



Risk Sharing and Transactions Costs in Producer-Processor Supply Chains

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Introduction

Several forces are converging to encourage the agricultural industry to form more tightly aligned supply chains. Efficiency, synergies, inter-firm pooling of resources, customer responsiveness, and risk sharing are the four key objectives that firms seek to improve by forming such chains (Besanko, Dranove, & Shanley, 2000). Efficiencies are often gained by more accurately sharing information between parties in the chain. For example, a pork processor may be able to manage the flow schedule of hogs through the slaughter plant by contracting or even owning the production stage of the pork chain. And complementary inter-firm synergies resulting from, for example, alliances between research and development (R&D) and manufacturing firms and downstream distribution and marketing firms can also be captured with effective supply chains.

Responsiveness to consumer demand is another reason for developing supply chains. Products that can be differentiated at various stages of the food chain allow for the potential to meet the demands of certain segments of the market. Retailers as well as processors argue that their supply chains allow them to respond to an ever changing set of consumer preferences more quickly than they could with traditional open-market transactions.

In addition to efficiency, inter-firm synergy, and responsiveness, supply chain participants often express a desire to manage risks as a reason for forming supply chains. The risks may be input/output price risk, quantity/quality risks, and/or safety/health risks. The recent interest in food safety and traceability are often cited as reasons for forming tighter vertical alliances. Agricultural producers often state that reductions in price and volume variability are key influencers in their decision to join a supply chain (Hennessey & Lawrence, 1999; Rhoades, 1995).

Supply chains have been a dominant focus of both academic research and business strategy in the food and agribusiness industries for the past decade. Much discussion, analysis, and experimentation with various forms of vertical alignment using governance structures such as strategic alliances, joint ventures, contracts, and vertical integration has occurred. Much of the recent debate and discussion, as well as the controversy concerning the development of these arrangements has focused on the production sector, and in particular, the linkages between producers and processors.

The effectiveness and long-term viability of a supply chain is determined in no small part by how well the coordination governance structure manages the sharing of the risks and rewards of the supply chain among its participants. The different types of risks encountered in alternative supply chain business structures, the incidence of risk on the part of individual supply chain partners and the sharing of risk and reward among supply chain participants has important implications for who will be the most likely participants in a supply chain, as well as the benefits the various players will receive.

Risk Sharing and Costs of Vertical Alignment

The research on supply chain risk/reward sharing in agriculture has often been focused on producer impacts. As noted, producers are often seeking avoidance of risk in these arrangements. However, governance structures such as contracting that lead to risk avoidance also result in lower returns on average. Governance structures that reduce risks for producers can lead to misalignment of incentives resulting in shirking behavior (moral hazard) if not monitored carefully. For example, producers on fixed payment contracts may be more inclined to deliver lighter weight hogs to the slaughter facility than the processor desires. In addition, governance structures that reduce

