PRICE EXPECTATION FORMULATION IN THE

QUEENSLAND TOMATO GROWING INDUSTRY

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Price expectations are believed to play a major role in determining supply responses in agriculture. This paper reports part of a study designed to investigate the price expectation formulation behaviour of 40 Queensland tomato growers during the 1986 tomato season.

The full study (Whybrow 1987) is concerned: first, with demonstrating that tomato growers actively formulate price expectations and that these expectations are important determinants of production and marketing decisions; secondly, with modelling, the price expectation formulation behaviour of growers and investigating how this process changes during the growing season; and thirdly, with the nature and sources of information used by growers both to initially formulate and then to revise their price expectations during the season.

This paper is primarily concerned with the second of these three aspects. A ran·e of a priori models are postulated and estimated using data collected by a series of field and telephone surveys.

1. INTRODUCTION

Traditional supply response analysis based on aggregative time series data can not allow for modification of price expectations during the production period. Such models fail to capture short-run (within season) supply responses. In the case of annual horticultural crops (such as tomatoes) these within season supply decisions may be crucial to the survival of the firm. They may also significantly influence both the level of and the day-to-day stability of market prices. A better understanding of short-term changes in price expectations and hence supply response is, therefore, relevant to improving the efficiency of both production and marketing.

Data were collected by three field surveys and eight telephone surveys between May and December 1986. Half of the 40 growers studied lived in Redland Bay, an old traditional tomato growing area. The other 20 growers were from the Bundaberg district, a new and rapidly expanding tomato producing district. A subsidiary objective of the investigation was to compare price expectation behaviour in these two districts.

2. THE DEVELOPMENT OF THE PRICE EXPECTATION MODELS

During the 3 field surveys data were collected which demonstrated that growers in both districts used a combination of factors in formulating and revising their price expectations. The most commonly mentioned factors in the Bundaberg district were potential industry wide supply and demand together; potential industry supply alone; and average prices in recent years. Growers in Redland Shire commonly mentioned potential supply; average price in recent years and seasonal weather possibilities (also related to potential supply). The frequency with which broad economic factors were mentioned in both districts indicated that growers search for relevant information in relation to these factors and that they use this information to formulate their price expectations. The emphasis growers placed on known prices (e.g., average prices in recent years, trends in past prices, average price year-to-date, price last year, current prices) indicated that realistic models of price expectations for tomato growers in both districts should attempt to blend both the traditional style expectation model based on known prices and quantitative variables representing the other factors (or groups of factors) mentioned by growers.

The approach adopted in this investigation can be contrasted with the conventional approach to price expectations. In this case price expectations were studied <u>within</u> one production period rather than, as in most conventional supply response studies, <u>across</u> a number of production periods. Nine models were developed to examine relationships between the <u>average price</u> expected during the time when the crop was to be picked and observed independent variables. Three of these models were estimated 9 times and 2 models were estimated 8 times using cross-sectional data collected at different dates throughout the 1986 "spring" season. The remaining 4 models were estimated by pooling either 9 or 8 sets of cross-sectional data, with the number of sets of data used depending on the variables included in each model. Although traditional <u>a priori</u> models were used to test relationships, it was necessary to modify these models to accommodate the special circumstances of the tomato growing industry and to facilitate statistical analysis.

2.1 Simple Cobweb Response (Model 1):

The nature of the crop and the behaviour of tomato growers dictate that the dependent variable be the average expected price over a period. Tomatoes are highly perishable with a storable life from picking at "mature green" grade of only about 2 weeks (i.e., they have to be sold almost immediately when they reach market maturity). This, together with the vagaries of weather, result in either gluts or dramatic falls in short term supply which, in turn, causes large short term fluctuations in price. Tomatoes are harvested and sold over several weeks from any given planting. Thus a weighted average expected price over this extended harvesting period is required rather than an expected price at one unique point in time.

In addition, growers have tended to react to the changeable nature of tomato prices by spreading their plantings so as to have product ready for market throughout the season. It is now common for all growers in both the districts being studied to plant small areas 2 weeks apart throughout July, August, and September and then to pick almost continually from early October to just prior to Christmas. In effect, the "spring" crop is made up of many crops and thus the price realised by it must be the weighted average of the component crops.

