More than just a pig story: Explaining the evolution of chain coordination and structures in the hog industry in Quebec

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*Abstract*

*Recent studies show that several governance structures can coexist to frame the same type of transaction. This situation is particularly true in the Agrifood sector where a wide variety of corporate structures and value chains coexist. The coexistence of several vertical coordination modes within the same production sector is intriguing since it calls into question the issue of the most performing coordination mode. What are the factors that explain the use of several vertical coordination modes within a same value chain? Are these factors mainly strategic, economic, technological, institutional or historical? The objective of this paper is to dig into these questions by providing a comprehensive historical analysis of the drivers behind the evolution of hog supply chains structures and coordination in Quebec over a 50 year-period. The paper develops an historical analysis based on in-depth interviews with experts that are or were active in the Quebec hog industry, combined with insights from organizational economics. Our analysis reveals that over the period 1960-2010, hog chain structures in Québec were mainly modelled by factors that changed over time, especially uncertainty and risks, the institutional and economic environment, and commercial considerations.*

**1. Introduction**

The evolution of the Agrifood industry towards increasingly specialized and concentrated systems did not prevent the maintenance of a wide variety of corporate structures and the coexistence of many value chains. Indeed, several vertical coordination modes of transactions between the various segments of value chains such as contracts, partnerships and vertical integration coexist and develop simultaneously with the same market conditions. Recent studies show that several governance structures can coexist to frame the same type of transaction. Da Silva et al. (2005) found that the coexistence of several governance structures in the chicken sector in Brazil is due to the strategic and historical reasons. Brousseau and Codron (1998) in their analysis of supply supermarkets fruit against the season, explain that the coexistence of two governance structures provides more flexibility in an environment characterized by high uncertainty. Both governance structures used are shown to have additional properties. The authors conclude that choosing a mode of governance depends on many factors.

The economic literature identifies many drivers for firms to choose among various coordination modes to frame their transactions with other firms. Technology, strategic behaviour, regulations, financial motivations, risks and transaction costs are among the most cited (Mahoney and Crank, 1993; Hayenga *et al*, 1996; Williamson, 1985; Hobbs and Young, 2001, Ménard, 2013). Understanding the sources of this variety would increase our knowledge on the effectiveness of value chains and the *modus operandi* of industry actors. Indeed, efficiency gains can be generated by a more efficient vertical coordination of transactions. In this context, it is interesting to study the reasons of this variety. What are the driving factors that explain the use of several vertical coordination modes within a same value chain? Are these factors mainly strategic, economic, technological, institutional or historical? Do these factors vary over time, depending on the changing economical and institutional environments? Moreover, the coexistence of several vertical coordination modes within the same production sector is intriguing since it calls into question predictions of some theories. According to the Darwinian principle, governance structures should all converge to one, the most effective.

In the province of Quebec in Canada, the hog industry is specifically concerned with the coexistence issue since value chains composing these chains are very diverse and coordination modes vary widely, even for the same segment of the chain and the same product. Moreover, hog supply chains have evolved greatly over the last 50 years, passing from a very loose coordination to a tight one, disappearance of intermediaries like auctions and middlemen, appearance and disappearance of weaning facilities, integration of farrowing by feed mills, development of production contract for the finishing stages, etc. Although many studies have focused on why firms in the hog industry adopt different coordination modes (Lawrence and Grimes, 2001; Gillespie and Eidman, 1998; Key and McBride, 2003; Davis and Gillespie, 2007), much less work has been done to understand how coordination modes within hog chains evolve and what are the factors that explain the co-existence of plural forms in an historical perspective.

The objective of this paper is therefore to dig into these questions by providing an historical analysis of the drivers behind the evolution of hog supply chains structures and coordination in Quebec. We limit our historical analysis to the period beginning in the 1960s and finishing in the 2010s in order to provide a comprehensive investigation. The paper uses theoretical concepts from organizational theory, combined with an historical perspective based on a literature review and 15 in-depth interviews to explain why and how theses changes have occurred. Our results show that chain actors, mostly feed mills and slaughterhouses, have made important changes to their coordination and structures in order to reduce health risk and related economic losses as diseases affected their herd as well as maintain a steady supply of high quality piglets and market hogs. The agricultural policy of the Quebec government and the producer marketing board also had a great impact on the survival or development of certain types of enterprises and coordination modes. We conclude that the evolution of hog chains in Quebec was mainly influenced by economic (uncertainty, crisis, risks), as well as commercial and institutional factors. The originality of the paper lies in its chain and historical perspectives. Indeed, very few papers tackled the coordination drivers’ issues with these two perspectives at once, leading to an extended understanding of agrifood chains’ evolution.

The paper is organized as follows. Section 2 starts with a literature review of the factors influencing chain coordination and explaining the co-existence of coordination modes. Section 3 presents the methodology used and the transactions at stake. Section 4 analyses the evolution of Quebec hog chains from the 1960s until 2010s through the analytical lens developed in the previous section. Section 5 concludes.

**2. Drivers of vertical coordination**

Agrifood chains can be vertically coordinated through various coordination modes. Three main modes are generally identified: the market, full integration and hybrid forms. These modes are often presented on a continuum of possibilities with the market and vertical integration as polar modes. All these forms are used to coordinate transactions within agrifood chains. The economic literature identifies several factors that explain the choice for a vertical coordination mode over another (Mahoney et Crank, 1993; Hayenga et al. 1996). Transaction costs economics has been particularly useful to improve our understanding. According to the discriminating alignment hypothesis developed by Williamson (1985), the mode that minimizes the most transaction cost shall be chosen given dimensions of transactions at stake (frequency, uncertainty and asset specificity). The relation between transaction costs and transaction dimensions is given in Figure 1.

