Analysis of the relationship between quality and price of yam in Ghana - second round (NRI report no. 2428)

Analysis of the Relationship Between Quality and Price of Yam in Ghana – Second Round

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Summary

In 1997, NRI staff and officers from the Ghanaian Ministry of Food and Agriculture conducted two quantitative surveys of yam trading in Techiman market. The aim was to establish the importance of financial losses caused by poor yam quality and to measure the relationships between price and a series of quality defect variables.

This report summarises the analysis of data gathered during the second survey. Data was analysed using multiple regression. Of the nine quality variables measured in the market, only "rotting" could be proved to have a significant influence on price. This result should not be interpreted to mean that other quality variables do not have an impact on price, merely that there was insufficient variation in quality for the statistical techniques to prove the existence of other price quality relationships. Moreover, at the time of the survey, these findings suggest that the financial losses caused by quality defects were slight.

The report concludes with suggestions for improving the data gathering methodology for future surveys. In particular, it recommends extensive qualitative surveys to establish the incidence of quality defect related financial losses throughout the year. If these surveys indicate high financial losses, the research should attempt to establish the quantitative nature of price quality relationships using biased sampling techniques.

Introduction

An understanding of how product quality affects market price is a pre-requisite for technical interventions designed to improve product value. In mid 1997, a predecessor to this report recommended a formal survey to identify the relationship between the quality and price of yams marketed in Ghana (Gray et al 1997A). Guided by qualitative information on quality defects that cause the greatest financial losses, such a survey was conducted in June 1997 at Techiman market, a important food wholesale and retail centre in Brong Ahafo.

A full description of the survey design, methodology and results appear in Gray et al (1997B). The survey spanned five weeks and gathered data on nine quality variables and price. Data gathering was categorised according to two types of trader (wholesaler and retailer) and two types of yam (one white and one water variety). In total, 120 heaps of yams were surveyed.

The data analysis produced inconclusive results. Quality of the surveyed yams was too uniform to allow statistical techniques to tease out the relationships between the quality variables and price. Type of trader and the variety of yam emerged as the only reliable predictors of price. The analysis was unable to conclude that the quality variables either did or did not have an impact, merely that quality problems were not prevalent in Techiman market during the survey period. To improve the chances of finding quality price relationships in future studies, Gray recommended a shortening of the survey period to reduce the price impact of changes in daily and weekly market conditions, and a different choice of season to capture greater quality variations that may occur at other times of the year.

This report summarises the analysis of the data generated during a second Techiman market survey conducted in November 1997. Details of the data gathering methodology appear in the Appendix.

The Quality Variables

Data was gathered on the following quality variables during the second survey. A description of how the variables were scored appears in the Appendix

- Tuber rotting
- Tuber breakage
- Surface damage (grazes, gashes, bruising, cuts)
- Termite damage
- Nematode damage
- Cooked spots

- Sprouting
- Tubers cut by trader due to rot
- Ageing

Analytical Methodology

The research adopted similar analytical methodology to that used by Gray in 1997. An examination of scatter plots of price against each of the quality variables revealed which variables could be excluded from the analysis due to zero or minimal variation and also gave an early indication of potential relationships between variables. Collinearity between the explanatory variables was judged to be a significant potential problem and so the author generated a correlation matrix to indicate where linear relationships may exist. He then conducted a series of multiple regressions on price, using only one quality variable per regression to minimise the effects of collinearity. In each regression, a dummy variable described the type of trader (wholesaler or retailer) and a time trend was incorporated to account for the week in which each yam heap was surveyed. Tests for normality and constant residual variance were conducted for each equation.

Results

Preliminary analysis of the variables allowed the author to exclude "surface damage", "cooked spots" and "cut due to rot" because they showed zero or close to zero variation (refer to Table 1 for coefficients of variation).