Thus, in the models under consideration, time t will be the time at which the first observation was made (i.e., the time of the first survey) rather than the time or month of harvest, as is conventional. This change was necessary because of the length of time over which the "spring" crop is picked (i.e., 2 to 3 months) and the need to establish a reference point in the period being examined. The most convenient point of reference is at that point in time when the first observation is made. The dependent variable therefore, becomes $\bar{P}_h^*$, which represents the weighted average price expected for a specific grade of tomatoes at picking time. Therefore $\bar{P}_h^*$ replaces the more conventional P_t^* notation for the expected price. The subscript h refers to the anticipated 2 to 3 month period over which the crop is to be picked commencing approximately 3 months after time t.

For similar reasons the variable $\bar{P}_m$ (rather than P_{t-1}) will be used to refer to the weighted average price obtained for the crop picked during the previous "spring" season. The subscript m is used to denote the actual length of the picking period in that season.

If the functional relationship for equation (1) is assumed to be linear, the model can now be expressed in the following way:

(1) $$\bar{P}^{*}_{h,i,j} = a_i + b_i\bar{P}_{m,j}$$

where

$\bar{P}^{*}_{h,i,j}$ = expected weighted average price anticipated in the current season at time of survey i by grower j;

i = survey number;

j = grower number; and

$\bar{P}_{m,j}$ = actual weighted average price obtained during the previous "spring" season by grower j.

Given the assumption is made that all growers adopt the same approach to expectations formulation at the time of each survey, this equation investigates the relationship between the expected price at harvest and the average price received for tomatoes from the previous "spring" crop. This model was tested using 9 different sets of cross-sectional data collected from both study districts during the 1986 "spring" growing season. The objective was to investigate: the strength of the relationship at each point in time (i.e., survey date) in each district; and the change in the strength of the relationship as the harvest time draws closer in each district.

2.2 First-stage Rational Expectations (Model 2):

"Expected prices" were defined as encapsulating all market information available to a decision maker about a point of sale some time in the future. Also "known prices" were defined as a major subset of all market information contributing to "expected prices". One such "known price" is the actual average price received the previous season. Another "known price" is the spot price at any point in time throughout the decision-making/growing-period of the crop in question.

"Spot price" assumes particular importance because it represents a balance in knowledge (information) between the sellers and buyers at one point in the continuum of all prices between 2 sets of critical decisions (i.e., planting and selling). The question which then arose was whether or not spot prices are part of the global set of market information used to derive price expectations. It follows if, in fact, spot prices are used, it is meaningful to determine when they become relevant and whether that relevance increases over time as the period of sale draws near.

Using $P_{i,j}$ to represent the spot price as perceived by grower j at the time of the ith survey and assuming a linear relationship, equation (2) becomes:

$$(2) \quad \bar{P}^{*}_{h,i,j} = a_i + b_i\bar{P}_{m,j} + c_iP_{i,j}$$

This statistical model was fitted to 9 sets of survey data.

2.3 Second-stage Rational Expectations (Model 3):

To assess the affect of "non-price" information on the formul. ion of price expectations, the variable $Z_{s,i,j}$ was introduced. This information variable relates to any market (supply and/or demand) factors Z_s which make the current season uniquely different from the previous season and which are anticipated by farmers to affect marketing prospects.

Given the assumption that all tomato growers adopt essentially the same approach to expectations formulation, and provided they have the same information available to them, then the model of rational expectations becomes:

$$(3) \quad \bar{P}^{*}_{h,i,j} = a_i + b_i\bar{P}_{m,j} + c_iP_{i,j} + d_{i,s}Z_{s,i,j}$$

where

$Z_{s,i,j}$ = current additional non-price market information factors relevant tc market conditions at picking/sale time for the present crop at the time of survey i as perceived by grower j; and

s = 1, 2,...n is the number of discrete informational factors (other than prices) which influenced price expectations at the time of survey i of grower j.

Two common Z_s variables (i.e., information indicating effects on supply and information relating to potential demand) were maintained in each survey and thus it was possible to examine the changes in the significance of these variables over time (i.e., from planting to late in the picking period). This would not have been possible if the Zs variables had changed from one survey to the next.