Figure 1. Relation between transaction costs and transactions’ dimensions

CT = f (Asset specificity; Uncertainty; Frequency)

+ + +/-

The more specific are the assets involved in a transaction and the more uncertainty surrounding the transaction, the higher the transaction costs. Agents should then have a preference to frame this transaction within a coordination mode that reduces these costs, that is, modes getting close to formal integration or integrate the transaction within the firm.

Although transaction costs economics has been very successful in explaining make-or-buy decisions, the literature underlines several other factors that might influence the choice for a governance structure and that explain the co-existence of various arrangements governing identical transactions, sometimes within the same company (Ménard, 2013). In the Agrifood sector, da Silva and Saes (2007) mention that market characteristics served by the chains (size, level of information needed, product type, number of competitors) and markets interconnections (the stronger the competition, the more differentiated the strategies will be) are factors to be taken into account to explain the coexistence of several modes of governance for a similar transaction. More recently, Ménard (2013) exposes a brief review of the main explanations for the co-existence of plural forms, namely, technological diversity, innovation-oriented solution, financial motivations, benchmarking, credibility of termination and knowledge-based perspective.

For the purpose of our study, we classified factors found in the literature into six different categories: (1) Strategic and business considerations, (2) control intensity, (3) transactional savings, (4) financial motivations, (5) innovation-oriented solution and (6) path dependency.

**2.1 Strategic and business considerations**

*2.1.1 Benchmarking*

Information asymmetry throughout food chains often leads to strategic behaviour. For instance, downstream firms that buy raw materials do not know the cost of producing these products, which does not allow the buyer to have a good negotiation position. The internal production of some inputs can create an effective benchmark that reduces the informational disadvantage and improves the bargaining power of the buyer (Perry, 1989). If the integration of input production reveals that the production cost is lower than believed, the integrating firm will benefit from internalizing all the input production or will be in a better bargaining position with external input providers. Benchmarking is therefore a factor that may explain the co-existence of different arrangements for similar transaction (Ménard, 2013).

*2.1.2 Market structure*

The number of competitors in a market may affect the degree of vertical coordination (Silva and Saes, 2007). For instance, a dominant firm in a market may use vertical integration to raise the costs of its competitors (Perry, 1989). It can acquire essential inputs or facilities, which would exclude competitors. The opportunity costs of owning these assets might be lower than the risk of reduced profits by competitors. In a consolidated sector, vertical integration may also be used to create a barrier to entry or apply price discrimination (Perry, 1989).

*2.1.3 Promotion of own products*

A closer vertical coordination by a firm may also be motivated by business considerations such as the desire to promote the sale of its own products (Mahoney and Crank, 1993). For example, a feed mill can integrate downstream into animal husbandry to promote the use of its feed.

*2.1.4 Knowledge-based perspective*

The decision to use multiple coordination modes to frame the same type of transaction might also be explained by the desire to acquire knowledge from different governance structure experience (Saes et al. 2011). Using production contracts besides fully owned farms allows the integrating firm to obtain information from breeders or growers through experience sharing.

**2.2 Control intensity**

According to some authors (Martinez and Reed, 1996; Peterson et al. 2001), the intensity of control is the key variable explaining the diversity of governance structures. Peterson and Wysocki (1998) argue that it is the need to exercise control over transactions that make a closer coordination more attractive to economic agents than the price mechanism. As the need for control over a transaction is stronger (ex. level of information needed, product type), it is advantageous to frame this transaction within a coordination mode that leans towards full vertical integration. Indeed, vertical integration allows more control over transactions and human assets. Firms choose a level of control by choosing a governance structure. Governance structures located near the market on the continuum have little intensity control while structures located near the integrated firm show a more intensive control.

*2.2.1 Control over quality*

In the Agrifood sector, control over the quality of products is important. A buyer may want to coordinate vertically with a producer to have more control over the process and quality of products. This transfer of control is usually accompanied by a transfer of uncertainty (less uncertainty for the agent that is integrated) and the provision of an incentive (bonus quality). But more often than not, control over quality is critical. Food safety can better be achieved through tighter vertical links.

*2.2.2 Technology and control*

A transaction involving a certain kind of technology may require to be framed by a specific governance structure in order to reduce transactional hazards and costs. The level of control over transactions implying different technologies may also vary. If a firm uses different technologies at some point in time, different governance structures might co-exist.

**2.3 Transaction costs considerations**

According to transaction costs economics, economic agents choose to coordinate their exchanges with a governance structure that reduces transaction and production costs (Williamson 1985). The need to frame the transaction is due to the bilateral dependence between the buyer and the seller (Ménard, 1994). The bilateral dependence occurs when one partner, or both, has invested in a specific asset that has a lower value if used for another transaction. In agriculture, uncertainty tends however to be a more decisive factor than asset specificity (Royer et al. 2012). Hybrid forms (contracts, strategic alliances and cooperation) that govern the bilateral dependence without going as far as vertical integration, are often used when the transactions requires intermediate levels of control, which is often the case in the agrifood sector. Closer vertical linkages may reduce transaction costs such as information search, negotiating and enforcement costs. The theory of transaction costs resulted in many theoretical proposals that have mostly passed the test of facts (Williamson 1996).

Hobbs and Young (1999) identified transaction costs as the main factor in the choice of agents for a coordination mode. According to these authors, the level of transaction costs depends on the characteristics of transactions, which themselves depend on the product characteristics (perishability of the product, differentiated products, quality, etc.) and three key factors: technology, public regulation and some socio-economic aspects. By changing the supply of new products (ex. Functional food), production techniques (ex. genetically modified organisms, organic farming) and economies of scale in production and processing, technology encourages different agents of supply chains to coordinate their trade differently to better preserve the characteristics of a certain product or protect a specific asset (Hobbs and Young, 1999; Baecke et al., 2002). Public regulation introduces new rules that can modify the size of a transaction. For example, food traceability requirements along the supply chain make transactions more complex and increase costs. Finally, some socio-economic factors such as consumer demand for prepared products and a quality label can influence the degree of coordination in the chain to effectively meet these demands (Menard and Valceschini, 2005; Verhagen and Van Huylenbroeck, 2002).

