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Comparison of alternative supply chain management strategies

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The title of this paper gives the impression that there is a set of strategies firms or individuals can employ to manage the supply chain; that there are some informed best practices solution to the problem of supply chain management. Though an economist's world might be this simple, by observing the changing organizational structure of the pork supply chain, it's clear there are practically infinite combinations. The primary field of economics that addresses these issues is industrial organization. The classic decision is simply the "make or buy" problem. That is, where does the production process for one firm end and the next begin? Should a firm integrate the production of hogs, pork, and distribution? Or, should several independent vertical firms be engaged in the production process? The solution depends on two fundamental economic questions:

- What is the structure of the market? and,
- What are the technical economics that drive the production processes?

The technical economics are controllable by firms and are largely endogenous to production processes, while market structure is exogenous to the firm or outside of firms' control. However, market conditions affect how firms choose their technical production systems and, similarly, how firms choose their technical production systems affects market structure. For strategic purposes the question for swine firms to address is: What is the best way to position my firm to 'grow' future competitiveness? To address this there must be some consideration given to the strategies of competitors, and, hence the overall structure of the swine industry. This paper will begin with an overview of the three major models of supply chain management: independent firms, contractually coordinated firms, and vertically integrated firms. Some attention will be given to tactics such as implementing electronic information systems. The latter portion of the paper will consider existing models of supply chain management in the pork industry with examples related to the conceptual discussion.

Demand defining supply

Very simply, a supply chain is the vertical sequence of activities necessary to bring a product to the final con-

sumer. However, each link in the chain consists of a firm and a market. A major concept for understanding any entity's strategic investment in the pork supply chain is that it is the combination of the firm economics and market interaction linking segments or firms of the supply chain that determines the effectiveness of the chain.

The sole economic measure of effectiveness of a supply chain from firms' perspectives is profitability. However, the two components of profitability are costs that are driven by technology and management, and revenues that are largely driven by customers' willingness to pay for the product.

In a commodity market, the output price is given, meaning that because customers cannot differentiate between commodities they will choose those products with the lowest price. The lowest price in a commodity market is driven in turn by the effectiveness of technology and management used in the production process. The most effective firms will produce at a lower cost and, hence, receive greater profits than less efficient competitors and will gain market share. Costs will also determine the effectiveness of the marketing component of the chain. Costs associated with markets are often referred to as transaction costs. Transactions costs include search costs associated with finding a counterpart in the market, monitoring costs (e.g., establishing record or grading systems to verify product attributes), and other general costs directly associated with transferring the product to the next stage of production or to the final consumer¹. Markets between vertical stages of production will exist as long as the transaction costs of exchange are lower than the costs associated with a firm directly entering the vertically adjacent stage of production. The economies of specialization with regard to management and economies of scale with regard to technology generally define the operational scope of firms in this paradigm. Firms attempting to broaden their scope by moving vertically to adjacent segments of the supply chain will generally begin to confront resource constraints either of management, technology, or capital.

The proliferation of differentiated pork products and even increased branding has led pork production from a commodity- or supply-driven market to a market in which consumers are driving investment decisions in agriculture. Increasingly, affluence allows consumers to demand

refinements in product quality, safety, and convenience. Agricultural products can be differentiated to consumers either through actual attribute differences (e.g., further processed pork products, organic products, consistency of products, or leaner products) or through perceived differences (branding and promotion). This fundamental change from a commodity to a product with attributes, which consumers may value differentially, alters the overall production-driven supply chain management strategies (focusing exclusively on cost control) to a supply chain that focuses on meeting consumer demands or a “demand-driven” supply chain. Consumers now exert a pull on the system, attempting to draw products that they desire primarily through the supply chain by their expenditures. This brings the revenue side of the firms’ profit objective into play as a supply chain management strategy. Thus, firms that can successfully anticipate, identify, and deliver on consumer tastes and preferences—as well as control costs—will define the supply chain. The problem, however, shifts from identifying the latest technologies to enhance cost efficiency (health practices, genetics, feed, and nutrition) and maintain competitiveness, to one of identifying consumers’ preferences and their willingness to pay for product attributes and then delivering those attributes. The supply chain faces a greater burden than simply delivering product to the customer; it must accurately identify consumer demands *and* communicate those demands to the stage in the chain at which the desired attribute is defined. Now, a firm needs to understand not only its own activities but activities of all previous and subsequent firms that may have an impact on either capturing consumer preferences or delivering on consumer preferences. Thus, the complexity of the market that previously was only concerned with quantity exchanges now is increased as it must deal with bundles of quality attributes and corresponding differentiated prices. It must now allocate value as well as quantity. Who contributes value? How is that value rewarded? How are new demands communicated and acted on? These are all core questions relevant to demand-driven supply chain management. The difficulty in addressing these questions is identifying contributions of each stage in the production process, both from a cost perspective and—with differentiated attributes—from a value perspective. If an individual were omniscient, one could presumably quantify costs, quantify the value (customers’ willingness to pay and value of activities to deliver this attribute) and allocate resources accordingly. However, no one is omniscient and there are problems of market structure, cost identification, and even moral hazard.

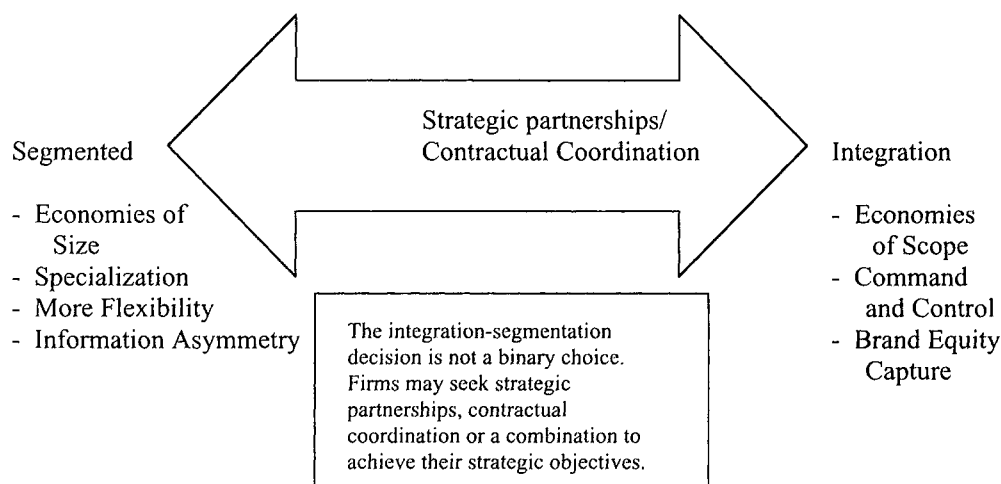
Using an arbitrary example of a bacteria-free pork product—in other words an extreme food safety requirement—illustrates the issues of demand-driven supply chain management. Suppose consumers are willing to pay for safer pork products. Further, suppose that all stages in the chain

