Transactions Costs Economics and the

Evolving Structure of Agricultural Production

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Introduction

The structure of worldwide grain and meat production industries appears to be undergoing an evolutionary change. Sectors of the value chain that once traded a commodity product are now creating vertical linkages. This development is particularly noticeable in the U.S. where grain marketing and hog production contracts are becoming increasingly common.

The literature on vertical integration has suggested two possible reasons for industries to become vertically integrated (or vertically coordinated). One explanation is based on the neoclassical model and uses imperfect competition as a key determinant of vertical integration. (See for Example Perry page 189) An alternative motivation for vertical integration can be found in the literature on transactions cost economics. This literature is interested in explaining patterns of vertical integration based on Coase's 1939 argument that industry structure evolves to minimize transaction costs (when transactions costs are broadly defined to include changes in operating efficiencies and value differences that may be captured from changes in product characteristics and services provided customers). In short Coase argued that industry structures evolve to minimize transactions costs, much as mechanical systems evolve to minimize friction.

In this paper, we offer results from two case studies--value-added grain and value-added meat -- and evaluate whether the transaction costs approach contributes to better understanding of the grain and meat sectors changing coordination systems and their future product mix.

The analysis suggests that the profound changes in transaction costs (especially perceived high values of several characteristics of meat products) appear likely to motivate a significant transformation of the meat sector. The results also suggest that changes in

transactions costs (for individual traits of corn) alone are not sufficient to justify the creation of a system to maintain the identity of single-trait modifications in corn in the primary market for corn-- the bulk feed-grain sector. However changes in transactions costs coupled with a technology that allows stacking of traits (or with government mandates) would be sufficient to justify a move to vertical coordination in the feed grain sector.

Transactions Costs Research

In 1939 Coase posed the following question. When do firms chose to procure in the market and when do they become involved in vertical structures? The answer he provided is that organizational structures evolve to minimize transaction costs. In other words industries rely on markets for inputs when it is cheaper than establishing a long term integrated relationship with suppliers. Those firms that chose the more expensive structure are eventually forced to adjust or are forced out of business. To use an analogy suggested by Oliver Williamson, transactions costs are akin to friction in machines. Industry structure evolves to minimize this friction.

For decades after the original work by Coase the transactions costs approach was largely ignored by mainstream economics. The topic area was kept alive by Williamson and by Coase himself. Then in 1991 Coase received the Nobel Prize for his work and the topic received new attention. Mansten 1996 summarizes this new output. One possible reason the area was ignored for 50 years is that so long as transactions costs are relatively stable then industry structure will not change and the theory will have little predictive power. By 1991 it must have been obvious to the Nobel Prize Committee that the information revolution was a revolution in transactions costs (Friedman). With dramatic changes in transactions costs it

became possible that industry structure would have to realign to re-optimize to find new industry structures with less friction.

The work by Coase and Williamson now provides a framework for understanding how these new structures will evolve. All that needs to be done is to compare the total amount of transactions costs in each of the systems under consideration, the theory predicts that the structure with the lowest total transactions costs will dominate. If this is not the current structure then one can predict an eventual evolution to this new structure. To stretch the analogy to mechanical systems, the car with the lowest amount of friction should win most races.

Transactions Costs and the Structure of Agriculture

Agricultural markets operate in a unique manner. First farmers grow foods such as meat and poultry, milk or produce. They do this with inputs purchased in retail markets. Then these products are sold at wholesale prices to processors who co-mingle products from several different farms. The relationship between the processor and the farmer is often antagonistic and farmers compete with each other on a perfectly competitive basis. The processor will often attempt to package the product under a brand, but because of the commingling that went on earlier, there is little the processor can do to differentiate the product except sort out distinctive segments of the product when possible. The commingling also makes it very difficult for processors to pay for quality traits and so the only signal the farmer receives is through the "average" price received. Under this incentive structure farmers have the incentive to minimize costs and to meet the minimum quality needs of the commodity market. Supply is determined by farmers expectation of price, and the actual price is set by the intersection of this supply with the demand curve. Market power, if it exists, lies with the processor.