Uncertainty may cause quite high transaction costs in agriculture. Hence, a firm may want to reduce these costs by using a coordination mode that reduces uncertainty, usually a tighter mode. Vertical integration or contracting may be motivated by the assurance of having inputs of a desired quantity and quality, or securing an outlet. Since agricultural production levels varies through the year given their seasonality and cyclical variation inherent to that sector, food processors often have difficulties to obtain a stable volume of desired quality inputs through the market, which may affect their profitability. Making more formal arrangements or integrating vertically into the input sector may greatly reduce input procurement uncertainty. In some cases where there are few suppliers, downstream companies produce their own inputs with higher production costs to ensure they have the desired quantity and quality of inputs. For instance, a slaughterhouse may integrate a hog finishing activity to secure its hog procurement. Similarly, an upstream firm may want to ensure it has an outlet for its outputs by contracting it with its buyers.

Risks are also a source of uncertainty. If firms must make decisions on prices and production levels before the actual production, then vertical integration can be a way to transfer risk. Predetermination of the content of the transaction to come (price, quantity, quality, delivery time) minimizes the risks associated with rapid changes in market conditions (Martinez and Reed, 1996; Boland et al, 2002; Mazé 2007). Upstream firms play an insurance role for businesses downstream. As more firms specialize and become larger, investment and risk become more important, which can promote coordination modes that share or reduce risks and secure investment.

Having access to information is a way of reducing uncertainty and therefore, a closer coordination may reduce information asymmetry. For example, a firm that produces an input has more information on the conditions of production of this input than downstream companies that use this input. It is then possible that upstream firms want to improve their access to information by integrating the downstream firm, which has more information on market demand and preferences. Similarly, a firm may want to integrate or make a partnership with a downstream firm in order to have better information on final customers’ conditions in order to better adjust to market demands. For example, a good coordination between genetics and slaughterhouses may well improve carcass performance at the slaughter line. It can also reduce measurement costs since a good coordination reduces the need to measure input and output quality (Barzel, 1982).

Finally, although often taken as given in economic analysis, institutions may play an important role in shaping Agrifood chains. They can be either formal (public, legal, governmental) or informal (social, moral). Institutions set the rules of the game of human interactions (Davis and North 1971; North 1990). By doing so, they decrease uncertainty and therefore, transaction costs. A new regulation or policy can increase or decrease transaction costs related to certain coordination mode, making some modes less attractive or encouraging others. That is why they can induce a vertical coordination change. For example, changes in the laws on food safety can increase substantially costs of monitoring firms within chains. A coordination mode that can reduce these costs will then prevail.

*2.4 Financial motivations*

The financial constraint has been an early and leading explanation of the co-existence of plural forms. Making in-house requires much more capital than contracting-out or franchising. Hence, firms that want to develop may want or have to consider buying solutions. The financial constraints would therefore explain why, for identical transactions, some are vertically integrated and other are contracted-out, especially if the financial market is not efficient (Rubin, 1978).

*2.5 Innovation-oriented solution*

Keeping in-house activities besides franchising or contracting might be useful to try innovation and experiment new technologies in order to convince partners (franchisees or contracting parties) that there are gains at stake (Ménard, 2013). In the hog sector, a hog firm having contracts with breeders might want to test a new method so as to implement it among its breeders later, making the convincing more easier with “real” evidences.

*2.6 Path dependence*

Another explanation of co-existence of plural forms for an identical transaction is path dependency. Some coordination modes would last only because the cost of changing them is too high and would thus co-exist with other modes that evolved.

Table 1 resumes the main factors that are generally identified as affecting strongly the choice for a governance structure in agrifood chains and/or that explain the co-existence of plural forms.

Table 1. Factors affecting agrifood chain coordination modes and their coexistence.

|  |  |
| --- | --- |
| Factors |  |
| Strategic and business considerations | * Benchmarking * Market structure * Promoting its own input or output * Knowledge-based perspective |
| Control intensity | * Quality * Technology |
| Transaction costs considerations | * Product characteristics * Technology * Public regulation * Socio-economic factors * Uncertainty (input procurement; finding output; price risk; information asymmetry; measurement costs) * Risk of hold-up * Institutions |
| Financial motivations |  |
| Innovation-oriented solution |  |
| Path dependence |  |

Menard (2013) recently proposed a unified theoretical framework that explains the variety of forms framing similar transactions. His model hypothesizes that modes of governance and their capacity to fit properties of the transactions they intend to frame can be submitted to ambiguities on the advantages of a more or less important control over key assets; to the complexity in the characteristics of the transaction that generates uncertainties about the adequate mode of organization; and to strategic behaviour from some partners in order to rip benefits from many strategies or using various means of control.

**3. Methodology and transaction characteristics**

Documenting coordination choices made by firms of all size from late 1960’s to 2010’s is not an easy task since very few records were kept and their access remains difficult. The only way to understand what happened is to rely on the memory of the main actors and to confirm as much as possible the information collected by cross-checking with the available documentation, reports, newspaper, and by other interviews.

Our results are based on a summary of 15 in-depth interviews undertaken between February 2012 and December 2013. Semi-structured interviews were done with former veterinarians working in the industry, officers of private and cooperative feed mills and slaughterhouses, former producer’s union leaders, and quality and genetics managers of the industry. Experts were asked to relate their personal understanding of the evolution of Quebec hog chains and the reasons underlying their changes in a historical perspective. The information collected in previous interviews was verified along the process and during the following interviews until we reached a saturation point. Unconfirmed information was left over.