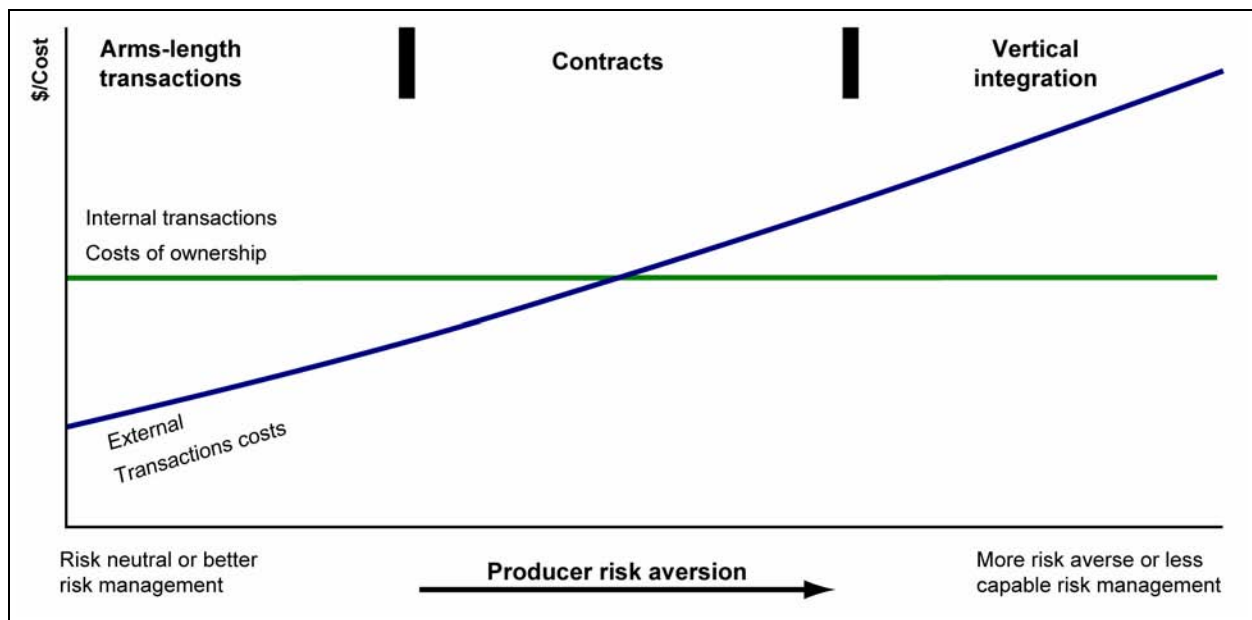


Figure 1. Conceptual framework for external transactions costs of risk sharing versus the internal transactions costs of vertical ownership.

risks for producers can attract producers that are relatively more risk averse (adverse selection). This risk averse nature often manifests itself in less aggressive adoption of new technologies and business practices – behaviors that do not enable a value chain to reap full benefits of efficiency and productivity improvements over time. Thus, channel partners that absorb more risk in their agreement with producers generally expect and receive higher returns to compensate for the higher risk and/or risk mitigation costs.

For some firms, the risk sharing transactions cost of monitoring channel partners exceeds the willingness of the marketplace to compensate them. In these cases, the firm may choose to acquire the chain (vertically integrate), thereby avoiding the transactions costs associated with moral hazard and adverse selection. These firms have decided that the internal transactions costs associated with owning both stages of the chain (agency costs, influence costs, increased production risks, employee

risks, etc.) are less than the external transactions costs (moral hazard, adverse selection, and risk premia). Smithfield Foods and Tyson Foods offer examples where vertical ownership has been the preferred choice in an industry where other governance structures continue to be employed. These two firms, with their international brand identity and diverse product bases, may be in a position where the transactions costs of open-market, contract, or joint venture agreements exceed their internal transactions costs of owning the chain.

Figure 1 depicts the conceptual framework of external transactions costs of risk sharing in comparison to internal transactions costs of ownership. The vertical axis measures the total cost of the transactions of products, services, information, and compensation between stages of the chain. The horizontal axis represents the risk aversion and/or ability to manage risk for producers from whom the processor may choose to acquire products. The processor is

assumed to have a lower relative risk aversion than producers. Thus, as channel captain, if the processor wants to source products from more risk averse producers, they must design vertical arrangements to either take on more of the risk, or compensate the risk averse producers more for accepting the same share of the risk.

Two separate lines are displayed in Figure 1. The external transactions costs line reflects the additional risk-sharing cost borne by the processor when the exchange is between the processor and producers in a vertical arrangement. This line increases at an increasing rate as producer risk aversion increases. Increasing external transactions costs reflect the additional costs that must be borne by the processor in the form of either increased risk taking or increased compensation to the more risk averse producer for taking on more risk.