Contrast the commodity market structure described above with that for soft drinks (or any other branded product). First, inputs are purchased on wholesale markets from identified suppliers who receive quality premiums. Brands are created by altering inputs to suit consumer tastes and by enormous advertising expenditures. The company that created the product owns these brands. The brand owner chooses the profit maximizing price and quantity level and these prices are typically well in excess of marginal costs. The product is sold through distributorships that have very little market power and quality problems that occur at the retail level can be traced back by batch numbers. The brand owner pays wholesale prices for inputs and charges retail prices for outputs. Attracted by high profit margins, new entrants create competing brands and the consumer benefits from an expanded choice set, and from the attempts of brand owners to customize flavors to particular consumer groups.

One very obvious reason for the unusual structure of agricultural markets is that the costs of organizing and transporting the products of the many thousands of small farms must have been greater than the benefits that would accompany such a structure. It has always been possible for individual farmers to create unique products and to market them to consumers. The fact that so few have done so successfully suggests that the average consumer was unwilling to pay the additional costs associated with maintaining the identity of the product from farm to customer. Thus Coase would argue that agriculture evolved as it did because the costs associated with any alternative system were too great.

Defining Transactions Costs in Agriculture

The transactions cost approach argues that industries become vertically integrated when the transactions costs associated with *market* exchange outweigh the benefits of such an

exchange. When this occurs, firms in the industry realize the benefits of a coordinated or integrated structure and industry structure will begin to evolve. (See for example Williamson page 153 Figure 3.3). The transactions cost approach suggests that the reason we see commodity markets in agriculture is because this structure has been the most efficient way to organize the millions of firms involved in agricultural production.

When communist countries attempted to run agriculture with an integrated top down approach the system failed because it was so hard to provide each worker with appropriate incentives (i.e. the transactions costs of the alternative structure were too high). Likewise it has been difficult for large-scale corporations to organize many sectors of agriculture because of the enormous transactions costs involved.

To provide intuition on the way transactions costs influence agricultural production it is useful to list some of the transactions costs associated with livestock and crop production. We begin with lists of the transactions costs that are incurred when the industry uses an integrated structure or a commodity structure. Our emphasis is on those costs that differ across the two structures. We assume throughout that the integrated system requires voluntary involvement of farmland owners and of farmers via contract (though it could be via ownership).

Transactions Costs in Integrated Agricultural Markets

1. The bureaucratic costs and distortions associated with managing and coordinating integrated production, processing and marketing.
2. The value of the time used to communicate with and coordinate all of the participating farms.

3. The costs of the incentives used to convince farmers to voluntarily participate in integrated production.
4. The inefficiencies caused by workers in the system minimizing effort because rewards are not directly related to the success of the system. (The free rider problem)
5. The legal costs involved in writing and monitoring long term contracts.
6. The economies of scale forgone when batch production replaces commodity production.

Transactions Costs in Commodity Agriculture

1. The bid/ ask spread in the commodity market.
2. The risk premium that must be earned to justify investment in each of the risky sub sectors of the chain.
3. The costs associated with inventory management and with running plants at less than full capacity.
4. The earnings forgone by not taking advantage of a willingness by consumers to pay for information about the history of the product (traceability, animal welfare, health and husbandry programs).
5. The income forgone by not taking advantage of the willingness of consumers to pay for branded agricultural products that suit unique tastes.
6. Production inefficiencies associated with the use of generic rather than specialized inputs.