2.4 Third-stage Rational Expectations (Model 4):

An expected price formulated in a past period for some time in the future should encapsulate all of the information available and recognised at the point in time when that expectation was formulated. As such, the most recent past expected price could be viewed as information in addition to last year's price, current spot prices and new non-price information. It would include an element of the average price received in the same season in the previous year but the size of this element would reduce as the current season progresses. Thus, with the exception of possibly some minor double counting of the effects of the past season's average price, the inclusion of the most recently formulated expected price before the current one in the model should exhaust all of the historical information available to and observed by the grower.

The rational expectations model therefore becomes:

$$(4) \quad \bar{P}^{*}_{h,i,j} = a_i + b_i\bar{P}_{m,j} + c_iP_{i,j} + d_{i,s}Z_{s,i,j} + e_i\bar{P}^{*}_{h,i-1,j}$$

where

$\bar{P}^{*}_{h,i-1,j}$ = expected weighted average price anticipated in the current season at the time of survey i-1 by grower j.

Since $\bar{P}^{*}_{h,i-1}$ is a lagged variable from the previous period, it was not possible to estimate this model for the first field survey. This model was, therefore, estimated only 8 times.

2.5 Adaptive Expectations (Model 5)

Nerlove (1956) presented his adaptive expectations hypothesis as:

> ...each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period.

and this was expressed mathematically as:

$$P_t^* - P_{t-1}^* = B(P_{t-1} - P_{t-1}^*)$$

where

$0<B\leq 1$

Later Nerlove (1958) restated his hypothesis in terms of the long run normal price concept:

> ...each period people revise their notion of 'normal' price in proportion to the difference between their current price and their previous idea of normal price.

Using the same logic for the very short term it could be stated that the expected price at any point in the season could be perceived as the "normal" price for that particular season and that growers may alter their notion of the "normal" price for that season in proportion to the difference between the current spot price and their previous expectations for the season. That is, spot price is perceived as encapsulating all of the relevant market information about the market at that point in time and growers may perceive that information (i.e., the spot price) as having an influence on future prices. Thus the hypothesis could be restated for the present study as:

$$(5.1) \quad (\bar{P}^*_{h,i,j} - \bar{P}^*_{h,i-1,j}) = b(P_{i,j} - \bar{P}^*_{h,i-1,j})$$

where, as with Nerlove's hypothesis, $0<b\leq 1$. That is, if b=1 then the grower would have no faith in his previous prediction and would adopt the current spot price as his new expected price.

The above equation can be restated as:

(5.2) $\bar{P}^{*}_{h,i,j} = a_i + c_i P_{i,j} + e_i \bar{P}^{*}_{h,i-1,j}$

where

$e_i = 1 - c_i$

The coefficients (i.e., c_i and e_i) were tested to determine whether they are consistent with adaptive expectations for each survey in each district. This was achieved by using the t-test of equality (homogenity) to test whether $c_i = 1 - e_i$ for each survey (Steel and Torrie, 1980).

2.6 Pooled Data Models (Models 6 to 9)

In Models 1 to 5 it was assumed that on average all growers use the same price expectation formulation process at each point in time. This assumption could have been tested by estimating each model for each grower using the 9 observations obtained from each grower over the season. The coefficients of these equations would then give an indication of the extent of difference between growers. However, owing to the small number of observations for each grower, this was not statistically feasible. It was considered that it may still be useful to estimate the average effect of such variables over the whole season. This was achieved by pooling cross-sectional and time-series data.

These pooled data were used to test all of the previously specified models except Model 1 (the cobweb model). The latter was not considered because, *a priori*, it was expected that the relationship between $\bar{P}^{*}_{h,i,j}$ and $\bar{P}_{m,j}$ would become less significant as the season progressed. Preliminary analysis confirmed that this was the case. It seemed illogical therefore, to test the explanatory power of this model relative to the whole season since this would only serve to hide important changes in the pattern of relationships. This would not necessarily be the case for the other models, since they are more exploratory and *a priori* anticipations were not as strong.

