

CHAPTER 13

QUANTIFYING STRATEGIC CHOICE ALONG THE VERTICAL COORDINATION CONTINUUM

Implications for agri-food chain performance

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Abstract. Given the increasing emergence of highly integrated agri-food supply chains, a key question arises as to how to measure the performance of these chains. This chapter postulates that agri-food supply-chain performance can be best understood with the help of three separate, but related phenomena: the individual firm's desire to participate in the supply chain; the governance structure of the whole chain; and the application of industrial organization and institutional economic theory. The Peterson, Wysocki and Harsh (PWH) model of vertical coordination strategy selection is provided. A brief overview of the various forms that agri-food chains may take on and a multi-disciplinary approach to understanding agri-food chain performance are offered, including channel master, chain web and chain organism. The chapter ends with research challenges still needing to be addressed including the limited access to information and measurement issues. We conclude that the PWH model, learning supply-chain governance structures, and application of additional economic theories model can be useful in understanding and measuring performance in agri-food chains.

Keywords: agri-food chain performance measures; chain web; chain organism; channel captain; integrated supply chain; learning supply chain; PWH model; unintegrated supply chain

INTRODUCTION

Given the increasing emergence of highly integrated agri-food supply chains, a key question arises as to how to measure the performance of these chains. Performance matters because policy makers care about individual and supply-chain performance. Firms within supply chains care about their firm-specific performance and the performance of other firms in a given supply chain, especially if their performance is impacted by others in the supply chain. Therefore, the question is, what would performance depend upon in agri-food supply chains?

This paper postulates that agri-food supply-chain performance can be best

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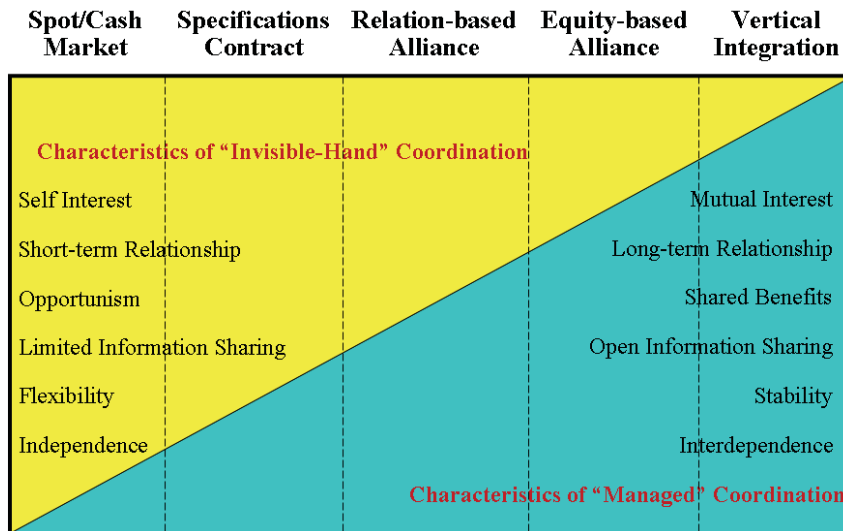
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explained and understood with the help of three separate, but related phenomena: 1) the individual firm’s desire to participate in the supply chain, 2) the governance structure of the whole chain, and 3) the application of industrial organization and institutional economic theory.

Coordination choices firms make along the vertical coordination continuum representing the various levels of supply-chain participation desired by firms are presented. The Peterson, Wysocki and Harsh (PWH) model of vertical coordination strategy selection is provided. A brief overview of the various governance structures that agri-food chains may adopt and a multi-disciplinary approach highlighting the relevance of industrial organization and institutional economics to understanding agri-food chain performance are offered. Implied performance measures that emerge from the explanatory models are discussed and the paper concludes with research challenges still needing to be addressed regarding the measurement of performance in agri-food chains.