contribute to this safety—producers must use feeds that are free of bacterial contamination, and the product must also be handled accordingly throughout the pork processing chain to prevent contamination from entering at any level. How does one assure that the hog producer has implemented effective methods of production and monitoring to assure quality at the end of their involvement in the production process, are tests available, or is it necessary to monitor actual production inputs? A similar question can be asked of the processing chain: how do they assure product integrity is maintained either by further processing of the product itself or by avoiding commingling with pork products not meeting the specifications? Again, this requires monitoring or testing of the product for some kind of assurance. Finally, once the product is purchased—assuming consumers will pay a higher value for this product—how does that extra value get allocated back through the chain? This example simply illustrates another fundamental aspect of supply chain management: information management is the economic glue that holds the supply chain together. In a completely segmented supply chain (i.e., one where markets connect multiple firms within the chain), prices are relied upon to allocate resources and provide all information. When market imperfections arise (cheating, market power, imperfect information), the prices become less accurate conveyers of information. In a completely integrated chain (no markets between stages of production, the only market being the final sale to the consumer), product information can be very efficiently transmitted; however, there is still the primary element of information failures even within the integrated chain. This leads to the second critical concept of supply chain management: which management model is best is an empirical question that revolves primarily around how information is captured and conveyed and the efficiency of information.

Basic supply chain management strategies

The previous overview framed the issue of supply chain management in fundamental economic terms. In summary there are two critical components to the supply chain: (1) the firm’s cost structure itself and (2) the market structure linking firms if there are multiple, vertically linked firms. Encompassing all this is information: information necessary to drive investment from a firm cost perspective, and information driving value transfer from a market perspective. The choice of supply chain strategic management is not a binary choice. There is a spectrum between completely segmented supply chains where production processes are coordinated by the market and completed integrated supply chains where there is a complete absence of markets between production processes. **Figure 1** provides an illustration of this spectrum and brief points of differences relating to the polar extremes. Following

Figure 1. The supply chain organization spectrum



is an overview of the strategic issues with three nodes for supply chain management: segmented chain strategies, contractually coordinated strategies, and integration strategies.

Segmented chain strategies

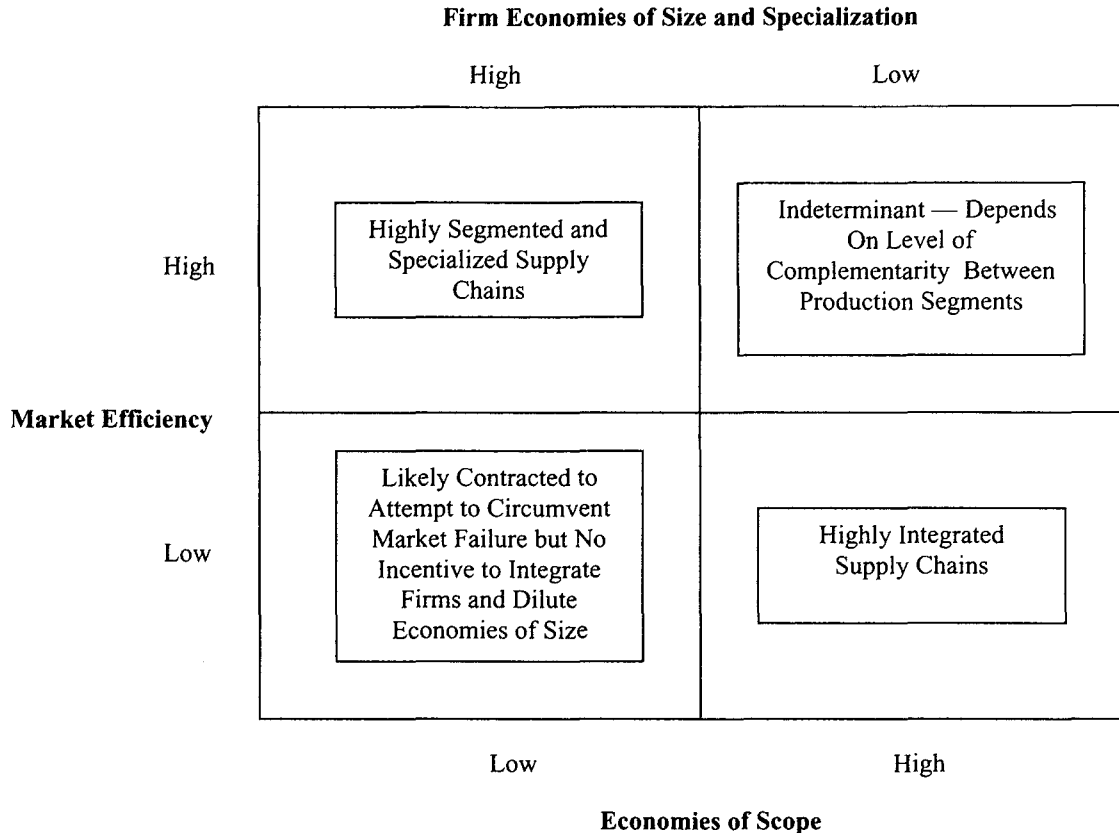
Segmented and independent firms aligned completely by markets are the traditional form of organization most people think of when considering supply chain issues in agriculture and the swine industry. In this arrangement, one stage of the production process completes its contribution to the final product and then markets it to the next vertical link in the production process. Where the within-firm production processes begin and end is continuously changing depending on technology, capital requirements, and the demands of the markets. For example, 25 years ago one would have considered the hog production phase to include crop production, swine genetic management, farrowing, nursery, and grow-finish to be a single firm’s activity—this was the prototypical hog farm. The hog was then marketed to the packer and most packers were engaged in further processing, as well as cut and kill operations. Packers/processors marketed to wholesalers who in turn sold product to distributors and, ultimately, retailers. Notice how the activities of swine operations have changed today. Many swine operations do not include cropping activities as part of the firms’ operations, largely as a result of economies of scale in production. Similarly, even farrowing, nursery and grow finish have been separated to take greater advantage of economies of scale in genetics and animal health. This illustrates how the economics of the firm itself via cost and technology can affect the activities any given firm undertakes.

