to the other firms (Perloff et al., 2007). When the concentration of sellers rises, prices will increase. When the concentration of buyers rises, prices will decrease (Carlton & Perloff, 2005).

Barriers to entry can be used as structure measure in SCP research because prices can be at a level above competitive levels in industries with long-run entry barriers (Perloff et al., 2007). Barriers to entry can increase the profit within the supply chain (Carlton & Perloff, 2005). If there are no long-run barriers to entry or exit, rates of return across industries should reduce in the long run (Perloff et

al., 2007). There are six sources that cause entry barriers when they are present in a supply chain (Porter, 1979):

1. Economies of scale: New entrants within the supply chain should immediately have a large scale or they should accept a cost disadvantage;
2. Product differentiation: New entrants should spend a lot of money to reduce customers and consumers loyalty to current brands;
3. Capital requirements: New entrants should invest a lot of money before they are able to compete with the current firms in the supply chain;
4. Cost disadvantages independent of size: Current firms in the supply chain can have a cost advantage compared to new entrants which does not depend on the size of the firms;
5. Access to distribution channels: New entrants must secure the distribution of their products or services;
6. Government policy: The government can reduce or stop new entry in a supply chain.

2.1.2 SCP indicators

In this research, several structure indicators will be used to explain why both supply chains are differently organized. Besides that, statements from the expert interviews regarding the behavior of the actors in both supply chains will be used as indicator for conduct. These indicators will also be used to explain why both supply chains are differently organized.

First the concentration in all levels of both supply chains, except the farming levels, will be analyzed. The farming levels are not included, because there are many farms in both supply chains, especially compared to the amounts of firms on other levels of the supply chains (CBS, 2012). Therefore the farming levels are not highly concentrated. The $C(q)$ ratio will be used as a measure of concentration, which indicates the sum of the market shares of the q largest firms. The value of q will be based on how the concentration of the firms is expressed in recent literature. The concentration ratios will be corrected for imports and exports if necessary.

Different rates of concentration between the broiler meat and pig meat supply chain could explain why contracts are used in the broiler meat supply chain and not in the pig meat supply chain, because differences in concentration can lead to differences in market power (Perloff et al., 2007). When there are for example only one or a few large pig slaughter companies, there is a monopoly or oligopoly situation and the porker farmers can sell their porkers only to one or a few slaughter companies (Carlton & Perloff, 2005). It could also be that there is a dominant pig slaughter company which has market power. That company might ensure supply of porkers to that company by using its market power. Therefore it might be unnecessary for firms in the pig meat supply chain to make contractual agreements with porker farmers to ensure supply (Carlton & Perloff, 2005). When these situations do not occur in the broiler meat supply chain, then there might be more necessity to ensure supply by making contractual agreements with farmers in the broiler meat supply chain.

Second, it will be analyzed whether there are any differences in entry barriers between the broiler meat and pig meat supply chain. To do so, the six sources that cause entry barriers, provided by Porter (1979), will be used. It will be analyzed whether any of these six sources differs between both supply chains. When there are any differences in the six sources between both supply chains, there are also differences in entry barriers between the broiler meat and pig meat supply chain (Porter,

1979). When there are differences in entry barriers between both supply chains and they are caused by differences in governance structure, then this can explain why both supply chains are organized in the way they are (Carlton & Perloff, 2005).

Third, it will be analyzed whether the attitude of the actors in both supply chains is different. Because a different attitude of the actors can possibly explain whether both supply chains are differently organized (Perloff et al., 2007). To analyze this, statements from the expert interviews regarding the behavior of the actors in both supply chains will be used.

When there are differences in concentration, entry barriers or attitude of the actors between both supply chains, the effect of these differences on the rate of return of farmers will be analyzed. This will be done to analyze whether differences in performance between broiler farmers and pig farmers between both supply chains can be caused by differences in governance structure between both supply chains.

2.2 Transaction Cost Economics theory

In section 2.2.1 the general theory of TCE is described. Section 2.2.2 describes which TCE indicators will be used in this research to analyze whether the differences in governance structure between the broiler meat and pig meat supply chain can be explained based on TCE.

2.2.1 General theory

The basis of TCE is that people are bounded rational and that they sometimes display opportunistic behavior (Douma & Schreuder, 2008). Bounded rationality means that people cannot be fully rational since people do not have complete knowledge of the consequences of a choice they make (Simon, 1961).

TCE states that the costs of a transaction are determined by three factors (Douma & Schreuder, 2008):

1. Asset specificity: The degree to which assets are necessary for the transaction that lose value when they are used for other transactions. According to Williamson (1998) there are six types of asset specificity, namely physical asset specificity, human asset specificity, site specificity, dedicated asset specificity, brand name capital and temporal specificity.
2. Uncertainty and complexity: The more uncertain and/or complex a transaction will be, the more bounded rationality will become a problem;
3. Frequency: The higher the frequency, the more the governance structure for a transaction will shift from vertical integration to spot market (Hobbs, 1996).

Increasing asset specificity will lead to an increase of transaction costs. When uncertainty and/or complexity go up, transaction costs will also go up. However, when the frequency of a transaction increases, transaction costs will decrease (Ménard, 2005).

Transactions with low asset specificity, little uncertainty and complexity and very high frequency should be transacted on a market (Douma & Schreuder, 2008; Hobbs, 1996). When these transactions are vertically integrated, the transaction costs would be much higher than when these transactions take place on a spot market (Douma & Schreuder, 2008). Transactions which are very asset specific, in which much uncertainty and complexity is involved and with a frequency that is

neither too low nor very high should be transacted within organizations (Douma & Schreuder, 2008; Hobbs, 1996). In other words, a transaction will become more vertically integrated when the asset specificity increases, when more uncertainty and complexity is involved and when it has a frequency that is neither too low nor very high (Douma & Schreuder, 2008; Guldbrandsen & Haugland, 2000; Hobbs, 1996). So a transaction will become more vertically integrated when the transaction costs of a transaction increase.

This is shown for asset specificity in figure 2.1. When the asset specificity is between 0 and level A, a transaction which takes place on a market results in the lowest transaction costs (figure 2.1). A market is a governance structure coordinated based on price (Williamson, 2002). If the asset specificity is above level B, complete vertical integration would result in the lowest transaction costs. When a supply chain is completely vertically integrated, all firms in that supply chain are owned by one firm (figure 2.1; Williamson, 2002). When the asset specificity is between level A and B, a hybrid governance structure results in the lowest transaction costs. A hybrid governance structure is positioned between a market and complete vertical integration and could take the form of contracts (figure 2.1; Douma & Schreuder, 2008; Williamson, 2002).

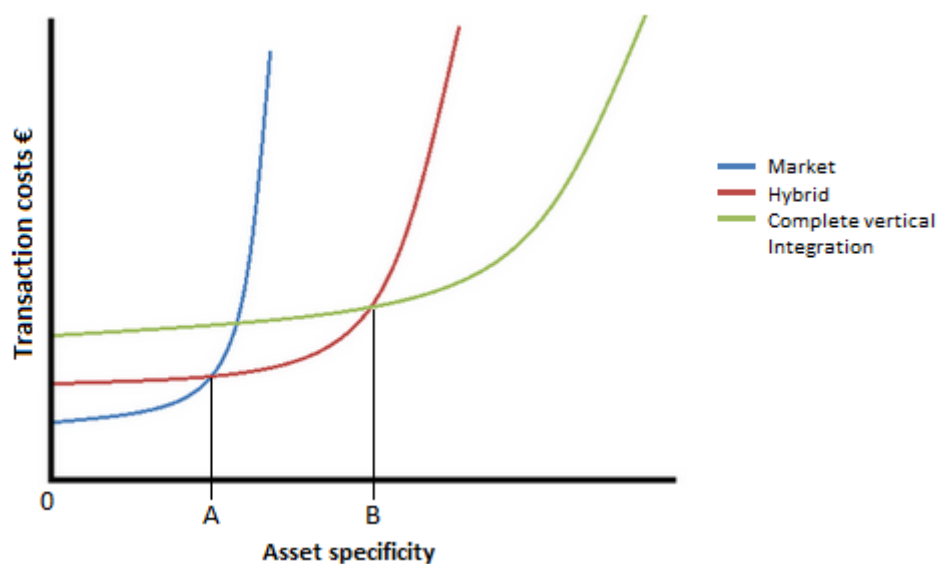


Figure 2.1: The transaction costs per type of governance structure at a certain level of asset specificity (Ménard, 2005).

When the frequency of a transaction is high, the transaction will take place on a spot market. This is the case because buyers and sellers will probably attach value to repeat business and therefore they do not behave opportunistically. A high frequency will increase the amount of information that sellers and buyers have about each other. This will reduce opportunistic behavior (Hobbs, 1996).

When the frequency of a transaction decreases, the possibility that sellers and buyers will behave opportunistically increases. Therefore, transactions with lower frequency tend to be integrated vertically, since increasing the rate of vertical integration can reduce opportunistic behavior (Hobbs, 1996; Whinston, 2003). However, when a transaction is vertically integrated, the frequency of that transaction should be high enough to cover the additional costs of more vertical integration compared to the costs of transacting on a spot market (Douma & Schreuder, 2008).

2.2.2 TCE indicators

Several TCE indicators will be used to analyze whether the differences in governance structure between the broiler meat and pig meat supply chain can be explained based on TCE. TCE can be used to explain the differences in governance structure between both supply chains because contractual agreements can be considered as a way of vertical integration (Rehber, 1998). Contractual agreements are a hybrid governance structure (Ménard, 2005).

First, it will be analyzed whether there are any differences in the six types of asset specificity mentioned by Williamson (1998) between both supply chains. When the level of asset specificity in the broiler meat supply chain is higher than in the pig meat supply chain, asset specificity might explain why contracts are applied in the broiler meat supply chain while the pig meat supply chain is organized like a spot market.

Second, it will be analyzed whether there are any differences in uncertainty and/or complexity between the broiler meat and pig meat supply chain. When there is more uncertainty and/or complexity in the broiler meat supply chain compared to the pig meat supply chain, this can explain why contractual agreements are used in the broiler meat supply chain and not in the pig meat supply chain.

Third, it will be analyzed whether the transactions in the broiler meat supply chain have a lower frequency than in the pig meat supply chain. If so, this can explain why firms in the broiler meat supply chain make contractual agreements with each other and firms in the pig meat supply chain do not.

3 Pig meat supply chain

This chapter provides a description of the Dutch pig meat supply chain and of the types of relations between the different levels of the supply chain. Section 3.1 provides some general information about the supply chain. In section 3.2 a description about the breeding organizations is provided. In section 3.3 a description of the sow farms and sow breeding farms is given. In section 3.4 a description of the porker farmers is provided. In section 3.5 a description is made about the slaughter and retail companies. In section 3.6 finally, a description of the Dutch feed companies will be provided.

3.1 General information

The Dutch pig meat supply chain is operating in the European market for pig meat, within which the supply of pigs exceeds the demand of pigs. The European market for pig meat is approximately 110% self sufficient (Hoste, pers. com. 2012).

The pig meat supply chain is a complex supply chain which involves many different parties from farm to fork (Wognum et al., 2008). The pig meat supply chain is organized like a spot market (Backus et al., 2012; Janssens et al., 2012). One pig farm can play a role in more levels of the supply chain, because there are pig farms with both sows and porkers (Janssens et al., 2012). The all-in, all-out principle is hardly applied amongst pig farmers. Most sow farmers weekly deliver piglets to porker farmers and most porker farmers weekly deliver porkers to slaughter companies (Varkens, 2006; Wageningen UR Verantwoorde Veehouderij, 2012).

3.2 Breeding organizations

The first level of the supply chain consists of the breeding organizations (figure 3.1). These companies focus on genetic improvement and cultivation of pig species (Wognum et al., 2008). They produce crossbred sows by crossing purebred sows of one breed with purebred boars of another breed (varkensenzo.nl, 2004). Breeding organizations deliver these crossbred sows to sow breeding farms (figure 3.1). Two large breeding organizations, Pigtone Group and Hendrix Genetics, covered almost the whole Dutch pig breeding market in 2011. Pigtone Group was the largest one and covered approximately 85% of the Dutch pig breeding market in 2011. Both breeding organizations belong to the five largest pig breeding organizations in the world (Ten Napel et al., 2011; Snijders et al., 2007).

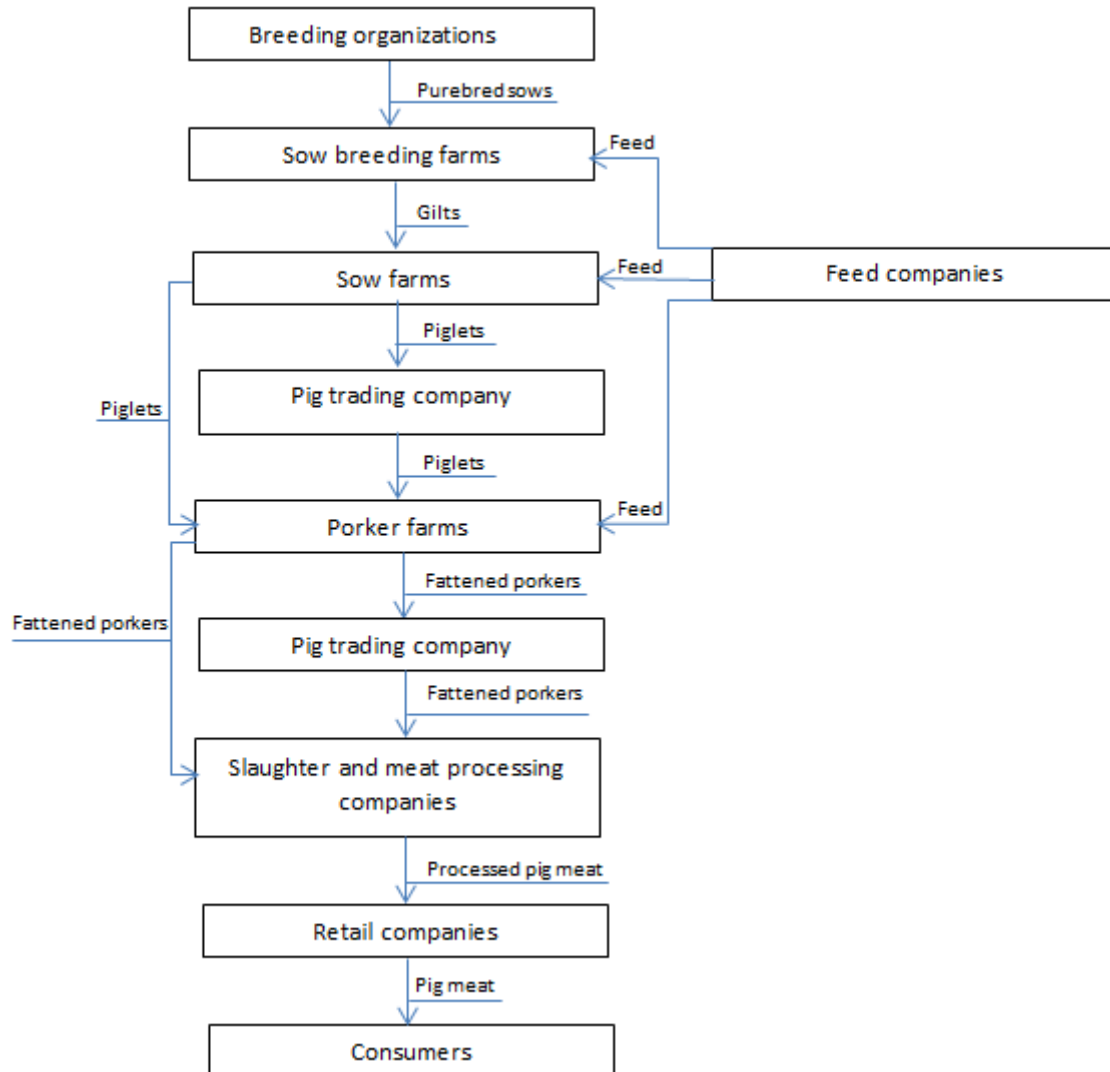


Figure 3.1: The most important levels of the Dutch pig meat supply chain (varkensenzo.nl, 2004; Wognum et al., 2008; Hoste et al., 2004).

3.3 Sow (breeding) farms

Sow breeding farms produce gilts which are sold to sow farms (figure 3.1). Sow farms produce piglets which are mostly sold to a pig trading company. These trading companies sell the piglets to porker farmers who are fattening the piglets (figure 3.1). However it is also possible that sow farms sell their piglets directly to porker farmers (figure 3.1). In approximately 30% of the cases one farmer is focusing on both sow farming and porker fattening (Exterkate, 2008; Janssens et al., 2012). It needs to be mentioned that piglets produced in the Netherlands are also exported to porker farms in other countries, besides to porker farmers in the Netherlands (Hoste et al., 2004; PVE, 2012b). In 2011 6.8 million piglets were exported, mostly to Germany (PVE, 2012b). In 2011 there were 2755 farmers with sows in the Netherlands (CBS, 2012).

