CATHERINE HALBRENDT, JOHN PESEK, APRIL PARSONS AND ROBERT LINDNER*

Analysis of Australian Consumer Preference for pST-Pork Products

Abstract: Conjoint measurement was used to determine consumer preference for pork produced with genetically engineered porcine somatotropin (pST). A preference model was constructed based on three pork attributes, fat reduction, price and technology, which allowed for estimable interactions between attributes. Interview surveys were used to collect conjoint data in several shopping centres in three cities. Respondents generally preferred leaner pST-produced pork, but only at fat reduction levels greater than currently attainable with conventional technology.

INTRODUCTION

The Australian meat industry is facing changes in consumer preferences toward the types and amount of meat in their diets. Per capita consumption of red meat (beef, veal, lamb and mutton) has fallen over the last several decades, while white meat (poultry), pork and seafood consumption have increased. One of the main reasons for the changing trend in meat consumption is the perceived health risks of red meat consumption (Gardner, 1990; and Bartley *et al.,* 1988).

Currently, there is an opportunity for expansion of the pig industry by promoting pigmeat as a healthier alternative to beef, chicken and other meats, with leaner pork produced with genetically engineered porcine somatotropin (pST), a protein that occurs naturally in pigs. Produced in the anterior pituitary gland, pST regulates pig growth and controls pig metabolism. Metabolic activity involves the decrease of fat storage and the increase in development of muscle (i.e., lean meat) (Turman and Andrews, 1955).

Through advances in genetic engineering technology, it is now possible to manufacture pST economically. Experiments have shown that pigs supplemented with man-made pST experience increases in growth rates and feed efficiency, and carcass fat reduction.

The implications of the successful adoption of pST by the pork industry include: benefits to consumers in the form of healthier, leaner pork products at lower prices; benefits to producers in the form of lower production costs and more lean meat per carcass, and; benefits to the environment in the form of more efficient feed use by pigs and less waste.

The successful adoption of pST by the Australian pork industry will depend on the extent to which Australian pork consumers will accept pST technology in pork production. In 1990, Taverner summarized the results of a survey conducted by Couchman and Fink-Jenson of over 2000 New Zealand residents. Respondents said their highest level of concern over the use of genetic engineering was in the case of meat products, and 27 percent said their main concern over eating genetically engineered meat was that it is 'unnatural'. This study's objective is to determine Australian consumers' preferences for pork produced with/and without genetically engineered pST, using conjoint measurement.

* University of Delaware, USA, University of Delaware, USA and University of Western Australia, respectively.

METHODOLOGY

Conjoint measurement is a multivariate market research technique which can aid in sorting out the relative importance of a product's multi-dimensional attributes (Green and Wind, 1975). Conjoint measurement refers to any decompositional method that estimates the structure of consumers' preferences given the consumers' overall evaluations of a set of alternative products that are pre-spectified in terms of levels of different attributes.

Conjoint Measurement

Two especially useful results yielded by conjoint measurement include the ability to determine a hypothetical 'ideal' product design that would maximize overall consumer utility, and the ability to construct a set of competitive product profiles for any specified level of utility (Green and Wind, 1975). To conduct the conjoint experiment, the product is presented to the respondent in the form of several product profiles, each comprised of several attributes which vary simultaneously. The respondent rates each profile according to preference, the rating representing the level of utility provided by each product profile.

More recently, the theory of consumer utility is increasingly considered a two-stage process that goes a step beyond the traditional economic theory of consumer demand. For example, based on Lancaster's model of consumer behaviour, the theory of brand preference states that goods are valued for the attributes they possess, and that differentiated products are essentially different packages of attributes (Ratchford, 1975). In other words, utility is determined not by the goods themselves, but by the consumer's preference for attributes which the goods possess. This two-stage theory of consumer utility is described according to Ratchford:

> A consumer maximizes an ordinal preference function for characteristics $U(z)$, where z is a vector of characteristics $1,\ldots,r$, subject to the usual budget constraint $px \leq k$, where p is a vector of prices for each of these goods and k is income. Goods, x, are transformed into characteristics, z, through the relation $z = Bx$, where B is an $r \times n$ matrix which transforms the n goods into r characteristics. The model may therefore by written succinctly as:
>
> Maximize $U(z)$
> Subject to: $px \leq k$
> With $z = Bx$.