Table 1. Coefficients of Variation for Price and Quality Variables

	Coefficients of Variation
Breakage	12.5%
Nematode damage	12.3%
Rotting	8.3%
Yam weight	4.1%
Termite damage	3.8%
Price per kg	2.1%
Sprouting	1.1%
Surface damage	0.1%
Cooked spots	0%
Tuber cut due to rot	0%

Regressions on price using the remaining quality variables, type of trader and week number as the independent variables yielded highly significant coefficients on the "type of trader" and "week number" variables, an unsurprising result in the light of

Gray's findings (1997B), qualitative surveys of the Techiman market (Gray et al 1997A), and common sense. Unlike previous findings (Gray et al 1997B), yam variety did not have a significant impact on price, a discrepancy that was almost certainly caused by the different choice of varieties in each survey.

Of the quality variables, only "rotting" emerged as having a significant influence on price. Table 2 presents the regression results.

Table 2. Regression of Type of Trader, Week Number and Rotting on Price

Variable	Constant	Type of trader	Week number	Rotting
Coefficient	496.2	111.8	87.2	-329.3
Standard Error	52.9	29.5	11.0	167.0
t-value	9.38	3.79	7.90	-1.97

Adjusted R squared = 0.409

The t-values indicate whether the coefficients are significantly different from zero, or in other words, whether the variables can be proved to have an influence on price. T-values of above 1.96 suggest significant differences from zero albeit with a 5% chance of having made a mistake. Under this criteria, all the coefficients are significant, although the "rotting" coefficient only just scrapes home.

A normal probability plot of the residuals and a scatter graph of the residuals against the fitted values revealed that the ordinary least squares assumptions of normality and constant variance had not been violated. Visual inspection of scatter plots revealed that collinearity between week number and "rotting" almost certainly exists. Collinearity's effect is to increase coefficient variances and thereby reduce the likelihood of finding significant coefficients (note the high standard error of the "rotting" coefficient). Given that the "rotting" coefficient is on the borderline of significance, the existence of collinearity gives greater confidence that rotting does indeed have a significant influence on price. However, given the high variance, there can be little confidence in the estimated value of the "rotting" coefficient, and consequently the equation should not be used for predicting prices.

Despite this warning, there are two features of the results worth highlighting. Firstly, the rotting coefficient has a negative sign, reflecting the expected relationship between rotting and price. Secondly, the coefficient on type of trader indicates that the retail margin was 112 Cedis per kg[1]. With an average retail price of 960 Cedis per kg, the retail margin is approximately 12% of the selling price.

A more general examination of collinearity between the independent variables revealed a strong positive linear relationships between week number and nematode damage, and also between week number and "termite damage". Unfortunately, a lack of manpower during the November survey did not permit the survey team to heed Gray's advice on shortening the survey period. In the case of nematode and termite

[1] In the light of the results from regressions that returned non-significant price quality relationships, this finding is reasonably robust. Coefficient values on type of trader ranged between 105 and 112.

damage, the time relationship appears to have been caused by the delivery of consignments of damaged yams towards the end of the survey period. While both nematode and termite damage may indeed have a strong influence on price, the strong collinearity in the dataset dramatically reduces the chances of finding significant coefficients. This again highlights the importance of conducting the survey over as short a period as possible in order to reduce the impact of undesirable relationships between time and the other variables.

Comparisons with The Previous Study

Unfortunately, a scarcity of robust results, both in the current and the previous quantitative research, means that common findings are few. Both studies revealed that type of trader and time have a strong influence on price. But while the current study found a relationship between one of the quality variables and price, Gray et al's research revealed no such influence. This may have been caused by differences in analytical approach or simply by variations between the seasons in which the surveys were conducted.

Revisions to the Survey Methodology

Future surveys should attempt to minimise the impact of time on the price and quality variables. A concentration of resources in a much shorter survey period, possibly within the space of just one week, would require greater survey resources but the benefits in terms of reducing collinearity may warrant the expense. However, just as prices vary on a weekly basis, day to day fluctuations also occur. An understanding of how market price patterns develop throughout an average week would allow the research team to devise a data gathering methodology that would minimise the impact of time on price. The data could then concentrate on telling the story of how quality affects prices.