THE VERTICAL COORDINATION CONTINUUM

Based on the work of Williamson (1973; 1975), Mahoney (1992) and Milgrom and Roberts (1992), Peterson et al. (2001) posited that the vertical coordination continuum has five major categories of vertical coordination strategy: spot markets, specification contracts, relation-based alliances, equity-based alliances, and vertical integration. Figure 1 contains a table of the relevant definitions for each category of vertical coordination strategy. The latent variable linking the five categories into a true continuum is the intensity of control that the alternative strategies employ to



Source: Peterson et al. (2001)

Figure 1. Strategic options for vertical coordination

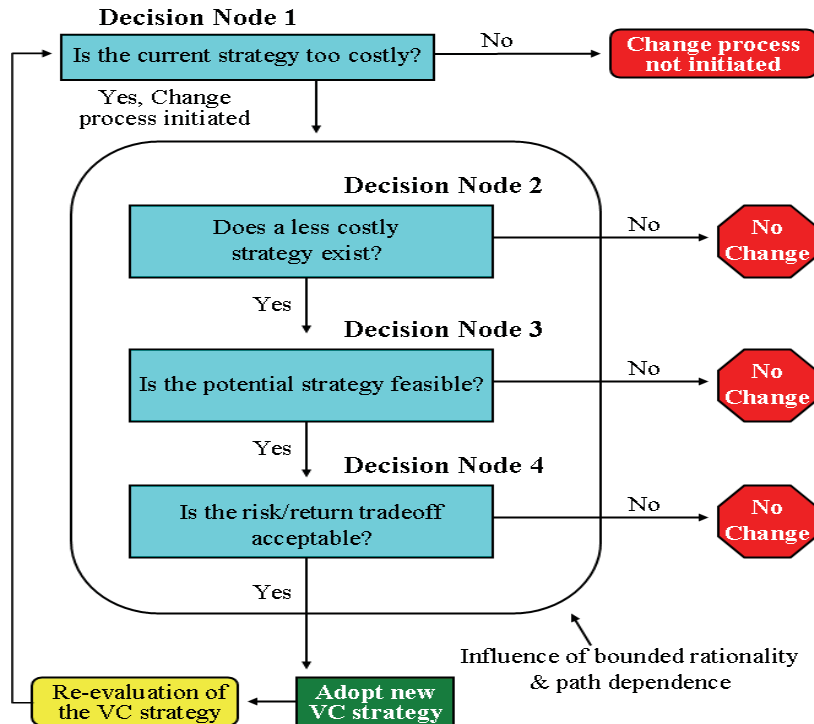
assure that proper coordination occurs (i.e., coordination with minimum potential for error). Coordination strategies move from low levels of *ex ante* control intensity (spot markets) to high levels of *ex post* coordination control (vertical integration) while passing through several transitional levels of ever-increasing intensity (specification contracts, relations-based alliances and equity-based alliances).

THE PWH MODEL OF VERTICAL COORDINATION STRATEGY SELECTION

The main objective of the PWH theoretical framework is to identify the decision-making process where decision makers accommodate issues of asset specificity, complementarity and coordination strategy feasibility in their coordination strategy choices. Peterson, Wysocki and Harsh (Wysocki et al. 2003) modelled a firm's decision about which strategy to pursue on the continuum as a four-step decision process. Figure 2 presents this framework. The framework is based on the presumption that a firm already exists and by intention or habit has already established a position on the continuum. The first decision step involves a process-initiation question: Is the perceived cost of the current coordination strategy too high relative to an available alternative strategy (Node1, Figure 2)? An existing strategy may be too costly for one of two reasons: (1) coordination errors regularly expose the firm to the opportunism of trading partners or result in chronic over- or under-production versus demand, or (2) the strategy is more costly to execute than the coordination errors it is designed to control.

If a firm decides it is dissatisfied with the current strategy from a costliness viewpoint, the second critical question becomes: Would an alternative strategy reduce the perceived costliness of coordination (Node 2, Figure 2)? The answer to this question depends upon whether or not another strategy would better match the intensity (and cost) of coordination control with the costliness of coordination errors. The match is judged better or worse under the logical principle that the more costly the errors, the more intense the control needed and conversely, the less costly the errors the less intense the control.

Again, drawing upon Williamson (1973; 1975), Mahoney (1992) and Milgrom and Roberts (1992), Peterson, Wysocki and Harsh (Wysocki et al. 2003) identify two criteria that can be used to assess the costliness of a coordination error for a given transaction: (1) asset specificity¹, and (2) complementarity². The costliness of a coordination error thus rises with both the level of asset specificity and the level of complementarity. Managers need to assess both of these variables relative to specific transactions and then select a coordination strategy that matches the intensity of control with the costliness of a coordination error. If there is no better match, the perceived costliness diminishes or becomes less important to the decision maker.