Conjoint measurement comes into play as a method for determining the level of consumer preference for these characteristics (product attributes).

The steps taken to implement the conjoint measurement of consumer preference for pST pork were: the selection of pork product attributes and their levels; construction of a set of pork product profiles for evaluation; specification of a preference model; selection of an appropriate estimation method; design of a survey instrument; administration of the survey and conjoint analysis; and evaluation of results.

Pork Product Attributes and Attribute Levels

Pork product attributes were chosen based on their importance to consumers in making pork purchasing decisions (according to past studies) and their ability to meet the main objective of the study (i.e., to evaluate preference for pST pork). A review of past pork studies revealed that the most important attributes to consumers are fat content and price. Technology was used as a pork attribute (pST or current technology) to meet the main objective of the study.

Attribute levels corresponded to points along a represented range of an attribute. Consultation with researchers on pig breeding indicated that fat reduction from 0 to 20 percent was attainable with conventional technology. Fat reduction ranging from 10 to 40 percent was attainable using pST (see Table 1). Price ranged from $A6.99 to $A8.99 per kilogram, which was in line with the Australian price for pork chops at the time of survey. Given the limitations of conventional technology and the high fat reduction potential of pST, the attribute combinations of some product profiles were unrealistic (e.g., a pork profile of zero fat reduction at the higher price of $A8.99/kg produced with pST) and they were eliminated. Once attributes and levels were selected, hypothetical products were formed for respondents to evaluate and assign preference ratings.

Table 1 *Pork Product Attributes and Attribute Levels*

Attributes	Attribute Levels
Price	$A6.99/kilogram
	$A8.99/kilogram
Fat reduction level	0% (current technology)
	10% (current technology, pST)
	20% (current technology, pST)
	40% (pST)
Fat reduction technology	Current technology/Trimming
	pST

Interactions Among Attributes

It is common in conjoint studies to assume no interactions between attributes (Halbrendt, *et al*; 1990; and Green and Wind, 1975). When the design of this conjoint experiment was being planned, the possible complex relationships between the attributes (price, pST and fat reduction) strongly suggested the design should allow for interactions between attributes.

Therefore, the product profiles in this study were designed to allow for estimable interactions between each of the attributes. The allowance of attribute interactions resulted in a large, automatic increase in the number of product profiles. To overcome this situation, the numbers of attributes and ranges of attribute levels were limited.

Attribute Levels and Utility Functional Form

Initially, two attribute levels for technology (pST or current), four levels for fat reduction: (0, 10, 20) percent for current technology and (10, 20, 40) percent for pST technology, and three levels for price were considered. Using three-level attributes would have allowed for the estimation of quadratic functional forms such as those for the fat reduction and price attributes. However, this would have yielded too large a number of product profiles for the respondents to evaluate. Pre-tests and past studies have shown that rating more than about nine product profiles becomes unmanageable for most respondents. However, the number of product profiles must be at least equal to the number of estimated parameters specified in the empirical model (see equation 1). Otherwise, the design matrix used in the analysis will not have full rank. Therefore, this study needed at least ten profiles. The price attribute was reduced from three to two levels, suggesting a linear functional form for price. A past conjoint study (Halbrendt *et al.,* 1990) in which three price levels were used revealed that the the price variable response was linear. In addition, given the modest nature of food price changes, a linear price response seemed very reasonable.

Product Profile Selection

The two-level price and technology attributes and the four-level fat reduction attribute resulted in a design with 16 profiles (2x2x4). The authors decided to use ten profiles to satisfy the requirements of the model and to reduce the possibility of respondent fatigue (ten profiles being close to the ideal number of nine). To collapse the number of profiles from 16 to 10, four infeasible profiles were first logically deleted (two current technology profiles with 40 percent fat reduction; and two pST-produced profiles with zero percent fat reduction. Forty percent fat reduction is not attainable using current technology and pST-produced pork must have some level of fat reduction). From the remaining 12 profiles, two more needed to be deleted. The D-optimality design criterion was used to determine which of the two profiles to exclude. From the work of several authors (see Box and Draper, 1971), this criterion is known to have excellent properties such as low variances for the parameters, and low correlations among parameters (Mitchell, 1974). The ten profiles yielded by the D-optimality design process are shown in Table 2.