Assuming linear relationships, the pooled data versions of Models 2 to 5 are as follows:

(6) $\bar{P}^{*}_{h,i,j} = a + b\bar{P}_{m,} + cP_{i,j}$

(7) $\bar{P}^{*}_{h,i,j} = a + b\bar{P}_{m,j} + cP_{i,j} + d_{s}Z_{s,i,j}$

(8) $\bar{P}^{*}_{h,i,j} = a + b\bar{P}_{m,j} + cP_{i,j} + d_{s}Z_{s,i,j} + e\bar{P}^{*}_{h,i-1,j}$

and

(9) $\bar{P}^{*}_{h,i,j} = a + cP_{i,j} + e\bar{P}^{*}_{h,i-1,j}$

where all variables are as defined earlier.

3. EMPIRICAL TESTING AND INTERPRETATION OF MODELS

The analysis of each model proceeded by determining whether any single one of the coefficients and/or all of the coefficients combined were different from zero at the .1, 1, 5, 10 and 20 percent levels of significance. The adjusted coefficient of determination ($\bar{R}^2$) was used to indicate the proportion of variation in the dependent variables explained by the independent variables.

Each model was checked for multicollinearity by examining the correlations between independent variables and by calculating the tolerance of each variable. The Durbin-Watson test was used to test for autocorrelation in the pooled cross-sectional/time-series models.

Once the statistical acceptability of each model was established for all surveys in each district, the acceptability of the models in terms of their economic logic was examined. This was achieved by determining whether the coefficients conform in relation to *a priori* expectations of sign and magnitude.

3.1 Cross-Sectional Models

The results for Models 1 to 5 using all available data are presented in Tables 1 to 5.

These results clearly demonstrate that the explanatory ability of Models 4 and 5 (i.e., Third Stage Rational Expectations Model and Adaptive Expectations Model) is substantially greater than that of Models 1 to 3 (i.e., Simple Cobweb Response Model and the First and Second Stage Rational Expectations Models). However, while the relationship between the expected average price for the season and the average price received in the same season in the previous year in Model 1 was not strong for most surveys, there seemed to be a more consistent pattern of relationships in the early part of the season in Redland Shire than in the Bundaberg district.

Owing to the relative weakness of relationships in Models 1 to 3, only Models 4 to 5 will be discussed in detail. Since no previous expectation was available at the time of the first field survey, these models were estimated for the 8 telephone surveys only.

3.1.1 MODEL 4

(a) Bundaberg District

As can be seen by comparing the results in Table 4 with Tables 1-3, the combined effect of the independent variables in Model 4 as measured by the F-statistic is better than any of the first 3 models for the Bundaberg district. The model is significant at the 5 per cent level (or better) for all surveys, with models for the first, second, fifth and final two surveys achieving significance at the 0.1 per cent level. Consistent with these relationships, $\bar{R}^2$ is above .5 for all but the third survey where the $\bar{R}^2$ was .403.

With regard to the individual coefficients, e_i is significant at the 5 per cent level (or better) for all surveys. Overall, the inclusion of $\bar{P}^{*}_{h,i-1}$ increased the significance of the coefficients of the information variables and spot price. However, in the main, it reduced the statistical significance of b_i. One possible reason for these effects could be that growers, on average formulate, their current price expectations by firstly considering the expectation they held just prior to the present time and adjust this with "new" information and the present spot price. The significance of b_i would have decreased because a certain information component within $\bar{P}_m$ would have already been expressed in $\bar{P}^{*}_{h,i-1}$ or in the information variables. With regard to the high significance of $d_{2,i}$ in the first survey, an examination of the demand related information provided during the survey revealed that 3 respondents believed that, owing to a worsening economic situation, housewives would have less money to spend on, amongst other things, tomatoes. They felt that this would result in buyer resistance at a certain price level and, irrespective of the supply situation, prices would not go past that point. That is, owing to decreased demand resulting from buyer resistance, the derived expected price was $2.03 per box less than the price indicated by other factors.