Prices for piglets are determined by a spotmarket and they are varying weekly (Backus et al., 2012). The price for piglets is a derivative of the price for porkers, but it also depends on the supply and demand of piglets (Janssens et al., 2012). However, besides the prices determined on the spot

market there are surcharges for quality and quantity of the piglets (Backus et al., 2012; Janssens et al., 2012).

3.4 Pig trading companies

There are two types of pig trading companies in the Dutch pig meat supply chain. On the one hand there are trading companies who export piglets, mainly to Germany. On the other hand there are trading companies who buy piglets from sow farmers and sell them to porker farmers. After fattening, the same trader will buy the porkers from the porker farmers to whom the trader delivered piglets and sell the porkers to slaughter companies. Approximately 50% of the porkers delivered to a slaughter company are bought by the slaughter companies themselves, the other 50% of the porkers is bought from traders or through intermediaries (Hoste, pers. com. 2012).

Trading companies are necessary because the productivity of sow farms is growing faster than the productivity of porker farms. Due to that, the amount of piglets produced by a sow farm does not fit the amount of piglets demanded by a certain porker farm anymore after a few years. The piglets of a certain sow farm therefore have to be sold to another porker farm every few years and trading companies are necessary to link a sow farm to another porker farm (Hoste, pers. com. 2012).

3.5 Porker farms

Porker farmers produce fattened porkers which are sold to a pig trading company or to a slaughter company. In the first case, the pig trading companies sell the porkers to slaughter companies (figure 3.1). In the second case, porker farmers sell their fattened porkers directly to a slaughter company (figure 3.1; Janssens et al., 2012). Trading companies are used as a partner in many cases due to market imperfections caused by imperfect information. Trading companies often know better than slaughter companies and porker farmers which porkers need to be delivered to which slaughter company (Hoste et al., 2004; Janssens et al., 2012). In 2011 there were 5501 farms with porkers. In total there were 6,525 farmers with pigs in 2011 (CBS, 2012).

Contracted porker production is a rarity in the Dutch pig meat supply chain. Most porker farmers sell their fattened porkers to one and the same pig trading company and their porkers are often supplied to the same slaughter company, only out of habit (Hoste et al., 2004; Janssens et al., 2012; Hoste, pers. com. 2012). Not all the porkers produced in the Netherlands are sold to Dutch slaughter companies. They are also exported to foreign, mostly German, slaughter companies (Hoste et al., 2004; PVE, 2012b). The gross domestic production of pig meat in the Netherlands was 1,852,000 tons in 2011 (PVE, 2012a). However only 691,000 tons of pig meat was consumed in the Netherlands in 2011 (PVE, 2012a). So the Netherlands was 268% self-sufficient in pig meat in 2011.

The porker market is a commodity market. The prices for fattened porkers are weekly determined based on a spot market and they vary weekly (Backus et al., 2012). The level of the prices depends on the European demand for pig meat. Besides the determined price a porker farmer can also receive a bonus or rebate on the porker price for multiple reasons (Hoste et al., 2004; Hoste, pers. com. 2012). Slaughter companies offer some market concepts for which porkers can be produced. Each concept has its own requirements regarding the quality and weight of the fattened porkers (Janssens et al., 2012).

3.6 Slaughter companies and retail

Slaughter companies buy fattened porkers from pig trading companies or directly from porker farmers (figure 3.1; Janssens et al., 2012). Slaughter companies have only a limited influence on the quantity and quality of the porkers which are delivered to them and they weekly have to find appropriate customers for the delivered porkers (Hoste et al., 2004). There are no contracts between slaughter companies and their customers, the retail companies. Slaughter companies prefer delivering their meat to solid trade partners but that is not always possible, partly due to weekly differences in quality of the delivered porkers (Hoste et al., 2004).

Dutch slaughter companies have integrated the supply chain forwardly by taking over a lot of activities from wholesalers, cutters and the meat industry, mostly because of cost reduction and efficiency (Bondt et al., 2003; ABN Amro, 2008). The most important slaughter companies process the meat by themselves and deliver it directly to retailers (Bondt et al., 2003). Slaughter companies and retailers make agreements with each other regarding marketing policies (Boston, 2003; Hoste, pers. com. 2012). However, the conditions regarding supply and prices are changed regularly because it is too risky for slaughter companies to make long-term agreements due to the enormous fluctuations of porker prices (Boston, 2003). Despite of this, the retail prefers more constant meat prices, because they do not want to change the prices of products in their supermarkets (Hoste et al., 2004).

Slaughter companies are not able to immediately charge a higher price for the meat they deliver to retail companies when the costs for pig production, for example the feed costs, increase. Due to this, the prices for pig meat and porkers react only slowly on changes in the costs for pig (meat) production (Hoste, pers. com. 2012).

In the past, prices for pig meat charged by slaughter companies were determined weekly based on the price changes of the different parts of a porker. Nowadays it is unclear to Hoste (pers. com. 2012) how the prices are determined, but it is stated that both the prices for pig meat and for porkers are determined by the European pig market (Hoste, pers. com. 2012). Pig slaughter companies can shift fluctuations in pig meat prices through to farmers (Hoste, pers. com. 2012).

The amount of porkers slaughtered in the Netherlands does not increase, in contrast to the rest of the EU. The Dutch pig meat supply chain focusses more and more on the export of living porkers which are slaughtered by a foreign slaughter company (De Winter & Tacken, 2010). In 2011 there were 17 pig slaughter companies in the Netherlands who slaughtered more than 25,000 pigs (PVE, 2012b). However, only two Dutch slaughter companies slaughtered 52.8% of all Dutch porkers in 2011. Besides that, 18.5% of the Dutch porkers was exported to Germany (PVE, 2012b; PVE, 2012c; PVE, 2012d).

In 2011 there were five retail companies, Albert Heijn, Jumbo, Aldi, Plus and Lidl, who had 76.1% of the total market share (Table 3.1, table 3.2). The amount of retail companies however is quite dynamic. In 2009 Jumbo acquired Super de Boer, former known as Laurus, and in 2011 they also acquired C1000 (Berkhout & Van Bruchem, 2010; NRC, 2011). However, since 2000 there are no new entrants who did not enter the market due to mergers and/or acquisitions (table 3.2). Based on table 3.2 it should be mentioned that 13 retail companies have joined their purchases in one cooperative

named Superunie (Superunie, 2012). This cooperative had a market share of 29.2% in 2011 (Foodpersonality, 2012). So in 2011 the largest retail organizations were Albert Heijn, Superunie and Jumbo (Foodpersonality, 2012; table 3.2).

Table 3.1: The largest retail companies in the Netherlands and their turnover, amount of shops and market share.

Retail company	Turnover (mln. €)	Amount of shops	Market share
Albert Heijn	10,500	850	33.80%
Jumbo	7,500	725	22.80%
Aldi	2,480	488	7.90%
Plus (Sperwer)	1,910	269	6.00%
Lidl	1,900	346	5.60%

Berkhout & Roza (2012).

Table 3.2: The market share of the Dutch retail companies that had significant market share between 2000 and 2011.

Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Ahold	27.8	28	27	26.7	26.7	26.9	27.5	28.8	31.3	32.8	33.6	33.8
Laurus	25.1	24	21	18.3	16.5	12.0	7.6	7.3	6.8	6.5	5.5	¹
Schuitema	14.4	15	15	15.8	15.8	14.8	15.8	12.8	13.4	11.7	11.5	¹
Aldi	6.4	¹	8	7.3	7.2	9.5	9.6	9.6	8.9	8.3	7.9	7.9
Dirk ²	5.4	¹	4	3.8	¹	¹	¹	¹	¹	¹	¹	¹
Sperwer ⁴	¹	¹	4	6.9	6.8	6.2	6.8	6.0	6.0	6.0	6.0	6.0
Jumbo ³	¹	¹	¹	¹	¹	¹	¹	¹	4.8	4.9	5.5	22.8
Lidl ³	¹	¹	¹	¹	¹	¹	¹	¹	4.6	5.4	5.6	5.6

Silvis & Van Bruchem (2001-2002), Berkhout & Van Bruchem (2003-2011) and Berkhout & Roza (2012).

¹ Market share not included in Landbouw-Economisch bericht.

² The market share of Dirk v/d Broek was not included in Landbouw- Economisch Bericht anymore after 2003.

³ Firstly included in Landbouw-Economisch Bericht 2008.

There is lot of competition in the retail part of the supply chain. Retailers do not matter about raising the prices for meat, as long as the meat prices in their stores do not raise faster than the meat prices charged by competitive retail companies. So the price of meat can only increase when the price is increased with the same level in all retail stores (Hoste, pers. com. 2012).

3.7 Feed companies

Feed companies deliver feed to sow breeding farms, sow farms and porker farms (figure 3.1). In 2011, 57% of the total feed demand in the Netherlands was produced by the three largest feed companies, namely by Agrifirm (market share of 23% in the Netherlands), ForFarmers (market share of 21% in the Netherlands) and De Heus (market share of 13% in the Netherlands) (Berkhout & Roza, 2012). Agrifirm and ForFarmers are cooperatives, De Heus is a private company (Agrifirm, 2012; FromFarmers, 2012; De Heus, 2012). However the feed industry is quite dynamic. In 2011, ForFarmers doubled their feed turnover by acquiring Hendrix, another large feed company (Berkhout & Roza, 2012; Nieuwe Oogst, 2011). In 2010 there was a merger between two large feed cooperatives, namely Agrifirm and Cehave Landbouwbelaang, which continued under the name Agrifirm (Boerderij, 2010a; Boerderij, 2011a). Although there are currently three large feed

companies there are also approximately 70 feed companies with a market share of 4% or less (Berkhout & Roza, 2012).

According to Hoste (pers. com. 2012) there are hardly any pig farmers who make contractual agreements with feed companies. Although there are no contracts, feed companies often have a strong relationship with farmers. Farmers do not change very often between feed companies. Most pig farmers buy feed from a certain feed company only out of habit (Bunte et al., 2003; Hoste, pers. com. 2012). In 2009, approximately 13% of all pig farmers switched between feed company and in 2008 approximately 9% of all pig farmers switched between feed company (Boerderij, 2009a). Feed companies maintain strong relationships with farmers by providing them with additional services, like extension services (Bunte et al., 2003).

4 Broiler meat supply chain

This chapter provides a description of the Dutch broiler meat supply chain and about the relations between the different levels of the chain. In Section 4.1 some general information about the supply chain is provided. In section 4.2 a description is given about the breeding organizations. In section 4.3 a description is provided about the broiler breeder (rearing) farms. In section 4.4 a description is provided about the broiler hatcheries and in section 4.5 about the broiler farmers. In section 4.6 finally, a description is given about the slaughter, meat processing and feed companies in the Dutch broiler meat supply chain.

4.1 General information

The Dutch broiler meat supply chain is operating in the North-Western European fresh market. The most important countries with which is traded are Germany, The United Kingdom and Belgium. Parts of the broilers, like paws, go to Eastern Europe. There is hardly any trade with Asia. Only some toes are exported to Asian countries (Van Horne, pers. com. 2012).

A lot of frozen broiler meat is imported in the EU, mainly from Brazil. Frozen broiler meat is a market segment which is separated from the fresh broiler meat segment, due to regulations. There are regulations which state that it is not allowed to thaw frozen broiler meat and sell it as fresh broiler meat. The frozen broiler meat is used by the broiler meat industry to produce amongst others nuggets and schnitzels. The Dutch broiler meat supply chain does not play a significant role in the frozen broiler meat market (Van Horne, pers. com. 2012).

The broiler meat supply chain is characterized by some vertical integration (De Bont et al., 2011). In the nineties there was trend towards increasing vertical integration of the supply chain. Slaughter companies, hatcheries and feed companies merged or cooperated extensively with each other (Bunte et al., 2003; Van Horne, 2007). However, from the early 2000s there is a trend towards less vertical integration. Most of the firms in the supply chain operate as independent companies nowadays. The firms on different levels in the supply chain make contractual agreements with each other (Van Horne, 2007; Karetsos, 2009). In the US, also a large broiler meat producing country, the supply chain is still vertically integrated (Van Horne, 2007; Appendix II).

A characteristic of all farms in the broiler meat supply chain is that they apply an all-in all-out system (Karetsos, 2009). This means that all birds on one farm have the same age and that all birds are replaced at once (Price & Swanson, 1977; Karetsos, 2009). Before a new flock of birds arrives, the farm is cleaned (Karetsos, 2009).

4.2 Breeding organizations

The first level of the broiler meat supply chain consists of the breeding organizations (figure 4.1). Breeding organizations own pure bred lines, so called pedigree lines (Tacken et al., 2003; Aviagen Group, 2012). These pedigree lines are used to produce purebred great-grandparent stocks (Pollock, 1999). Great-grandparent stocks are used to produce crossbred grandparent stocks (Groen et al., 1998; Pollock, 1999). Both great-parent stocks and grandparent stocks are owned by a breeding organization (Aviagen Group, 2012). Grandparent stocks are used to produce crossbred parent stocks (broiler breeders) which are sold to broiler breeder farmers (Groen et al., 1998; Pollock, 1999). The

parent stocks produced by the breeding organizations exist of males which are selected on meat production and females which are selected on both meat and egg production (Ellen et al., 2012).

There are three globally operating breeding organizations in the broiler meat supply chain which cover the whole broiler breeding market in the Netherlands, namely Aviagen, Cobb-Vantress and Hubbard (Ten Napel et al., 2011). None of them are Dutch companies, although Cobb-Vantress cooperates extensively with the Dutch company Hendrix Genetics (Groupe Grimaud, 2012; Hendrix Genetics, 2012; Ten Napel et al., 2011). The breeding organizations contract or own breeding farms for (great-)grandparent stocks, broiler breeder rearing farms and hatcheries to hatch (grand)parent stocks (Aviagen Group, 2012; Boerderij, 2011b; Boerderij, 2010c).

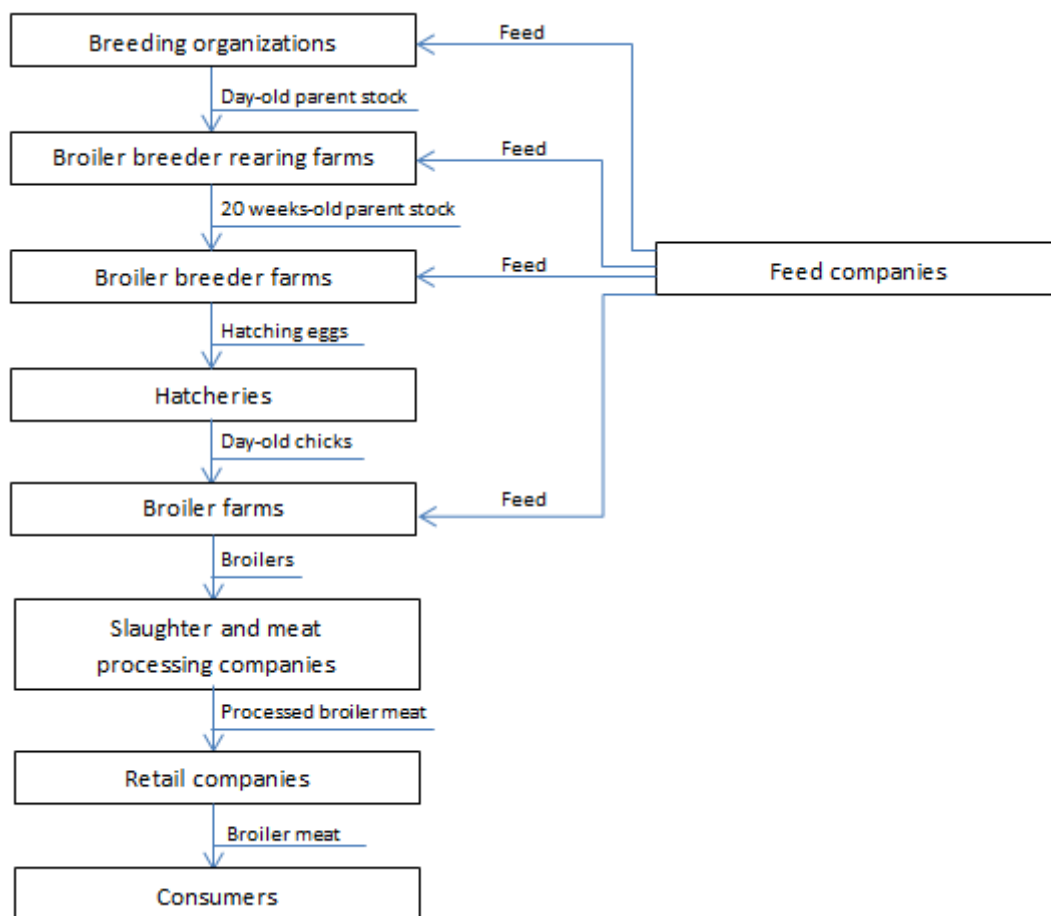


Figure 4.1: The most important levels of broiler meat supply chain (Boerderij, 2010b; Boerderij, 2010c; Bos & Janssen, 2010; Van Emous, 2007; Groen, et al., 1998; Van Horne et al., 2004; Van Horne et al., 2011).