Gray et al (1997B) recommended the collection of data on the best quality yam prices to establish a standard against which prices for inferior yams could be judged. Deviations from the average best quality price for a particular day could then be explained by variations in quality defects. This approach is appealing because it provides another method for eliminating the impact of time on price.

The lack of variation in the data is a cause for concern. A survey during the period January to May, when hot weather is reported to create quality problems (Gray et al 1997A), may reveal greater variation. However, just as quality has by and large been uniformly good during the first two surveys, a third survey may reveal uniformly bad quality and therefore add nothing to the understanding of the price quality relationship. Nevertheless, a survey during this period is necessary to complete the picture of the price quality relationship.

One way of injecting variability into the survey methodology may be to take a non-random sample. While ensuring that sufficient data is gathered throughout the whole ranges of the qualities variables, sampling could concentrate on poorer quality yams. This would be a useful approach if the aim of future studies is to establish the existence and nature of price quality relationships in the market. If, on the other hand, the aim is to establish the prevalence and therefore the economic importance of quality defects, then the biased sampling approach would give misleading results.

Another way of increasing variability may be to survey piles of yams rather than heaps. The first two surveys adopted yam heaps (wholesale units of 109 yams) as the survey units, yet by sampling yams piles (retail units of between 1 and 4 yams), the problem of reduced variation caused by averaging quality variables over a whole heap could be eliminated. Clearly this technique is only relevant for surveys at the retail level.

It is tempting to eliminate some of the quality variables for which data is gathered in order to concentrate survey resources on those relationships that are perceived to be the most important. However, we have yet to determine whether any of the quality variables definitely does not have an impact on price. Instead, we have merely concluded that during the first two survey periods, there has been insufficient variation to establish links between price and most of the quality variables. In other words, financial losses due to quality have probably been slight.

Because statistical analysis necessarily works with conservative probabilities, it is pretty weak at proving the existence of quantitative relationships. Ultimately, better information may be obtainable from carefully conducted and widespread qualitative interviews with traders.

Recommendations

1. Conduct a thorough and widespread qualitative survey of traders to establish the financial importance of losses caused by quality defects.

2. If quality is an important financial issue, conduct a modified quantitative survey to establish the relationships between quality variables and market price. The timing of the new survey should be informed by the findings of the qualitative survey in order to maximise the likelihood of finding substantial variations in yam quality. The survey should be conducted over a short period, and an attempt should be made to gather information on best quality yam prices. Sampling should be deliberately biased to include higher numbers of poor quality yams. For retailers, yam piles rather than heaps should be surveyed.

References

Gray, A., D. Crentsil, S. Gallat, S. Gogoe (1997A) "Survey of Yam Trading Practices and Loss Assessment in Techiman Market" NRI report for CPHP project R6505.

Gray, A., D. Crentsil, S. Acheampong, S. Floyd (1997B) "Analysis of the Relationship Between Quality and Price of Yam in Ghana", NRI report for CPHP project R6505.

Kennedy, P., (1992) "A Guide to Econometrics" Third Edition, Blackwell Ltd, Oxford.

Appendix

The following is an extract from Gray et al (1997B) and describes the data gathering methodology used during the first survey conducted in Techiman in June 1997. The second survey followed an almost identical methodology, and so Gray's description remains relevant. The text has been amended to account for slight variations in approach adopted during the second survey.

Sample Size & Random Sampling

A random sample from a cross section of traders, including retailers, itinerant wholesalers and sedentary wholesalers was collected. Owing to time constraints itinerant and sedentary wholesalers were treated as on group. While differences in pricing practices for the two types of trader are in fact likely to exist, they are probably small.

Thirty heaps of each variety were sampled for each group of traders (retailers and wholesalers). Therefore, in total 120 heaps of yams were sampled.

Two yam varieties were sampled, Olondo and Dente. These two varieties were chosen because they were most common in the market at the time of the study.