The paper uses the material provided by the interviews and links it to the theoretical insights in order to identify the main factors that affected chains evolution from the 1960s to the 2010s.

**Governance structures**

Hog chains in Quebec have greatly evolved over the last 50 years. We however can distinguished some

Three main actors characterize the Quebec hog chains. From upstream to downstream are distinguished (i) millers that supply hog producers in grain and feed, (ii) producers of hogs and (iii) slaughterhouses. A producer can be involved in farrowing, nursery and/or fattening of pigs.

Frequency, asset specificity, uncertainty.

## 4. The evolution of hog chains in Quebec

***4.1 From the 1960s to 1975: the piglets’ procurement fight***

The historical model in swine production in several countries has long been a family that produced feed, owned sows, raised piglets and slaughtered grown-up pigs for its own consumption or sold them to a butcher or a local slaughterhouse when pigs reached a certain weight. Family farms actually integrated all or most of the productive activities related to hog production. As markets developed, two activities quickly separated from the family farm in a process of technical division of labour.

Slaughter activities were gradually taken over by companies that specialized and increased in size, boosted by urbanization and stricter health requirements. The development of slaughterhouses depended heavily on their supply of pigs, which explains why they put in place several mechanisms to ensure a steady supply of quality animals. The second activity that developed outside farms is the production and commercialization of feed for livestock. Gradually, activities providing feed are realized outside the farm, which makes way for new commercial relationships. Farmer then began to buy all or part of their feed. Depending on the country, these two players at opposite ends of the chain, slaughterhouses and feed mills, will play a leading role in the evolution of hog chains structures. In the case of Quebec, the main producing province in Canada, feed mills seem to have been particularly important actors in the dynamic of the sector. As early as the 1960’s, a royal commission (Commission April, 1967) reported that as much as 70% of the total hog production was done under a form of integration (formal, contract, management, finance contract). For different motives, feed mills and slaughterhouses were both involved in the integration process.

The development of the pork market initially built on the population and household incomes growth in Canada. By the 1970s, particularly America but also Japanese export markets, offered opportunities of expansion for Canadian slaughterhouses. Back then, slaughterhouses had production contracts with few farmers to secure part of their supply. With these important development opportunities, slaughterhouses decided to devote all their resources to slaughter activities. They abandoned integration contracts with hog producers and developed business partnerships with major suppliers of live hogs, feed mills. These later rapidly became the preferred suppliers of live hogs to slaughterhouses. By deciding to do business mainly with feed mills, slaughterhouses could guarantee large volumes while minimizing transaction costs.

Millers can be categorized into two groups, private and cooperative millers. The first group focused their business on animal feed manufacture growth and profits. Cooperative millers had certainly an interest in increasing their turnover and profitability of their assets but their members’ needs also played a significant role. The “owners” of the cooperatives were mostly milk producers practicing a diversified agriculture. As agricultural "entrepreneurs", they were looking for additional sources of income to their main activity, especially in the 1960s and 1970s when milk production was experiencing economic difficulties. For many members of cooperatives, finishing pigs appeared to be a lucrative sideline, without excessive risk and consistent with their allocation of production factors, labour and buildings. In order to do so, cooperatives had to be involved in swine production. In addition to the service provided to members, the involvement in pig production allowed the cooperative to make its assets in animal feed more profitable by adding a production sector that consumed a lot of grain. For the cooperatives, the risk of losing members and their associated volume of feed was always present in an environment where the private sector was very competitive and aggressive.

At that period, cooperative and private millers operated in an almost similar manner by signing production contracts or finance contracts with farmers (fatteners). In the first case, the miller provided piglets, feed and veterinary care to the farmer who raised the animal to the slaughter weight in exchange of a fixed amount and eventually a performance bonus. This contract implied that the miller remained the owner of the animals until their slaughter and bore the price risk (food and animal) such as the risk of death or disease. In the financing contract, the miller provided the same inputs as the fixed price contract but the producer bought on credit until the sale of the animal. The miller usually had a right of first purchase on the hogs but the price fluctuated depending on the market prices. The producer assumed a larger share of production and market risk. These contracts allowed millers to develop their business without having to invest in buildings and human assets, therefore reducing their production and transaction costs.

The development of these integration activities by the feed mill and pig fatteners has had a significant impact on the production and marketing of piglets. The typical farrowing producer in the 1960s and 1970s is a small producer, often non-specialized, holding 20, 50 or 100 sows that does not raise all his piglets but sells part of them. Four marketing channels were available to these farmers, defining many supply chains. He can sell to an independent pig fattener, a miller integrator, an animal trader, or at a regional auction. The last two options involved a final sale to a fattener.

Millers did not produce piglets in sufficient quantity for their needs; they needed suppliers. The most dynamic millers used all alternatives available to secure their supply of piglets. They often set up their own system of collecting piglets in areas close to their facilities, developed business with traders in more remote areas and bought piglets in auctions to complete their needs. As the demand for slaughter hogs evolved in the 1970s, a competition to obtain piglets among fatteners (mills and independent fatteners) developed. In this context, we can define the main actors of the pig supply chains. First, a producer of piglets, who was previously a farrow-to-finish producer with piglets’ surpluses. In the 1970’s, many of them started to specialize in farrowing only. Second, a private or cooperative miller who buys piglets and has fixed price or financing contract with farmers to feed the hogs. Third, an integrated finisher for whom finishing is a complementary activity; some finishing producers started to specialize in this activity. Fourth, a piglets’ trader. Fifth, an auction of live animals. Independent finishers could co-exist with millers but had to face a fierce competition to get piglets.

The analysis of the early development of hog chains in Québec demonstrates that the need to develop feed sale and to secure the volume of an associated input, piglets, was a major driver of chain structure evolution. Engaging into contracts with finishing producers reduced uncertainty over feed outlet for private and cooperative millers but at this point, piglets’ procurement was left to the market and many coordination modes coexisted. Figure 1 illustrates the main chains during that period. The arrows represent contractual relations and the touching rectangles, vertical integration.