Adapted from Wysocki et al. (2003)

Figure 2. PWH model of vertical coordination strategy selection

The third relevant question³ becomes: Is the potential alternative feasible (Node 3, Figure 2)? Feasibility can be conceived as arising from four conditions: (1) capital availability (does the decision maker have the capital required to implement the strategy?), (2) existence of compatible partners (does the decision maker have a transacting partner who will meet the needs of the strategy being implemented?), (3) control competence (given that each coordination strategy has a different intensity of control, decision makers must examine their competence in exercising the type of control required by the strategy to be implemented; willingness as well as skill is key to competence), and (4) institutional acceptability (an obvious test of institutional acceptability is whether or not a particular strategy is legal, e.g., not in violation of antitrust laws; institutional acceptability is a broader concept that defines what economic behaviours or strategies are deemed appropriate by given social, cultural, industrial or group norms, the core values of the firm).

A recent USDA ruling illustrates the importance of institutional acceptability and its impact on decision makers in an agri-food chain. Creekstone Farms Premium Beef LLC asked the USDA in February 2004 for permission to test all its cattle for mad-cow disease so the company could restart sales to Japan. The USDA

subsequently denied Creekstone's testing request because it would have implied a consumer-safety concern that it said was not supported by scientific evidence (Adamy 2004). The USDA maintained that if some beef is labelled as mad-cow tested, it could suggest that untested beef may not be safe. In this particular situation, Creekstone would be prohibited from changing their vertical coordination strategy because of lack of institutional acceptability. Whether or not a particular alternative strategy is deemed feasible will depend on the decision maker's overall assessment of the above four conditions. Any one condition may create enough concern that a "no" decision about willingness to change will result.

Assuming that an alternative is deemed implementable, the fourth and final question in the change process becomes relevant: Does the alternative provide a risk/return trade-off acceptable to the decision maker (Node 4, Figure 2)? With this fourth question, the explicit task of balancing these potential returns and risks is added to the framework. Obviously, the decision maker's risk preferences will be a critical input to answering this question. Based on the decision maker's risk preference it seems fair to predict that any alternative strategy must meet the test that the perceived risk/return trade-off of the alternative is superior to the current strategy if change is to occur.

The framework of Figure 2 proposes that only a "yes" answer to all four of the relevant strategic questions will result in a changed coordination strategy. A "no" at any point stops the process from starting or continuing. A feedback loop is also presented in the framework to make it clear that the process of coordination strategy evaluation is a dynamic one. As transaction conditions, resource availability and strategy potentials change, the chance to create less costly coordination also changes. As an industry evolves, optimal coordination strategies for individual firms within the industry may move in either direction along the continuum depending upon changes in asset specificity, complementarity, feasibility and risk/return trade-offs.

APPLICATION OF THE PWH MODEL TO AGRI-FOOD SITUATIONS

The PWH model of vertical coordination strategy selection has been tested on decision makers in the Michigan celery and public-variety field seed agri-food chains, and in Brazil, at the São Paulo fresh-produce market.

Application of the PWH model to the Michigan celery and public-variety field seed agri-food chains

A qualitative and quantitative approach was undertaken to test the PWH model in the Michigan celery and public-variety field seed agri-food chains. Structured, in-depth, face-to-face interviews were conducted with 25 decision makers in these agri-food chains. Interview transcripts were coded and categorized as responses to each of the four decision-node questions. Qualitative and quantitative analyses were used to test four research propositions (Wysocki et al. 2003):

- RP₁: IF a decision maker is willing to change vertical coordination strategy THEN a “yes” assessment has been made at ALL decision nodes (necessary conditions for strategy change).
- RP₂: IF a “yes” assessment is made at ALL decision nodes, THEN a decision maker is willing to change vertical coordination strategy (sufficient conditions for strategy change).
- RP₃: IF a decision maker is not willing to change vertical coordination strategy THEN a “no” assessment has been made at one OR more decision nodes (necessary conditions for status quo).
- RP₄: IF a “no” assessment is made at ANY one decision node, THEN a decision maker is not willing to change vertical coordination strategy (sufficient conditions for status quo).