4.3 Broiler breeder (rearing) farms

Broiler breeder rearing farms receive day-old chicks from breeding organizations (figure 4.1; Pluvita, 2012; Veterinair Centrum Someren, 2012). After approximately 20 weeks the broiler breeders are delivered to broiler breeder farms (Van Emous, 2007; Tacken et al., 2003). In 2011 there were 111 broiler breeder rearing farms (CBS, 2012).

The third level of the broiler meat supply chain consists of broiler breeder farms (figure 4.1). Broiler breeder farms use a parent stock, so called broiler breeders, and produce fertilized eggs, so called

hatching eggs (Berkhout & Roza, 2012; Van Horne et al., 2004; Pollock, 1999). The hatching eggs are delivered to a hatchery (Van Horne et al., 2004).

Dutch broiler breeder farms are independent companies, who buy feed and new broiler breeder flocks by themselves (Van Horne et al., 2011; Tacken et al., 2003). They also carry the risk of a bad broiler breeder performance and rising feed prices (Van Horne et al., 2004). In 2011, there were 188 broiler breeder farms in the Netherlands (CBS, 2012).

Broiler breeder farmers generally have a contract with a hatchery or in some cases with a hatching egg exporter (Van Horne et al., 2004; Tacken et al., 2003). The duration of the contract is mostly one production cycle, but contracts for multiple production cycles are also used (Van Horne et al., 2004; Karetsos, 2009). A production cycle is equal to nine or ten months. After that, the broiler breeders are slaughtered and replaced by new ones (Tacken et al., 2003).

Different types of contracts are used. In most cases there is a marketing contract between broiler breeder farmers and hatcheries (Karetsos, 2009). A marketing contract is a verbal or written agreement between a farmer and a buyer that specifies quantity, quality, price and timing of the product to be delivered by the farmer. Most management decisions remain to the farmer, who retains product ownership during the production process (Perry et al., 1997). For broiler breeder farmers this means that the contracts generally determine the price per hatching egg, the duration of production cycle, the bonus or rebate which the broiler breeder farmer receives based on the hatchability or fertility of the eggs and it is stated that the chicks resulting from hatching the eggs should be free from salmonella and mycoplasma gallisepticum (Appendix III.1; Van Horne et al., 2004; Karetsos, 2009; Van der Vegte, pers. com. 2013).

Some broiler breeder farmers receive a fixed compensation for supplied labor and management (Van Horne et al., 2004; Karetsos, 2009). In that case a so called production contract is applied (Karetsos, 2009). In general the management is much more specified in production contracts (Holman et al., 2006). Most contracts between broiler breeder farmers and hatcheries are written agreements. Both new contracts and contract extensions are written agreements. Verbal agreements are hardly applied (Van der Vegte, pers. com. 2013).

Broiler breeder farmers are payed by the hatchery within two till four weeks after delivering of the hatching eggs regardless the type of the contract (Karetsos, 2009). According to Van der Vegte (pers. com. 2013) broiler breeder farmers are payed after 21 days because then the hatching results of the eggs are available.

Karetsos (2009) states that broiler breeder farmers also make contractual agreements with feed companies. This is in line with Van der Vegte (pers. com. 2013) and Beltman (pers. com. 2013) who state that it can be the case that broiler breeder farmers make contractual agreements with feed companies. Those contracts cover agreements about the delivery of feed and cover a period of one production cycle, so apprimately 40 weeks (Appendix III.4; Beltman, pers. com. 2013). The contracts also cover agreements about things like quantity discounts (Appendix III.4; Van der Vegte, pers. com. 2013).

It could also be that a broiler breeder farmer has one contract with both a hatchery and a feed company. In that case, the contract covers both the delivery of hatching eggs to a hatchery and the delivery of feed by a feed company and are initiated by a feed company in most cases. However, these type of contracts are not very often applied (Appendix III.1; Van der Vegte, pers. com. 2013).

Broiler breeder farmers switch in 7.5% of the cases between hatcheries after duration of the contract with a hatchery. Broiler breeder farmers switch in 16% of the cases between feed companies after duration of the contract. Differences in quality and price are the main reasons to switch for broiler breeder farmers (Karetsos, 2009).

In 2011 there were 188 broiler breeders farms in the Netherlands (CBS, 2012). In 2011, 694 million hatchable hatching eggs were produced in the Netherlands. 49.7% of those eggs was hatched in the Netherlands and delivered to Dutch broiler farmers as day-old chicks (table 4.1). 16.4% of the hatching eggs was hatched in the Netherlands and exported as day-old chicks (table 4.1). In 2008, day-old chicks were mainly exported to Germany and Belgium (Van Horne et al., 2011). 33.9% of the hatching eggs was exported as hatching egg (table 4.1). In 2010 hatching eggs were mainly exported to Russia, Libia and the United Kingdom (Berkhout & Roza, 2012).

Table 4.1: The amounts and percentages of hatching eggs per destination.

Destination of the Dutch hatching eggs	Amount of hatching eggs	Percentage
Hatched and delivered to a Dutch broiler farmer	479 mln	49.69
Hatched and exported as day-old chick	158 mln	16.39
Exported as hatching egg	327 mln	33.92
Total hatching egg production	964 mln	100.00

PPE (2012).

4.4 Broiler hatcheries

Broiler hatcheries are firms that buy hatching eggs from broiler breeder farmers (figure 4.1; Ellen et al., 2012). Broiler hatcheries hatch those eggs, which results in day-old chicks (Bunte et al., 2003). Those day-old chicks are delivered to broiler farmers, within or outside the Netherlands (figure 4.1; table 4.1).

Hatcheries have a contract with most broiler farmers about the delivery of day-old chicks (Van der Vegte, pers. com. 2013). Those contracts are marketing contracts with the duration of six to seven production cycles. It is determined how much broilers the broiler farmer should buy from the hatchery. Agreements are also made about the price that hatcheries receive for those day-old chicks. Mostly the price is based on a price quotation per delivered day-old chick. Besides that it is determined that broiler farmers are compensated for first week mortality by the hatcheries when first week mortality is above the value that is determined by the contract (Appendix III.2; Karetsos, 2009; Van der Vegte, pers. com. 2013).

Most contracts between broiler farmers and hatcheries are written agreements. Both new contracts and contract extensions are written agreements, while verbal agreements are hardly applied (Van der Vegte, pers. com. 2013). According to Van der Vegte (pers. com. 2013) at most two to three percent of the broiler farmers do not have a contract with a hatchery about the delivery of day-old chicks.

The majority of the broiler farmers (72%) pays the hatchery for the delivery of day-old chicks after delivering the broilers to the slaughter company. So the hatchery is paid approximately six weeks after delivering day-old chicks to a broiler farmer. 15% of the broiler farmers pays the hatchery with two till four weeks (Karetsos, 2009). Broiler farmers switch in 17% of the cases between hatcheries after duration of the contract with their current hatchery. Differences in price and quality are the main reason to switch between hatcheries (Karetsos, 2009).

In 2010 there were 18 broiler hatcheries in the Netherlands (PPE, 2010). Between 1990 and 2000 there was a trend toward more vertical integration. Hatcheries, slaughter companies and feed companies cooperated extensively with each other. However, from the early 2000s there is a reduction of vertical integration and most of the hatcheries, slaughter companies and feed companies returned into independent companies, although there are still strategic alliances and partnerships between them in many cases (Van Horne, 2007).

4.5 Broiler farms

Broiler farmers receive day-old chicks from a broiler hatchery (figure 4.1; Ellen et al., 2012). In most cases the day old chicks grow to broilers with a weight of approximately 2.2 kg within approximately six weeks (Ellen et al., 2012; Tacken et al., 2003). After approximately six weeks the broilers are delivered to a slaughter company (Berkhout & Roza, 2012; Tacken et al., 2003). There are approximately six to seven production cycles per year on a broiler farm (Tacken et al., 2003; Van der Vegte, pers. com. 2013).

Almost all broilers are delivered to Dutch slaughter companies (Tacken et al., 2003). Most broiler farmers have a contract with one of these companies or with a broiler trading company¹ (Karetsos, 2009; Tacken et al., 2003; Van der Vegte, pers. com. 2013). The contractual agreements with slaughter companies are marketing contracts with the duration of one year in most cases (Karetsos, 2009). So these contracts cover approximately six to seven production cycles (Karetsos, 2009; Van der Vegte, pers. com. 2013). According to Van Horne (pers. com. 2012), broiler farmers switch more between slaughter companies after duration of the contract than that broiler breeder farmers switch between hatcheries. So broiler farmers shift in more than 7.5% of the cases between slaughter companies.

Instead of having a contract with a slaughter company, some broiler farmers make contractual agreements with a broiler trading company like broiler integration Lagerwey, poultry trading company Mons and the trading office of feed company De Heus (Van der Vegte, pers. com. 2013; Nijenhuis & Ruitkamp, 2002). Most contracts between broiler farmers and slaughter or trading companies are written agreements (Van der Vegte, pers. com. 2013).

There are some Dutch slaughter companies that do not have contracts with broiler farmers. Just because contracting broiler farmers takes too much over their time in their opinion. Those slaughter companies buy broilers from trading companies based on contractual agreements that cover one

¹This report only speaks about the relationship between broiler farmers and slaughter companies in most cases. Trading companies and slaughter companies are assumed to have an equal role regarding broiler farmers and therefore the relationship between broiler farmers and trading companies is not separately dealt with.

year in most cases (Van der Vegte, pers. com. 2013). According to Van der Vegte (pers. com. 2013) at most two to three Dutch broiler farmers do not have a contract with a broiler slaughter or trading company, which is underlined by Beltman (pers. com. 2013).

Broiler farmers receive a price per kg of live weight of the broilers from the slaughter company. The price, mostly based on a price quotation plus an additional amount of money, for a certain range of the live weight is determined within the contract between broiler farmers and slaughter companies. When the live weight is outside that range, the broiler farmer receives a bonus or penalty (Appendix III.3; Karetsos, 2009; Van der Vegte, pers. com. 2013). The broiler farmer receives a penalty when the delivered broilers have certain unwanted characteristics, like broken legs (Karetsos, 2009; Van der Vegte, pers. com. 2013). They also receive a penalty when there are too much broilers that did not survive transportation from the broiler farm to the slaughter company (Van der Vegte, pers. com. 2013). Broiler farmers are paid by the slaughter company within four weeks after delivering the broilers (Karetsos, 2009).

Most broiler farmers make contractual agreements with feed companies (Beltman, pers. com. 2013; Karetsos, 2009). According to Van der Vegte (pers. com. 2013), those contracts mostly cover six to seven production cycles. Although Beltman (pers. com. 2013) states that the length of the contracts varies between the different broiler farmers. There are several types of contracts between broiler farmers and feed companies. Firstly, there are contracts between a broiler farmer and a feed company that state that the broiler farmer should buy feed from the feed company for a certain period (Appendix III.4; Beltman, pers. com. 2013; Van der Vegte, pers. com. 2013).

Secondly, there are also contracts which involve both the delivery of day-old chicks, the delivery of feed and the sales of broilers (Appendix III.4; Beltman, pers. com. 2013; Van der Vegte, pers. com. 2013). A feed company delivers feed and day-old chicks to the broiler farmer and that feed company also buys the broilers from the broiler farmer (Van der Vegte, pers. com. 2013). Although not all feed companies do offer this type of contracts. Some feed companies only want to focus on their core business, which involves production and sales of feed (Beltman, pers. com. 2013).

Most of the contracts between broiler farmers and feed companies are written agreements (Beltman, pers. com. 2013). There are hardly any broiler farmers who do not make contractual agreements with feed companies (Beltman, pers. com. 2013).

Broiler farmers switch in 20% of the cases between feed companies after duration of the contract with their current feed company (Karetsos, 2009). Differences in price and quality are the main reasons to switch between hatcheries and feed companies for broiler farmers (Karetsos, 2009).

Broiler farmers are mainly focused on low-cost and efficient broiler production. This is the case because the firms in the Dutch broiler meat supply chain operate on the international broiler meat market which is cost-price oriented (Ellen et al., 2012).

In 2011 there were 601 broiler farms in the Netherlands (CBS, 2012). Together they produced 959,800 tons of living broilers in 2011 (PPE, 2012).

4.6 Slaughter, meat processing and feed companies

Slaughter companies buy broilers with an average weight of approximately 2.2 kg from broiler farmers or from a broiler trading company (figure 4.1; Berkhout & Roza, 2012; Ellen et al., 2012; Karetsos, 2009; Tacken et al., 2003; Van der Vegte, pers. com. 2013). The majority of the broilers are slaughtered and splitted in parts (filet, legs, wings et cetera) by slaughter companies (Ellen et al., 2012). A part of the slaughtered broilers are splitted by slaughter companies and a part are splitted by specialized cutting companies (Ellen et al., 2012). However, most of the cutting companies are owned by or connected to a slaughter company (Tacken et al., 2003). Slaughter companies and cutting companies sell the processed broiler meat to Dutch retailers or they export it (Berkhout & Roza, 2012; Ellen et al., 2012; Karetsos, 2009).

Dutch slaughter companies mainly focus on the production of fresh broiler meat (Van Horne, pers. com. 2012). A large part of the broiler meat is exported (Berkhout & Roza, 2012; Van Horne, pers. com. 2012). In 2011, at least 62%² of the broiler meat produced by Dutch slaughter companies was exported, mainly to Germany and the United Kingdom (Berkhout & Roza, 2012; table 4.2). Besides that, broiler meat is imported from Brasil and Thailand to process into broiler meat products (Berkhout & Roza, 2012; Van Horne, pers. com. 2012).

Table 4.2: The amounts of imported and exported broiler meat.

	Amount of broiler meat
Broiler meat produced by Dutch slaughter companies	809,100 tons
Imported meat	414,600 tons
Exported meat (including imported meat)	916,800 tons
Minimum amount of exported broiler meat produced in the Netherlands	502,200 tons

PPE (2012).

Almost all broilers produced in the Netherlands are slaughtered by Dutch slaughter companies (Tacken et al., 2003). In 2011, 809,000 tons of broiler meat were produced by Dutch slaughter companies of which 710,300 tons came from Dutch broilers (PPE, 2012). Besides that, 16% of the total amount of broilers slaughtered in the Netherlands is imported, mainly from Germany (Berkhout & Roza, 2012; table 4.2).

In 2011 there were 15 slaughter companies who slaughtered more than 10,000 tons of broilers (carcass weight) in the Netherlands (PVE, 2012b). The amount of slaughter companies is reducing and the remaining companies grow in size (Berkhout & Roza, 2012; Bondt et al., 2003). Between 1990 and 2000 slaughter companies were often integrated with feed companies and hatcheries. Nowadays slaughter companies operate as independent companies (Van Horne, 2007).

² The Netherlands both imports and exports broiler meat. More broiler meat is exported than produced by Dutch slaughter companies. So a part of the imported broiler meat is also exported again. But it is unclear whether all the imported meat is exported again or (partly) used for consumption in the Netherlands. When all imported meat is exported again, still 62.1% of all broiler meat produced by Dutch slaughter companies is exported. When all Dutch broiler meat consumption exists of imported meat, 100% of all broiler meat produced by Dutch slaughter companies is exported. So the percentage broiler meat produced by Dutch slaughter companies that is exported is somewhere between 62.1% and 100%, but the exact percentage is unclear.

Feed companies deliver feed to (great-)grandparent farms, broiler breeder (rearing) farms and broiler farms (figure 4.1). The feed companies in the broiler meat supply chain are the same as those in the pig meat supply chain. The same firms deliver both pig feed and broiler (poultry) feed (ABN AMRO, 2012). Both broiler breeder farmers and broiler farmers have a contract with feed companies (Beltman, pers. com. 2013; Karetsos, 2009). Besides delivery of feed, some feed companies also buy broilers from broiler farmers and arrange the delivery of day-old chicks to them (Appendix III.4; Beltman, pers. com. 2013; Van der Vegte, pers. com. 2013).

5 Results

This chapter will describe the results from the analyses based on SCP and TCE. In section 5.1 it will be described whether the differences in governance structure between the broiler meat and pig meat supply chain can be explained by SCP. Section 5.2 describes whether the differences in governance structure between both supply chains can be explained by TCE.

5.1 Results SCP

In section 5.1.1 the analysis of the concentration ratios is described. Section 5.1.2 provides the analysis of entry barriers. Section 5.1.3 provides a description of the attitude of the actors in both supply chains and section 5.1.4 finally, provides an overview of the results based on the SCP analysis.

5.1.1 Concentration ratios

At first the concentration of the firms on all levels, except the farming levels, of both supply chains is analyzed based on several concentration ratios. These ratios come from recent literature. The concentration ratio of the pig slaughter companies is corrected for exports. The analysis shows that there is a high concentration on all levels of both supply chains. There are no large differences between the concentration ratios of the firms in both supply chains (table 5.1).

Table 5.1: Concentration ratios of the different supply chain levels, measured between 2003 and 2012.