Figure 1. Illustration of the main Québec hog chains over the 1960-1975 period.

Farrowing

Finishing

Independent finishers

Feed mills

Integrated

Finishers

Traders

Auctions

***4.2 From 1975 to 1980: growth and health issues***

Before the accelerated growth period that took place from 1975 to 1980, the main changes observed are the producers’ specialization in farrowing and their disintegration from the fattening activities, and the specialization of fatteners who started building dedicated facilities of greater size. Despite these changes, supply chains presented, overall, only little change. The old chains co-existed with the ones that were becoming dominant. The events of the second half of the 1970s will however modify substantially the chain structures. The favourable prices, driven by growing markets, increased Quebec hog production from 1.7 to 4.5 million heads over a five-year period (1975-1980). Private and cooperative millers wanted to meet the slaughterhouses’ demand and competed to contract with fatteners and get piglets. Our interviews indicate that recruitment of fatteners was somehow easy because this particular activity was profitable and potential fatteners were almost lined up to contract with millers. The State Agricultural Credit (Provincial Farm Credit Bureau) also began to pay more attention to this sector in the second half of the 1970s and producers interested in hog production were required to build dedicated barns and to hold a production contract, which reduced the producer's risk. It is also during that period that a governmental regulation banned pig farming in dairy facilities, encouraging specialization of hog producers.

On the other side, procurement of piglets seemed to have been a greater challenge for the millers. The piglet market became much more competitive and prices rose sharply. Two consequences followed. First, piglets’ producers were encouraged to sell a larger proportion of their animals and increase their sow herd, which led some to build their own specialised farrowing facilities. Producers with farrowing facilities enjoyed a certain market power over millers, being heavy consumers of feed and holding a rare input, piglets. During the same period, farrowing producers received a major institutional support from the provincial government, which set up a farm income stabilization insurance scheme[[2]](#footnote-2) for these particular producers. The market risk associated with piglet production was thus greatly reduced with this insurance program.

The other major consequence of this rapid growth was the lowering of piglets’ quality in terms of weaning weight and sanitary status. Towards the end of 1979, the various supply chains showed signs of weaknesses. A disease hitherto unknown appeared in Quebec herds, causing high levels of mortality and greatly damaging the quality of carcasses. By the time the disease was formally identified as pleuropneumonia in 1981, it had spread to the entire herd and piglets were found to be the source of the spread. The important losses incurred to millers and slaughterhouses created an unprecedented mobilization into research and veterinary medicine intervention in order to identify the problem and most importantly, find a solution. Slaughterhouses no longer had access to a sufficient quantity of quality hogs and their preferred suppliers, integrator-millers, were struggling to secure their piglets supply themselves. Slaughterhouses had little alternative of hog supply to operate their facilities at full capacity as the disease affected the entire North American herd, and millers had no more alternative sources of piglets for the same reason. Our interviews revealed that the solution was found into three sets of measures that would eventually modify greatly existing supply chains.

The first action was to improve herds’ health. It was absolutely necessary to eradicate the disease in farrowing facilities. Fieldwork was undertaken to disinfect buildings. Thereafter, the goal was to qualify the farrowing farms based on their health status. Animals were tattooed; producers were identified and classified according to their animal health status. The second novelty introduced was to raise hogs in an all in/all out system. Rather than entering piglets gradually as older hogs reached their slaughter weight, they were entered all at once, after a thorough cleaning of the building. The third measure was the establishment of a single supply source of piglets or at least a very few sources of piglets with the same health status level. Indeed, it was known that piglets with different health status were more at risk of contracting a disease that could decimate the entire herd. These changes had all the objective of raising the quality of supplied piglets to millers-integrators and fatteners, and hence, the quality of animals sold to slaughterhouses.

These changes did not take place overnight but within a decade, they radically altered supply chains coordination and structure. First, two links within the hog chain were totally removed by the new health requirements. Traders and piglets’ auctions, considered important vectors for disease spread, gradually disappeared. Second, significant pressure was put on producers specialized in farrowing to raise the level of sows’ and piglets’ health. Several of these producers were unable to adapt and lost their piglets’ market. Facing this issue, some of them vertically integrated into fattening and became farrow-to-finish producers so as to preserve an outlet for their piglets and reduce uncertainty.

Third, the best farrowing producers adapted but had to adjust to another condition. Millers wanted to get their piglets from a single source. This meant that a farrowing barn had to be large enough to provide a sufficient volume to fill up a fattening barn. The introduction of all-in/all-out production system therefore put pressure on the farrowing segment to increase their size.

Fourth, given this additional difficulty with their supply, millers decided to build and operate their own farrowing facilities with top-level health status and of sufficient size to fill up at once their integrated fattening barns. The need to control the health status of herds had therefore resulted in the vertical integration of millers into the production of piglets, an integration that is still lasting today. The objective of reducing measurement cost was probably also a reason why millers decided to have closer links with the farrowing segment, reducing their transaction (search) costs related to finding the level of health status of independent farrowing barns. Integration contracts with farrowing producers had never been a popular alternative for integrators even if it existed, because of the specificity of this activity, notably technical difficulty and its related production and transaction costs.

Full integration of farrowing activities and the recruitment of independent farrowing producers with a good volume of sows with a high health status became important issues for millers. These two elements largely determined their profit and became conditional in the recruitment and retention of integrated fatteners. The latter were also able to evaluate the quality of piglets they were provided and their gain improved in terms of piglets’ health quality. Their mode of remuneration reflected the mortality rate and performance (feed conversion ratio or age to a specified weight). The initial quality of the piglet is a fundamental factor in achieving performance. Since integrators were competing with each other, the quality of piglets they had to offer directly affected their ability to recruit the best hog fatteners. Figure 4 shows the main hog chains that formed during that period. The arrows represent contractual relations whereas touching rectangles represent vertical integration.