The internal transactions costs line reflects the cost of ownership to a processor that owns both stages of the chain where separate firms are

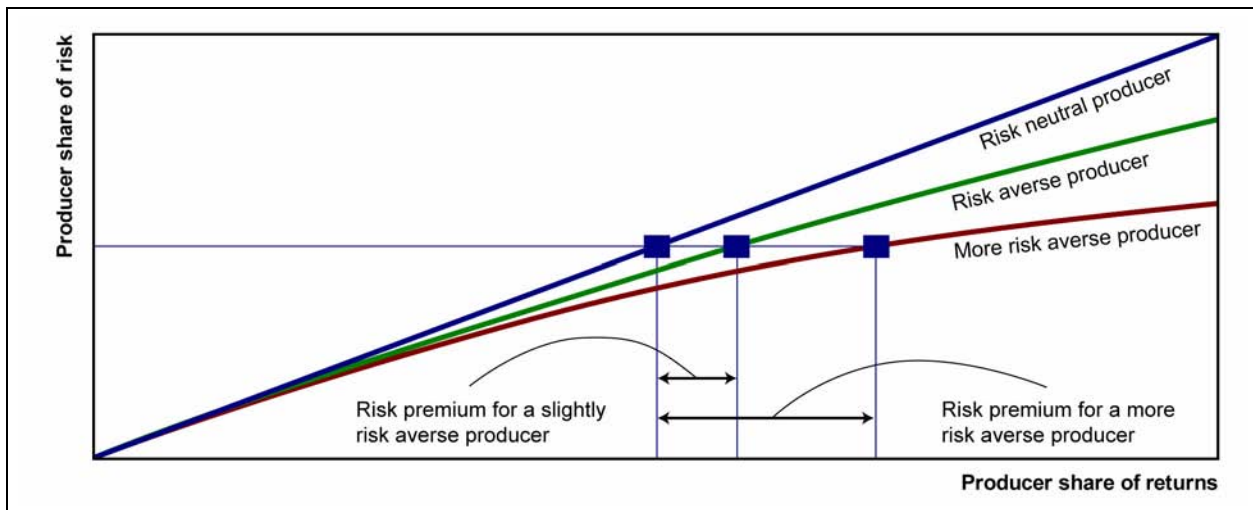


Figure 2. Risk/reward sharing between the processor and producers at various risk aversion levels.

replaced with employees. Internal transactions costs of ownership are initially assumed to be higher than external transactions costs. That is, we assume that the efficiencies of an open-market transaction in the absence of risk aversion by the producer result in lower transactions costs than vertical ownership.

As producer risk aversion increases, the internal transactions costs of ownership do not change -- only the risk sharing transactions costs of a market-based exchange increase. There is a point where the additional transactions costs of risk sharing cause the transactions costs of the market exchange to exceed the internal transactions costs of ownership.

The delineations across the top of the figure illustrate the different governance structures likely to be employed. When producers have risk management capabilities or have low enough risk aversion that risk sharing transactions costs are low, channel partners are likely to align in an arms-length exchange such as open markets, strategic alliances, or joint ventures. As producer risk aversion rises or management ability declines, the external transactions costs rise for

the processor due to increased risk sharing costs. The increase in external transactions costs lead to more formal vertical arrangements such as contracts, where the risks and returns are dictated by the channel captain (processor). There is a point along the producers' risk aversion/management scale where the risk sharing transactions cost of the market exchange are higher than the internal transactions costs of owning the chain. It is at or just beyond this point where ownership of the channel (vertical integration) becomes an option because the transactions costs of risk sharing exceed the internal transactions costs of ownership. Producers at this level of risk aversion would likely choose to become a grower for a vertically integrated firm, receiving a flat fee for their services much like an employee of the company.

Research in supply chains in other industries shows that eventually external transactions costs decline below the internal transactions costs of chain ownership as firms become more accustomed to working together and better equipped to handle the risks in the exchange between segments of the chain (a learning

supply chain as described by Spiller & Peterson, 2003). If the goal is to reduce external transactions costs, then firms will favor partners that are less risk averse or better able to manage risk. As such, contracts and similar vertical arrangements would likely accrue to larger producers. However, for processors willing to absorb more risk, the preferred partner may be more risk averse producers in very tightly linked production contracts, where producer risks are transferred to the processor but rewards to the producer are lower. The framework presented here ignores any concept of market power among channel participants, and yet illustrates a logical economic reason for more tightly aligned vertical arrangements and industry consolidation to occur even in the absence of market power.