Table 2 *Pork Product Profiles used for Evaluation by Respondents*

Profile	Technology	Fat Reduction %	Price $A/kg
1	Current	10	6.99
2	Current	20	8.99
3	pST	40	6.99
4	pST	20	8.99
5	pST	20	6.99
6	Current	20	6.99
7	pST	10	6.99
8	pST	40	8.99
9	Current	0	8.99
10	Current	0	6.99

MODEL ESTIMATION TECHNIQUE

Conjoint experiments are usually 'repeated measures' designs. In other words, the same experimental unit (respondent) is measured (asked to rate product profile) several times. The advantages of repeated measures are lower costs and variance reduction. It is generally less expensive to ask 500 people to rate 10 profiles than to ask 5000 people to rate one profile each. The other major advantage of repeated measures designs is variance reduction. Even ignoring costs, 5000 people would be more heterogeneous, resulting in a likely loss of precision.

However, because measurements by the same respondent are apt to be correlated, an analysis of a repeated measures study should correct for the within-respondent correlation. Ignoring the correlation structure may lead to inaccurate estimates, standard errors and tests. In this paper the weighted least squares approach of Grizzle, Starmer and Koch (1967) was used to correct for possible within-respondent correlation.

Sampling

The population to be surveyed consisted of Australian consumers who eat pork. The surveys were conducted in shopping centres. A commonly encountered feature of survey sampling is that a certain amount of information is known about the elements of the population to be studied. Supplementary information (e.g., income or an area) can be used either at the design stage to improve the sample estimators or both. Because information on respondents' attitudinal responses on genetic engineering has revealed that various socio-demographics can have an effect, the sample should adequately represent various socio-demographic groups. This study's data were collected in shopping centres around the country.

Surveys were conducted in June and July, 1992. Survey interviews were administered in three cities: Perth, Sydney and Brisbane. According to census data, the combined populations of the three cities make up one-third of Australia's total population.

Model Specification

Unlike most conjoint experiments in which the importance of the main effects of product attributes are emphasized, the model for consumer preference of pST-supplemented pork products was specified to include interactions among the attributes. Interactive models imply that there is variation in the dependent variable (rating) associated with two or more of the independent variables (product attributes) working together. Although results are easier to interpret, main effects models could be misspecified, especially with attributes having negative correlation (i.e., price and leanness), and often do not provide as good a fit as models including interactions (Forthofer and Lehnen, 1981). The conjoint model was specified to include attribute interactions as:

$$\text{RATING} = \beta_0 + \beta_1\text{PST} + \beta_2\text{RED} + \beta_3\text{RED2} + \beta_4\text{PST*RED} + \beta_5\text{PST*RED2} + \beta_6\text{PRICE} + \beta_7\text{PST*PRICE} + \beta_8\text{PRICE*RED} + \beta_9\text{PRICE*RED2} \quad (1)$$

where: RATING = 1 to 6; 1 is least preferred and 6 is most preferred

PST = dummy variable for technology; 1 if pST, 0 if current technology

RED = Level of fat reduction; 0, 10, 20, or 40 percent

PRICE = Price for pork products; $A8.99/kg or $A6.99/kg.

The model was estimated using Weighted Least Squares (WLS), a regression technique which gives more weight to the product profiles that have smaller variances than those with larger variances (Forthofer and Lehnen, 1981). This technique was appropriate given the potential problems of correlation among responses by each respondent and unequal variances among product profiles.

RESULTS

Socio-Demographics Responses

A total of 600 surveys was completed, of which 557 were usable. Of the 557 respondents, 74 percent were the primary shopper for the household and 26 percent were not. The majority of respondents were female (68 percent). Over half of the respondents lived in households with 2–3 members (52 percent). There was also a large majority of married or defacto respondents, totalling 60 percent. Fifty-one percent of the respondents were over 39 years of age. Twenty-eight percent of the respondents completed secondary school, 19 percent had some tertiary education, and 21 percent completed tertiary education. Sixty-one percent of the respondents who answered the income level question had incomes of over $A25 000. Australia was the most-represented birthplace, with 66 percent of the respondents being born there. The occupations of respondents varied over the list of categories, but there was a fairly large representation of retired and professional respondents (40 percent). After testing for socio-demographic effects on pork product profile ratings, it was found that the model was homogeneous in response. In other words, ratings of pork product profiles across different socio-demographic groups of respondents were not significantly different.