Most of the costs described above are intuitive. However the last point on generic versus specialized equipment deserves some explanation. The transactions costs literature suggests that one of the key determinants of whether an industry will become integrated is the degree of asset specificity required in the optimal production process. For example if livestock

production involves the use of assets such as barns and fields that can be used for other purposes then markets will tend to predominate. However if livestock production requires the construction of specialized confinement units, then the integrated structure will be favored. The intuition here is that the farmer will not build the specialized equipment unless they can be sure of a long-term market for the product. Farmers who construct specialized facilities without a long-term contract may be forced to operate them when prices are lower than the level required to pay all costs. The processor will know that this is the case and tend to offer prices that are lower than would otherwise be the case. This is known as the 'hold-up' problem. It is interesting to note in this regard that modern pork and poultry production now require specialized units, but that beef and crop production do not.

Case Study Number 1:
Specialized Feed Grain Production

One of the most innovative applications of the World Wide Web in agriculture has been created by an Ames, Iowa based company called E-Markets. This company has developed a web-based platform to link farmers with input suppliers and with output buyers. The early applications developed by this company linked farmers who were interested in growing specialty feedgrains with suppliers who were prepare to pay premiums for these products. Farmers could use the web to agree to deliver specific quantities of identity-preserved grain to a particular elevator at an agreed upon time. The web-based system eliminated costs associated with coordinating and organizing production. Also the costs of transporting an identity-preserved product could be greatly reduced by having several farmers agree to deliver the same grain to the same elevator on the same day.

This application has had an enormous impact on the transactions costs associated with identity-preserved grain for the animal feeding business and it is an opportunity to test whether these new transactions cost structure justifies a move to an integrated production system. The use of the web to organize farmers sharply reduces the *marginal* costs of organizing production, and so the test becomes whether the consumer is willing to pay the additional premium required to maintain the identity of feed grain in return for the different traits from customized varieties of grain created for particular customers.

Animal feeding is unusual because of the widespread use of least-cost rations in the livestock industry. The use of these formulations means that livestock farmers or feed companies (the customers for feed grains) value grains for the sum of the component parts and are prepared to switch formulations in response to minor changes in the cost of these components. The use of these least-cost programs has meant that, to date, the commodity market has produced grain that meets the minimum quality standards at the lowest price. This means that it has been most profitable for seed companies to focus on yields and production costs.

To date there has not been a commercially successful effort to produce a customized grain for a particular type of livestock because farmers pay attention only to the sum of the components in grain and are not prepared to pay a premium for a grain that is suited to their unique needs[1].

The enormous emphasis on cost in the animal feed business has succeeded in creating a bulk commodity production and transportation that has achieved enormous scale economies.

[1] This statement would seem to run in the face of existing markets for high oil corn, however it will be argued below that high oil corn will not succeed in the domestic market so long as animal fat has any positive value. In other words animal fat (which is a by-product) will fall in value as high oil corn production grows. This will eventually reduce the commercial viability of high oil corn.

However, it also means that any integrated system involving specialized seed varieties faces some hurdles. First, the consumer of this seed (the livestock feeder) will not pay any more for the seed than the sum of the component parts. Second, any customized product will need to have a system in place that maintains the identity of that product. This system will not be able to take full advantage of the commodity transportation system. Third, farmers who grow the customized product will be concerned about yield differences and about the poor liquidity of the smaller customized market, and they will have to be compensated for taking these additional risks. Fourth, the seed company will need to be compensated for the risks and research needed to bring these products to market. Finally, there is the possibility that any successful customized product will upset the market for the additive that would otherwise have been added to commodity grain. For example, high oil corn displaces animal fat and high lysine corn displaces synthetic lysine; the producers of these products will lower prices when faced with new competition. The nature of the supply curve (very inelastic) for many of these products means that the price drop that occurs will be just enough to ensure that the customized product will not displace much of the commodity product.

Two recent Iowa State University studies use least cost formulations to determine the added value of specialty feed grains under the transactions costs that existed in 1999. The second study also uses least cost formulations to find the decrease in the market price of the existing feed component that would force the new specialty feed grain out of the ration.

The first of the ISU studies evaluated the potential benefit to the animal feed industry of a list of feasible genetic improvements (Johnson et al 1999). It did not incorporate yield drag, any costs associated with identity preservation, or any price reductions in competing additives. The key results of the study are reported in Table 1 below.