However, breaking apart the activities of a given firm does not solve or address market interactions or, more basically, the transfer of product from one stage of production to the next. Again, assuming no contracting or inte-

gration, by breaking apart activities (increasing economies of scale and specialization), new markets may arise to link segments of the chain. For example, there is now a nascent market for weaned pigs which did not exist 25 years ago, or existed solely in the form of feeder pig markets. Similarly, although there has always been a market for purebred genetics, the market now has evolved to commercial suppliers of gilts for populating commercial farrowing operations. Now, lets bring in the market role for independent production stages. If the markets are perfectly efficient (i.e., minimal transaction costs, perfect information, numerous buyers and sellers, and low barriers to entering the market as a supplier or purchaser), one would expect the scope of production activities of any particular firm to decrease as long as there are positive returns to scale and specialization. The market would effectively allocate the output from one producer to the input use by the producer in the next vertical stage. However, markets are rarely this efficient—there are market imperfections in the real world. There are barriers to entry in the form of capital costs to match economies of scale; there is information distortion or errors either on the quality of the product or the quantities which will be supplied at any given price; there are oligopolies in meat packing (few buyers); and transactions costs of monitoring production activities and quality can be high. Hence, the optimal strategy for a firm to choose which activities to undertake in any given stage of production depends on the trade-off of economies of scale and specialization and the economic costs of participating in a market with imperfections.

Figure 2 provides an illustration of the expected supply chain strategies given the three fundamental economic factors: economies of size and specialization, market efficiency, and economies of scope (i.e., complementarity between vertical stages of production). The two polar extremes—segmented markets and integrated markets—are located in the first and fourth quadrants. With per-

Figure 2. The integration matrix



fectly efficient markets, large economies of size, and limited economies of scope, firms will choose segmented market strategies, focusing their efforts on highly specialized production processes. With inefficient markets, low economies of size, and large economies of scope, firms will gravitate towards vertical integration. Between these two extremes lies the real world where particular circumstances will dictate firms' supply chain management strategies.

Coordinated chain strategies

The general problem of supply chain management strategy is dependent on the economics of the firm (cost/technology related) and the efficiency of the market. In the discussion of independent and highly segmented chains, one must assume that there are large economies of size and specialization in production and that markets are highly efficient or nearly perfectly efficient. In such a case there are limited incentives to coordinate the supply chain. However, simple observation suggests that fewer and fewer production stages are independent. The next broad strategic supply chain management solution is contractual coordination. The contractual adjective emphasizes a slightly more formal method of coordinating supply chains. Markets can be thought of as coordinating the supply chain in that prices provide incentives to market

certain quality attributes or quantities of products. So, formally, all chains have a coordination mechanism, in most cases it is the market. Contractual coordination simply means that adjacent segments of the supply chain have formally agreed to link their decisions, either by assuring quantities, qualities, or prices. The contractual agreement may be highly rigid in its performance requirements or it may be very loosely defined—the minimum criterion is that in some way the two are basing their individual decisions on something other than external markets. Contractually coordinated supply chain management can arise primarily from market failures in the sense that in a perfectly competitive situation there's no fundamental reason for coordination. This market failure can be due to capital constraints (barriers to entry), information failures that can include moral hazard and monitoring, or excessive transactions costs such as search costs for acquisition of products. These are more likely to occur as attributes are refined away from a commodity market basis and as these attributes become less observable.

Returning to the previous example of a high food safety pork product, suppose a packer wishes to purchase hogs that are salmonella free. Let's also assume that other than the direct monitoring of feeding practices, there's no way to identify hogs that are grown according to specified pro-

ocols. Without observability, there is virtually no way for the market itself to monitor treated and untreated hogs—it's up to the producer honestly representing the treatment. Further, if there is a limited supply of such animals the costs of finding appropriate hogs likely increases. At some point it becomes more efficient to pre-identify these animals to at least reduce search costs, and in doing so it may be possible to implement monitoring strategies as well. Keep in mind there are market mechanisms that can also facilitate the exchange. There may be independent certifying agencies or simply a legal penalty for misrepresentation that would provide incentives for truth telling. However, all these increase the cost of the exchange in a market environment, making the possibility of contractual coordination more attractive. Hence, we arrive back at the standard empirical question—is the cost of exchanging in an open market greater than the cost savings from coordination through contracts?

A much simpler incentive for coordination strategies relies almost exclusively on the concept of search costs. Search costs can include finding adequate inputs or buyers, or also the costs of managing logistics, such as scheduling. Returning to the economies of scale and specialization in firm decisions, it's easily observable that the economies of scale on a per head basis are optimized at a much higher level for packing plants than for grow-finish facilities. State-of-the-art packing plants (from a scale perspective) typically operate on the order of slaughtering 16,000 to 30,000 head per day. At the same time, a single state of the art grow finish facility will produce approximately 1,000 head every 90–100 days. One could argue a single site might provide 4,000 head every 80–90 days, but the point is still relevant that an efficiently scaled packing plant must, at a minimum, procure hogs from several different sites. Given that variation in the hog population exists around stage of growth, on any given day a packer must find a large number of hogs from a large number of producers. Contractual agreements can significantly lower search costs in this case. This is an example of “forging fit” within the supply chain. Depending on search costs, there can be significant incentives to pre-identify supplies through contracting when there are economies of size incompatibilities between adjacent stages of the supply chain.

As with integration, which will be discussed subsequently, an incentive for contracting as a strategy may be an attempt to capture a dominant share of the market to obtain higher-than-normal returns². Typically, competitive forces will exclude this from occurring over the long-term. However, this can be particularly troublesome in industries with high asset specificity and high capital costs making entry more difficult for newcomers. By controlling multiple segments, the barriers to entry by other firms can be insurmountable. Gaining complete vertical ownership initially has high barriers for the firm as well so it can be

difficult to do. However, once established, other firms may seek to vertically coordinate to compete effectively with an already established vertically coordinated supply chain. Other vertically coordinated systems begin to act as a countervail on the existing vertically coordinated chain. The dynamics of this strategy are quite complex and are playing out in the current pork supply chain as firms seek to carve out competitive positions in the market.