The traders were randomly selected by a process which involved counting the number of traders in the market e.g. around 100 retailers. Each day the number of traders to be sampled was determined (this was usually around six retailers or three to four wholesalers per day, depending on the number of heaps each trader had for sampling). When selecting which retailers to sample, for example having decided to sample 6 in one day, every 17th trader was interviewed (100/6 = 17). The starting point was taken to be the area of the market where the Yam Association office was located, and a number between 1 and 17 was randomly selected to find the first trader to interview.

By the same method 18 yams in each heap were randomly selected for sampling. If, for example, one retailer had divided the heap into 36 piles of 3 tubers each, then 6 piles would be taken out of the heap for sampling. In this case every 6th pile was sampled (36/6 = 6). A number was randomly selected between 1 and 6 for the starting point.

In some cases the retailers had already sold some tubers by the time the team arrived to sample the heap. In these cases the price of those tubers which had already been sold was not included in the calculations, since they did not form part of the sample. The heap was still sampled if 50 or more tubers remained in the heap.

Quality Defects

Yams in the sample were assessed for the following quality defects:

- Rotting
- Rot due to cuts
- Breakage
- Surface damage (grazes, gashes, bruising, cuts)
- Termite damage
- Nematode damage
- Cooked spots
- Sprouting
- Ageing

The nine quality defects had been determined in previous interviews with farmers, traders and consumers to be those which were likely to have an impact on price.

The enumerator examined each tuber and gave a score between 1 and 3 for each quality characteristic apart from breakage, sprouting and ageing. The scores were given according to the following guidelines:

0 = no damage
1 = up to 1/3 of the tuber affected
2 = between 1/3 and 2/3 of the tuber affected
3 = over 2/3 of the tuber affected

For breakage and sprouting the responses were 'yes' or 'no'. When the data were analysed the percentage of tubers in each sample suffering from breakage or sprouting (i.e. with the response 'yes') was calculated.

For ageing, the number of days since harvest was noted. However, since most traders did not know when the consignment had been harvested, the time taken to sell the tubers after arrival in the market was found to be a more accurate estimation of the effect of ageing on price.

The analysis took into account the number of days that the tubers were in the market before sale[2] by calculating a weighted average to determine the average number of days in which the heap was sold. For example, if 18 piles were sold on day three of the market, 13 piles on day four and 5 piles left until the next week, the calculation of the weighted average was as follows:

[2] This applied to the retailers only, since it was assumed that age deterioration would only occur after 5-7 days in the market and most of the wholesalers managed to sell the yams within the week.

$$\frac{((18 \times 1^{3}) + (13 \times 2) + (5 \times 7))}{36} = 2 \text{ days}$$

Therefore the average number of days for the heap to be sold was 2 days.

Weight

The tubers were weighed so that an average weight per yam could be established, and a price per kilogram was calculated.

Price Data

The selling price noted was the actual price received by the trader for each of the piles in the heap (i.e. all of the tubers which had not been sold by the time the heap was sampled).

The actual price of the heap was the sum of the actual price of piles times the number of piles. In some cases tubers from the consignment were taken home by the retailers for home consumption. In the cases where the yams taken home for consumption were healthy, the retailer was questioned about the price she felt she could have received for the yams and that price was used in the analysis. The price per yam sold was calculated in order to account for the fact that the heap may not have been complete when it was sampled.

In some cases the retailer had given extra tubers to the customer. While no price was paid for these tubers, they were counted as tubers sold, since it formed a part of the traders pricing strategy. In such a way they can reduce the price paid by the customer or give the customer extra for taking inferior quality.

Questionnaire

A separate questionnaire was filled in for each heap of tubers. The quality rating (0-3) was entered for each tuber.

[3] Note that the fact that the first batch of tubers was sold on day three of the market does not mean that the retailers had held onto them for three days. It is more likely that they received the consignment on day three and begun to sell immediately. Therefore, in this instance the first batch was sold after one day with the retailer, the second batch after two days (on day four) and the third batch on the following week, taken to be day 7 for the purpose of calculation.