Figure 4. The main hog chains during the 1975-1980 period.

Finisher

Farrowing

Independent

Finishers

Farrowing

Integrated finisher

Feed mills

Farrowing

Feed mills

***4.3 The 1980s: the economic crisis and marketing scheme***

The health issue continued to play a substantive role in the restructuring of supply chains in the 1980s, notably the involvement of integrators in the farrowing segment of the chain. However, this issue should not hide other cyclical and structural factors that also had a great influence and showed a second trend. The health crisis and the losses that followed were accompanied, from 1981, of a widespread economic crisis that slowed down the pig market growth. Production stagnated until 1995. But more importantly, the economic crisis pushed interest rates to record highs, reaching peaks of over 20%. This episode allowed testing the financial strength of millers using production contracts. Indeed, the financing of piglets and feed during the fattening period is the responsibility of the owner of the animals. In the case of production contracts, the miller-integrator owns the animals and must finance them. In this difficult context, a whole segment of the production contracts system collapsed. Cooperatives were not able to bear all losses and members, mainly dairy farmers, became disillusioned over the boom years during which the pig brought additional income. Most cooperatives decided to abandon hog production and sold the remaining animals to their contract farmers at low prices. If cooperative millers had not the financial strength needed to cope with the economic situation, this was also the case for some private millers. Some of them also opted to sell the animals to farmers.

Many hog fatteners, who had been integrated producers, gained their status as independent producers in the first half of the 1980s. This disintegration of the fattening segment was facilitated by the eligibility, in 1981, of hog fatteners to the farm income stabilization program of the provincial government. For these new independent producers, the procurement of piglets became a serious issue. Two choices were available to them. They could source piglets from independent farrowing producers with the health risks that this solution entailed. This alternative implied a good understanding of these risks and the finding of a reliable supplier. The other solution was the integration of farrowing activities. This alternative, to become a farrow-to-finish producer, was not available to all producers because it meant a significant financial investment and very specific technical skills. Some fatteners opted for the integration of farrowing activity while others returned to production contracts with millers at the earliest opportunity. However, the farrow-to--finish status was favoured by the economic crisis and the government's support in risk management.

The eligibility of fatteners to governmental insurance scheme can be seen as a response to the crisis and an encouragement to independent production but it was also a positive response to the organization of producers who voted the implementation of a marketing plan in 1981, after several unsuccessful attempts. This marketing plan, set up by the producer marketing board, would allow them to negotiate a mandatory collective contract binding all producers to all buyers. The process was laborious and the mechanism chosen, the electronic auction, was only implemented in 1989 (Lepage-Gouin 2014).

This new mandatory mechanism to market all pigs in Quebec, regardless of ownership, brought a break in the evolution of supply chains. Producers had the obligation to provide all their pigs and accredited abattoirs had an obligation to buy them. The auction led to a complete anonymous market, where the source of hogs became of secondary importance. Several consequences are attributable to this new mechanism. First, slaughterhouses that used to have a close relationship with millers-integrators responsible for their hog procurement saw no utility to pursue this relationship to the extent that the latter were required to sell their pigs on the auction system. This link was broken. Second, independent producers and integrators found the new mechanism a simple and effective tool to sell their hogs at competitive prices. Independent producers, fatteners or farrow-to-finish famers, did not have to worry about finding a buyer for their animals. Their situation was easier and the number of animals available individually lost its importance. Third, slaughterhouses located in the heart of the production areas and having a strong relationship with suppliers lost their competitive advantage with a mechanism that gave a more equal chance to all slaughterhouses.

***4.4 The 1990s: three sites and early wean***

In the fall of 1988, a new "mysterious disease" (Porcine Respiratory and Reproductive Syndrome, PRRS) appeared[[3]](#footnote-3). Before this outbreak, Quebec had bacterial diseases that were dealt well with antibiotics. But PRRS was a viral disease. PRRS causes abortions, sow mortality, piglets with respiratory problems, and a reduced immune response of the animal. By 1990, 90% of Quebec farms were positive. The problem was global and it was long before isolating the virus.

At the same time, the idea of the three farm sites and the early wean appeared. The idea was to raise animals in three separate sites by introducing a nursery building between farrowing and fattening where piglets were early weaned, medicated and raised between 4-8 and 25-30 kg (Harris, 2000). The three sites technique was already used in a few genetic farms but the PRRS outbreak led to its spread in commercial herds. In Quebec, the first nurseries were set up in 1990s. From 1990 to 1995, the three sites organization became the norm in the province.

PRRS was a turning point in the integration of farrowing by integrators. In the years that followed, their strategy was to build vertically integrated farrowing facilities. Integrators began to build large maternity barns. They definitely changed from buyers of piglets to piglets’ producers. A person interviewed cited the case of a large integrator who had full ownership or production contract of 2500 sows in 1984. Twelve years later, he owned 25,000 sows and had abandoned production contracts. Integrators also decided to take control over nurseries, not that attractive back then. Sanitary technology became a commercial technique; within a few years, private and cooperative integrators controlled 95% of nurseries in Quebec.

For small farrowers, the situation was becoming increasingly unbearable. The possibility of establishing a collective nursery for three or four producers existed in principle, but producers had an independence culture that ​​prevented them to organize that way. These small farms continued to decline in number although they were supported by the provincial insurance scheme. They became farrowers with production contracts, farrow-to-finish producers or fatteners with production contracts. The PRRS also caused a deterioration of the farrow-to-finish farms’ health status. Our interviews revealed that from 1996 to 1998, we observe a fall in their number, as well as small farrowers that cannot provide large amounts of piglets from a single source to fill large finishing barns.