Finally, there may be strategic incentives for coordination when there are complementary factors of production that an individual firm will not adequately capture from the market. A classic current example of this is crop and hog production and manure. Manure is a complementary input to crop production. However, the market for manure is highly inefficient because of the variable nature of the nutrient content of manure and also the seasonal demand for it (virtually zero in the summer). It is hard to imagine an effective market for manure even though it has a complementary value in crop production. Hence, contracts or coordination arise to share the costs and value of manure by pre-identifying its use and value.

The problems of contracts are well documented. Contracts are generally incomplete. That is, except under very simple terms, it is difficult to include all contingencies of a contractual relationship. The objective of a contract is to draft it so as to be optimal from both parties' perspectives; otherwise the contract will likely not be honored. Contracts typically require monitoring costs in the cases where a particular condition is to be performed and the result of this action is not observable. There will also likely be enforcement costs, either in terms of legal fees associated with contract remedies or other aspects. So, vertical contracting as a strategy again has empirical tradeoffs that must be considered.

Vertical integration

The polar opposite of independent and segmented market chains are vertically integrated supply chains. In this case a firm directly owns and controls two or more vertical stages in the production process. In the extreme case, the firm may own every stage in the production process from the primary input (land) to the consumer. Many of the incentives for vertical integration are very similar to incentives for contractual coordination. However, integration often rises out of the failure for contractual coordination to adequately achieve potential efficiencies of more direct integration.

Once again, a primary incentive for vertical integration is that there is a market failure that imposes large enough costs on the firm to provide it with an incentive to integrate. In a demand-driven supply change, these “costs” may be the costs of lost value (revenue) resulting from a misallocation by the market. Typically, this market failure will involve information asymmetries such that ap-

propriate investment and production decisions are substantially distorted by market signals. Secondly, as mentioned above, the firm may be attempting to create barriers to entry, or there may be complementary inputs that improve its economic position by increasing its scope of operations. An example of integrated complementarity is illustrated by changes in who performs further processing activities of fresh pork. Traditionally, grocery stores cut boxed primals to portion cuts for customers. Now, nearly all major packers have established case-ready programs, capturing efficiency by reducing the redundancy of multiple stores having their own in-house fabrication.

Another oft cited reason for vertical integration is vertical diversification³. Vertical diversification benefits are similar to the concept of portfolio diversification. If returns from vertically linked segments are negatively correlated this will reduce overall risk exposure in the market. For this argument to hold any merit there must be a market failure. If markets are perfectly efficient, the market will allocate returns according to resource contributions. Vertical diversification may only be an incentive for vertical integration when the subsequent or prior stage of production has an activity which is entirely exogenous to the primary product and which has a distribution of returns different from the primary product. However, technically, this firm would then be conducting a horizontal integration rather than a pure vertical integration play.

Firms may also integrate to learn more about a vertical stage of production and capture proprietary knowledge that they may view as providing a competitive advantage in the market. For example, suppose a packer has proprietary supply agreements with retailers for specific markets (e.g., Japanese exports). At the same time a producer may suspect that this proprietary agreement provides added returns which are not being adequately passed back to the grower (as always, this implies some market failure otherwise the packer could not capture these added returns). To gain access to these supplies the producer may find it advantageous to purchase the packer and gain direct access himself.

There are drawbacks to integration as well. While a command and control system may improve information flows, it also can distort intra-firm incentives. The potential break-up of Microsoft provides an apt illustration. For simplicity, let's consider the Windows 2000 operating system and Microsoft Office 2000 as vertical stages in production. Windows must be produced prior to being able to run Microsoft Office. Microsoft has integrated the two stages of production (operating systems and software application that run on the operating system). In this form, Microsoft has behaved as having a clear incentive to develop Microsoft Office applications for its own Windows system but to avoid developing it for other platforms such as Linux (a competing operating system). This helps cre-

ate a barrier of entry for consumers who use Microsoft Office but would like to use Linux as an operating system. However, as Linux becomes more popular, Microsoft is actually failing to capture market share for Microsoft Office operating on a Linux system. In an attempt to maintain market share for Windows, they are limiting market share for Office. The investment incentives interpreted by the integrated Microsoft firm are quite different from the investment incentives of two non-integrated companies. This argument is actually central to the argument for breaking up Microsoft for anti-trust practices. Now, consider how similar incentives can be distorted for integrated swine firms. A packing plant may have an incentive to purchase and finish their own hogs even as competitors' hog quality may be improving. The markets are often said to provide discipline to investment decisions, removing the market checkpoints from intermediate stages of production in an integrated system can distort these disciplining forces.

Another issue with integrated firms is capital extension and asset fixity. Changes in technology, macro-economic conditions, and other factors can rapidly affect incentives for investment in vertically linked stages of production. A recent example of this is the movement from three-site systems to two-site systems of hog production. Suppose a vertically integrated firm (a packer) has recently invested in three-stage production; given the long-term nature of that investment it is very unlikely they would be able to reinvest in the two-site systems. In cases where there is not vertical integration, the packer would begin to purchase from new investment in two-site systems if the pigs were presumably cheaper because of improved technical efficiency.

New electronic information systems

From the prior economic and organization structure overview, one of the key drivers of chain coordination or integration is the capture of information or the effective transmission of information. The tremendous increases in computing power and the management of large-scale databases hold the potential to change the way physical information is transmitted. No longer are prices the only method of capturing quality attributes and quantities. Prices can now be augmented with individual transaction-based data, which can include characteristics of the customer, such as demographics; timing of sales; and, characteristics of the product itself in highly refined terms. In addition, financial and cost information can be monitored and transmitted equally as effectively.

Electronic Data Interchange (EDI) has been a major initiative in manufacturing and retail processes for years. The concept of EDI is simply to remove the avalanche of purchase orders, invoices, and bills of lading common in transactions by allowing for electronic sharing of documents and other information between firms. Historically,

EDI systems have been implemented via mainframe systems and communication between firms within the supply chain required major investment in computing infrastructure as well as electronic coding architecture. To exchange information requires common electronic documentation and software connections. Typically, this has limited access to larger firms with the infrastructure and financial capabilities to implement these systems.