Level	Measure	Pig chain	Broiler Chain
Breeding organizations	C2	0.950 ^{1,2} (2003; 2007)	0.900 ^{3,4} (2011; 2012)
Hatcheries	C11	No hatcheries	0.960 ⁵ (2011)
Trading companies		Concentration unclear	Concentration unclear
Slaughter companies	C2	0.528 ^{6,7,8,9} (2011)	0.530 ¹⁰ (2011)
Retail	C2	0.630 ^{10,11} (2011)	0.630 ^{10,11} (2011)
Retail	C3	0.858 ^{10,11} (2011)	0.858 ^{10,11} (2011)
Feed companies	C3	0.570 ¹⁰ (2011)	0.570 ¹⁰ (2011)

¹: Snijders et al. (2007).

²: Bijman & Eaton (2003).

³: Ten Napel et al. (2011).

⁴: Pluimveehouderij (2012).

⁵: Van Horne et al. (2011).

⁶: Calculated based on Boerderij (2012).

⁷: Calculated based on PVE (2012b).

⁸: Calculated based on PVE (2012c).

⁹: Calculated based on PVE (2012d).

¹⁰: Berkhout & Roza (2012).

¹¹: Foodpersonality (2012).

The concentration ratio of the Dutch pig slaughter companies involves some calculation, since 21.2% of the porkers produced in the Netherlands in 2011 were exported alive and 4.0% of the porkers slaughtered in the Netherlands were imported alive (PVE, 2012b; PVE, 2012c; PVE, 2012d). Not including imports and exports might lead to biased estimates of the relationship between concentration and performance. This is the case because large exports of living porkers will reduce

the concentration ratio and therefore the market power of the domestic slaughter companies (Carlton & Perloff, 2005).

The imports and exports show that the market within which the Dutch pig meat supply chain is operating is not properly defined in this research. In this research it is defined as the Dutch market for pig meat, while the exports of porkers indicate that the market is larger than only the Netherlands (PVE, 2012b; PVE, 2012c; PVE, 2012d). This is in line with Hoste (pers. com. 2012) who states that the Dutch pig meat supply chain is operating in the European market for pig meat.

Each country to which porkers are exported is considered to be an additional slaughter company. 87.1% of the porkers exported from the Netherlands were slaughtered in Germany in 2011 (PVE, 2012c). In 2011, 3,745,449 porkers were exported alive, so 3,262,286 porkers (87.1% of 3,745,449) were exported to Germany (PVE, 2012c). In 2011, 17,662,245 porkers were produced in the Netherlands, so 18.5% of the porkers produced in the Netherlands was exported to Germany in 2011 (PVE, 2012b; PVE, 2012c; PVE, 2012d). So Germany had a market share of 18.5 % on the Dutch porker market in 2011.

VION and Van Rooi, the two largest Dutch slaughter companies, slaughtered respectively 51% and 16% of all porkers slaughtered in the Netherlands in 2011 (Boerderij, 2012). In 2011, 14,500,000 porkers were slaughtered in the Netherlands of which 583,204 porkers were imported (PVE, 2012b; PVE, 2012d). So 13,916,796 Dutch porkers were slaughtered in the Netherlands in 2011. VION slaughtered 51% of these porkers, which is equal to 7,097,566 porkers. Van Rooi slaughtered 16% which is equal to 2,226,687 porkers (Boerderij, 2012; PVE, 2012b; PVE, 2012d). Since 17,662,245 porkers were produced in the Netherlands in 2011, it can be stated that VION slaughtered 40.2% of all porkers produced in the Netherlands and Van Rooi 12.6%.

Since Germany is the second largest “slaughter company” operating in the Dutch pig meat supply chain with a market share of 18.5%, the C3 of the slaughter companies equals the sum of the market share of VION, Germany and Van Rooi in the Dutch pig meat supply chain which is equal to 0.713. The C2 of the Dutch slaughter companies (VION and Van Rooi) corrected for exports of living porkers to Germany and imports of living porkers is equal to 0.528.

Based on table 5.1 it can be stated that both pig slaughter companies and broiler slaughter companies do not have market power regarding retail companies, since the C2 of the retail is larger than the C2 of the slaughter companies (Perloff et al., 2007). This is in line with Hoste (pers. com. 2012) and Van Horne (pers. com. 2012) who state that both pig slaughter companies and broiler slaughter companies do not have market power regarding retailers. Because there are only a few pig and broiler slaughter companies compared to the amount of pig farmers and broiler farmers in the Netherlands, it could be the case that slaughter companies have market power regarding farmers. However, Hoste (pers. com. 2012) states that pig slaughter companies do not have market power regarding porker farmers and Van Horne (pers. com. 2012) states that broiler slaughter companies do not have market power regarding broiler farmers.

Pig slaughter companies do not have market power because they do not have a financial buffer (Hoste, pers. com. 2012). Because of that, they cannot permit themselves to use less than their full

production capacity. The pig slaughter companies do not have financial reserves to overcome periods with less production than possible according their slaughter capacity (Hoste, pers. com. 2012). Although pig slaughter companies do not have market power there are a lot of porker farmers and porker traders who always sell their pigs to the same slaughter company, only out of habit (Hoste, pers. com. 2012).

Table 5.1 shows that the C11 of hatcheries is equal to 0.96. A concentration ratio with less firms involved is not available in recent literature, but Van Horne (pers. com. 2012) states that hatcheries do not have market power.

The breeding organizations are highly and almost equally concentrated in both supply chains (table 5.1). Because there is hardly any difference in concentration, it cannot be stated that there is a difference in market power of breeding organizations between both supply chains.

It is not analyzed whether feed companies have market power in one or both supply chains, because the market share of the different feed companies in each supply chain is unknown. The market share of feed companies in table 5.1 is the market share of the three largest Dutch feed companies in the total market for animal feed. Because the market shares of the different feed companies in the pig feed market and broiler feed market are unknown, it is assumed that the market shares of the three largest Dutch feed companies in the pig feed market and broiler feed market is equal to their market shares in the total feed market.

This assumption might bias the results, because it could be that there are some firms that have a large market share in the pig meat or broiler meat supply chain, but only a small market share in other supply chains. Due to that they are not a large feed company, but they are a large firm in one supply chain. An example of this is feed company De Hoop. The total production of De Hoop is of an average size compared to all Dutch feed companies, but they only produce poultry feed. Therefore they belong to the top five of the largest poultry feed companies in the Netherlands (De Hoop, 2013).

It is also not analyzed whether pig trading companies have market power, because the market share of the different pig trading companies is unclear. But in 2004 there were around 350 certified and active pig trading companies in the Netherlands (Boston, 2003). That is a lot, especially when it is compared to the amount of pig slaughter companies (Boston, 2003; table 5.1). The difference between both supply chains is that there are many trading companies in the pig meat supply chain, while there are only a few trading companies in the broiler meat supply chain (Hoste et al., 2004; Van der Vegte, pers. com. 2012).

Finally, it is not analyzed whether the three largest Dutch retail companies have market power since their market share in both supply chains is unknown. Only their market share in the total food retail market is known. Therefore it is assumed that the market share of the retail companies in both supply chains is equal to their market share in the total food retail market. Due to this, there is no difference in concentration ratio of the retail companies in both supply chains. So it cannot be stated that there is any difference in market power of the retail companies between both supply chains. This assumption might bias the results, but that seems unlikely since there are no large retail companies who have a very large market share in one supply chain, while they are only small in

others, as occurs in the feed industry. Because this is not the case, the assumption that the market share of the three large retail companies in each supply chain is equal to their total market share is quite similar to the real situation.

Although there are no firms with market power in both supply chains, it could be the case that one of those firms will obtain market power in the future. Because each level of both supply chains, except farming levels, already exists of only a few firms who have the majority of the market share (table 5.1; CBS, 2012). When two of these firms merge or one of those large firms acquires another large firm than the concentration on that level of the supply chain will increase quickly. Especially because there are no new entrants for years now in both supply chains.

An example of this is the merger between Agrifirm and Cehave and the acquisition of Hendrix by ForFarmers. Due to this, and some growth in market share of De Heus, the C3 in the feed industry changed from 0.45 in 2009 to 0.57 in 2011 (Berkhout & Roza, 2012; Boerderij, 2009b). Only because of a merger and an acquisition amongst the four largest feed companies of 2009 the C3 has been increased with 19%, corrected for the growth of the market share of De Heus between 2009 and 2011.

5.1.2 Entry barriers

Differences in performance between both supply chains could also be influenced by differences in entry barriers (Carlton & Perloff, 2005). To analyze possible differences in entry barriers it is analyzed whether there are any differences in one source of entry barriers between both supply chains mentioned by Porter (1979), namely access to distribution channels.

The other five sources of entry barriers mentioned by Porter (1979) are assumed to be the same between the broiler meat and pig meat supply chain. It is difficult to measure the necessary scale, the necessary amount of capital and cost disadvantages independent of size for new entrants in both supply chains. It is assumed that new entrants need a large scale and a large amount of capital in both supply chains. Besides that, there is not much branding in both supply chains so it is assumed that product differentiation does not play an important role for new entrants. So costs disadvantages independent of size do not play a major role for new entrants. Although there will be established relationships between the current partners in both supply chains. Finally, it is assumed that there are no differences in governmental policies regarding new entrants between both supply chains. It is assumed that the Dutch government does not reduce or stop new entry, although they stopped the increase of the amount of pigs and poultry in the Netherlands by applying production rights (DR-Loket, 2013). A disadvantage of these assumptions is that they might bias the results since there might be more differences in barriers to entry between both supply chain than mentioned in this report.

Vertical integration of a supply chain can be seen as an entry barrier, because firms that want to enter that supply chain need to become part of the integration (Caves & Porter, 1977; Porter, 1979). Because contracts are a way of vertical integration it can be stated that the contracts used in the broiler meat supply chain can be seen as an entry barrier (Rehber, 1998). Hatcheries, slaughter companies and feed companies need a certain number of contracts with broiler (breeder) farmers before they can start production. Broiler breeder farmers need a contract with a hatchery and a feed

company. Broiler farmers need a contract with a hatchery, slaughter company and feed company. Without a contract, it is difficult to get access to distribution channels and that is a source of entry barriers (Porter, 1979). This is in line with Van der Vegte (pers. com. 2013), who states that a contract extension with a broiler breeder farmer that is already customer of your hatchery is preferred over offering a contract to a new broiler breeder farmer or one that is currently not a customer of your hatchery. Especially when the new one does not perform better than the current broiler breeder farmer and when its size does not fit to your hatchery. It is also in line with Van Horne (pers. com. 2012) who states that the use of contractual agreements in the broiler meat supply chain can be a barrier to entry.

In the pig meat supply chain, contractual agreements are not applied (Backus et al., 2012; Janssens et al., 2012; Van Wagenberg, 2010). Due to this, it can be stated that there is an additional barrier to enter the broiler meat supply chain compared to the pig meat supply chain.

According to the SCP paradigm, significant long-run entry barriers can lead to prices that are above marginal costs. Profits will also be higher in industries with high entry barriers (Carlton & Perloff, 2005). So according to the SCP paradigm it could be that the application of contracts in the broiler meat supply chain leads to a better performance of that supply chain compared to the pig meat supply chain.

This is in line with LEI Bedrijfsinformatienet (2012a) which shows that the average rate of return of broiler farms was larger than the average rate of return of both porker and sow farms between 2001 and 2011 (figure 5.1, table 5.2). The standard deviation of the rate of return of broiler farms was also lower than that of sow and porker farms. The standard deviation is an indicator for the spread of a dataset (Field, 2009). So in this case the standard deviation indicates that the rate of return of sow and porker farms fluctuates more than that of broiler farms (table 5.2). It should be mentioned that both the level and standard deviation of the rate of return of farmers is influenced by multiple factors and not only by the level of entry barriers.

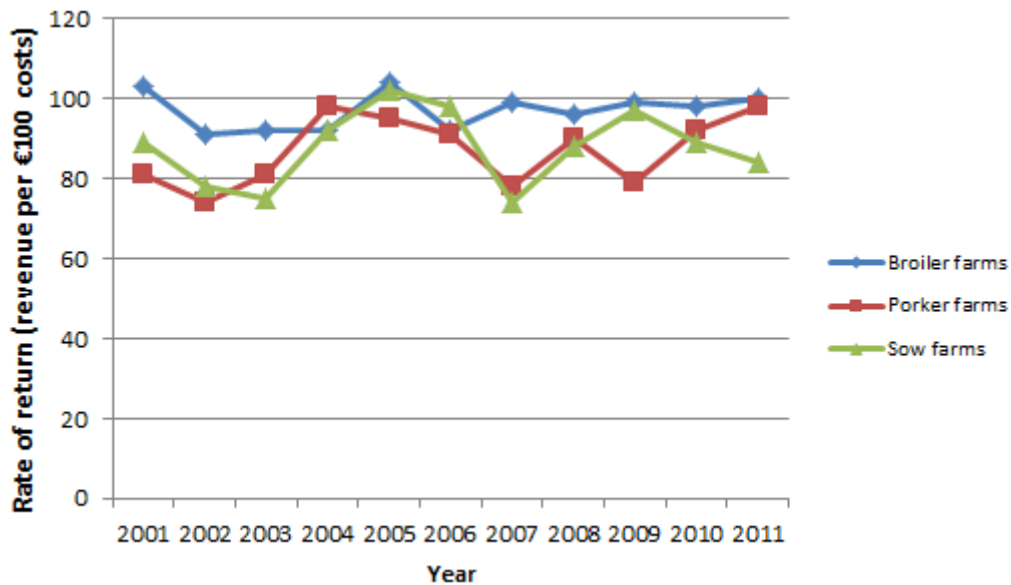


Figure 5.1: The rate of return of broiler farms, porker farms and sow farms (LEI Bedrijfsinformatienet, 2012a).

Table 5.2: The minimum, maximum and average rate of return (profit per €100 costs) of broiler farms, porker farms and sow farms and its standard deviation between 2001 and 2011.

	Broiler farms	Porker farms	Sow farms
Average rate of return	96.9	87.0	87.8
Standard deviation	4.64	8.61	9.36
Minimum rate of return	91	74	74
Maximum rate of return	104	98	102

LEI Bedrijfsinformatienet (2012a).

5.1.3 Attitude of the actors

Both the Dutch pig farmers and the Dutch broiler (breeder) farmers do not want to do business in a completely vertically integrated supply chain, even if it is beneficial for them (Beltman, pers. com. 2013; Hoste, pers. com. 2012; Van Horne, pers. com. 2012; Van der Vegte, pers. com. 2013; Van Horne, 2007). So they do not want to do business with a broiler meat or pig meat integrator and receiving a fixed amount of money, based on production contracts, for taking care of the broilers, broiler breeders or pigs. This is the case because the Dutch pig farmers and broiler (breeder) farmers are entrepreneurs (Beltman, pers. com. 2013; Hoste, pers. com. 2012; Van Horne, pers. com. 2012; Van der Vegte, pers. com. 2013; Van Horne, 2007).

Hoste (pers. com. 2012) states that the Dutch pig farmers are such good farmers that they can survive on the spot market, while integrations are mostly applied when farmers have less craftsmanship. The Dutch broiler (breeder) farmers state that only taking care of the broilers or broiler breeders and receiving a fixed compensation for it is not in line with the idea that broiler (breeder) farmers have about entrepreneurship (Van Horne, pers. com. 2012).

According to Hoste (pers. com. 2012) a disadvantage of complete vertical integration of a supply chain is that farmers do not receive market incentives anymore. While the market incentives (feed

price, piglet price and porker price fluctuations and fluctuating margins) have led to superior performance of the Dutch pig meat supply chain (Hoste, pers. com. 2012).

In the United States (US) however, complete vertical integration of all levels of the supply chain, except farming levels, is widely applied in both supply chains (Appendix I; Appendix II). In the US pig meat supply chain marketing contracts are applied between pig farmers and integrators in most cases and production contracts are also becoming more common (Appendix I). In the US broiler meat supply chain production contracts are applied between broiler (breeder) farmers and integrators (Appendix II). These differences between the Netherlands and the US are caused by different circumstances in both countries (Appendix I; Appendix II).

5.1.4 Overview results SCP

Based on the SCP analysis, it cannot be stated that farmers in one of both supply chains are doing business with firms with market power. So market power does not explain why contracts are applied in the broiler meat supply chain and not in the pig meat supply chain. However, on each level of both supply chains, except the farming levels, there are only a few large firms which have the largest share of the market (table 5.1). When two of those large firms merge, market power might occur, because due to the merger of two large firms the concentration increases.

The SCP analysis shows that contract farming could lead to better supply chain performance. This is the case because the contracts in the broiler meat supply chain can act as a barrier for new firms to enter the Dutch broiler meat supply chain. This is in line with LEI Bedrijfsinformatienet (2012a) which shows that broiler farmers have had a better average rate of return between 2001 and 2011 than pig farmers. Although SCP indicates that contract farming could lead to better supply chain performance, it does not indicate why contracts are not applied in the pig meat supply chain.

It can be stated that the attitude of the farmers in both supply chains is quite similar. In both supply chains, the farmers are entrepreneurs who do not want to produce pigs, broilers or hatching eggs for a fixed compensation for a pig meat or broiler meat integrator. Because the attitude of the farmers in both supply chains is quite similar, it does not indicate why contracts are applied in the broiler meat supply chain and why the pig meat supply chain is organized like a spot market.