The fourth, fifth and eighth surveys are of particular interest in that they occurred during the time when the average expected price increased the most. At the time of the first 2 of these surveys, spot prices appeared to experience a marked increase and growers were receiving messages about factors that could potentially reduce supply (e.g., harvesting in the Bowen district finishing early because of weather and disease problems, plantings were delayed in southern States because of cold weather, hail damage in the Bundaberg district etc.). Thus, while the significance of e_i was maintained at .1 per cent, c_i and $d_{s,i}$ were positive and greater than 1 and the coefficient of the previous expectations less than 1. By the time of the eighth survey, the results indicate that growers felt that the sustained high spot prices had vindicated their earlier expectations. This was supported by messages of supply shortages in the market.

(b) Redland Shire

As with the Bundaberg district, the significance of the F-statistic greatly improved for the Redland Shire with the inclusion of $\bar{P}^{*}_{h,i-1}$ in Model 4. All but the eighth survey were significantly different from 0 at the 5 per cent level or less with the second to the sixth surveys being significant at .1 per cent. The explanatory power of the model as measured by $\bar{R}^2$ was again high with only the first and eighth telephone surveys having results below .622 (i.e., .360 and .266 respectively).

The coefficient e_i was significant within acceptable levels for all surveys. The significance of the information coefficients improved, as in the Bundaberg district, but to a greater extent. This indicated that Redland Shire growers place more importance than the Bundaberg district growers on information, particularly in relation to supply factors, to update previous price expectations.

The effects of the inclusion of $\bar{P}^{*}_{h,i-1}$ on the "known" price coefficients varied slightly. In the main, the significance of b_i decreased while two coefficients became significant at the 5 and 20 per cent levels.

The reasons for the above observed changes are broadly similar to those given for the Bundaberg district.

The results for the fifth, seventh and eighth surveys are of particular interest due to the large increase in average price expectations at those times. The relatively large and positive value of $d_{1,i}$ in the fifth survey (i.e., 2.112) was probably caused by reports of hail and other weather damage to crops in the Bundaberg district and the early cessation of picking in Bowen affected price expectations at that time. While previously held price expectations influenced the formulation process, the magnitude of e_i (i.e., .697) indicates that only part of these past expectations was relevant (i.e., some of the information content of the previous price expectation was superseded by the current supply situation). In the seventh survey the magnitude and sign of the coefficients of significant variables (i.e., $d_{1,i}$ and e_i) clearly demonstrates the importance growers placed on both the new knowledge that a supply shortage was likely and previously held expectations. That is, it is estimated that the Redland district growers adjusted their previous average expected price upwards by approximately $2.00 a box because of the new supply side information they had received.

The result for the eighth survey is puzzling in that the large and marginally acceptable a_i, together with the significant e_i (i.e., at the 1 per cent level), would normally indicate that the average price expectations are largely explained by $\bar{P}^{*}_{h,i-1}$ and the other variables not covered by the model. However, 15 out of the 19 growers responding to this survey in this district recorded a shortage of supply message and all but one increased their price expectations. Also, spot prices were unusually high at that time. Thus, it would be logical to anticipate that both c_i and $d_{1,i}$ would be highly significantly positive and large in magnitude. A possible explanation of this apparent anomaly could be that the recorded values of $\bar{P}^{*}_{h,i}$ were regressed against 15 values of 1 for the supply information variable and 12 values of $26.00 for the spot price variable. Thus while most growers agreed that the shortage of supply and spot prices would increase average expectations, these relationships would have been obscured because of the common values given to both variables (i.e., graphically, most observations would fall on a line parallel to the Y-axis from a common point on the X-axis). This interpretation is supported by the poor overall fit of the equation for the eighth survey.

The fourth telephone survey is also of interest because of the highly significant but negative and relatively large values for $d_{1,i}$. This was mainly due to the expectation of normal/large supplies of tomatoes from the Bundaberg district and the good weather conditions prevailing at the time in both the Bundaberg district and Redland Shire (i.e., both these factors reduced averaged price expectations).