Table 3 *Mean Utility Values for Survey Product Profiles*

Profile	Technology	Fat Reduction %	Price $A/kg	Mean Utility	Standard Deviation	Standard Error
1	Current	10	6.99	2.44	1.34	0.06
2	Current	20	8.99	3.55	1.30	0.06
3	pST	40	6.99	4.97	1.70	0.07
4	pST	20	8.99	3.02	1.26	0.05
5	pST	20	6.99	3.57	1.37	0.06
6	Current	20	6.99	4.18	1.29	0.05
7	pST	10	6.99	2.12	1.13	0.05
8	pST	40	8.99	4.36	1.67	0.07
9	Current	0	8.99	1.41	1.04	0.04
10	Current	0	6.99	1.57	1.19	0.05

Conjoint Experiment Results

The conjoint analysis allowed respondents to choose among several products, each being a unique combination of attributes. Respondents were asked to evaluate each product in terms of the level of utility they would gain from the purchase of a particular product. The ten product profiles and their mean utility values are presented in Table 3. The product with the highest mean utility of 4.97 was profile 3, which was pST-supplemented, 6.99/kg, and has a fat reduction level of 40 percent. The higher-priced profile 8 also pST supplemented with the 40 percent fat reduction level had the second-highest utility of 4.36. Profile 6, which is current technology, 6.99/kg, and 20 percent fat reduction also had a fairly high mean utility of 4.18. Respondents considered leanness an important attribute to pork products. This can be seen at the 40 percent fat reduction points at which utility was the highest. However, at the 20 percent reduction points, respondents preferred the pork produced with current technology. They were getting roughly the same utility for the high-priced current technology pork as the low-priced pST-produced pork when fat reduction was 20 percent. The profiles with the lowest utilities were those with the 0 percent fat reduction. These are profiles 9 and 10, and have utilities of 1.41 and 1.57, respectively.

Table 4 *Estimated Conjoint Model Parameters*

Variable	Parameter Estimate	Standard Error	Chi-Square
Intercept	2.1135	0.1423	220.52*
PST	–16879	0.2418	48.74*
RED	0.1632	0.0194	71.02*
RED2	0.0025	0.0006	20.30*
PST*RED	0.1771	0.0178	99.41*
PST*RED2	–0.0069	0.0006	138.95*
PRICE	–0.0777	0.0158	24.26*
PST*PRICE	0.0411	0.0321	1.64
PRICE*RED	–0.0172	0.0023	54.89*
PRICE*RED2	0.0003	0.0001	27.95*

Note: * Implies significance at the 1 percent level.

The weighted-least-squares estimated parameters are presented in Table 4. Nine of the ten parameters were significant at the 1 percent level, indicating the interactive model was well-specified. Consistent with economic theory, the price parameter estimate was negative, indicating an inverse relationship of price with utility. The estimated pST parameter alone was negative, suggesting pST has an adverse impact on utility. However, when pST interacts with either leanness or price, the overall effect was positive indicating pST that could produce leaner pork at a competitive price increases which respondents' utility. The fat reduction parameters generally were positive, confirming that higher fat reduction translates to higher utility. As shown in Table 3, current technology products at a fat reduction level of 20 percent even at a higher price of $A8.99 per kilogram can compete with pST pork with the same amount of fat reduction at a lower price of $A6.99 per kilogram. Only at greater levels of fat reduction was pST-produced pork preferred over non-pST pork. Table 5 shows the combinations of fat reduction levels and price of pST products that yield the same level of utility (4.18) to respondents as the current technology products at the 20 percent fat reduction level, assuming a price of $A6.99/kg. For consumers to accept pST pork, the pork sold has to be comprised of attribute levels better than the combinations presented in Table 5.