The explosion of the Internet for electronic commerce has the potential to bring EDI to its ultimate fruition. The general concept of EDI on the Internet is commonly referred to as business-to-business commerce. The primary contribution of the Internet is its common architectural platform and a universal user interface, the Web browser. Computing infrastructure declines both from software investment and hardware investment reductions. Rather than investing in proprietary servers and mainframe capabilities, firms wishing to implement EDI can now outsource many of these assets to third party vendors. The greater innovation perhaps comes from the common software and communications platform. XML language provides a new strategy for developing electronic documents that are universally transferable across firms. Rosettanet (<http://www.rosettanet.org>) is a non-profit consortium whose vision is to create a common international electronic commerce platform for exchanging business documents and transactions. Another illustration is the American Institute of Certified Public Accountants' (AICPA) attempt to develop a common software code for all financial statements for business firms (<http://www.xfrml.org>). Further, both parties in an exchange can have access to the same databases and can more easily share complementary data. The Uniform Codes Council (UCC) will play a role in the grocery industry. The UCC established the original bar codes for retail scanner data. They are a non-profit entity concerned with electronic coding of products. They have a pilot project titled UCCNET, an attempt to unify the bar code process between retail, distribution, and manufacturing. Beyond that, UCCNET seeks to develop an Internet-based platform for standardizing information across the supply chain. Currently, there are different coding requirements across levels of the chain. Another project they are working on is a readable bar code that can contain variable weight product information. This is currently a huge stumbling block for developing codes that fit fresh pork products. The simple reason is that weights carry a specific code (e.g., 16oz. can of Hormel chili), and this code is measured to 1/10 of a pound. Therefore, every one-tenth difference in a pork chop classifies the chop as a unique product bar code. Obviously this would not only require a massive database, but would be confusing to have an infinite number of different kinds of pork chops. If UCCNET and the new coding systems work, it will improve the capabilities to transmit point of

purchase information through to other participants in the pork supply chain.

Another form of coordinated information is an initiative by the Uniform Codes Council and VICS (Voluntary Industry Commerce Standards). The project is Collaborative Planning, Forecasting, and Replenishment (CPFR). The concept basically seeks to improve the ability of firms in the supply chain to better manage inventories and ordering process. Take, for example, the problem of a retail chain and a meat processor who provides case-ready product. The retailer has excellent access to demand data and product sales, particularly if they use scanner data. The meat processor has excellent data on meat supplies and production, but is one step removed from the demand data. Without the demand data, the meat processor must rely on whatever data it has compiled from retailers or other orders. The same is true for the retailer—they do not have reliable information on supplies and therefore will have errors in their estimates of how much can be purchased or needs to be ordered ahead of time to avoid issues such as stock outs. By collaboratively developing electronic exchanges of supply and demand information, both can improve their forecasting abilities and improve product flow. This is particularly important in perishable industries such as meat and produce. Hence, errors of information can again be reduced, possibly reducing the incentives to integrate stages in the chain. Similar models might be useful for the interface between producers (e.g., farrowers, nursery, and grow-finish) and between producers and packers.

The salient issue is: can the virtual exchange of information serve to mitigate some of the market failures that currently provide incentives for vertical integration? This will be a key strategic question firms will have to deal with in addressing supply chain management optimization. Clearly, the same technology may also enhance integrated chains as well. The possibility of improved electronic monitoring of all stages of production improves the capability of performance monitoring and intervention in vertical production activities. It may overcome the scope of management constraints that may limit firms' abilities to integrate both horizontally and vertically. Hence, as with strategic chain management prior to the new information systems, the same empirical economic issues exist. As Hal Varian, a noted economist said "Technology changes, economic laws do not." As your firm pursues chain management strategies with new information technologies it would be wise to have this simple quote as the bellwether for your strategies.

Allied supply chain management

For the most part, this paper considers only those management issues related to the direct process flow of hog and pork production. Clearly, there are a number of allied supply chain inputs including pharmaceuticals, building,

and equipment manufacturers and so on. These firms typically have products that are used by every firm in the supply chain and so they have no incentive to align with any particular chain. However, they will likely become critical in managing information flows. These inputs (e.g., pharmaceuticals) can effectively be the determining factor in the attribute of the final pork product. Hence, monitoring and tracking systems become more critical for them to capture value from their products.

Existing pork supply chain

Figure 3 provides a diagram of the existing pork supply chain and the major firms engaged in the supply chain. **Figure 4** shows the estimated value of production at each major stage of the supply chain. **Figure 5** illustrates the level of involvement in each stage of the supply chain by major packers, and broadens the supply chain to include inputs such as feed, crop, and other inputs into the hog production stage. Of all supply chains, Smithfield represents the greatest degree of integration, owning each stage of the production process through fresh and processed pork production. By Smithfield's own estimates (1999 10K SEC filings) they are 28% vertically integrated as a firm. Other firms such as Excel and Swift have either owned assets or have vertical contractual relationships that tie production segments together. Farmland is organized as a cooperative rather than as a corporation, but also has alliances that provide supply linkages through the production chain. At this time, only Swift has significant inroads into the direct store distribution segment of the chain. This is primarily through their deli and foodservice operations. Other firms have manufacturing distribution centers, but these serve as distribution points for commercial distributors or retailers themselves. However, several of the firms (Hormel, Farmland, Swift) have tying arrangements with supermarket chains. These are similar in nature to contract arrangements in swine production. The retailer agrees to purchase a contracted amount of fresh or processed pork products from the processor. Similar to hog purchases, the pork purchases are formula priced rather than negotiated at the time of sale.

In figure 3, the packer and processor are listed in two boxes, however, all major processors have fresh and case-ready programs in their chain, so more often than not the processing and fresh pork operations are integrated. Two key exceptions are Sara Lee Foods and Kraft Foods (Oscar Mayer). Sara Lee and Kraft have no ownership interest in hog slaughter and fresh pork production. However, they do have contracts with major packers to provide fresh pork inputs to their further processing operations. This provides a stark contrast on a large scale to vertical integration of the pork chain.

Major firm supply chain management strategies

A great deal of information can be gained by examining the structure of major pork firms. Following is an overview of several of the major processors.

IBP

IBP reports no holdings of swine production facilities as of 1999. They do offer long-term procurement contracts to growers and would be considered to have a combination of contractual vertical coordination and open market procurement of their hog inputs. In 1998, IBP began its case-ready pork operations, including rib chops, country style ribs, butterfly pork chops, and pork butt roasts. These products are sold under the "Supreme Tender" label. Clearly, IBP is vertically integrating into fresh product processing and branding strategies, as other firms have done. They are attempting to capture the value of their brand equity in fresh products. They have also integrated into processed products through their "Enterprises" operations. These holdings include Foodbrands America, Inc., and the Bruss Company. Foodbrands manufactures and markets frozen and refrigerated food products such as pepperoni, beef and pork toppings, pizza crusts, appetizers, desserts, prepared meals, Mexican and Italian foods, soups, sauces, side dishes and branded and processed meats. Foodbrands America has five divisions: DFG Foods, KPR Foods, Specialty Brands, Continental Deli Foods and Dorskocil Food Service. Bruss manufactures and markets high quality, portion-controlled steaks, pork chops, and other products. In general, IBP is vertically integrating downstream in the pork processing chain rather than upstream to hog production.