Risk Premiums and Contract Production

A common governance structure that more explicitly shares risks and rewards between supply chain partners is the contract. Figure 2 illustrates the nature of the risk premium required to entice more risk averse producers into contract arrangements that share more risk. The horizontal

axis is the proportion of returns shared by producers in a vertical arrangement with a processor. The vertical axis is the risk shared by the producer. There are three lines in the graph, each representing different levels of producer risk aversion. If the producer and the processor were both risk neutral, then the sharing of risk and reward would be illustrated by the 45 degree line. If the risk-neutral processor wishes to maintain this same level of risk sharing, but must do so with more risk averse producers, the processor will have to give a greater share of the rewards to the producer — a risk premium required by the producer. And the greater the producer's risk aversion, the more sizeable the risk premium becomes. To minimize this risk premium payment, the processor would prefer to contract with producers who are less risk averse or have more capacity to manage or absorb risk; this motivation again favors larger producers.

Contracts frequently spell out portions of both "fixed" payments and incentive payments from buyers to suppliers based on performance variables. The balance of fixed versus incentive payments depends, ultimately, on the relative risk aversion/management capability of the partners in the chain. If a processor seeks a governance structure that allows the risks to be shared between the parties, then they will seek a governance structure with more incentive payments. To entice risk averse producers to accept more incentive payments (share more of the risk), the fixed payment would have to be greater than for less risk averse producers (this is reflected in Figure 2 as the risk premium).¹ The risk sharing transactions cost of governance structures with more incentive payments will be less if the producers are relatively less risk averse or relatively

more capable of managing risk. This again suggests that agribusinesses seeking production partners in a contract-coordinated supply chain that will share the risks and rewards will tend to favor larger producers with the ability to spread risk and/or producers that are less risk averse. For processors that are more willing and/or able to manage risk, a fixed payment contract may be the preferred arrangement to attract risk averse producers that are willing to take less return for lower risk.

Implications for Producer Financial Performance

The transfer of risk and the accompanying reward from supplier (producer) to buyer (processor) suggests that suppliers will likely be less profitable under a vertically aligned governance structure compared to the traditional open-market governance structure that has dominated agriculture. And in fact most studies support this argument when profitability is measured by traditional metrics such as profit per unit of production or return on assets (ROA). But vertical arrangements that share business risk and rewards allow producers to access more debt capital if the business risk is reduced through contracting or similar business arrangements.

Analysis of pork contracting illustrates the financial implications of using more debt in the capital structure of the contract production farm compared to an independent grower. Contract swine growers can in fact finance their operations with debt

comprising a large portion of their capital structure (Lins, 1997; Roberts et al., 1997). Table 1 illustrates the implications of different capital structures for different business arrangements on the return on equity (ROE). Note that with no debt, independent business arrangements generate a higher ROE (and ROA since they are equal when no debt is used) than the typical contract business arrangements analyzed. As debt becomes a larger proportion of the capital structure of the business, the ROE increases for all business arrangements. But the independent grower who does not manage operating risk will likely not be able to use as much debt as part of his/her capital structure as the contract grower. Comparing the ROE of the independent grower at 40% debt (23.5%) with that of contract growers at 80% debt (23.1% and 27.6%), it is apparent that vertically aligned systems that transfer risk to the buyer (processor) have equal or superior financial performance. By accessing more external financing these firms also have increased capacity to expand their business.

Increased access to debt capital allows vertically aligned producers to generate competitive financial performance, grow at a more rapid pace, and adopt new technologies more quickly than those not vertically aligned — further separating these producers from those with less access to vertical markets and debt capital. This outcome may, again, lead to a more rapid consolidation as well as vertical coordination of the industry as has been witnessed in poultry, pork, and potato industries.

Risk of Vertical Alignment

The development of more tightly aligned supply chains creates new

1. *The discussion here is based on incentive contract literature and more explicitly from the discussion of the "Second-Best" Contract by Besanko, Dranove, and Shanley (2000).*

Table 1. Financial performance of various pork production business arrangements (mean return on equity, %).