5.2 Results TCE

Besides SCP, TCE is applied to analyze whether firms in the broiler meat supply chain make contractual agreements with each other and firms in the pig meat supply chain do not. Differences in asset specificity between both supply chains are analyzed in section 5.2.1. The analysis of differences in uncertainty and complexity between the broiler meat and pig meat supply chain is described in section 5.2.2. The analysis of differences in frequency of the transactions between both supply chains is described in section 5.2.3. Section 5.2.4 finally, provides an overview of the results of the TCE analysis.

5.2.1 Asset specificity

In the broiler meat supply chain there is more site specificity, which has to do with the location of buyers and sellers, and temporal asset specificity, which has to do with timely delivery, involved than in the pig meat supply chain (Martinez, 2002; Ménard & Klein, 2004). There is more site specificity involved in the broiler meat supply chain because porkers can be transported over larger distances

than broilers without losing value. There is more temporal asset specificity involved in the broiler meat supply chain, because porkers can be slaughtered in a wider age range than broilers (Ménard & Klein, 2004). This is explained in more detail in section 5.2.2, since it also leads to more complexity. The difference in site specificity and temporal asset specificity can explain why the broiler meat supply chain is more vertical integrated than the pig meat supply chain, since a higher level of asset specificity leads to more vertical integration according to TCE (Douma & Schreuder, 2008).

It is assumed that there is a high and almost equal level of physical asset specificity between both supply chains. The level of physical asset specificity indicates the amount of assets that can only be used for one specific transaction (Martinez, 2002). Most of the assets within each supply chain can only be used within the broiler meat or pig meat supply chain. Therefore it is not analyzed whether there are any differences in the level of physical asset specificity between the broiler meat and pig meat supply chain. It is also assumed that the other sources of asset specificity mentioned by Williamson (1998), human asset specificity, dedicated asset specificity and brand name capital, are equal between both supply chains. It could be that there are any differences in the level of physical, human and dedicated asset specificity and brand name capital between both supply chains in reality, so the assumption could reduce the validity of the results.

Both supply chains have an established governance structure and so there is a high procedural asset specificity in both supply chains. Procedural asset specificity refers to the workflows and processes of the actors in a supply chain. Due to these procedural assets it is costly to switch to an alternative supply chain structure (Zaheer & Venkatraman, 1994). So because both supply chains already have a certain governance structure it is costly to change to another structure. This is the case because the actors in both supply chains are familiar with the current structure.

Due to the high procedural asset specificity in both supply chains a lock-in problem will occur for all firms in both supply chains. When there is lock-in problem, parties are locked into a specific relationship because they have invested in highly specific assets for that relationship (Douma & Schreuder, 2008; Slangen et al., 2008). Because of the high procedural asset specificity and lock-in problem in both the broiler meat and pig meat supply chain, it is very difficult and costly to change the governance structure of those supply chains.

In the pig meat supply chain this is especially the case for pig trading companies. According to Hoste (pers. com. 2012) the pig trading companies are less necessary when the pig meat supply chain would switch from a spot market governance structure to contractual agreements like in the broiler meat supply chain. Therefore it can be stated that it is favorable for pig trading companies that the pig meat supply chain is organized like a spot market (Hoste, pers. com. 2012). This situation might reinforce the lock-in of the pig meat supply chain in the current governance structure.

5.2.2 Uncertainty and complexity

It is difficult to measure differences in uncertainty between both supply chains, but differences in price uncertainty can be measured. Analyzing the fluctuation of porker price and broiler spot market price between 2001 and 2011 shows that the fluctuation of the porker price has a much lower standard deviation than the fluctuation of broiler spot market price (table 5.3). The fluctuation of the broiler contracted price has a standard deviation that is lower than that of the porker price (table

5.3). So broiler farmers who make contractual agreements with a slaughter company face less price fluctuation than both porker farmers and broiler farmers without a contract (table 5.3).

Table 5.3: The average porker price (€ per kg carcass weight), broiler spot market price (€ per kg live weight), broiler contract price (€ per kg live weight), minimum and maximum mutation of those prices and the standard deviation of the mutations between 2001 and 2011. The calculation of the price mutations is explained in appendix IV.

	Porker price	Broiler spot market price	Broiler contract price
Average price¹	1.25	0.73	0.73
Minimum mutation¹	-28.49%	-36.36%	-7.86%
Maximum mutation¹	21.05%	60.00%	5.93%
Standard deviation of the mutation¹	0.07	0.13	0.02

¹Calculated based on the prices presented by LEI Bedrijfsinformatienet (2012b).

So it can be stated that broiler farmers without a contract face more risk regarding fluctuating prices than porker farmers. Because broiler farmers face more price uncertainty, price uncertainty can explain why the broiler meat supply chain is more vertically integrated than the pig meat supply chain according to TCE. This can be the case, because a higher level of uncertainty will lead to higher transactions costs and therefore to more vertical integration (Douma & Schreuder, 2008).

This is in line with Van der Vegte (pers. com. 2013) who states that contracts are necessary because broiler farmers without a contract face too much risk that they cannot sell their broilers. Because sometimes the slaughter companies hardly demand additional broilers, on top of the broilers that they have contracted. Because of this, broiler farmers without a contract will sometimes receive a very low price (Van der Vegte, pers. com. 2013).

However, only a few broiler farmers do not have a contract with a broiler slaughter company and are operating on the broiler spot market (Van der Vegte, pers. com. 2013). The small number of broiler farmers operating on the broiler spot market will lead to more fluctuating prices on the broiler spot market (Douma & Schreuder, 2008). So because there is too much price risk involved in operating on the broiler spot market, almost all broiler farmers make contractual agreements with slaughter companies. But because there are only a few broiler farmers operating on the broiler spot market, there is more price risk involved in operating on the broiler spot market than if all broiler farmers would operate on the broiler spot market (Douma & Schreuder, 2008).

Besides price uncertainty there are many other sources of uncertainty, but they are difficult to measure. Therefore it is assumed that they are equal between both supply chains. Although it could bias the results when there are any additional differences in uncertainty between both supply chains.

There are some differences in complexity of the transactions between both supply chains. Pig slaughter companies weekly match the supply of porkers to the demand of pig meat. It is almost always possible to solve differences between supply and demand of porkers. When there are differences between supply and demand, a pig slaughter company can slaughter a number of porkers a week earlier or later. Besides that, pig slaughter companies can buy additional porkers on the spot market when they face a shortage of porkers (Hoste, pers. com. 2012).

In the broiler meat supply chain it is less easy to solve differences between supply and demand. This is the case for two reasons. Firstly, when broilers are already hatched the slaughter date of broilers can be shifted fewer days than the slaughter date of porkers (Van Horne, pers. com. 2013; Hoste, pers. com. 2013). Shifting too much with the slaughter date of broilers results in disproportional and unwanted quality losses (Van Horne, pers. com. 2012). Besides to more complexity, this also leads to a higher level of physical asset specificity in the broiler meat supply chain compared to the pig meat supply chain (Martinez, 2002; Ménard & Klein, 2004).

Although the slaughter date of broilers can be shifted less than the slaughter date of porkers, the contracts between broiler farmers and slaughter companies do not exactly determine at which date the broilers of the six or seven production cycles covered by the contract will be slaughtered (Van der Vegte, pers. com. 2013). The slaughter date is not exactly determined because it is unclear in advance whether light or heavy broilers will be produced in a certain production cycle (Van der Vegte, pers. com. 2013). The contracts with the hatchery also do not determine specific dates at which day-old chicks will be delivered to the broiler farmer. When the chicks of the current flock are approximately three weeks old it is determined when a new flock of day-old chicks will be delivered by the hatchery (Van der Vegte, pers. com. 2013).

Although the contracts do not determine specific slaughter dates and dates of delivery of day-old chicks, the contracts lead to more efficiency in the broiler meat supply chain (Beltman, pers. com. 2013). Due to the contracts, it is more easy for slaughter companies, hatcheries and broiler farmers to optimally use their production capacity (Beltman, pers. com. 2013; Van Horne, pers. com. 2013).

Secondly, resulting from the first, there is hardly a spot market for broilers. So broiler slaughter companies cannot solve shortages of broilers by buying additional broilers on the spot market (Van Horne, pers. com. 2012). Because of these two reasons a constant supply of hatching eggs and broilers must be created, which is done through contracts (Van Horne, pers. com. 2012).

These two reasons for the use of contracts in the broiler meat supply chain are in line with TCE, because TCE states a supply chain becomes more vertically integrated when the transaction becomes more complex (Douma & Schreuder, 2008; Hobbs, 1996). The transactions in the broiler meat supply chain are more complex than those in the pig meat supply chain, because it is more difficult to solve for differences in supply and demand of broilers (Hoste, pers. com. 2012; Van Horne, pers. com. 2012).

Furthermore, due to the all-in, all-out system applied by broiler farmers, each broiler farmer delivers a large amount of broilers at once to a broiler slaughter company every seven to eight weeks. Delivery of 100,000 broilers at once by one broiler farmer is very common (Van Horne, pers. com. 2012). These are large amounts, especially compared to the average amounts of porkers that are weekly delivered to a pig slaughter company by each porker farmer at once (Van Horne, pers. com. 2012; Hoste, pers. com. 2012). Without contracts in the broiler meat supply chain it is difficult to match the large amounts of broilers that each broiler farmer supplies to a slaughter company every seven to eight weeks with the demand for broiler meat (Van Horne, pers. com. 2012).

So it can be stated that the transactions in the broiler meat supply chain are also more complex than in the pig meat supply chain due to the applied all-in, all-out system (Van Horne, pers. com. 2012; Hoste, pers. com. 2012). Therefore, according to TCE, the application of an all-in, all-out system on most broiler farms and a system of weekly porker delivery on most porker farms could also be a reason why contracts are applied in the broiler meat supply chain and why the pig meat supply chain is organized as a spot market.

5.2.3 Frequency

According to Van Horne (pers. com. 2012) the idea in the Dutch broiler meat supply chain is that contracts are applied, amongst others because the transactions take place very often. This is not in line with TCE, because TCE states that the level of vertical integration goes up when the frequency of transaction goes down (Douma & Schreuder, 2008; Hobbs, 1996).

Because there are approximately seven production cycles per year on a broiler farm, a broiler farmer delivers broilers seven times per year to a slaughter company (Tacken et al., 2003). So there are approximately seven transactions per year between a broiler farmer and a broiler slaughter company. Most porker farmers weekly deliver porkers to a slaughter company (Wageningen UR Verantwoorde Veehouderij, 2012). So there are approximately 52 transactions per year between a porker farmer and a pig slaughter company. These numbers show that there is a large difference in frequency of the transaction between broiler farmers and a broiler slaughter company and porker farmers and a pig slaughter company.

The large difference in frequency of the transactions between both supply chains could explain why contracts are applied in the broiler supply chain, while the pig meat supply chain is organized as a spot market. Since a lower frequency leads to more vertical integration according to TCE (Douma & Schreuder, 2008; Hobbs, 1996). Although this is not in line with Van Horne (pers. com. 2012).

Both Hoste (pers. com. 2012) and Van Horne (pers. com. 2012) cannot state whether the different length of the production cycles between the broiler meat supply chain and the pig meat supply chain have any effect on the governance structure of both supply chains. Although it could be the case that, due to the short production cycle of broilers, shifting with the slaughter date of broilers has more impact on both costs and benefits of broiler farmers and on the quality of the broilers compared to shifting with the slaughter date of porkers. Since shifting the broiler slaughter date with one week leads to a much larger adjustment of the length of the production cycle than shifting one week with the slaughter date of porkers. This is in line with Van Horne (pers. com. 2012) who states that shifting the slaughter date of broilers with one week leads to unwanted quality losses. It is also in line with Hoste (pers. com. 2012) who states that it is possible to shift the slaughter date of porkers with at least one week.

5.2.4 Overview results TCE

There is more site specificity and temporal asset specificity in the broiler meat supply chain, which can explain why, according to TCE, contract farming is applied in the broiler meat supply chain while the pig meat supply chain is organized as spot market (Martinez, 2002; Ménard & Klein, 2004). It is assumed that both supply chains have a high and almost equal level of physical, human and dedicated asset specificity and brand name capital. The high level of procedural asset specificity in both supply chains leads to a lock-in problem. Due to this, it is difficult and very costly to change from

the current governance structure to another in both supply chains (Douma & Schreuder, 2008; Slangen et al., 2008; Zaheer & Venkatraman, 1994).

Broiler farmers without a contract have faced more price uncertainty than porker farmers between 2001 and 2011. The broiler spot market price fluctuated more than the porker price (LEI Bedrijfsinformatienet, 2012b). Since a supply chain will become more vertically integrated when uncertainty goes up, price uncertainty can explain why the broiler meat supply chain applies contract farming while the pig meat supply chain is organized as a spot market (Douma & Schreuder, 2008; Hobbs, 1996). Broiler farmers who made contractual agreements with slaughter companies have faced less price uncertainty between 2001 and 2011 than both porker farmers and broiler farmers without a contract (LEI Bedrijfsinformatienet, 2012b). Although it should be mentioned that price uncertainty on the broiler spot market goes up, because there are only a few firms operating on that spot market (Douma & Schreuder, 2008; Van der Vegte, pers. com. 2013).

Because it is more complex to solve for differences between supply and demand in the broiler meat supply chain compared to the pig meat supply chain, there is more complexity involved in the transactions in the broiler meat supply chain (Hoste, pers. com. 2012; Van Horne, pers. com. 2012). There is also more complexity involved because broiler farmers apply an all-in, all-out system while porkers are weekly delivered to a slaughter company (Van Horne, pers. com. 2012; Wageningen UR Verantwoorde Veehouderij, 2012). According to TCE, these differences can be reasons why contract farming is applied in the broiler meat supply chain and not in the pig meat supply chain.

The transaction between broiler farmers and broiler slaughter companies has a much lower frequency than the transaction between porker farmers and pig slaughter companies. According to TCE this can explain why contracts are applied in the broiler meat supply chain and not in the pig meat supply chain.

Both Hoste (pers. com. 2012) and Van Horne (pers. com. 2012) cannot state whether the difference in length of the production cycles between broilers and porkers is a reason for the different governance structures of both supply chains. But it could be that the difference in length of the production cycles explains why contracts are applied in the broiler meat supply chain and not in the pig meat supply chain, since shifting the slaughter date of broilers with one week has much more impact on the length of the production cycle than shifting the slaughter date of porkers with one week (Van Horne, pers. com. 2013; Hoste pers. com. 2013).

6 Conclusions and discussion

This chapter consists of the conclusions based on the results from this research, described in section 6.1. An overview of the most important results is also provided. Besides that there are some discussion points described in section 6.2.

6.1 Conclusions

The Dutch pig meat supply chain is operating in the European pig market, which is approximately 110% self sufficient. The pig meat supply chain is organized like a spot market. There are no contractual agreements within the pig meat supply chain. Prices for both porkers and piglets are determined by a spot market and are varying weekly.

In the pig meat supply chain piglets are weekly delivered to porker farms and porkers are weekly delivered to slaughter companies. Besides direct relationships between sow farmers and porker farmers there are trading companies who facilitate the transaction of piglets from sow farmers to porker farmers. The same applies for the relationship between porker farmers and slaughter companies. Trading companies are necessary to optimally link the supply of piglets to the demand of porkers and because of market imperfections between porker farmers and slaughter companies.

The Dutch broiler meat supply chain is operating in the North-European market for fresh broiler meat. A characteristic is that broiler farms apply an all-in, all-out system, so all broilers at the farm are sold to a slaughter company at once and replaced by new day-old chicks.

The broiler meat supply chain is characterized by some vertical integration. Most broiler breeder farmers make contractual agreements with hatcheries and feed companies. Most broiler farmers make contractual agreements with hatcheries, slaughter companies and feed companies. Mostly marketing contracts are applied which are agreements that keep most management decisions to the broiler (breeder) farmers. The broiler (breeder) farmers are owner of the broilers or broiler breeders during the production process on their farm.

Both supply chains are characterized by many farmers and only a few and often concentrated companies on all other levels of the supply chains. More than 50% of the market share is in the hands of only two breeding organizations, two slaughter companies, two retail companies and three feed companies in both supply chains. The hatchery level in the broiler meat supply chain is less concentrated. The concentration of pig trading companies is unknown. Although most levels of both supply chains are concentrated, it cannot be stated that farmers in both supply chains are doing business with firms with market power, at least up and till now.

The contractual agreements in the broiler meat supply chain can act as an entry barrier. Because broiler (breeder) farmers that enter the supply chain firstly need a contract with a hatchery and slaughter company in most cases before they can start production. Slaughter companies and hatcheries that will enter the supply chain also need contracts with broiler (breeder) farmers before they can start producing. Because of this, the contracts can be a reason why broiler (breeder) farmers have had on average higher incomes than pig farmers between 2001 and 2011, although other factors also play a role in determining the income of farmers.

Both porker farmers and broiler (breeder) farmers have a similar attitude. They do not want to do business with a pig meat or broiler meat integrator based on production contracts. When doing business with such an integrator a farmer gets a fixed compensation for taking care of the broilers. That is not in line with the idea of entrepreneurship that Dutch pig farmers and broiler (breeder) farmers have.