Smithfield Foods

Smithfield Foods is integrated in hog production, slaughter, and processing. The company consists of two "groups," the Hog Production Group and the Meat Processing Group. A major emphasis by the Meat Processing Group is to put greater emphasis on the sale of value-added higher margin fresh pork products, such as boneless loins, hams, butts, and picnics. Smithfield also recently developed a case-ready pork program designed to supply supermarket chains with pre-packaged, weighted, labeled, and pre-priced fresh pork products ready for immediate sale to the customer. Note that by pre-packaging and standardizing weights, it will be possible to scan fresh pork products (this is already common in chicken) and improve supply chain monitoring through EDI. Smithfield markets under several regional brand labels, including Smithfield Premium, Smithfield Lean Generation Pork, Gwaltney, Patrick Cudahy, John Morrell, Dinner Bell, Ember Farms, Esskay, Great, Kretschmer, Lykes, Patrick's Pride, Rath, and Valleydale.

U.S. Pork Distribution Chain Overview

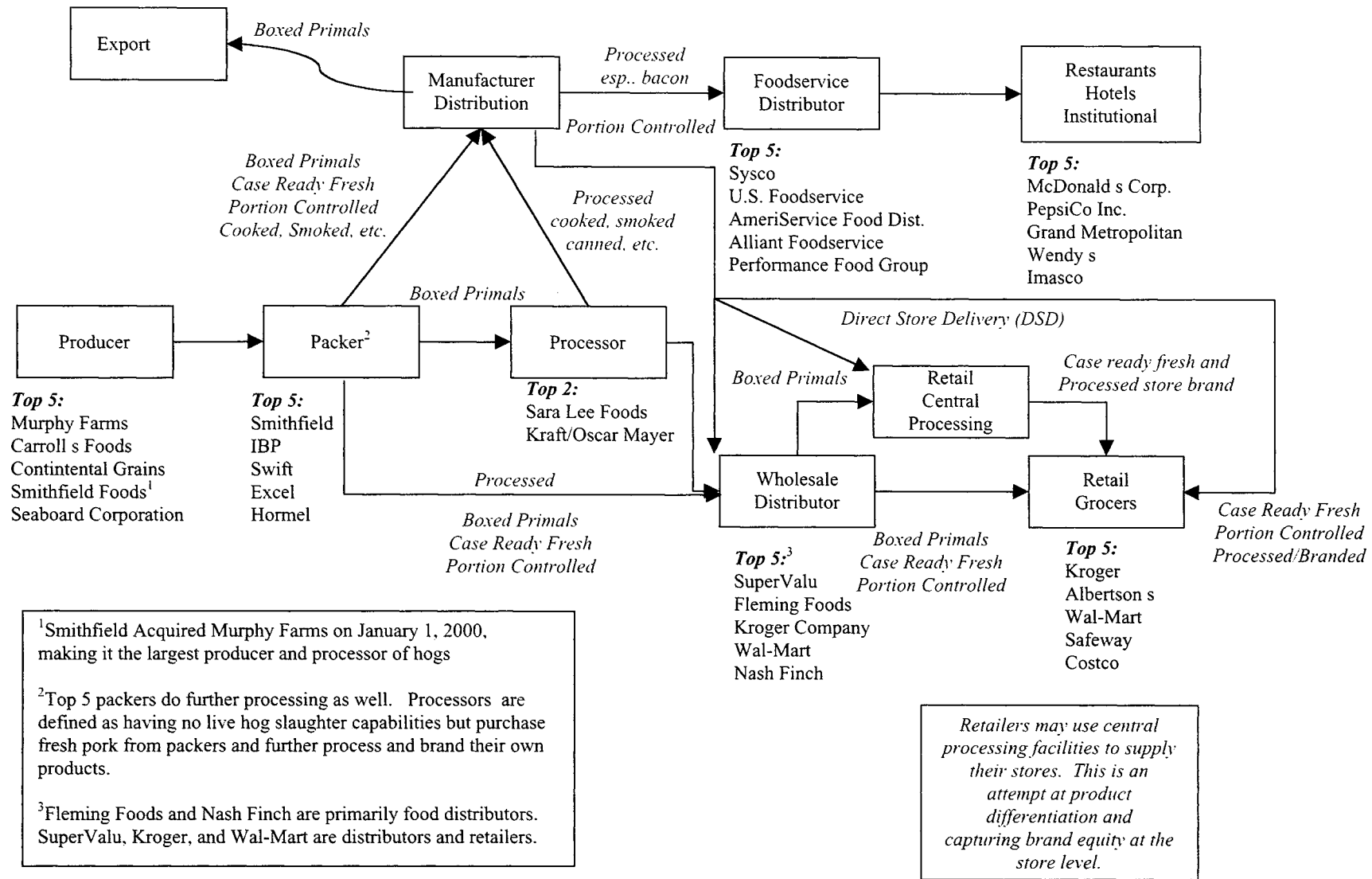
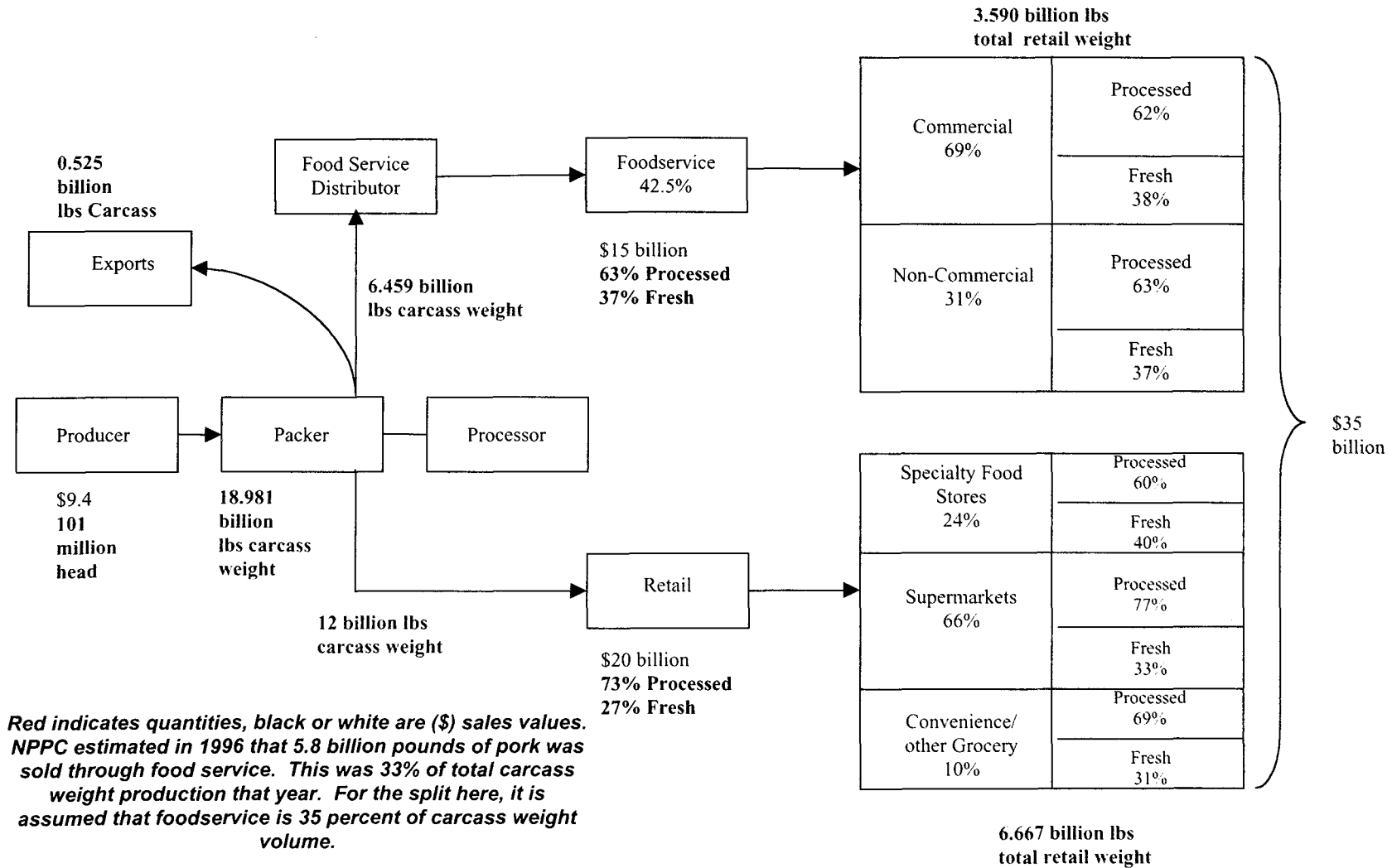