(c) The Two Districts Compared (Model 4)

The addition of $\bar{P}^{*}_{h,i-1}$ in Model 4 greatly improved the explanatory power, as measured by $\bar{R}^2$, in all surveys in both study districts. The F-statistic became significantly different from 0 at acceptable levels for all but the eighth Redland Shire survey, which as discussed above had data problems. The significance levels of the "additional" information variables were either maintained or improved compared with Model 3. "Additional" information affected average price expectations more in Redland Shire than in the Bundaberg district. For example, $d_{1,i}$ is significant at acceptable levels in 6 out of the 8 surveys in Redland Shire compared with 4 in the Bundaberg district. Also, this coefficient is larger in magnitude in the former district in 6 of the surveys. The coefficient e_i is highly significant in all surveys in both districts. However, it is larger in magnitude in 5 surveys in the Bundaberg district, thus indicating a greater hesitancy in that district to change expectations from one point in time to the next.

3.1.2 MODEL 5

(a) Bundaberg District

The results for Model 5 (adaptive expectations) for this district and for Redland Shire are presented in Table 5. In addition to the size and levels of significance of the coefficients, the F-statistic and $\bar{R}^2$, this table also provides the values of the t-statistics used to test whether, on the basis of the data available, the coefficient c_i is or is not significantly different from $1-e_i$ for each survey.

The combined effect of the regression coefficients in this model as measured by the F-statistic is highly significant in all surveys in the Bundaberg district. The second, fourth and final three surveys are significant at the .1 per cent level and the remaining surveys at the 1 per cent level. The explanatory power of the surveys with the most significant relationships, as measured by $\bar{R}^2$, ranged from .576 to .721.

With regard to the individual coefficients, e_i is highly significant in all surveys while c_i is significant at acceptable levels for 5 surveys. In the surveys where the major changes in average expectations occur (i.e., the fourth, fifth and eighth) e_i is significant at the .1 per cent level while c_i is significant at the 5 per cent and 10 per cent levels for the fourth and eighth surveys respectively. Given the strength of $\bar{R}^2$ for the latter 2 surveys (i.e., .662 and .721 respectively), this model can be considered as relevant to the formulation of price expectations at this time. However, the magnitude of c_i is relatively small for both surveys. This indicates that, while it is highly probable that spot price had an effect on expectations at this time, that effect was only minor. The significant, relatively large positive constant in survey 8 (i.e., at the 5 per cent level) is largely due to the effect of information about supply factors at that time.

(b) Redland Shire

Model 5 yields acceptable results for all the Redland Shire surveys. Its explanatory power, as measured by $\bar{R}^2$, ranged from .290 in the fifth telephone survey to .665 in the sixth survey, with the latter having the only F-statistic with a significance level at .1 per cent.

With regard to the seventh and eighth surveys (i.e., when the largest changes in average expectations were observed) c_i is significant at the 20 per cent level for the former and not significant at an acceptable level for the latter, possibly because of the data problems detailed in the section on Model 4. At the time of both surveys spot prices were unexpectedly high and most growers were receiving shortage of supply messages from various sources, particularly in the eighth telephone survey. Thus, in the seventh survey, the significance of the individual variables indicates growers formulated their expectation by considering both $\bar{P}^*_{h,i-1}$ and P_i. The magnitude of c_i was relatively small (i.e., not approaching 1) because picking had commenced 2 to 3 weeks beforehand and the prices received then would reduce the overall average for the season below the current spot price. In the eighth survey, the constant is large and significant because of the effect of variables not covered in this model.

(c) The Two Districts Compared (Model 5)

Generally the F-statistic for each of the surveys is significant at lower levels in Redland Shire than in the Bundaberg district. The explanatory power of the model, as measured by $\bar{R}^2$, is also much less, with Redland Shire having only 1 survey with $\bar{R}^2$ above .6 compared with 4 in the Bundaberg district. The significance of the e_i coefficients are not as tight in Redland Shire as in the Bundaberg district but they are still all significant at levels between the .1 per cent and 10 per cent levels. The magnitude of this coefficient is larger in the Bundaberg district in 6 out of the 8 surveys. Five out of the 8 c_i coefficients in the Bundaberg district are significant at acceptable levels compared with 4 in Redland Shire. With the exception of the fifth Redland Shire survey the magnitude of this coefficient is less than .5 for all those with acceptable levels of significance, thus indicating that, in general, the probable effect of spot prices on average expectations is not great in both districts.

In summary, it would appear that, while Model 5 is relevant to both districts, it is more effective as a model of price expectations in the Bundaberg district than in Redland Shire.