***4.5 The 2000s: Integration of slaughterhouses and market risks***

From 1995 to 2002, the Quebec hog production experienced a second phase of rapid growth supported by the markets and the provincial income stabilization system. Yearly production went from 4.5 to 7.5 million heads. Private and cooperative millers played some role in this explosion of production. The increasing involvement of millers in genetics and maternity facilities led them to invest in slaughter activities in order to get the full profitability of the whole chain. The process of vertical integration was therefore pursued by the integration of complete chains, from the genetics to the slaughter of animals. At the turn of the 2000s, many integrated networks owned or had partnerships with slaughterhouses. In fact, only two slaughterhouses in the whole province did not have a direct link with production or feed mills by that period of time.

The role of private millers in the coordination of the Quebec pork industry strengthened in the 2000s. The collective auction mechanism was therefore losing its relevance since many networks had sufficient production capacity to fully operate their slaughterhouse, or wanted to produce a hog with specific characteristics (Lepage-Gouin, 2014). In 2009, the electronic auction was abolished and direct relations were re-established between producers and slaughterhouses. This modification brought a major challenge to the two slaughterhouses that had no formal relation with the production segment of the chain. We assisted to the creation of new partnerships and an increasing integration of chains as an important miller concluded a co-ownership agreement with one of the two slaughterhouses and the other slaughterhouse also sought to make such links. The end of the electronic auction seemed to have rushed the formal process of vertical integration between the feed milling, production and slaughter segments.

More recently, risk aversion and risk management are pointed as causes that encourage producers to prefer production contracts rather than being independent (B'Denam Assih, 2014). Very large fluctuations and low hog prices over the period 2006-2012 combined with a strong increase in the price of grain and soybeans have undermined the financial situation of many producers in Canada. Quebec producers have generally fared better thanks to the contribution of the insurance scheme. However, the provincial scheme recently ended up with an important deficit that led the government to put financial limits to it.

With the increasing difficulty of individual producers to manage grain and hog prices variations, many producers have chosen to contract with an integrator-miller that manages these risks and pays them a fixed price. A recent study showed that in 2012, Quebec hog production was more than 60% integrated by agents whose principal activity was not agricultural production (Royer and Vézina, 2012). Other producers simply left the production. In 2009, 1,311 fattening farms participated to the ASRA scheme; four years later, they were no more than 978 (FADQ, 2014). Over the same period, 899 maternity farms participated in the ASRA scheme and four years later, they were 646.

Besides, contracting with producers has many advantages for hog integrators. Compared to vertical integration, it reduces investments in capital, the cost of manure management and the need in –rare- skilled workers (CIRANO, 2015).

Some integrators still own fattening facilities acquired when they started as integrators. They keep them in order to test new techniques before introducing them to integrated producers (CIRANO, 2015).

***4.6 The cooperative model***

Local cooperatives and their union, the Cooperative Fédérée de Quebec, played an undeniable role in the development and configuration of hog chains in Quebec. Over the last fifty years, their positions and strategies have varied widely, as their hesitations and lack of coordination of their actions allowed the emergence of more fragmented supply chains than it would have been otherwise.

The Cooperative Fédérée[[4]](#footnote-4) has been involved very early in the slaughter of pigs in Quebec City and Montreal. This activity was considered a service to cooperatives and their members. Over the decades, the Coopérative Fédérée has completed the purchase and construction of several major slaughterhouses, among them Olymel, the largest slaughterhouse group in Quebec, if not in Canada, that is still in business.

Throughout that period, local cooperatives have had an ambivalent attitude towards hog production. Dairy farmers, more numerous than hog producers, controlled cooperatives. Many dairy farmers raised pigs and in the census of 1961, dairy farmers possessed a higher proportion of pigs in Quebec than specialized hog producers. Low milk prices during the 1960s and 1970s, as well as the establishment of milk quotas in the mid-1960s, increased the interest of dairy farmers for hog production. Local cooperatives became more and more interested in pig production, in part because of their dairy members, who saw that production as an additional activities and income. For producers who left milk production, pigs appeared as an alternative to fill their barns and ensure a stable and transitory income. From the 1970s, the profitability of cooperatives’ mills added a new interest in pork production, a huge grain consumer.

The first ambiguity of cooperatives concerning coordination modes in the pig sector can be summarized in two words: integration or not. Data from the governmental report indicated that cooperative mills used finance contracts for 84 % of their pig production in 1966 (Commission April, 1969). Cooperatives provided the service of finding piglets for producers but did not see these relationships as a loss of autonomy for producers. Finance contracts were widespread in several sales activities.

During the 1960s and 1970s, several events changed the nature of the relationship and interest between the Cooperative Union, local cooperatives and producer members. First, the acquisition of slaughtering structures posed the question of their full use. Although the Union first wanted to offer a service to its members, the profitability of the slaughter segment of the chain became more important. Financial pressure forced the local cooperatives to send their production of hogs to the cooperative slaughterhouses. The same phenomenon took place with mills. The cooperative mills had to generate great volumes to make these investments profitable and integration was a way to secure their revenues.

As we have seen earlier, the economic crisis of the early 1980s forced cooperatives ​​to return the property of animals to producers. Once integrators, local mills then became simple feed input suppliers. From 1985 to 1987, cooperatives questioned their involvement in hog production. Were they to remain outside the sector, at the risk of seeing private competitors providing better quality piglets to their members, and so eventually lose their feed market? Or did they have to grasp the opportunity to produce their own piglet and invest in genetics? This second option was the safe choice in order to keep their place in future grain and feed trade. The Fédérée set up a genetic program and got involved in the production of high quality animals. The possession of maternity facilities producing high quality piglets and the provision of extension services to members were shared among local cooperatives. Coordination models multiplied. As the three sites and the early weaning was needed in the 1990s, following the crisis of PRRS, the cooperative model invested in large maternity facilities and nurseries, leading to the vertical integration of these segments in the cooperative network.