Figure 3. Pork Supply Chain and Major Participants.

U.S. Pork Distribution Chain Values \$'s (1998 Estimates)



Comparison of alternative supply chain management strategies

Source: USDA, NPPC, AMI, Food Service Industry Usage Study

Figure 4. Major Product Quantities and Values in Pork Supply Chain.

Pork Supply Chain

Comparison of Production Stage Involvement by Major Packers

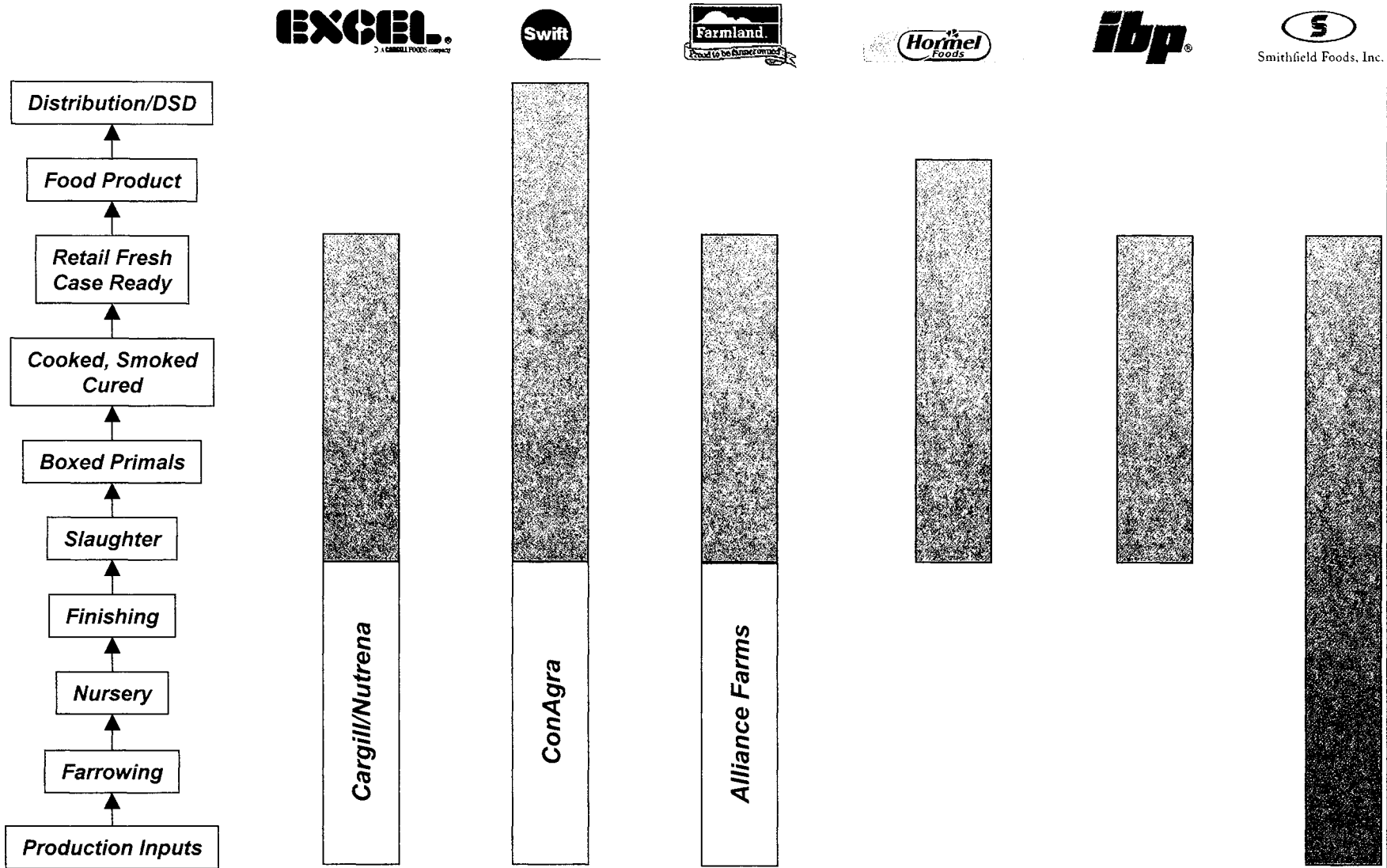


Figure 5. Pork Supply Chain Coordination

Hormel Foods

Hormel Foods, like IPB, reports no hog holdings. However, they do offer contractual procurement agreements meaning they are vertically coordinated in their hog procurement strategies. Hormel has long been a food company, integrating its pork slaughter operations into food product development. As with others, Hormel has multiple branded fresh and further processed products, including Hormel, Always Tender, American Classics, Black Label, Chi-Chi's, Cure 81, Curemaster, Di Lusso, Dinty Moore, Dubuque [in case your wondering about what happens to the Dubuque label with Smithfield's closure of the plant in Dubuque, Hormel already owns the label from their previous agreements], Spam, and about 15 others.

Swift and Company

Swift and Company operates as a subsidiary of ConAgra, so less information is readily available. Swift is not known to own any hog operations, but does contractually procure hogs. Swift has vertically integrated into further processing and markets pork under the labels Armour, Swift, Eckrich, Swift Premium Delicatessen Style, Cook's, and Decker. Armour-Swift operates a direct store delivery program designed to market pork directly to retailers, circumventing the major third party distribution channel. Swift also operates the ASE Deli Foodservice Company which provides direct store distribution to delis and foodservice clients.

Excel

Excel opened pork operations in 1987. They are clearly aligned with Cargill's hog production operations and Tyson Foods, but as an entity do not appear to own hogs directly. However, there is very tight vertical coordination from hog production to plant. Excel also is engaged in further processing operations. Relative to other processors, food branding is limited. Excel maintains the Excel Tender Choice products and a variety of deli meats and cooked products. They also have a Sterling Silver Pork program that emulates their Sterling Silver Beef program.

This discussion brings up the issue of branding in supply chain management. Since consumers cannot be integrated, branding is a critical component in conveying the value of your product to consumers. Failure to effectively brand products can lead to a loss of value at the most important step in the supply chain and, hence, effective branding should rightfully be included in the discussion of supply chain management strategies. Currently, many producers and processors are considering "functional" branding. That is, branding which conveys direct information about the technical attributes of the product to consumers. Labeling items as "organic pork" or "heart healthy" labeling as Smithfield and Farmland have done are considered functional branding. However, functional branding is more

like technology adoption in that other firms can easily replicate functional brands and erode the brand equity. Brands which are more effective tend to draw the consumer to psychological triggers such as we see in soda advertising. "The Joy of Cola" says absolutely nothing about the functionality of Pepsi in quenching thirst. It does convey an upbeat thrill to its consumption.