TABLE 1. GROSS VALUES OF SELECTED LEVELS OF CORN MODIFICATIONS IN FEED RATIONS (RANKED IN ORDER OF ANNUAL MARKET IMPACT)

Modification	Gross Value (billion $/yr)	Average Gross Added Value (cents/bu)[a]	Quantity of Corn Affected by Modification (billion bu/yr)
Add 8% points of protein	3.45	72.2	4.8
Add 8% points of oil by enlarging germ for oil	2.51	44.8	5.6
Increase size of germ to 27% of dry matter	2.06	28.7	7.2
Add 7% points of protein by enlarging germ for protein	2.04	24.6	8.3
Add 10% points of starch digestibility	1.44	21.5	6.7
Double glutelin protein content	1.18	27.3	4.3
Add 10% points of protein digestibility	0.88	11.1	7.9
Double oil content	0.74	14.0	5.3
Double lysine content and increase protein content	0.48	11.5	4.8
Triple C-zein and D-zein protein cotents	0.38	9.8	3.8
Double lysine content only	0.36	19.5	1.8
Double albumin protein	0.33	7.9	4.2
Triple phosphorus availability	0.26	11.7	2.2
Double TSAA content and increase protein content	0.25	6.3	4.0
Double methionine content and increase protein content	0.14	3.6	4.1
Double C-zein protein	0.12	2.9	4.1
Triple total/available phosphorus contents	0.09	3.8	2.3
Double TSAA content	0.08	9.0	0.9
Double methionine content	0.07	7.4	0.9
Double tryptophan content and increase protein content[b]	0.04	2.2	1.7
Double tryptophan content[b]	0.03	9.9	0.3
Double threonine only[b]	0.01	0.9	0.1
Double threonine content and increase protein content[b]	< 0.01	0.9	0.1
Add 5% points of starch content	< 0.01	0.1	0.4

[a] Distributes gross value ($) over estimated bushels used.

[b] Swine diets only.

These results show that the most important improvement is to double the protein content of the grain[2]. This change is worth about nine cents per bushel for each 1 percentage point increase in protein. Other valuable improvements include those that would increase lysine, tryptophan, germ size and oil content. One improvement that is ranked relatively low is an increase in phosphorous availability. However, the analysis does not include any benefits from reducing phosphorous going into the environment.

In a follow-up study, economists identified which sectors of the animal feed business would most likely pay for each of the most promising improvements identified in the first report (Baumel, et al. forthcoming). They also used the earlier scientific results to see if any of the improvements would justify the costs associated with yield drag and maintaining the identity of the grain. Using actual experience with high oil corn in one county, yield drag would add 18 cents per bushel, additional seed costs would add 12 cents per bushel, and additional handling cost associated with identity-preserved grain would add 5 cents per bushel[3]. The livestock specific analysis is shown in Table 2 below and the results net of the additional costs are presented in Table 3.

[2] This modification seems extraordinarily optimistic, especially given that the authors do not assume any yield impact from the modification. However, as was mentioned earlier, the authors of the study as well as those from industry who advised them are very well qualified. It seems unlikely that this group would have made such an assumption had they not been told that it was technically feasible.

[3] The assumption of a 5 cent per bushel additional handling charge seems low, however the yield drag value seems a little high and the total value seems to be about right.