For research propositions 2, 3 and 4, 100 percent of the cases upheld the PWH model. Testing of research proposition one revealed that 10 out of the 13 cases studied upheld the PWH model. Three decision makers indicated that they were “unsure” about the risk return trade-off (Decision Node 4 in Figure 2), leading to a classification of the research proposition not holding. Furthermore, discriminant analysis revealed a high degree of predictability with the PWH model. The results of the discriminant analysis of the interview responses revealed that the ability of an alternative to reduce uncertainty was critical to the willingness and unwillingness to change strategies. The acceptability of the risk/return trade-off, the final decision variable, was as important as the reduced costliness of a coordination error in the analysis. Implementability was found qualitatively and quantitatively significant, although not to the same extent as costliness of a coordination error or acceptability of the risk/return trade-off. There was strong quantitative and qualitative evidence to support research propositions 2, 3 and 4 and moderately strong evidence to support research proposition 1. Even with the relatively imprecise instruments (i.e., the decision variables), it appears the proposed framework was a reasonable model of how decision makers view the decision process for altering a vertical coordination strategy.

Application of the PWH model to the São Paulo fresh-produce market in Brazil

Manville and Peterson (in prep.) provided another empirical test for the PWH model for vertical coordination strategy selection, drawing evidence from four firms’ procurement strategies in São Paulo’s fresh-produce markets. The evolution of firms’ coordination strategy decisions for fresh-produce procurement were analysed through seven cases using the PWH framework.

Case analysis and application to the PWH model led to several insights. In six of the seven cases (in one case a firm that began with a vertical integration strategy and subsequently de-integrated) firms consistently tended to shift their strategies toward ones offering greater intensities of control. In general, this does not necessarily indicate that the firms initially made the ‘wrong’ coordination strategy choice. Instead, there are suggestions that both retailers and suppliers in this produce market benefited from the gradual intensification of coordination control, over which period

they learned to work better with one another and adjusted to the greater levels of interaction and interdependence, while incompatible partners were identified and weeded out. There were also important driving forces, namely the shifts in underlying demand and supply conditions faced by the firm that also drove these strategic shifts towards ever-increasing levels of control (Manville and Peterson in prep.).

Second, differentiation between issues of complementarity and asset specificity permit a considerably richer insight into issues of coordination than a single-minded focus on asset specificity. The defining difference between the two concepts highlights that coordination can be costly even where there is no reason to anticipate opportunistic behaviour on the part of either party, i.e. in situations of complementarity where both parties will benefit from the successful completion of transactions (Manville and Peterson in prep.).

Third, it seems that as one moves from lesser to greater degrees of control intensity, one can observe early shifts rightward to be oriented to resolving issues of complementarity, with the resolution of these leading to gradual increases in the levels of asset specificity implicit in the transaction; and this in turn leading to the need for additional shifts in coordination strategy. For example, in the first phase of one firm's coordination strategy, they sought to facilitate the achievement of complementarity benefits by tightening control through a supplier registry, which led to relationship-specific investments whose asset specificity later needed to be accommodated through further shifts in coordination.

In this situation, case-study analyses provided significant support for the PWH model, as well as new insight into the firms' coordination strategy decisions that might be forgone when analysed using a model that lacks the operational approach and consideration of incentives and feasibility guiding the PWH model. The results support the hypothesis that the PWH framework provides empirical and theoretical insight into managers' coordination decisions. Analyses of the evolution of the firms' coordination strategies appear to provide powerful evidence supporting the determinants and processes of decision-making that Peterson, Wysocki and Harsh posit in their model. The case-study results provide considerable insight into issues of incentives and feasibility, as well as the influence that asset specificity, complementarity and risk/return criteria have on the coordination strategy decision.

AGRI-FOOD CHAIN FORMS: UNINTEGRATED AND INTEGRATED CHAINS

A supply chain, whether in the agri-food system or not, is "an association of customers and suppliers who, working together yet in their own best interests, buy, convert, distribute, and sell goods and services among themselves resulting in the creation of a specific end product" ((National Research Council 2000, p. 22). By this definition, every firm is part of a supply chain, and supply chains have always existed even within the context of spot-market interfaces between firms, level by level, in a vertical chain. Traditional supply chains coordinated by open markets can be referred to as unintegrated. Today, integrated supply chains are moving beyond open-market association to "an association of customers and suppliers who, using

management techniques, work together to optimize their collective performance in the creation, distribution, and support of an end product” (National Research Council 2000, p. 27). An integrated supply chain can only be optimized when the chain participants function together to improve the performance of the whole chain (Peterson 2002).