**5. Discussion and conclusion**

From a complete integration before the 1960s, the hog chains first disintegrated due to the process of technical division of labour, leading to three main chain segments: feed, production and slaughter. The feed segment was mainly coordinated to the production segment through contracts and the market. Slaughterhouses contracted with producers to get hogs. Then, in order to secure their hog supply, slaughterhouses abandoned production contracts with multiple hog producers and developed business partnerships with major suppliers of live hogs, feed mills, guaranteeing large volumes while minimizing transaction costs. At the same time, millers began using production contracts with fatteners in order to develop their business without having to invest in buildings and human assets, therefore reducing their production and transaction costs.

At the end of the 1970s, health issues became important factors of chain evolution. Pigs are rather sensitive animals in terms of infectious diseases and health hazards are very high in that agricultural sector. Over the last 35 years, many disease outbreaks have affected the Quebec hog sector leading to important economic losses. To sell feed and develop their business, feed mills involved in hog production had to find piglets of a good health status. We therefore assisted to the formal integration of farrowing by millers and the creation of an additional chain segment: nurseries.

The health status uncertainty also led to the consolidation of the farrow-to-finish producers facilitated by an institutional change, the provincial income insurance scheme. These factors mainly led to closer coordination modes among chain segments, notably the use of contracts and formal integration. The economic crisis had some opposite effects as the cost of production contracts became unbearable for contractors and integrators, who decided to disintegrate during that period.

Besides these coordination modes changes, many structural changes occurred, caused by both piglets’ procurement and health status uncertainty. Two important chain segment, piglets’ traders and auctions, disappeared and farms (finishers and the farrowing farms) became larger.

The introduction of a new institutional arrangement, collective marketing through an electronic auction, reduced the interest in having a close relationship between slaughterhouses and millers.

Finally, in the last decade, the issues of risk and genetics have become increasingly important factors influencing chains’ coordination. In order to get the full profitability of their investment in genetics, integrators made closer vertical links with the slaughter segment. The abolishment of the electronic auction facilitated this phenomenon. Moreover, market risks became so high that the financial situation of independent producer became unbearable; many of them signed production contracts with integrators. Vertical coordination of most chains is getting tighter, evolving towards complete integration from genetics to the final distribution to consumers.

In the light of this historical analysis, we observe that the main factors influencing the Québec hog chains coordination modes over the 1960-2010 period were 1) the uncertainty surrounding input (piglets) procurement, 2) the uncertainty over the quality of piglets (health status), 3) the promotion of the sale of input (animal feed), 4) the governmental insurance scheme (ASRA), 5) the 1980s economic crisis, 6) the marketing plan and its electronic auction, and 7) increasing market risks in the 2000s. Table 2 resumes our main results.

Table 2. Main factors influencing Quebec hog chains coordination evolution.

|  |  |
| --- | --- |
| Factors |  |
| Strategic and business considerations | * Benchmarking * Promoting its own input or output |
| Control Intensity | * Increased control over health status of piglets |
| Transaction costs considerations | * Uncertainty related to piglet procurement, finding an outlet for market hogs, price risk * Measurement costs for evaluating piglets’ health status * Technology (process of division of labour; all in-all out) * Institutions (ASRA, electronic auction, high interest rates caused by economic crisis) |
| Financial motivations | * Cost of integration versus contracting |
| Innovation-oriented solution | * Technological tests in-house |

As we have seen, the Quebec hog chains underwent various changes and their evolution is not straightforward. The variety of factors driving these changes is striking. Having a 50 years interval to observe chains evolution allows us to see that factors influencing coordination have changed over time, adapting to changing conditions. However, our analysis shows that uncertainty seems to be the main driver of chain coordination evolution through time. Uncertainty leads to strategic behaviour, increases transaction costs and triggers the need for control. Technology aimed at reducing uncertainty related to health hazards also has a huge influence on chain coordination. Institutional devices intended to reduce uncertainty, such as the ASRA scheme, have a strong influence on chain evolution.

Today, there are two main chain structures in the Quebec hog industry. First, a miller producing its own piglets and feed, contracting with a producer to fatten its hogs, and owning or contracting with a slaughterhouse. The increased control of agricultural production by downstream and upstream businesses is not unique to the case of hog production in this Canadian province. We also find this trend in the poultry and egg industries all around the world, as well as in the hog industry. Second, independent farrow-to-finish producers, numerous in the cooperative model, who are extremely competitive when they successfully manage financial and sanitary risks. Our analysis therefore seems to support results found in Brousseau and Codron (1998). The authors also concluded that choosing a mode of governance depends on many factors, uncertainty being of foremost importance. The institutional factor also seems to be a critical factor of influence. Without the public insurance scheme and the mandatory collective marketing, chains would have evolved quite differently, most probably in a more homogeneous manner favouring integration since these institutions supported looser modes of coordination.

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1. Both authors are professors at the Agrifood Economics and Consumer Science Department of Laval University, Québec, Canada. [↑](#footnote-ref-1)
2. This insurance program is called *Assurance stabilisation des revenus agricoles* (ASRA) and is specific to the province of Québec. The insurance program pays the farm a compensation payment when the average selling price is lower than a stabilized price calculated on a production cost basis. [↑](#footnote-ref-2)
3. This disease was present in the US since 1987. [↑](#footnote-ref-3)
4. It is important to note that it is the Union of the cooperatives, the Coopérative Fédérée, and not the cooperatives themselves that was involved on the slaughter activities. That organisation meant that the Union had to buy hogs from the cooperatives or other sources depending on the market demand and availability. This institutional distance is still present today. [↑](#footnote-ref-4)