Table 2. Added value of six genetic modifications of corn in swine and poultry rations, in cents per bushel

	Swine		Poultry		
Modification	Piglets 8-13 lb	Finishers 233-283 lb	Broiler	Tom turkeys	Layer
High protein	29.4	15.6	57.4	45.0	27.1
Enlarged-germ	0.0	10.3	48.0	44.2	36.3
High starch digestibility	-	-	39.8	33.4	31.1
High methionine	-	-	7.4	4.1	5.7
High lysine	0.0	5.2	-	-	-
High available phosphorus	1.7	1.7	-	-	-

Table 3. Net value of each of the six genetic modifications of corn in swine and poultry rations, in cents per bushel

	Swine		Poultry		
Modifications	8-13 lb piglets	Finishers	Broilers	Tom turkey	Layers
High protein	-5.6	-19.5	22.3	10.0	-8.0
Enlarged germ	-35.0	-24.8	12.9	9.2	1.2
High starch	-	-	4.8	-1.6	-3.9
High methionine	-	-	-27.6	-31.0	-29.3
High lysine	-35.0	-29.8	-	-	-
High available Phosphorus	-33.3	-33.4	-	-	-

The results suggest that the hog and cattle industries will not be prepared to pay economically viable premiums for customized identity-preserved grain[4]. The broiler and turkey industries are however likely to pay a premium for corn with a much higher protein content and for an enlarged germ. These results also indicate that corn with high available phosphorous would *cost* an additional 33 cents per bushel were it to be added to hog rations.

In a final phase of the study the authors calculated the reductions in the traditional ingredients that would be required to drive the modified rations out of poultry diets. These estimates are presented in Table 4 below.

Table 4. Estimated reductions in traditional ingredient prices needed to drive modified corn out of poultry rations in dollars per hundred weight

		Price reductions in dollars per cwt.		
Modification	Traditional ingredient	Broilers	Tom turkeys	Layers
High protein	Soybean meal	$ 0.60	$ 1.40	--
	Feed fat	3.10	11.80	--
	Methionine	127.70	128.90	--
Enlarged germ	Soybean meal	0.20	2.20	$4.80
	Feed fat	0.20	1.60	3.30
High starch digestibility	Soybean meal	0.10	--	--
	Feed fat	0.02	--	--

Any one of the above reductions would drive the modified grain out of the ration. This suggests that soybean meal price reductions of 1.4 to 4.8 cents per pound would drive the modified corn out of all rations. Soybean meal is currently worth about eight cents per pound and a 3-cent per pound price reduction would be very significant. This would correspond to a drop of $1.44 per bushel at the farm level (assuming that each 60 pound bushel of soybeans

[4] Although not explicitly recognized in the report, it was assumed that monogastric animals such as hogs would be able to make better use of the modifications than cattle. Therefore, the conclusion that the modifications would not be economically viable for hog producers can be extended to the cattle industry.

contains 48 pounds of meal). Under current U.S. market conditions this drop would not have a major influence on soybean acreage because farm returns are not influenced by market prices that go below the loan rate. However, if this modification were to be commercialized under free market conditions, then there would be a significant move away from soybean production and into corn production. In other words, sales of this high protein corn seed would go up significantly. One important caveat not considered by the authors is that a doubling of the protein content of corn would probably be associated with a yield drag in excess of that experienced for high oil corn. The results in Table 3 show that after an 18 cent per bushel allowance for yield drag, the net benefit in broiler rations of high protein is 22.3 cents per bushel. Adding 22 cents net benefit to the 18 cents that have already been subtracted by Baumel, et. al., we get an advantage before yield drag of 40 cents per bushel. This suggests that so long as yield drag costs less than 40 cents per bushel, the high protein corn will be economically viable.

At current prices a yield drag of 20 percent would cost about 40 cents per bushel. It is not clear whether the protein content of corn can be doubled while maintaining yields at 80 percent of those of commodity corn. If this can be done then this modification would be worthwhile. Note, however, that the modification cannot be incremental. In other words, a 4 percentage point improvement in protein would not be economically viable.

The bottom line is that livestock feeders using least cost ration formulations will not pay premiums for grain customized to their needs. Also, because modern grain farming does not require specialized production equipment, grain farmers are not interested in lining up long term contracts unless there is a price premium. In this particular case the benefits of commodity grain markets (scale economies in the handling and transportation of grain)

outweigh any benefits associated with integrated production even if the costs of organizing farmers, and coordinating delivery of specialty trait, identity-preserved grains is zero. These conclusions suggest that corn modified with these traits individually will not be commercially viable. However, if some value-added traits could be combined or inserted in conjunction with insect or herbicide resistance in high yielding varieties, as many seed companies are likely to do, then the feasibility looks much rosier for specialty corns to expand their share of the market.