The benefits of an integrated supply chain are argued to be many: inventory reduction throughout the chain; reductions in supplier redundancy; reduced transaction costs, frictions and barriers; increased functional and procedural synergies between chain members; faster response to changing market demands; lower operating and investment costs across the chain; and shorter product realization cycles and lower product development costs (National Research Council 2000). These benefits mirror quite well the ones expected from the concepts of transaction-cost economics (Williamson), the theoretical foundation for much of supply-chain management. As information is shared, functions rationalized and system flows made more certain across the supply chain, transaction costs fall and the responsiveness and profitability of the whole chain rises.

An earlier section of the paper described the usefulness of applying the PWH model to the Michigan celery and public-variety field seed agri-food chains. In fact, 9 out of the 25 firms studied, were operating in unintegrated agri-food chains using a spot market strategy as their primary market-coordinating mechanism. The remaining 16 firms were operating in integrated agri-food chains by utilizing contracts, relation-based alliances, equity-based alliances and vertical integration (Wysocki 1998).

LEARNING SUPPLY CHAINS

Learning supply chains are formed from the union of learning organizations and integrated supply chains. Learning organizations are those organizations that have developed knowledge management systems that allow them to adapt continuously to their environment based on learning (Senge 2000). Learning is “the process by which knowledge assets are increased over time” (Seemann et al. 2000, p. 91). Learning organizations have “explicit management efforts to build intellectual capital in support of the firm’s strategy” (Seemann et al. 2000, p. 92). Learning arises from the creation and sharing of both tacit and explicit knowledge.

For our purposes, a learning supply chain can be defined as an integrated supply chain that has an added dynamic, agile ability to learn from and respond to changing market environments. The added capacity of a learning supply chain is the knowledge or intellectual capital held and applied collectively by the supply chain (Peterson 2002). Mason-Jones and Towill (1999) argue that the key added capacity formed by a learning supply chain is the simultaneous feeding of end-user market information to all supply-chain participants. Dyer and Nobeoka (2000) describe the crucial addition to capacity as highly effective, free-flowing interfirm knowledge transfers. For De Vries and Brijder (2000), the two-way knowledge sharing of upstream functional/operational knowledge and downstream contextual (market) knowledge between chain members is the significant added capacity.

ALTERNATIVE MODELS FOR LEARNING SUPPLY CHAINS

Rice and Hoppe (2001) suggest three different models for future supply chain versus supply-chain competition. Each of these models has implications for agri-food chain performance and for distribution of costs and benefits generated by each. The three models are the channel master, the chain web and the chain organism.

The channel-master model

Inter-chain competition in the channel-master model centres on a dominant firm, or channel master, in each supply chain. The dominant firm specifies the terms of trade across the entire supply chain, and the supply chain rises or falls competitively based on the coordinating skill of this firm. Most existing automotive supply chains (except one noted shortly) are examples of this model. The model is also well represented in the agri-food system. It may even be the prevailing model today given the pervasiveness of 'integrators' in a number of agri-food chain settings. Tyson, Purdue and Smithfield would all represent examples (Peterson 2002).

The chain-web model

The chain-web model is an integrated supply chain in which individual firms compete with others outside their respective supply chains but based on their own supply network capabilities. Individual firms may well be members of multiple supply chains. They will also connect and disconnect from these chains as they find it in their own best interest to do so. Integration is created through a broad range of relationships, including joint ventures, joint marketing arrangements, collaborative initiatives in systems and processes, etc. (Peterson 2002). The picture that emerges for this model is a web of interfirm relationships that is continually changing shape, dimension and membership. The driving logic of the web remains the individual strategies of the firms. The computer industry is largely characterized by this form of chain organization (Rice Jr. and Hoppe 2001). In many respects, smaller processing and food-manufacturing firms must already behave in this manner in order to serve food retailers. The adoption of category management creates a significant incentive for these smaller firms to combine and recombine in order to maintain access to the retailer (Peterson 2002).