In contrast to the Netherlands, there are large integrators in the United States (US) broiler meat and pig meat supply chain. They are doing business with broiler (breeder) farmers based on production contracts and with pig farmers based on marketing contracts, although production contracts are also becoming more common in the US pig meat supply chain. These differences in governance structure between the Netherlands and the US are caused by different circumstances in both countries.

There is more site specificity and temporal asset specificity in the broiler meat supply chain compared to the pig meat supply chain, which seems likely to explain why the broiler meat supply chain is more vertically integrated than the pig meat supply chain. Both supply chains have a high and almost equal level of physical, human and dedicated asset specificity and brand name capital. Because there is a high level of procedural asset specificity in both supply chains, there is a lock-in problem. Due to the lock-in problem it is very difficult and costly to change the current governance structure of both supply chains into another one. This effect might be stronger in the pig meat supply chain because of the pig trading companies. They are less necessary when a more vertically integrated governance structure is applied in that supply chain.

Broiler farmers without a contract face much more price uncertainty than porker farmers. This difference in uncertainty seems likely to explain why contractual agreements are applied in the broiler meat supply chain and not in the pig meat supply chain. Because Transaction Cost Economics (TCE) states that the higher the uncertainty of a transaction is, the more vertically integrated that transaction will be. Broiler farmers who have a contract with a slaughter company face less price uncertainty than both broiler farmers without a contract and porker farmers. The price uncertainty for broiler farmers without a contract is also a result of the fact that there are only a few broiler farmers operating on the broiler spot market. There are many other sources of uncertainty, but they are difficult to measure and therefore not analyzed in this research.

The transaction between broiler farmers and broiler slaughter companies is more complex than the transaction between porker farmers and pig slaughter companies. Because it is less easy to match supply and demand of broilers than supply and demand of porkers. This is the case because the slaughter date of broilers can be shifted fewer days than the slaughter date of porkers. This results in a more complex transaction in the broiler meat supply chain and therefore it should lead to more vertical integration according to TCE. So contracts are applied in the broiler meat supply chain and not in the pig meat supply chain because it is more difficult to match supply and demand of broilers.

Due to the all-in, all-out system applied in the broiler meat supply chain, each broiler farmer delivers large amounts of broilers to a slaughter company every seven to eight weeks. This is in contrast to porker farmers that weekly deliver smaller amounts of porkers to a slaughter company. Therefore, without contracts it is more complex to match the supply and demand of broilers which results in more complexity of the transactions in the broiler meat supply chain. According to TCE this is can

explain why contract farming is applied in the broiler meat supply chain while the pig meat supply chain is organized like a spot market.

The transaction between a broiler farmer and a slaughter company is less frequent than that between a porker farmer and a slaughter company. According to TCE this could explain why the broiler meat supply chain is more vertically integrated than pig meat supply chain.

It is plausible that the different lengths of the production cycles between both supply chains explain why contracts are applied in the broiler meat supply chain, while the pig meat supply chain is organized like a spot market. Since shifting with the slaughter date of broilers has much more impact on the costs and benefits of broiler farmers and on the quality of broilers than shifting with the slaughter date of porkers. Since shifting the slaughter date of broilers with one week leads to a much larger adjustment of the length of the production cycle than shifting the slaughter date of porkers with one week.

6.2 Discussion

As in every scientific research, there are some points of discussion regarding this research. This section mentions some main discussion points and provides recommendations for additional research. A first point for additional research is that the sources of entry barriers and asset specificity in both supply chains could be investigated more in depth. In this research, it was assumed that only one source of entry barriers differed between both supply chains. It was also assumed that for most types asset specificity was almost equal between both supply chains. Because of the topic of and time available for the research, this was the best option, but additional research should confirm these assumptions.

Furthermore, the relation between contracts and the performance of a supply chain could be investigated more in depth. This research stated that it could be the case that contract farming leads to a better performance of a supply chain compared to spot market organization. Because the contracts can act as entry barrier and entry barriers can lead to higher profits within a supply chain. However it was not analyzed whether there really exists a relationship between contracts and profit.

The main focus of this research was on the relationships between farmers and the firms with which the farmers are doing business. Additional research could focus on the other relationships within both supply chains and investigate if those relationships are also differently organized. Differences in the relationship between slaughter companies and retail for example might also explain differences in governance structure between both supply chains.

References

- ABN AMRO. (2008). *Focus op Agrifood. Brancherapport 2008*. Amsterdam: ABN AMRO.
- ABN AMRO. (2012). *Visie op food. Sectorupdate 2012*.
- Agrifirm. (2012). *coöperatie*. Retrieved 10 09, 2012, from Agrifirm.com:
<http://www.agrifirm.com/agrifirm-group/cooperatie>
- Aviagen Group. (2012). About Us/ *Global Security of Supply*. Retrieved 10 12, 2012, from aviagen.com: <http://en.aviagen.com/global-security-of-supply/>
- Backus, G., Baltussen, W., Bens, P., & Reinders, M. (2012). *De Nederlandse varkensvleesketen richting 2020. Van speelbal tot speler*. Den Haag: LEI Wageningen UR Report 2012-013.
- Barkema, A., Drabentstott, M., & Novack, N. (2001). The New U.S. Meat Industry. *Economic Review. Federal Reserve Bank of Kansas City. Second Quarter 2001*, 33-56.
- Berkhout, P., & Bruchem, C. van. (2003-2011). *Landbouw-Economisch Bericht 2003-2011*. Den Haag: LEI Wageningen UR.
- Berkhout, P., & Bruchem, C. van. (2010). *Landbouw-Economisch Bericht 2010*. Den Haag: LEI Wageningen UR Report 2010-013.
- Berkhout, P., & Roza, P. (2012). *Landbouw-Economisch Bericht 2012*. Den Haag: LEI Wageningen UR.
- Bijman, J., & Eaton, D. (2003). *Conservering van genetische bronnen voor de landbouw in Nederland. Organisatie en institutionele inbedding*. Den Haag: LEI Wageningen UR Report 7.03.14.
- Boerderij. (2009a, 08 28). *Achtergrond*. Retrieved 10 02, 2012, from boerderij.nl:
<http://www.boerderij.nl/Home/Achtergrond/2009/8/Recordaantal-varkenshouders-neemt-ander-voerbedrijf-AGD151749W/>
- Boerderij. (2009b, 10 01). *Samenvoeging grootmachten logische stap*. Retrieved 01 10, 2013, from boerderij.nl: <http://www.boerderij.nl/Home/Achtergrond/2009/9/Samenvoeging-grootmachten-logische-stap-BOE009598W/>
- Boerderij. (2010a, 05 26). *Fusie Agrifirm en Cehave Landbouwbelang rond*. Retrieved 10 09, 2012, from boerderij.nl: <http://www.boerderij.nl/Home/Achtergrond/2010/5/Fusie-Agrifirm-en-Cehave-Landbouwbelang-rond-AGD162779W/>
- Boerderij. (2010b, 02 01). *De eerste opfokkuikens in nieuwe stal*. Retrieved 10 30, 2012, from boerderij.nl: http://www.boerderij.nl/Pluimveehouderij/Foto-Video/2010/2/De-eerste-opfokkuikens-in-nieuwe-stal-BOE017629W/?nb=boerderij_pluimveehouderij&editie=02%20februari%202010&link=Eerste%20opfokkuikens%20in%20nieuwe%20stal&WT.mc_id=mail_boerderij_pluimveehouderij
- Boerderij. (2010c, 12 17). *De Heus sluit overeenkomst met Aviagen Epi*. Retrieved 10 30, 2012, from boerderij.nl: <http://www.boerderij.nl/Home/Nieuws/2010/12/De-Heus-sluit-overeenkomst-met-Aviagen-EPI-AGD557788W/>
- Boerderij. (2011a, 07 01). *Cehave Landbouwbelang*. Retrieved 10 09, 2012, from boerderij.nl: <http://www.boerderij.nl/Home/Achtergrond/2009/11/Cehave-Landbouwbelang-AGD141257W/>
- Boerderij. (2011b, 09 14). *Cobb investeert in Europa*. Retrieved 10 11, 2012, from boerderij.nl: <http://www.boerderij.nl/Home/Achtergrond/2011/9/Cobb-investeert-in-Europa-BOE014749W/>
- Boerderij. (2012, 07 02). *Van Rooi slacht fors meer varkens in 2011*. Retrieved 11 13, 2012, from boerderij.nl: <http://www.boerderij.nl/Varkenshouderij/Nieuws/2012/2/Van-Rooi-slacht-fors-meer-varkens-in-2011-AGD580519W/>

- Bondt, N., Bont, C. de., Cotteleer, G., Haan, M. de., Sengers, H., & Vlieger, J. de. (2003). *Ontwikkelingen in de vleesindustrie tot 2007*. Den Haag: LEI Wageningen UR Report 5.03.07.
- Bont, C. de., Everdingen, W. van., Knijff, A. van., & Meulen, H. van. (2011). *Actuele ontwikkeling van de resultaten en inkomens in de land- en tuinbouw in 2011*. Den Haag: LEI Wageningen UR Report 2011-063.
- Bos, A., & Janssen, A. (2010). De Pluimveevleesproductieketen in kaart. Wageningen UR Livestock Research.
- Boston, C. D. (2003). *Analysis of the Dutch Pork Industry. To generate competitive strategies*. Wageningen: Wageningen University.
- Boyd, W., & Watts, M. (1997). Agro-Industrial Just-In-Time. The Chicken Industry and Postwar American Capitalism. In D. Goodman, & M. Watts, *Globalising food. Agrarian questions and global restructuring* (pp. 192-225). London: Routledge.
- Bugos, G. (1992). Intellectual Property Protection in the American Chicken-Breeding Industry. *The Business History Review*, Vol. 66, No. 1, 127-168.
- Bunte, F., Kuiper, W., Galen, M. van., & Goddijn, S. (2003). *Macht en Prijsvorming in Agrofoodketens*. Den Haag: LEI Wageningen UR Report 5.03.01.
- Carlton, D., & Perloff, J. (2005). *Modern Industrial Organization*. Addison-Wesley.
- Caves, R., & Porter, M. (1977). From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterrence to New Competition. *The Quarterly Journal of Economics*, Vol. 91, No 2, 241-262.
- CBS. (2012, 02 23). *Statline*. Retrieved 09 04, 2012, from CBS: <http://statline.cbs.nl>
- De Heus. (2012). *About*. Retrieved 10 09, 2012, from de heus: <http://www.deheus.com/About/default.aspx>
- De Hoop. (2013). *Bedrijf: Specialisme De Hoop Mengvoeders*. Retrieved 01 16, 2013, from www.dehoop-zelhem.nl: <http://www.dehoop-zelhem.nl/?pagina=bedrijf>
- Douma, S., & Schreuder, H. (2008). *Economic Approaches to Organizations*. Harlow: Pearson Education Limited.
- DR-Loket. (2013). *Het houden van dieren*. Retrieved 01 10, 2013, from [hetInvloket.nl](http://www.hetInvloket.nl): <http://www.hetInvloket.nl/onderwerpen/mest/dossiers/dossier/dierproductierechten/het-houden-van-dieren>
- Ellen, H., Leenstra, F., Emous, R. van., Groenestein, K., Harn, J. van., Horne, P. van., Jong, I. de., Kense, M., Mevius, D., Wagenaar, J. (2012). *Vleeskuikenproductiesystemen in Nederland. Vergelijkende studie*. Lelystad: Wageningen UR Livestock Research Report 619.
- Emous, R. van. (2007). Later loont. *Pluimveehouderij* 37, November 2007, 35.
- Exterkate, R. (2008). Verdubbelen in zeugen of gesloten worden. *Varkensbedrijf* No. 9 November 2008, 20-21.
- Field, A. (2009). *Discovering Statistics Using SPSS. Third Edition*. London: SAGE Publications LTD.
- Foodpersonality. (2012, 01 30). *Branche/ Marktaandeelen 2011*. Retrieved 12 10, 2012, from [foodpersonality.nl](http://www.foodpersonality.nl): <http://www.foodpersonality.nl/marktaandeelen-2011.html>
- FromFarmers. (2012). Retrieved 10 09, 2012, from [fromfarmers.eu](http://www.fromfarmers.eu): <http://www.fromfarmers.eu/nl/>
- Gereffi, G., Lee, J., & Christian, M. (2008). *The Governance Structures of U.S.-Based Food and Agriculture Value Chains and their Relevance to Healthy Diets*. Durham: Duke University.
- Groen, A., Jiang, X., Emmerson, D., & Vereijken, A. (1998). A Deterministic Model for the Economic Evaluation of Broiler Production Systems. *Poultry Science* 77, 925-933.

- Groupe Grimaud. (2012). *Contacts et accès*. Retrieved 10 11, 2012, from grimaud.com:
http://www.grimaud.com/fr/contact_index.html
- Guldbrandsen, B., & Haugland, S. (2000). *Explaining vertical integration: Transaction cost economics and competence considerations*. Bergen: Foundation for research in economics and business administration.
- Hayenga, M. (2000). *Structural changes in the pork production and processing industry of the U. S. and other OECD countries: major trends and issues*. Paris: Organization for Economic Co-operation and Development (OECD).
- Hendrix Genetics. (2012). About Us/ *Facts and Figures*. Retrieved 10 11, 2012, from hendrixgenetics.nl: <http://www.hendrixgenetics.nl>
- Hobbs, J. (1996). A transaction cost approach to supply chain management. *Supply Chain Management: An International Journal, Vol 1, Iss 2*, 15-27.
- Hobbs, J., & Young, L. (2001). *Vertical Linkages in Agri-Food Supply Chains in Canada and the United States*. Ottawa: Research and Analysis Directorate. Strategic Policy Branch. Agriculture and Agri-Food Canada.
- Holman, T., Feuz, D., & Baltensperger, D. (2006). *An Introduction to Agricultural Production and Marketing Contracts*. Lincoln: Lincoln Extension, Institute for Agriculture and Natural Resources. University of Nebraska.
- Horne, P. van. (1996). *Waarom kunnen Amerikanen zo goedkoop vleeskuikens produceren?* LEI-DLO. Praktijkonderzoek 96/1.
- Horne, P. van. (2007). *Ketenorganisatie van de Nederlandse vleeskuikensector in internationaal perspectief*. Wageningen: LEI Wageningen UR Verantwoorde Veehouderij.
- Horne, P. van. (2009). *Productiekosten van kuikenvlees: Een internationale vergelijking*. Den Haag: LEI Wageningen UR Report 2009-004.
- Horne, P. van., Vermeij, I., & Ellen, H. (2004). *Concurrentiepositie van de Nederlandse broedeisector*. Den Haag: LEI Wageningen UR Report 2.04.01.
- Horne, P. van., & Bondt, N. (2006). *Kostprijzontwikkeling kuikenvlees 2004-2010. Basisjaar 2004*. Den Haag: LEI Wageningen UR Report 2.06.02.
- Horne, P. van., Asseldonk, M. van., & Bergevoet, R. (2011). *Verzekeren van broedeieren bij een uitbraak van vogelgriep*. Den Haag: LEI Wageningen UR Report 2011-008.
- Hoste, R., Bondt, N., & Ingenbleek, P. (2004). *Visie op de varkenskolom*. Wageningen: LEI Wageningen UR Report 207.
- Janssens, S., Hoste, R., Baltussen, W., & Bunte, F. (2012). *Handelsrelaties in de aardappel- en varkenssector. De relatie tussen aanbieder en afnemer*. Den Haag: LEI Wageningen UR Report 2011-077.
- Karetsos, K. (2009). *Economic impact of alternative contracts on Dutch broiler chain performance*. Wageningen: Wageningen University Student Report.
- Kliebenstein, J., & Lawrence, J. (1995). Contracting and Vertical Coordination in the United States Pork Industry. *American Journal of Agricultural Economics, vol. 77, No. 5*, 1213-1218.
- LEI & CBS. (2011). *Sector in cijfer/ land- en tuinbouwcijfers/ Inkomen en financiering/ bedrijfsresultaten*. Retrieved 09 18, 2012, from www.lei.wur.nl:
<http://www3.lei.wur.nl/ltc/Classificatie.aspx>
- LEI Bedrijfsinformatienet. (2012a). *Inkomen en financiering/ bedrijfsresultaten*. Retrieved 09 18, 2012, from [www.lei.wur.nl](http://www3.lei.wur.nl): <http://www3.lei.wur.nl/ltc/Classificatie.aspx>