Table 5 *Hypothetical pST Products that Yield the Same Utility as Current Technology at 20 Percent Fat Reduction*

Current Technology	Competitive pST Products			
	Price $A/kg	Fat Reduction %	Price $A/kg	Fat Reduction %
Price = $A6.99/kg	6.04	23	8.45	32
Rating = 4.18	6.40	24	8.63	33
	6.73	25	8.80	34
Fat Reduction =	7.04	26	8.96	35
20 percent	7.32	27	9.10	36
	7.58	28	9.24	37
	7.82	29	9.36	38
	8.05	30	9.47	39
	8.26	31	9.58	40

SUMMARY

In general, respondents appeared to be in favour of pST-produced pork at the higher fat reduction levels. Utility was greatest for pST products where fat reduction is at a very high level, e.g. 40 percent. When given a choice between pST or current technology when both were available (10 or 20 percent fat reduction levels), respondents preferred the current technology pork products.

Also, as fat reduction increases, consumers were found to be more price sensitive. Respondents were not as willing to pay for fatty pork products, but exhibit high levels of utility with high levels of fat reduction combined with a low price.

For the successful adoption of pST, the price of pork products produced with pST will have to remain very competitive, and the level of fat reduction will have to be higher than current technology can attain. Therefore, with a combination of leaner pork at competitive prices, consumers will be willing to consume pST pork, but not willing to pay a premium unless they achieve leanness beyond that which current technology can achieve.

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DISCUSSION OPENING — Eugene Jones *(The Ohio State University, USA)*

This paper addresses an important and very timely subject. It is widely recognized that farms groups must become more market oriented if they are to compete successfully in the market place. Heretofore, many producers have pursued a production-orientated strategy, expecting consumers to purchase whatever they produce. Producer groups pursuing production-oriented strategies are facing marketing challenges, particularly as the variety of products available to consumers continues to increase. Fortunately, this paper focuses on a market-oriented strategy, attempting to identify product attributes demanded by consumers and then communicating these desired product attributes to producers for incorporation into the production decisions. Such an approach is much needed and I commend the authors for this very interesting paper.

As a discussant, I simply want to highlight a few things to help initiate discussion from the audience. First, information communicated to pork producers regarding consumer preferences needs to reflect the preferences of the 'true' population. That is, a representative sample of the population must be surveyed. As presented, it is not clear if the authors have conducted a random sample of the population. Although the survey method included a diverse group with respect to income, it still appears as though those surveyed included anyone who would spend time with the survey conductors. Secondly, it seems that the range of fat reduction offered to the consumer includes an irrelevant range. With studies suggesting that the current technology can achieve up to 20 percent fat reduction, it seems unreasonable for consumers to express a preference for pST treated products that obtain fat reduction of only 20 percent. That is, with the pST treated pork considered 'unnatural' it seems unreasonable to expect consumers to purchase it if they can get the same product in its 'natural' form.

Some additional points related to this paper are also noted. If we can assume that consumers have clearly expressed their preferences to researchers, it is still important for the researchers to recognize the gap that most often exists between consumers' expressed preferences and preferences revealed in their market purchases. That is, it is important for the researchers to communicate to farm producers that consumers' stated preferences will likely overstate their revealed preferences. Fourthly, with respect to interaction variables in the model, it would have been helpful to this reader if the authors had provided a theoretical discussion of the expected effects of these variables. For example, what is the expected effect on utility of pST interacting with fat reduction or price interacting with fat reduction? Clearly, Weighted Least Squares regression will yield some signs that can be rationalized, but it would be useful to have some *a priori* expectations regarding the effects of these variables.

Finally, I wish to comment on the use of 'product attributes' as opposed to 'products' in empirical studies. Although I am convinced that the use of product attributes is the right approach, it seems inappropriate to evaluate them in isolation. For example, with respect to the current study where fat reduction appears to be the dominant product attribute, it is quite likely that one's preference for fat reduction is a function of one's taste for the product and frequency of eating the product. In general, one who eats pork twice a month is likely to have a lower preference for pST-treated pork than one who eats pork twice per week. In short, it seems that other socio-economic factors must be integrated with the product attributes.

In summary, the authors have presented an interesting and thought provoking paper. Anyone interested in consumer research related to product attributes is likely to gain tremendous insights from reading this paper. The authors are certainly to be applauded.