The chain organism

The chain-organism model is an integrated supply-chain model in which the supply chain itself competes as one entity, one dynamic organism. To distinguish this model from the channel master, note that there cannot be a dominant firm in the chain. All firms share the decision making and find themselves inherently interdependent in their ability to act. The strength of this interdependence is central to resolving the dilemmas inherent in a learning supply chain (Peterson 2002).

Dyer and Nobeoka (2000) present extensive case evidence that Toyota is a high-performance knowledge-sharing network, that is, a learning supply chain. Their

evidence also suggests that Toyota is not a channel master; rather it has created a chain organism. Their case is made through a detailed examination of the various coordination mechanisms used by Toyota to establish and maintain the character of the supply-chain network, most especially its focus on knowledge management. Network-level knowledge management processes include a supplier association, Toyota's operations management consulting division, voluntary small-group learning teams, and interfirm employee transfers. Collectively these processes create a network that promotes the sharing of knowledge, both explicit and tacit, in multilateral and bilateral settings (Peterson 2002).

AGRI-FOOD CHAIN PERFORMANCE MEASURES

Research on supply chains has traditionally focused on identifying performance measures for specific firms in a given supply chain. In a world where agri-food supply chains increasingly compete against other supply chains, performance measures need to include the entire supply chain, not just individual firms within a given supply chain. This section outlines possible performance measures for agri-food chains including chain efficiency, profitability, distribution of returns, chain responsiveness, prices, and the value that is delivered.

Increased chain efficiency

While increased efficiency can be measured in numerous ways, it would seem reasonable to consider a limited number of metrics, as agri-food chain efficiency measures of performance. Transaction-cost metrics could include the percent of products sold and introduced the same year, the percent of product sales introduced the same year, the cycle time needed to develop and deliver a new product, inventory reduction and supplier redundancy reduction, and lower operating and investment cost.

Shorter product realization cycles could be measured and metrics could include: inventory value, inventory turns (annual cost of sales divided by annual average inventory value), return on sales, cash-to-cash cycle time (this is the time it takes from when a company pays its suppliers for materials to when it gets paid by its customers), activity cycle time (amount of time it takes to perform a supply-chain activity such as order fulfilment, product design, assembly which can be measured within a firm or more importantly across an entire chain), upside flexibility (the ability of a chain to respond quickly to additional order volumes, which could be measured as the percentage increase over the expected demand for a product that can be accommodated), and outside flexibility (the ability to provide the customer quickly with additional products outside the bundle of products normally provided).

Increased profitability, distribution of returns, and equity versus equality

Measuring profitability for an entire supply chain is no simple task. One immediate problem in today's business environment is obtaining accurate financial information

for privately held firms. It is possible to obtain financial data from publicly-held entities, but financial information on privately held firms is usually a guess at best.

How are profits distributed across the agri-food chain? The answer to this question may depend, in part, on the supply-chain form. One would not expect to see the distribution of returns to be the same for a channel-master supply chain as opposed to a chain web or chain organism. The use of institutional economics could be very helpful in answering questions of equity and equality when it comes to agri-food supply-chain performance measures.

Chain responsiveness

Chain responsiveness could become increasingly important in the future. Customers continue to gain market power and knowledge by ready access to information – virtually wherever, whenever and however they want it. Retailers must provide value propositions and shopping experiences that keep customers coming back, even in a world of total information transparency. The world's top retailers are rapidly expanding across geographies, channel formats and product/service categories, blurring market segments and devouring market share. Competitors must successfully differentiate themselves in order to survive (IBM Business Consulting Services 2004).

The IBM Business Consulting Services (2004) calls this focus on the shopper 'customer centricity'. Greater customer focus must go beyond the superficial by addressing all the basic building blocks of the organization. The status quo must change from disconnected, multiple channels and silos to a unified orchestration of the customer experience. Retailers will need to be capable of delivering a unified seamless customer experience that treats customers as the unique individuals they are.

So the important question might become – is the agri-food supply chain able to meet the expectations of its customers? Metrics that could be measured include: order fill rates, on-time delivery rate, value of backorders, number of backorders, frequency and duration of backorders, line-item return rate, quoted customer response time and on-time completion rate, value of late orders and number of late orders, frequency and duration of late orders, and number of warranty returns and repairs. From an end-user's perspective are prices being driven lower over time and is value or the relationship of the bundle of services to price improving over time?