- LEI Bedrijfsinformatienet. (2012b). *Agrarische prijzen*. Retrieved 11 19, 2012, from [www.lei.wur.nl: http://www3.lei.wur.nl/BIN_ASp/frm_start_binternet.aspx?Database=Prijzen](http://www3.lei.wur.nl/BIN_ASp/frm_start_binternet.aspx?Database=Prijzen)
- Manning, L., & Baines, R. (2004). Globalisation: a study of the poultry-meat supply chain. *British Food Journal*, Vol. 106, Iss. 10, 819-836.
- Martin, L., & Zering, K. (1997). Relationships Between Industrialized Agriculture and Environmental Consequences: The Case of Vertical Coordination in Broilers and Hogs. *Journal of Agricultural and Applied Economics*, Vol. 29, No. 1, 45-56.
- Martinez, S. (1999). *Vertical Coordination in the Pork and Broiler Industries: Implications for Pork and Chicken Products*. Washington DC: Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 777.
- Martinez, S. (2002). A Comparison of Vertical Coordination in the U.S. Poultry, Egg, and Pork Industries. *Current Issues in Economics of Food Markets. Agriculture Information Bulletin*, No. 747-05, 1-6.
- Ménard, C. (2005). A New Institutional Approach to Organization. In C. Ménard, & M. Shirley, *Handbook of New Institutional Economics* (pp. 281-318). Dordrecht: Springer.
- Ménard, C., & Klein, P. (2004). Organizational Issues in the Agrifood Sector: Toward a Comparative Approach. *American Journal of Agricultural Economics*. Vol. 86, no 3., 750-755.
- Napel, J. ten., Oonk, R., & Hiemstra, S. (2011). *Ontwikkelingen in octrooien die invloed hebben op het gebruiksrecht van dieren in de veehouderij*. Lelystad: Wageningen UR Livestock Research Report 523.
- National Chicken Council. (2011, 02 07). *About the Industry/ Statistics/ How Broilers are Marketed*. Retrieved 02 07, 2013, from [nationalchickencouncil.org: http://www.nationalchickencouncil.org/about-the-industry/statistics/how-broilers-are-marketed/](http://www.nationalchickencouncil.org/about-the-industry/statistics/how-broilers-are-marketed/)
- National Chicken Council. (2012a). *Industry Issues/ Industry Structure/ Vertical Integration*. Retrieved 02 06, 2013, from [nationalchickencouncil.org: http://www.nationalchickencouncil.org/industry-issues/vertical-integration/](http://www.nationalchickencouncil.org/industry-issues/vertical-integration/)
- National Chicken Council. (2012b). *About the Industry/ Statistics/ Domestic Market Segments*. Retrieved 02 06, 2013, from [nationalchickencouncil.org: http://www.nationalchickencouncil.org/about-the-industry/statistics/domestic-market-segments/](http://www.nationalchickencouncil.org/about-the-industry/statistics/domestic-market-segments/)
- National Chicken Council. (2013, 01 11). *About the Industry/ Statistics/ Broiler Exports Quantity & Share of Production*. Retrieved 02 07, 2013, from [nationalchickencouncil.org: http://www.nationalchickencouncil.org/about-the-industry/statistics/u-s-broiler-exports-quantity-and-share-of-production/](http://www.nationalchickencouncil.org/about-the-industry/statistics/u-s-broiler-exports-quantity-and-share-of-production/)
- Nieuwe Oogst. (2011, 11 16). *Overname Hendrix spekt kas ForFarmers*. Retrieved 10 09, 2012, from [nieuweoogst.nu: http://www.nieuweoogst.nu/scripts/edoris/edoris.dll?tem=LTO_TEXT_VIEW&doc_id=1551411](http://www.nieuweoogst.nu/scripts/edoris/edoris.dll?tem=LTO_TEXT_VIEW&doc_id=1551411)
- Nijenhuis, E., & Ruitkamp, F. (2002). Virtuele Integratie Pluimveevleesketen. Het ei van Columbus? *Agro-Informatica*, juli 2002, 7-9.
- NRC. (2011, 11 24). *Overname C1000 kost Jumbo 900 miljoen euro*. Retrieved 10 09, 2012, from [nrc.nl: http://www.nrc.nl/nieuws/2011/11/24/overname-c1000-kost-jumbo-900-miljoen-euro/](http://www.nrc.nl/nieuws/2011/11/24/overname-c1000-kost-jumbo-900-miljoen-euro/)

- Ohanian, N. (1994). Vertical Integration in the U.S. Pulp and Paper Industry, 1900-1940. *The Review of Economics and Statistics*. Vol. 76, No. 1, 202-207.
- Pan, C., & Kinsey, J. (2002). *The Supply Chain of Pork: U.S. and China*. St. Paul: The Food Industry Center. University of Minnesota Working Paper 02-01.
- Perloff, J., Karp, L., & Golan, A. (2007). *Estimating Market Power and Strategies*. New York: Cambridge University Press.
- Perry, J., Morehart, M., Banker, D., & Johnson, J. (1997). Contracting-A Business Option for Many Farmers. *Agricultural Outlook May 1997*, 2-5.
- Pilgrim's. (2013). *Our company/ Our chickens*. Retrieved 02 06, 2013, from pilgrims.com: <http://www.pilgrims.com/company/our-chickens.aspx>
- Pluimveehouderij. (2012). Welzijnsplus heeft wind in de rug. *Pluimveehouderij 42, 11 mei*, 7-9.
- Pluvita. (2012). *Home*. Retrieved 10 30, 2012, from pluvita.nl: <http://www.pluvita.nl/>
- Pollock, D. (1999). A Geneticist's Perspective from Within a Broiler Primary Breeder Company. *Poultry Science* 78, 414-418.
- Porter, M. (1979). How Competitive Forces Shape Strategy. *Harvard Business Review March-April 1979*.
- PPE. (2010). *Duurzaam ondernemen in de pluimveesector. MVO-verslag*. Zoetermeer: Productschap, Pluimvee en Eieren.
- PPE. (2012). *Statistisch Jaarrapport pluimveevlees en eieren 2011. Definitief*. Zoetermeer: Productschap, Pluimvee en Eieren.
- Price, F., & Swanson, M. (1977). *All-in, All-out Replacement System*. University of California. Division of Agricultural Sciences. Leaflet 2626.
- PVE. (2012a). *Varkenssector. Statistisch Jaarrapport 2011 Definitief*. Zoetermeer: Productschap Vee en Vlees.
- PVE. (2012b). *Vee, Vlees en Eieren in Nederland. Kengetallen 2011*.
- PVE. (2012c). *Varkens/ Markt/ Uitvoer*. Retrieved 12 5, 2012, from pve.nl: https://apps.mijnpve.nl/DB-P/mivwpve.miv_pck_webinfo.webinfo_parameters?i_pag_id=62&i_pub_id=69&i_week_van=1&i_jaar_van=2011&i_week_tm=53&i_jaar_tm=2011&i_actie=Start
- PVE. (2012d). *Varkens/ Markt/ Invoer*. Retrieved 12 5, 2012, from pve.nl: https://apps.mijnpve.nl/DB-P/mivwpve.miv_pck_webinfo.webinfo_parameters?i_pag_id=1&i_pub_id=71&i_week_van=1&i_jaar_van=2011&i_week_tm=53&i_jaar_tm=2011&i_actie=Start
- Rehber, E. (1998). *Vertical Integration in Agriculture and Contract Farming. Working Paper #46*. Storrs, Connecticut: Food Marketing Policy Center, University of Connecticut.
- Rhodes, V. (1995). The Industrialization of Hog Production. *Review of Agricultural Economics*, Vol. 17, No. 2, 107-118.
- Roy, E. (1963). *Contract Farming, U.S.A.* Danville: The Interstate printers & publishers Inc.
- Silvis, H., & Bruchem, C. van. (2001-2002). *Landbouw-Economisch Bericht 2001-2002*. Den Haag: LEI Wageningen UR.
- Simon, H. (1961). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization*. New York: The Macmillan Company.
- Slangen, L., Loucks, L., & Slangen, A. (2008). *Institutional economics and economic organisation theory : an integrated approach*. Wageningen: Wageningen Academic Publishers.
- Snijders, H., Vrolijk, H., & Jacobs, D. (2007). *De economische kracht van agrofood in Nederland*. Ministerie van Landbouw, Natuur en Voedselkwaliteit en Rijksuniversiteit Groningen.

- Superunie. (2012). *Over Superunie*. Retrieved 12 10, 2012, from superunie.nl:
<http://www.superunie.nl/>
- Supply Chain Magazine. (2009). Honger naar convenience food blijft. Gemaksvoeding stelt hogere eisen aan de keten. *Supply Chain Magazine, No. 3*, 66-69.
- Tacken, G., Leeuwen, M. van., Koole B., Horne, P. van., Vlieger, J. de., & Bont, C. de. (2003). *Ketenconsequenties van de uitbraak van vogelpest*. Den Haag: LEI Wageningen UR Report 6.03.06.
- Teece, D., Armour, H., & Saloner, G. (1981). *Vertical Integration and Risk Reduction*. Stanford University Research Paper No. 563.
- Tyson Foods. (2013). *About Tyson/ Our Products*. Retrieved 02 06, 2013, from tysonfoods.com:
<http://www.tysonfoods.com/About-Tyson/Products.aspx>
- Varkens. (2006). Vierwekensysteem verbetert contactstructuur. *Varkens, 19 juli 2006*, 38-38.
- varkensenzo.nl. (2004). *Varkenshouderij/ De sector*. Retrieved 09 26, 2012, from varkensenzo.nl:
<http://www.varkensenzo.nl/NL/>
- Veterinair Centrum Someren. (2012). *Pluimvee/ Vleessector*. Retrieved 10 30, 2012, from vc-someren.nl: <http://www.vc-someren.nl/G4751,P4980,C4983/Pluimvee/Vleessector/fokkerij.aspx>
- Wagenberg, C. van. (2010). *Incentive mechanisms for food safety control in pork supply chains. A study on the relationship between finishing pig producers and slaughterhouses in the Netherlands*. Wageningen: Wageningen University.
- Wageningen UR Verantwoorde Veehouderij. (2012). *Managementmaatregelen/ Bedrijfsprotocollen/ Voorbeeldhandleiding "Afvoer van varkens"*. Retrieved 11 19, 2012, from gezondcijfers.nl:
<http://www.verantwoordeveehouderij.nl/index.asp?gezondcijfers/home/projectinfo/index.asp>
- Whinston, M. (2003). On the Transaction Cost Determinants of Vertical Integration. *The Journal of Law, Economics, & Organization, Vol. 19, No. 1*.
- Williamson, O. (1998). Transaction Costs Economics: How it Works; Where it is Headed. *De Economist 146, No1*, 23-58.
- Williamson, O. (2002). The Theory of the Firm as Governance Structure: From Choice to Contract. *The Journal of Economic Perspectives, Volume 16, No. 3, August 2002*, 171-195.
- Winter, M. de., & Tacken, G. (2010). *Concurrentiemonitor varkensvlees*. Den Haag: LEI Wageningen UR Report 2010-016.
- Wognum, P., Wever, M., Nijhoff-Savvaki, O., Trienekens, J., & Omta, O. (2008). *Towards a multi-dimensional framework for characterising and comparing pork chains*. Wageningen: Wageningen UR.
- Zaheer, A., & Venkatraman, N. (1994). Determinants of Electronic Integration in the Insurance Industry: An Empirical Test. *Management Science, Volume 40, No. 5*, 549-566.
- Zonderland, J., & Enting, J. (2006). *Varkenshouderij in Brazilië. Sterke integraties en stevige merken*. Lelystad: ASG Wageningen UR Praktijkrapport Varkens 48.

Appendices

Appendix I: The pig meat supply chain in the United States

This appendix consists of a short description of the pig meat supply chain in the United States (US). It is further explained why the governance structure of the US pig meat supply chain differs from the governance structure of the Dutch pig meat supply chain. The goal of this appendix is not to provide a complete description and analysis of the governance structure of the pig meat supply chain in the US. The goal is to provide a short overview of the US pig meat supply chain and to explain the main reasons why the US pig meat supply chain has another governance structure than the Dutch pig meat supply chain.

I.1 Description of the US pig meat supply chain

Globally, the US are the third largest pig producer, after China and the EU (Zonderland & Enting, 2006). Data from 2006 show that the US can produce pig meat at lower costs than the Netherlands (De Winter & Tacken, 2010). The US are also a large pig meat exporter, although they hardly trade with the European Union. They are particularly focused on China (Backus et al., 2012; De Winter & Tacken, 2010). Till 2006 the largest pig slaughter company from the world was a US pig meat integrator, namely Smithfield (De Winter & Tacken, 2010). Traditionally, pig production and processing was concentrated in the upper Midwest of the US, an area of surplus feed production (Hayenga, 2000). In the 1990s, pig production started to grow outside that area, especially in North Carolina, Kansas and Oklahoma (Hayenga, 2000).

In the 1990s, the governance structure of the US pig meat supply chain changed from spot market to more integrated governance structures, ranging from arrangements between pig farmers and other firms to complete vertical ownership (Pan & Kinsey, 2002; Kliebenstein & Lawrence, 1995). During this change many small farms left the industry, resulting in fewer and larger pig farms (Pan & Kinsey, 2002). In the early 1990s the US pig meat supply chain was integrating horizontally. Pig farmers contracted other pig farmers because they wanted to rapidly enlarge their production capacity (Rhodes, 1995). Some firms, like PSF and Smithfield were already applying vertically integration (Rhodes, 1995).

In the late 1990s, the US pig meat supply chain moved towards more vertical integration by applying vertical strategic alliances, marketing contracts and production contracts (Hobbs & Young, 2001). Close relationships between porker farmers and slaughter companies were established (Pan & Kinsey, 2002). This process was accelerated by the acquisition of the three largest pig producers of the US by Smithfield foods in 1999. Due to that acquisition Smithfields controlled approximately 10% to 15% of US pig production (Hobbs & Young, 2001).

In 2001, about 72% of the total amount of pigs in the US pig meat supply chain were sold through marketing contracts, compared to only 10% in 1993 (Martinez, 2002). The marketing contracts specify that the farmer should produce pigs with a certain quality and deliver the pigs at a certain time against a price based on a price quotation (Martinez, 2002).

Production contracts are also becoming more common (Hobbs & Young, 2001; Martinez, 2002; Pan & Kinsey, 2002). Production contracts state that the pig farmer manages the production of pigs while

the slaughter companies provide young pigs, veterinary supplies and management advice to the farmers. Pig farmers are paid based on the quality of the pigs they deliver (Pan & Kinsey, 2002; Kliebenstein & Lawrence, 1995). The contractor of both marketing and production contracts can be a large pig producer or a slaughter and meat processing company, like Smitfield Foods (Martinez, 2002).

I.2 Reasons for integration of the US pig meat supply chain

There are several reasons why the US pig meat supply chain integrated vertically by applying contract farming. First, the consumption trends in the US are dynamic and new technologies for production were available (Pan & Kinsey, 2002). According to Barkema et al. (2001) and Pan & Kinsey (2002) the food demand in the US changed towards food products that are easy to prepare and safe to eat. This led to more vertical integration, and consolidation, of the US pig meat supply chain, because it is more difficult to ensure the quality of convenience foods than ensuring the quality of standard food products (Barkema et al., 2001; Pan & Kinsey, 2002; Supply Chain Magazine, 2009). This is in line with TCE, because due to the increasing demand for convenience foods complexity goes up and TCE states that a supply chain will become more vertically integrated when complexity goes up (Douma & Schreuder, 2008).

New technologies can lead to contract farming since contracts can facilitate the transfer of new technologies (Manning & Baines, 2004). Besides that, changes in technology will lead to uncertainty (Martinez, 2002). This is in line with TCE, since uncertainty will lead to more vertical integration of a supply chain according to TCE (Douma & Schreuder, 2008).

Second, the US pig farmers want to reduce the amount of risk they face, which is becoming more important since the 1990s (Kliebenstein & Lawrence, 1995). Risk can be reduced by vertically integrating a supply chain (Teece et al., 1981). This is in line with TCE, since TCE states that uncertainty leads to more vertical integration of a supply chain (Douma & Schreuder, 2008).

Third, a part of the US pig farmers had a lack of capital, but this problem was declined during the 1990s (Kliebenstein & Lawrence, 1995). Lack of capital will lead to more vertical integration for multiple reasons. It can be the case that integrators or contractors own the animals when vertically integrating the supply chain, which reduces the amount of capital needed by farmers (Manning & Baines, 2004). It can also be that the integrator or contractor pays some of the costs of a farmer or finances capital purchases of a farmer (Perry et al., 1997).

Fourth, the need for more income was a reason for US pig farmers to make contractual agreements with other firms in the supply chain (Kliebenstein & Lawrence, 1995). More income can amongst others be achieved, because vertically integrated supply chains tend to have greater efficiency than supply chains operating on the spot market (Kliebenstein & Lawrence, 1995). It can also lead to a better quality of the porkers produced and therefore to higher prices (Kliebenstein & Lawrence, 1995). According to the Structure-Conduct-Performance paradigm (SCP), vertical integration can also lead to more income since vertical integration can act as a barrier to enter a supply chain (Caves & Porter, 1977; Porter, 1979). When there are barriers to enter a supply chain, higher incomes can be achieved in that supply chain (Carlton & Perloff, 2005).

Fifth, the US pig meat supply chain is industrializing since the 1970s, resulting in a large size increase of the US pig farms (Rhodes, 1995). These developments led to more vertical integration of the US pig meat supply chain (Hobbs & Young, 2001; Rhodes, 1995). This is the case because a larger firm can save more transaction costs than small firms by integrating vertically (Ohanian, 1994).

Finally, Smithfield and PSF were integrating their supply chains to increase the quality of the products delivered by those supply chains (Rhodes, 1995). This is underlined by Van Horne (pers. com. 2012) who states that it is more easy to control quality when vertically integrating a supply chain.