Case Study Number 2:
An Integrated Pork Production System

There is increasing evidence that consumers are prepared to pay premiums for food that is safer and can be traced back to the producer. A Danish meat factory has recently developed an electronic process that allows it to track pork products from slaughter through the boning hall in a facility that slaughters 10,000 animals per day (Meat International). This makes it possible for the company to identify the farmer who produced a particular cut of retail pork. This illustrates the potential for technological change that could change the transactions costs in the pork sector, and stimulate significant organizational change if there is a demand for particular product traits or services that could be served using new information technologies.

The purpose of this case study is to determine whether these changes in transactions costs (i.e. the net value differences which could be captured) are enough to justify a switch to a closely-linked system. If we assume that the new structure will use the internet to organize and coordinate production, this element of the information technology system will have

marginal costs near zero. The feasibility of this new system will therefore depend on the willingness of the customers and processors in the system to pay a premium that is large enough to justify the additional costs with identity preservation (measurement and tracking methods from farm to customer locations).

Meat customer survey

Survey design

We asked the leading companies who serve customers for beef and pork about the willingness of the consumer or the merchandiser serving the consumer to pay for some of the changing demands expected in the marketplace and the benefits associated with a more closely integrated system (Hayenga, et al.). We faxed surveys to 18 leading importers, meat processors, food retailers, and food service companies, and received a 50 percent response rate (nine usable responses, 2 or 3 from each type of customer). Some of the questions asked these experts to represent their consumers and some treated the firms themselves as consumers.

The questions we pose in the survey are based on two extreme versions of the U.S. meat chain. One version is a pure commodity market where packers and processors co-mingle product from many suppliers. In this world, it is difficult for the chain to create differentiated products, and little branding is done. The anonymity of the commodity system also allows some producers to skimp on product quality, and signals about consumer tastes are passed to producers using the very blunt instrument of commodity prices. Each individual in this system faces both input and output price risk. The commodity system puts enormous pressures on costs and takes advantage of economies of scale in packing and processing.

The alternative system is one where "integration" (by contract or ownership linkages) has occurred and full traceback of product and process is possible. This allows creation of

branded, differentiated products. The direct link between consumers and producers in this system allows signals about quality and tastes to be transferred to producers and allows some firms to create valuable brand names. The lack of anonymity in this system encourages all participants to behave responsibly because the consumers (and their lawyers) can identify and punish those who behave irresponsibly. This system can be coordinated so that plants run at optimal capacity, but the scale of each facility is necessarily smaller because of the multitude of branded products. Firms in this system face additional costs as they attempt to market branded products, and the costs of coordinating all parties can be relatively high because they have to serve more functions more effectively than if they were solely linked by markets.

Survey results

While the sample is small, the results are suggestive of potential values that need to be evaluated in more depth by companies contemplating new organizational arrangements within their operations and with customers and suppliers. The responses are summarized in Tables 5 to 9 below.

These responses in Table 5 suggest that by 2005 the average consumer will be willing to pay two to three cents per pound for a range of quality traits. A branded product with a minimum amount of exterior fat, a specified degree of marbling and a tenderness guarantee would be worth more than six cents per pound more than a commodity product.[5]

[5] Respondents were asked to value each attribute individually. We summarize the results simply assuming that the values for two or more attributes are additive, though we realize that there may be added value for customers where attributes are synergistic, and reduced value where there is some degree of substitutability among two or more attributes.