(d) Model 5 and the Adaptive Expectations Hypothesis

As explained earlier, the t-test for equality was applied to determine whether, on the basis of the data available, c_i is or is not significantly different from $1-e_i$ for each survey. If these two values are not significantly different from each other, the data are consistent with the adaptive expectations hypothesis. That is, the data suggests there is no reason to reject the hypothesis that tomato growers revise their average expected price for the season in proportion to the difference between the current spot price and their previous expectation for the season.

This test revealed that the model is, indeed, consistent with adaptive expectations for all 8 telephone surveys for the Bundaberg district at the 5 and 10 per cent significance levels and for all but the third and eighth telephone surveys for Redland Shire. Thus, it could be said that, with only minor exceptions, tomato growers in both districts used the market signals as relayed through the spot price to adjust their average expectations from one period to the next during the season. In the 2 surveys, where the results are not consistent with adaptive expectations, the constants are significantly different from zero at the 5 per cent level and they are relatively large and positive. This indicates that important explanatory variables are excluded from the model in these cases (e.g., information about supply factors). Also, as already mentioned several times, with regard to the eighth survey, the repetition of the same value of P_i would have adversely affected the ability of the regression analysis to estimate the relationship between that variable and $\bar{P}^{e}_{h,i}$. The t-statistics of equality for all surveys are presented in Table 5.

3.2 Pooled Cross-sectional/Time-series Models

The results for the pooled cross-sectional models are given in Table 6. The First and Second Stage Rational Expectations Models (i.e., Models 6 and 7) appeared to produce promising results but the Durbin-Watson test suggested the presence of serial correlation in both models in both districts.

The Third Stage Rational Expectations Model and the Adaptive Expectations Model (i.e., Models 8 and 9) became even more powerful when the data was pooled. In the former the coefficients for spot prices, information about factors relating to supply and the expected price formulated in the most recent period before the current period, were all significant at the .1 per cent level for both districts. The coefficient for information about factors relating to demand was significant at 1 per cent for the Bundaberg district. These results clearly indicate that growers, on average, use these variables throughout the season to formulate average price expectations for the season. The coefficients of all the variables in the Adaptive Expectations Model (i e., Model 9) were significant at the .1 per cent level, also indicating a close fit for this model throughout the season. This model was also shown to be consistent with the adaptive expectations hypothesis.

4. CONCLUSIONS

Tomato growers, like most horticultural producers, can and do alter both the level and the timing of their production during a growing season. These within season supply responses can not be captured by the traditional aggregative annual time-series approach.

The principal aim of this paper was to develop and evaluate a series of models designed to quantify the price expectation formulation behaviour of tomato growers and to investigate how these price expectations changed within one growing season.

Overall, the results are consistent with economic rationality and suggest that growers attribute considerable importance to being able to formulate realistic price expectations. As one would expect, the evidence is that growers' expectations are very much influenced by their previously held expectations. In this regard, contrary to what one may think, the growers in the new and expanding tomato growing area (Bundaberg) appear more reluctant to change their expectations over time than the growers in the more traditional district (Redland Bay). The adaptive expectation hypothesis is supported by the analysis which means that when tomato growers do alter their price expectations, they do so largely in response to changes in the spot price. This finding emphasises the importance growers place on the need for an accurate (and trusted) market reporting service.

TABLE 1

Cross-Sectional Regression Estimates Using Simple Cobweb Response (Model 1): Bundaberg District and Redland Shire