However, the US pig meat supply chain is less integrated than the US broiler meat supply chain (Ménard & Klein, 2004). This is the case because pigs can be transported over larger distances than broilers without losing value. Pigs can also be slaughtered in a larger age range than broilers (Ménard & Klein, 2004). Therefore there is less site specificity and temporal asset specificity involved in pig production than in broiler production. Because of this, the US pig meat supply chain remains less tightly coordinated than the broiler meat supply chain (Martinez, 2002; Ménard & Klein, 2004).

I.3 Differences between the US and Netherlands

Although above results give indications why contracts are applied in the US pig meat supply chain, they do not show why the Dutch pig meat supply chain is not vertically integrated. Therefore some differences between the Dutch pig meat supply chain and US pig meat supply chain will be mentioned and it will be analyzed whether these differences lead to differences in governance structure.

First, the Dutch pig farms are much smaller than those in the US and most of the Dutch pig farms are family owned businesses. Furthermore, the slaughter and processing level of the Dutch pig meat supply chain is less concentrated than the slaughter and processing level of the US pig meat supply chain (Hayenga, 2000). This explains why the US pig meat supply chain is more vertically integrated than the Dutch pig meat supply chain, because there is a positive relationship between firm size and vertical integration (Ohanian, 1994). This is the case because larger firms can save more transaction costs by integrating vertically compared to small firms (Ohanian, 1994).

Second, the Dutch pig farmers performed on average, in the 1990s, better than the US pig farmers, amongst other because the Dutch pig farmers produced on average more piglets per sow than the US pig farmers (Hayenga, 2000). This can explain the difference in governance structure between the US and Dutch pig meat supply chain, because Hoste (pers. com. 2013) states that vertical integration will occur in a supply chain when farmers have less craftsmanship.

Third, the US pig slaughter companies produce branded meat of a high-quality, while branded meat is a rarity in the Netherlands (Hayenga, 2000). Because of this there is more brand name capital involved in the US pig meat supply chain than in the Dutch pig meat supply chain. More brand name capital will lead to a higher level of asset specificity. Therefore the difference in branding can explain why the US pig meat supply chain is more vertically integrated than the Dutch pig meat supply chain, since more asset specificity will lead to more vertical integration of a supply chain according to TCE (Hayenga, 2000; Williamson, 1998; Douma & Schreuder, 2008).

Fourth, in the Netherlands there is less demand for convenience food than in the US (Supply Chain Magazine, 2009). Therefore there is less necessity to vertically integrate the Dutch pig meat supply chain compared to the US pig meat supply chain according to TCE (Douma & Schreuder, 2008). This is the case, because less complexity is involved in the Dutch pig meat supply chain since ensuring the quality of standard food products is less difficult than ensuring the quality of convenience foods (Supply Chain Magazine, 2009).

Although the Dutch pig meat supply chain is not integrated vertically, the Dutch pig farmers still use fairly advanced technologies (Hayenga, 2000). So differences in adoption of new technologies are not very likely to explain why the US pig meat supply chain is vertically integrated while the Dutch pig meat supply chain is not.

Appendix II: The US broiler meat supply chain

In this appendix a short description of the broiler meat supply chain in the United States (US) is provided and it is shortly analyzed why the US broiler meat supply chain is organized in the way it is. Furthermore the governance structure of the Dutch broiler meat supply chain is compared with the governance structure of the US broiler meat supply chain. The goal of this appendix is not to provide a complete overview and analysis of the US broiler meat supply chain, but to provide the main reasons why the US broiler meat supply chain is organized in another way than the Dutch broiler meat supply chain.

II.1 Description of the US broiler meat supply chain

The United States (US) are the largest broiler meat producer of the world (Gereffi et al., 2008). They are operating as exporter on the world market for broiler meat (Van Horne & Bondt, 2006). Data from 2004 and 2007 show that the US can produce broilers at lower costs than the Netherlands (Van Horne & Bondt, 2006; Van Horne, 2009).

The US broiler meat supply chain separated from the egg supply chain after the Second World War (Martin & Zering, 1997). In the 1950s, the US broiler meat supply chain started integrating vertically (Martinez, 1999). Feed companies started making contractual agreements with broiler farmers, because they recognized a potential for growth in the broiler industry, resulting in more demand for their feed (Boyd & Watts, 1997; Martinez, 1999). Later on, the contracts were also applied by feed companies to ensure their feed sales, to reduce the risk faced by the broiler farmers and to trigger the broiler farmers to produce more efficient (Martinez, 1999). By applying contractual agreements, risk and management decisions shifted from the farmers to the feed companies (Martinez, 1999).

Due to the declining cotton industry in the Southern part of the US, the broiler industry mainly grew in that part of the US (Roy, 1963). Because sharecropping was applied in the cotton industry, the Southern farmers were already familiar with contract farming before the broiler industry started to grow in the South of the US (Bugos, 1992).

Nowadays there are only a few firms, so-called integrators, that own multiple stages of the US broiler meat supply chain. The integrators own hatcheries, feed mills, slaughter plants, meat processing and distribution plants and sometimes also breeding companies (Gereffi et al., 2008; Van Horne, 1996; Pilgrim's, 2013; Tyson Foods, 2013). Most integrators were originally hatcheries or feed companies (Gereffi et al., 2008). Two integrators, Tyson Foods and Pilgrim's, have about 50% of the market share in the US broiler meat supply chain (Gereffi et al., 2008).

Most of the broiler (breeder) farmers in the US make contractual agreements with integrators. In approximately 90% of the cases these contracts are production contracts (Hobbs & Young, 2001; Van Horne, 1996; Van Horne et al., 2004; Martin & Zering, 1997; Martinez, 1999; National Chicken Council, 2012a). When applying production contracts the integrator owns the broilers or broiler breeders. The integrator also supplies feed, medications, veterinarian support and technical support to the broiler (breeder) farmers (Van Horne, 1996; Van Horne & Bondt, 2006). The broiler (breeder) farmers receive a payment for taking care of the broilers or broiler breeders and for supplying their buildings. The level of these payments is based on the productivity and performance of the broilers

or broiler breeders on the broiler farm (Gereffi et al., 2008; Van Horne, 1996; Van Horne & Bondt, 2006; Martinez, 1999).

II.2 Reasons for production contracts in the US broiler meat supply chain

There are multiple reasons why production contracts are applied in the US broiler meat supply chain. First, the demand for processed broiler meat was growing rapidly in the US in the end of the 20th century (Gereffi et al., 2008; National Chicken Council, 2011). This change in demand was caused by the fact that the amount of broiler meat consumed in (fast food) restaurants has increased (Gereffi et al., 2008; National Chicken Council, 2012b). The increasing demand for processed broiler meat products led to more vertical integration of the US broiler meat supply chain and to the emerge of large integrators like Pilgrim's and Tyson Foods (Gereffi et al., 2008). This is in line with Transaction Cost Economics (TCE), because the increasing demand for processed broiler meat leads to more complexity. Therefore it seems likely that the increased demand for processed broiler meat products leads to more vertical integration (Douma & Schreuder, 2008).

Second, the availability of new technologies led to vertical integration of the US broiler meat supply chain (Martinez, 1999). Integrators can more easily introduce better chicks, better feeds, techniques to control diseases and standard management on the broiler (breeder) farms when making more formalized contractual agreements with broiler (breeder) farmers (Boyd & Watts, 1997). This is in line with Manning & Baines (2004) who state that new technologies can lead to contract farming since contracts can facilitate the transfer of new technologies.

Third, US broiler (breeder) farmers receive a guaranteed price and they do not face market risk when making contractual agreements with integrators (National Chicken Council, 2012a). This reason for vertical integration was especially valid when the broiler production was shifting to the South of the US, since many Southern farmers were financially unable or unwilling to deal with the price risk involved in broiler production (Martinez, 1999). When vertically integrating the US broiler meat supply chain by applying production contracts, the risk is shifted to the integrators (Holman et al., 2006; Martinez, 1999; Teece et al., 1981). This reason for vertical integration of the US broiler meat supply chain is confirmed by TCE, since TCE states that the more uncertainty is involved, the more a supply chain will become vertically integrated (Douma & Schreuder, 2008).

Fourth, the size of broiler slaughter and processing companies in the US increased largely and nowadays they process large amounts of broilers. Therefore a constant and reliable supply of standardized and uniform broilers is required, which led to more vertical integration between slaughter and processing companies and broiler farmers (Bugos, 1992; Gereffi et al., 2008; Martinez, 1999). According to Martinez (1999), growth in firm size led to more vertical integration of the US broiler meat supply chain. This is in line with Ohanian (1994) who found a positive relationship between firm size and the level of vertical integration of a supply chain, because larger firms can save more transaction costs by integrating vertically than small firms.

Finally, geographical shifts in broiler production led to more vertical integration of the US broiler meat supply chain (Martinez, 1999). This could be the case because the broiler production shifted to the South of the US and the Southern farmers were not able or willing to deal with price risks involved in broiler production (Martinez, 1999). Besides that the Southern farmers were already

familiar with contract farming, because sharecropping was applied in the cotton industry (Bugos, 1992).

II.3 Differences between the US and the Netherlands

There are several differences between the Dutch broiler meat supply chain and the US broiler meat supply chain, which cause differences in governance structure between both supply chains. The Dutch broiler meat supply chain is much more export oriented than the US broiler meat supply chain. At least 62.1%³ of all broiler meat produced by Dutch slaughter companies in 2011 was exported (PPE, 2012). Only 18.9% of all broiler meat produced in the US was exported in 2011 (National Chicken Council, 2013). This difference seems to explain why marketing contracts are applied in the Dutch broiler meat supply chain while production contracts are applied in the US broiler meat supply chain. This is the case because for exported broiler meat it is much more difficult than for broiler meat sold at the domestic market to get a surcharge for ensuring quality and traceability through production contracts (Van Horne, 2007).

The firms operating in the Dutch broiler meat supply chain are relatively small and slaughter companies and hatcheries are often family-owned firms (Van Horne, 2007). In the US there are only a few large integrators operating in the broiler meat supply chain (Gereffi et al., 2008). According to Ohanian (1994) there is a positive relationship between firm size and vertical integration. That is similar to Van Horne (2007) who states that the level of vertical integration of the Dutch broiler meat supply chain can only be increased when the size of the Dutch broiler slaughter companies increases. That is also in line with Ohanian (1994), since he found a positive relationship between firm size and vertical integration. So the difference in size of the firms between both supply chains seems plausible to explain why marketing contracts are applied in the Dutch broiler meat supply chain while production contracts are applied in the US broiler meat supply chain.

Dutch broiler (breeder) farmers are entrepreneurs and they want to take the management decisions on their farms by themselves (Van Horne, 2007; Van Horne, pers. com. 2012). While in the US management decisions were shifted from the broiler (breeder) farmers to the integrators by vertically integrating the supply chain through production contracts (Martinez, 1999). So it seems likely that Dutch broiler (breeder) farmers do not want to apply production contracts, since they do not want to shift management decisions to integrators.

³ The Netherlands both imports and exports broiler meat. More broiler meat is exported than produced by Dutch slaughter companies. So a part of the imported broiler meat is also exported again. But it is unclear whether all the imported meat is exported again or (partly) used for consumption in the Netherlands. When all imported meat is exported again, still 62.1% of all broiler meat produced by Dutch slaughter companies is exported. When all Dutch broiler meat consumption exists of imported meat, 100% of all broiler meat produced by Dutch slaughter companies is exported. So the percentage broiler meat produced by Dutch slaughter companies that is exported is somewhere between 62.1% and 100%, but the exact percentage is unclear.

Appendix III: Main agreements in the contracts

This appendix consists of a description of the most important agreements that are made in the contracts applied in the broiler meat supply chain.

III.1 Contract between broiler breeder farmer and hatchery

The following issues are dealt with in the contract between a broiler breeder farmer and a hatchery (Van der Vegte, pers. com. 2013):

- The breed of the broiler breeders, based on the breeds demanded by broiler farmers.
- The hatchery to which the hatching eggs are delivered.
- It is agreed that the chicks from the hatching eggs delivered by the broiler breeder farmer must not be infected with salmonella and mycoplasma gallisepticum.
- The age at which the broiler breeders should be replaced. Generally, the broiler breeders are replaced at the age of 60 weeks.
- Agreements are made about the price per hatching egg, based on the assumption that 80% of all delivered hatching eggs result in viable chicks after hatching. Each additional percent viable chicks results in an increase of the price per hatching egg with €0,001. Each percent less viable chicks results in a decrease of the price per hatching egg with €0,001. The price is not a fixed price, but based on a price quotation. These quotations can fluctuate during the year and so the price a broiler breeder farmer receives per hatching egg can fluctuate.
- It is agreed that the hatching eggs are paid after 21 days, because then the hatching results of those eggs are available.

III.2 Contract between hatchery and broiler farmer

This contract is quite similar to that between a broiler breeder farmer and a hatchery. The following issues are dealt with in the contract (Van der Vegte, pers. com. 2013):

- The number of production cycles covered by the contract.
- The amount of day-old chicks the broiler farmer will buy from the hatchery.
- Agreements are made about the price for day-old chicks.
- It is agreed that the hatchery should compensate for more than one percent first-week mortality.
- It is agreed that the hatchery should compensate for certain medications when they are necessary.

No specific agreements are made about the dates on which a new flock of day-old chicks is delivered by the hatchery. These dates are determined when the current flock of broiler has an age of approximately three weeks, because at that moment the hatchery needs to know when to start hatching the new flock of day-old chicks (Van der Vegte, pers. com. 2013).

III.3 Contract between broiler farmer and slaughter company

This contract is quite similar to that between a hatchery and a broiler farmer. The following issues are dealt with in the contract (Van der Vegte, pers. com. 2013):

- Agreements about the broiler price, mostly based on a price quotation (so-called basic contract price) plus an additional amount of money.

- The broiler farmer should compensate the slaughter company when more than 0.5 percent of the delivered broilers are rejected by the slaughter company due to unwanted characteristics.
- The broiler farmer should compensate the slaughter company when more than 0.2 percent of the delivered broilers did not survive transportation from the broiler farm to the slaughter company.
- Agreements are made about the bonus or penalty a broiler farmer receives regarding weight of the broilers.

Broiler farmers and slaughter companies also do not make specific agreements about the slaughter date of the broilers. This is the case because the slaughter date of broilers depends on the supply and demand of specific types of broilers. When light broilers are demanded, the broilers are sometimes slaughtered somewhat earlier. When heavy broilers are demanded, the broilers are sometimes slaughtered somewhat later (Van der Vegte, pers. com. 2013).

III.4 Contracts between broiler (breeder) farmer and feed company

The following issues are dealt with in the contracts between a broiler (breeder) farmer and a feed company (Beltman, pers. com. 2013; Van der Vegte, pers. com. 2013):

- Broiler breeder farmers should buy feed from the specific feed company for one production cycle, so for approximately 40 weeks.
- Agreements are made about things like quantity discounts.
- Broiler farmers should buy feed from the specific feed company for a certain period, which differs between the different broiler farmers.
- Some feed companies offer contracts with agreements regarding the delivery of feed and day-old chicks by the feed company to the broiler farmer and delivery of broilers by the broiler farmer to the feed company.
- Some feed companies offer contracts to broiler breeder farmers together with hatcheries. Those contracts consist of agreements about both the delivery of feed by the feed company and the delivery of hatching eggs by the broiler breeder farmer to the hatchery.

Appendix IV: Calculation of price mutations

To analyze the price risk that broiler and porker farmers face, the monthly change in broiler or porker price, the so-called price mutation, is calculated. This appendix explains the calculation of these price mutations.

The price mutation is calculated for the broiler market price, the broiler contract price and the porker price published by LEI Bedrijfsinformatienet (2012b). Firstly, for both the broiler market price, the broiler contract price and the porker price a table was developed which consists of all monthly prices between January 2001 and December 2011. For every month between February 2001 and December 2011 the percentage price change with respect to the previous month was calculated, the so-called price mutation. This is done with formula 1, in which the price in month x_{i-1} is subtracted from the price in month x_i , divided by the price in month x_{i-1} and multiplied by 100:

$$\text{percentage price mutation month } x_i = \frac{\text{price month } x_i - \text{price month } x_{i-1}}{\text{price month } x_{i-1}} * 100 \quad (1)$$

Secondly, the standard deviation of the price mutations between 2001 and 2011 was calculated for both the broiler market price, the broiler contract price and the porker price. This is done to show how much each of the three prices was fluctuating between 2001 and 2011.

Appendix V: Interviewed persons

Beltman, E. (2013): Erlend Beltman is sector manager broiler at Agrifirm Feed, a Dutch feed cooperative that is one of the three largest Dutch feed companies.

Horne, P. van (2012): ir. Peter van Horne is poultry economist at the Agricultural Economics Institute (LEI) of Wageningen UR.

Hoste, R. (2012): ing. Robert Hoste is pig production economist at the Agricultural Economics Institute (LEI) of Wageningen UR.

Vegte, W. van der (2013): Wim van der Vegte is CEO of hatchery and broiler integration Lagerwey. Lagerwey is a Dutch firm that hatches day old chicks and that is also operating as a trading company between broiler farmers and slaughter companies.