Table 5. Monetary Value of Some Quality Attributes

Quality Attributes	During 2000	Expect in 2005
A more integrated system might allow the meat chain to deliver a wider range of quality attributes to customers provided that they are willing to pay a premium for customized quality traits. Listed below are some quality traits that might be influenced by integration. Please provide your estimate of the willingness of your average customer to pay a premium for each of these traits	*Please provide your best estimate as to the maximum amount your typical consumer would pay for each of the following attributes on a* ***cents per pound*** *basis*	*Please provide your best estimate as to the maximum amount your typical consumer would pay for each of the following attributes on a* ***cents per pound*** *basis*
Current research shows that about 20 percent of meat is too tough to enjoy. What do you think your customers would pay for a branded range of products that was guaranteed to have less than 2 percent tough meat?	1.44	2.24
A branded range of products with consistent muscle size and predictable portions.	1.94	2.81
A branded range with a specified degree of intra-muscular fat (marbling).	2.20	3.10
A branded range of products that is guaranteed to have a minimum amount of exterior fat.	1.39	2.10
Please list other quality attributes and the value of each to your typical consumer.	.50	.50

Food safety issues

The next set of questions focused on food safety. Table 6 shows the monetary values for meat that is guaranteed to be free of some of the most troublesome food borne pathogens, an increasingly important issue in the meat industry.

These results indicate that E Coli is important today, and that it will continue to be important in the future. A range of products with a guarantee against all food borne pathogens might be worth as much as seven cents per pound more than a commodity product in 2005.

Table 6. Monetary Value of Food Safety

Food Safety Attributes	During 2000 Cents per pound	Expected 2004 Cents per pound
The next three questions ask you to put a monetary value on improvements to the safety of the meat you sell.		
A branded range of products guaranteed to be free of E Coli	2.61	4.0
A branded range of products guaranteed to be free of Trichina	.72	1.06
A branded range of products guaranteed to be free of Salmonella	1.75	2.13

Marketing issues

Some of the premiums that exist in branded markets are due more to successful advertising and marketing than to true differences in product quality. The next set of questions explores whether the meat chain might ever reward advertising that was based on subjective characteristics such as packaging and color.

The results suggest that the meat chain has an immediate and future need for attractive packaging. A well-packaged product could command as much a seven-cents-per-pound in premium. This type of package is unlikely to evolve at the meat counter of individual stores because the set up costs and marketing required for a successful product launch are high. It also seems less likely that attractive packaging will evolve so long as meat is co-mingled and undifferentiated.

Table 7. Monetary Value of Subjective Attributes

Marketing Issues	During 2000 Cents per pound	Expected 2004 Cents per pound
Certain product features are not measurable, yet may add value to meat products for some consumers. Please let us know how much more your average consumer would be willing to pay for the following attributes.		
A colorful label supported by nationwide advertising	.81	1.28
A picture of the actual farm that grew the animal	.22	.44
A picture of the individual farmer (farm family) that grew the animal	.22	.39
An attractive package designed to compliment the product	.64	1.31
A package designed for gift giving	3.09	3.75

Legal issues

As mentioned above, an integrated meat system would remove the anonymity that exists in the current system. If this anonymity were removed, then firms at all segments of the chain would realize that problems caused by poor quality control could eventually be traced back to the offending party. This might in turn create an incentive for these firms to improve. The next set of questions is designed to measure the potential importance of a traceback mechanism that moved product liability to the party responsible for the problem.

Table 8. Monetary Value of Traceback Mechanism

Legal Issues	During 2000 Cents per pound	Expected 2004 Cents per pound
In your opinion how much would it be worth today to the US beef and pork chains to be able to trace-back food safety incidents to the firm that created the problem? Please take into account the incentive that each person in the system would have to minimize these legal problems.	2.33	3.0
How much would consumers be willing to pay to buy a product that could be traced back through each step of the system?	.97	1.36

The payoff for traceback is perceived to be much greater for firms in the chain than for consumers, perhaps because of the liability issues that have proven to be extremely expensive for some firms in the meat industry, and the expanded use of costly-to-introduce branded product merchandising programs. More importance is expected in the future.