IMPLIED PERFORMANCE MEASURES ARISING OUT OF A MULTI-DISCIPLINARY APPROACH TO UNDERSTANDING AGRI-FOOD CHAIN PERFORMANCE

A deeper understanding of agri-food chain performance is likely to require a multi-disciplinary approach. This multi-disciplinary approach could include insights from transaction-cost economics, industrial organization, strategic management and institutional economics. This section concludes with a discussion of the implied agri-food chain performance measures that result from the incorporation of the PWH

model, learning supply-chain governance structures, and application of additional economic theories.

Transaction-cost economics

Much has been written and studied about transaction-cost economics and the work of Coase, Williamson and others. Application of concepts such as asset specificity, quasi-rents, principal-agent problems and opportunism help to explain agri-food chain relationships and their impacts on chain performance. For example, it is widely known that entering the Wal-Mart supply chain as a supplier will require the use of specific assets such as computer and data transmission systems that are required to interact with Wal-Mart's just-in-time purchasing and inventory systems. The sheer buying power of a company like Wal-Mart causes agri-food suppliers to worry about opportunistic behaviour on the part of Wal-Mart. This is especially true when suppliers find themselves in a position of having a significant portion of their sales devoted to one customer.

Industrial organization and strategic management theory

Just as with transaction-cost economics, an extensive body of knowledge exists within industrial organization and strategic management theory to help explain agri-food chain relationships and their impacts on chain performance. The structure-conduct-performance paradigm is one of the cornerstones of industrial-organization theory. The basic tenet of the S-C-P paradigm is that the economic performance of an industry is a function of the conduct of buyers and sellers, which, in turn, is a function of the industry's structure (Mason 1939; Bain 1956). Economic performance is measured in terms of welfare maximization (resources employed where they yield the highest valued output). Conduct refers to the activities of the industry's (for our purpose, agri-food chain's) buyers and sellers. Sellers' activities include installation and utilization of capacity, promotional and pricing policies, research and development, and interfirm competition or cooperation. Industry structure (the determinant of conduct) includes such variables as the number and size of buyers and sellers, technology, the degree of product differentiation, the extent of vertical integration, and the level of barriers to entry (Scherer 1980, p. 4).

For example, the meat-processing industry continues to become more concentrated, with two or three firms capturing the majority of the market share (structure). These firms are increasingly able to impose their will on suppliers (e.g., producers) to provide specific products and services they specify. Often, this is done through contracting (conduct). Producers in these concentrated industries often have few alternatives for their product or services, which can lead to revenues that are regulated by the few, large, buyers (performance).

Institutional economics

Institutional economics incorporates a theory of institutions into economics. It builds on, modifies and extends neoclassical theory. It retains and expands on the fundamental assumption of scarcity and hence competition – the basis of the choice-theoretic approach that underlies microeconomics. It has developed as a movement within the social sciences, especially economics and political science, that unites theoretical and empirical research examining the role of institutions in furthering or preventing economic growth. It includes work in transaction costs, political economy, property rights, hierarchy and organization, and public choice. Most scholars view the work of Ronald Coase as a central inspiration for the field (North 1992).

Social capital, trust and property rights are additional tenants of institutional economics that are relevant for a better understanding of agri-food chains. Social capital is a feature of social organizations, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions (Putnam 1993). Social capital is often inherent to the structure of relations between and among actors. Each variety of social capital consists of some aspect of social structure, and each facilitates certain actions of actors – persons or corporate actors – within the structure (Coleman 1988). The economic property rights of an individual over a commodity or an asset are the individual's ability, in expected terms, to consume the good or the services of the asset directly or to consume it indirectly through exchange. These can include (1) the right to use an asset, (2) the right to earn income from an asset and contract over the terms with other individuals, and (3) the right to transfer ownership rights permanently to another party. Legal property rights are the property rights that are recognized and enforced by the government (Barzel 1997; Eggertsson 1990).

Consider the institutional economics aspects of the highly concentrated meat-processing industry. An institutional economics perspective would explore in detail, the property rights of the parties involved and how this impacts the distribution of a performance measure like profit. For example, meat processors like Tyson specify the genetics and husbandry practices of their broiler producers. Tyson has the property rights to the genetics and the power to enforce the husbandry practices. One might also argue that Tyson is taking on more risk in this relationship relative to producers, and as a result is entitled to more of the profit generated from this integrated agri-food supply chain.