A major structural change is also underway at the distribution and retail end of the pork chain. Retailers (supermarkets, grocers, etc.) have traditionally had no interest in integration of the supply chain—their primary activity was the fabrication of boxed primals into portion cuts for consumers. Further, this was typically done in behind the counter butcher shops. However, some retailers are going to central processing facilities where they fabricate boxed primals into case-ready packaging and ship it to their chain stores. There are several reasons for this. First, it avoids duplication of store efforts as stores become chains rather than independent grocers. Second, technologies of fresh meat cutting and shelf-life have improved allowing for central cutting and packaging which does not reduce shelf life over cutting boxed primals directly in the stores. This same technology has allowed processors themselves to create case-ready products (e.g., Hormel provides case ready portion cuts for retailers). Third, retailers who control their central processing can better capture brand equity of their stores. The meat case, fresh produce, and deli-operations are the three areas in which grocers can gain brand equity other than as being the low cost provider. H.E. Butt in San Antonio, Texas is a leader in case-ready, store brand, fresh meat products. In contrast, packers and processors are also attempting to build brand equity at the case with the customer. Retailers learned from the poultry industry experience that providing shelf space leads their poultry category to a cost center for the store—simply providing point of access to the product for consumers. They are unwilling to let the rest of the meat case go as a major profit center for stores. This battle for capturing brand equity will be central to the following discussion on chain management strategies.

This brief descriptive overview of the current supply chain illustrates why it is so difficult to define a comprehensive supply chain management strategy that informs all decisions. There is a broad spectrum of supply chain management strategies exhibited across firms, from highly integrated structures such as Premium Standard Farms to very limited integration exhibited by IBP. There are also examples of "dis-integration" as in the case of Sara Lee Foods. What is perhaps more interesting is that even firms have multiple supply chain management strategies within their own operations. For example, Hormel contracts for hogs and procures hogs on the open market. Seaboard Farms is highly integrated, but also contracts with other growers to provide supplies. This inter-firm differing supply chain management aspect is likely related to a similar

concept as portfolio theory in stocks. Most firms will recognize the trade-offs between independence and participation in markets, vertical coordination contracts, and total vertical integration. No firm has a clear road-map as to which strategy will be the “best strategy” at all times given that they know there will be technology and market condition changes with certainty. Hence, these “supply management portfolios” seek to minimize the risk of selecting a wrong single strategy.

Conclusions

Supply chain management strategies revolve around three core issues: the economics of the firm, the efficiency of markets, and the efficiency of information. Combined, these fundamentals will provide incentives for firms to operate independently, relying on markets to coordinate their activities, to contractually coordinate activities to assist in improving information exchanges and product flows, or to vertically integrate to control the entire chain. The brief description of pork industry supply chain management suggests a complex mix of independent, coordinated, and integrated structures. All three forms are seen even within a single form. It is often suggested that the hog and pork industry will be completely integrated. The problem with this question is that it assumes some end game solution. However, technologies change, market structures change and information systems change. All can have profound fundamental impacts on firms’ decisions to coordinate via the markets or by contracts and integration. Firms will choose the mechanism that provides the greatest profits and incentives.

The single greatest technology that will affect supply chain management will be electronic information systems. Within the next two to three years, every firm must have strategically identified how they will implement electronic information systems. Electronic information systems will be their critical linkage to suppliers and customers and failure to adapt will place them outside the mainstream of commerce.

References

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