Pork Production Business Arrangement	FINANCIAL STRUCTURE		
	0% Debt	40% Debt	80% Debt
Independent Farrow-to-Finish	17.0	23.5	56.5
Efficiency and Marketing Incentive Finishing Contract	10.4	12.5	23.1
Death Loss Incentive Only Finishing Contract	11.3	14.0	27.6

Source: Boehlje and Ray (1999)

and less easily quantifiable risks for the participants in the supply chain. For example, one of the supply chain risks faced by both suppliers and buyers is contractual or relationship risks. A grower may have a contract that guarantees a price for his/her products, and enticements to invest in specific assets, but what happens if the processor goes bankrupt? What happens to the contract (availability or terms) and the capital investments made by the producer next year if the processor finds other suppliers in other areas who can satisfy their needs at a lower price? This risk is not unlike that of losing a critical supplier or a lender, but losing access to the product market has typically not been a significant risk for producers in commodity-based agriculture.

The adoption of more tightly aligned supply chains in agriculture is likely to compound the risk and uncertainty related to the effectiveness of markets in providing accurate messages to consumers and suppliers in the food chain concerning prices, quantities, and qualities of products and attributes. With the formation of more tightly aligned food supply chains, it can be argued that messaging is much more precise, timely, and generally more accurate for participants in the chain than might be provided by market forms of coordination. But, what about the risk faced by those who are not part of the tightly aligned supply chain – are not qualified suppliers? Is there more vol-

atility in the prices they receive because of thin markets? Do they have access to a market or are they closed out because only qualified suppliers can participate? Because of the thinness of these markets, are they not only subject to more volatility, but also more potential for manipulation? Do the prices and other information conveyed by these thin markets provide accurate messages to consumers and suppliers concerning quantities, qualities, cost, and value?

Conclusions

Tightly aligned supply chains are forming at a rapid pace in the agricultural section. Traditional transactions costs are a critical determinant of the appropriate governance structure for these supply chains. However, risk considerations and the risk aversion/sharing characteristics of the players are also important. The search for reduced risk sharing transactions cost leads to the formation of supply chains among participants that are more willing to share risks as well as rewards. More specifically, strategies to reduce internal/external transactions costs lead to the formation of supply chains among participants who are less risk averse or have more ability to manage or mitigate risk. This suggests that, in general, most tightly aligned supply chains that seek to share risk and rewards among participants will be increasingly dominated by larger firms at both the buyer and supplier level –

leading to more consolidation, particularly at the production end of those industries. However, channel captains that have the willingness and ability to absorb the risk may allow producers with less ability to manage risk to maintain a role in the industry as service providers for these risk absorbing processors. At the same time, the transformation of the industry to more tightly aligned supply chains will introduce new strategic risks which will require additional analysis and skills to manage and/or mitigate those risks.

For More Information

- Besanko, D., Dranove, D., & Shanley, M. (2000). *Economics of Strategy*. New York: John Wiley & Sons, Inc.
- Boehlje, M., & Ray, J. (1999). Contract vs. Independent Pork Production: Does Financing Matter? *Agricultural Finance Review*, 31-42.
- Hennessey, D., & Lawrence, J. (Spring/Summer 1999). Contractual relations, control, and quality in the hog sector. *Review of Agricultural Economics*, 21(1), 52-67.
- Lins, D.A. (October 1997). *Financing pork producers: Challenges and opportunities*. Paper presented at the 1997 National Pork Lending Conference, Minneapolis, MN.
- Rhoades, V.J. (1995). The industrialization of hog production. *Review of Agricultural Economics*, 17(1), 107-118.

Roberts, B., Barry, P., Boehlje, M., & Baker, T. (Summer 1997). Financing capacities of independent versus contract hog production. *Journal of Agricultural Lending*, 8-14.

Sporleder, T.L., & Peterson, H.C. (2003). Intellectual capital, learning and knowledge management in agrifood supply chains. *Journal on Chain and Network Science*, 3, 75-80.

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