Implied agri-food chain performance measures as they relate to PWH model, learning supply-chain governance structures and application of additional economic theories

The PWH model draws heavily on transaction-cost economics. The implied performance measures include the costliness of coordination errors, both in magnitude and probability, and the costliness of transaction within a given

governance structure. The trade-off between costliness of coordination errors and costliness of transactions contributes to overall efficiency of the supply chain. This efficiency can be measured as technical efficiency, transaction efficiency, innovation ability, profitability (across firms and entire supply chains), responsiveness and equity.

While the PWH model is useful for understanding overall efficiency measures, the learning supply-chain framework is well suited for understanding relative efficiency of the three types of integrated supply chains versus unintegrated supply chains. Relative efficiency measures include technical efficiency, transaction efficiency, innovation ability, profitability (across firms and entire supply chains), responsiveness and equity.

There is a connection between the intensity of coordination control and supply-chain governance structure. The intensity of coordination control (from low to high across the vertical coordination continuum) is the underlying variable affecting coordination choice in both unintegrated and integrated supply chains. It has already been shown how PWH analysis can be applied to firms in an unintegrated and integrated chain to predict changing relationships between stages. With learning supply chains, an important performance issue becomes one of 'who' controls the intensity of coordination control. In the channel-captain model, the channel captain controls. Supply chains organized as chain webs rely on individual networks within the chain for control. The chain collective of the chain organism is responsible for regulating the intensity of control.

The coordinating skills of the channel captain dictate the success or failure of the chain. For example, if largely based on specifications contracts, the chain may not keep pace with changing marketplace conditions. If the channel master wants to organize in a way that puts individual supply-chain members at sub-optimal levels, the performance of the entire chain will be sub-optimal.

Under the chain web form, organizations that connect or disconnect for self-interest may not be in the best interest of the entire web chain. The motivation to share valuable individual information may be less present in a chain-web form. Continual reconfiguration of the chain web maximizes the potential loss of knowledge, which can lead to increased transaction costs and missed market opportunities.

Substantial barriers exist regarding the formation of learning supply chains and chain organisms in the agri-food system. To date, the authors are hard-pressed to describe an example of a chain organism in the agri-food system. The channel-master and chain-web forms may function quite well to meet needs of agri-food end-users even if the added benefits of knowledge management are absent. The bottom line is: would agri-food chain performance be improved under the chain-organism model? The answer remains unclear.

There is redundancy, overlap and inter-connectedness to measuring agri-food chain performance when using the PWH model, learning supply-chain governance structures, and application of additional economic theories. For example, coordination error could be a failure of responsiveness or transaction inefficiency.

CONCLUDING REMARKS

A number of challenges remain for researchers wishing to measure performance in agri-food supply chains. Access to information issues exist. Under increasingly closed chains, how does one gain access to the needed information? Measurement issues are common as well. How does one measure profitability across a supply chain? Should variables be measured in the same place across the entire chain? Even if one were able to measure the performance variables stated earlier, would that tell enough of the story? The rich history of institutional economics tells us it is still useful to ask the distributional issues of who wins and loses. Even if one were able to quantify answers to the PWH key variables across an entire chain, would we learn that much more? As with many of the performance issues, the PWH model is complex enough to apply to a single firm in a supply chain, let alone to an entire agri-food chain.

In the end, understanding agri-food chains is likely to require a multidisciplinary approach. Measuring agri-food chain performance is a complex task that requires innovative techniques. The PWH, learning supply-chain governance structures, and application of additional-economic-theories model can be useful in understanding and measuring performance in agri-food chains.

NOTES

¹. Asset specificity is the degree to which an asset can be redeployed to alternative uses and by alternative users without sacrifice of productive value.

². Complementarity exists when the combining of individual activities across a transaction interface yields an output larger than the sum of outputs generated by individual activities.

³. The PWH model originally included programmability as a third decision (addressed before the feasibility question) in their model. This step is omitted, as it was not found to be significant in our initial work. It is expected that firms will only seriously consider coordination strategies that they consider to be programmable, so that programmability is addressed implicitly in the range of alternatives that the firm initially chooses to consider.

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