Niche market opportunities

The final set of questions asks about niche market opportunities. We ask for an estimate of the size of the market segment and the willingness of customers in that segment to pay for certain attributes. The results suggest that sizable market niches exist for hormone free animals and for animal friendly production practices. These responses do not reflect the views of customers in the European Union but that they do include responses from individuals with expertise in Japan and South Korea.

Hormone-free and animal rights-related product claims gather the largest potential consumer groups from this small sample of domestic and international customers. However, it

is clear that these markets cannot be satisfied by product from a commodity system with continued anonymity.

Table 9. Niche Market Potential

Niche Markets	Size of Market Segment (Percent)	Willingness to Pay (Cents per pound)
Some product attributes are of value to a subgroup of consumers. Please let us know the size of the likely subgroup and the willingness of the typical member of the subgroup to pay for each of the following characteristics.		
Animal friendly production practices	15	3.14
Hormone free production practices	20	3.94
Animals produced without feed grade antibiotics	6	1.25
Animals produced in a way that is viewed as being friendly to the environment	17	1.17

The results presented above are from a small set of well-regarded experts. These results indicate that the consumers of beef and pork are willing to pay an additional 20 to 30 cents per pound for meat from a system of production that results in a branded, customized product if these results are additive. The results also suggest that this premium will grow over the next five years.

Evident, too, is the value they perceive that consumers place on food safety and the ability to trace product to the point of origin. A potential market for attractively packaged products is also suggested here. The results also indicate that a group of consumers is willing to pay more for products from hormone-free and other animal- friendly environments. This added value to beef and pork products cannot be captured without innovative vertical linkages throughout the beef and pork production, processing, and merchandising system. That perceived value, as it increases in the future, serves as an increasingly important driving force in the industry reorganization which is now underway and very likely to continue.

Costs of Identity Preservation in the U.S. meat sector

The final question we need to address is whether the costs associated with meeting these consumer needs is greater than the costs associated with offering an identity-preserved product. Many of the costs associated with an identity-preserved meat system are those associated with the branding process. For example the individual who finds an attribute that consumers are willing to pay for should be rewarded as should those who develop the new package and the marketing materials. But these costs are really the reward to those who notice and follow up on the new opportunity and the size of these returns will equal the difference in transactions costs between the new and the old system. For our purposes what is most interesting is whether these returns will be positive or negative, i.e. will those who create the brands be rewarded? For this we need a measure of what it will cost to maintain the identity of meat through the system.

To date there are no large scale slaughtering facilities in the U.S. that track all their meat from farmer to retailer, but many companies have begun tracking product partly through their system, and others are exploring the technical and economic feasibility of such a move. One company estimated that the set up costs amortized over five years plus the incremental operating costs might cost $0.30 per hog. Others suggested that the most of the changes necessary to implement a full traceability system will be put into place as part of their HAACP quality control processes to minimize costs associated with product recalls. This suggests that the largest companies may have relatively small added costs to implement the identity-preserved system necessary to capture some of the values now not being captured in our less-integrated systems. If the potential values that could be captured from some of the innovations above are realistic, there is a clear incentive for the industry to evolve away from

the commodity system. The emrging scenario is that packers are beginning to introduce traceback for their own benefits at first; once traceback is feasible, some of the other benefits associated with the growth of branded products in the beef and pork sectors will be captured and shared with suppliers providing raw materials essential to capture those benefits.

Conclusions

The analysis suggests that the profound changes in transaction costs (especially perceived high values of several characteristics of meat products) appear likely to motivate a significant transformation of the meat sector. The results also suggest that changes in transactions costs (for individual traits of corn) alone are not sufficient to justify the creation of a system to maintain the identity of single-trait modifications in corn in the primary market for corn-- the bulk feed-grain sector. However changes in transactions costs coupled with a several traits adding value in one corn variety will be necessary to justify a significant shift toward higher cost identity preservation, contract systems for specialty grains in the feed grain sector.

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