$$P^*_{h,i,j} = a_i + b_i P_{m,j}$$

	Coefficients(1)		Statistics	
	a_i	b_i	$F^{(2)}$	$\bar{R}^2$
		Bundaberg district		
First field	3.801 (2.319)	.665* (.301)	4.872* (1,17)	.1177
First telephone	4.892++ (2.448)	.479+ (.318)	2.270+ (1,17)	.066
Second telephone	.240 (2.140)	1.077** (.240)	14.999** (1,17)	.437
Third telephone	3.220 (4.894)	.798 (.650)	1.505 (1,15)	.030
Fourth telephone	2.239 (3.208)	1.038* (.417)	6.181* (1,16)	.234
Fifth telephone	7.098+ (4.692)	.847+ (.611)	1.924+ (1,16)	.050
Sixth telephone	4.635 (3.609)	1.115* (.470)	5.640* (1,16)	.214
Seventh telephone	8.369* (3.060)	.673+ (.399)	2.851+ (1,16)	.098
Eighth telephone	11.483** (3.390)	.461 (.441)	1.093 (1,16)	.005
		Redland Shire		
First field	5.355*** (.778)	.289* (.117)	6.149* (1,19)	.205
First telephone	5.486*** (.817)	.242++ (.125)	3.767++ (1,18)	.127
Second telephone	5.702*** (.942)	.256++ (.144)	3.147++ (1,18)	.102
Third telephone	5.691*** (.629)	.322** (.096)	11.250** (1,16)	.376
Fourth telephone	6.504*** (.851)	.176+ (.129)	1.864+ (1,17)	.046
Fifth telephone	7.346*** (1.467)	.229 (.222)	1.066 (1,17)	.004
Sixth telephone	8.376*** (1.628)	.134 (.246)	.297 (1,17)	-.041
Seventh telephone	11.309*** (2.255)	-.044 (.341)	.017 (1,17)	-.058
Eighth telephone	14.272*** (1.725)	.097 (.261)	.138 (1,17)	-.050

(1) The figures in parentheses are standard errors.

(2) The figures in parentheses are degrees of freedom.

Symbols:

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TABLE 2

Cross-Sectional Regression Estimates Using First Stage Rational Expectations (Model 2): Bundaberg District and Redland Shire

$$\hat{P}^{*}_{h,i,j} = a_i + b_i P_{m,j} + C_i P_{ij}$$

Survey	Coefficients			Statistics	
	a_i	b_i	c_i	$F^{(2)}$	$\bar{R}^2$
			Bundaberg district		
First field	5.971+ (3.156)	.721* (.320)	-.135 (.222)	2.531+ (2,16)	.145
First telephone	2.872 (3.212)	.496+ (.319)	.313 (.321)	1.606 (2,16)	.063
Second telephone	-.604 (2.445)	.940* (.321)	.180 (.205)	7.460** (2,15)	.432
Third telephone	2.294 (5.238)	.565 (.770)	.231 (.387)	.898 (2,14)	-.013
Fourth telephone	1.552 (3.022)	.481 (.523)	.387++ (.204)	5.884* (2,14)	.379
Fifth telephone	4.624 (6.472)	.726 (.659)	.179 (.315)	1.083 (2,15)	.010
Sixth telephone	-.849 (4.053)	.838++ (.438)	.516* (.231)	6.029* (2,15)	.372
Seventh telephone	6.570++ (3.435)	.447 (.444)	.248 (.221)	2.078+ (2,15)	.113
Eighth telephone	9.014++ (4.524)	.287 (.505)	.138 (.162)	.876 (2,14)	-.016
			Redland Shire		
First field	4.346*** (.964)	.321** (.108)	.090 (.110)	5.842* (2,17)	.338
First telephone	3.380+ (2.028)	.200+ (.129)	.463 (.409)	2.555 (2,17)	.141
Second telephone	1.700 (2.226)	.330* (.139)	.385++ (.197)	3.732* (2,17)	.223
Third telephone	4.754** (1.287)	.241* (.110)	.130 (.121)	4.147* (2,13)	.296
Fourth telephone	4.486* (1.970)	.045 (.123)	.266+ (.153)	1.551 (2,14)	.064
Fifth telephone	1.768 (3.036)	.213 (.204)	.337++ (.165)	2.734++ (2,16)	.162
Sixth telephone	6.163 (4.825)	.131 (.252)	.144 (.294)	.261 (2,16)	-.089
Seventh telephone	6.728+ (3.930)	-.149 (.340)	.416+ (.296)	.995 (2,16)	-.001
Eighth telephone	11.029++ (5.361)	.061 (.272)	.132 (.206)	.272 (2,16)	-.088

(1) The figures in parentheses are standard errors.

(2) The figures in parenthesis are degrees of freedom.

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TABLE 3

Cross-Sectional Regression Estimates Using Second Stage Rational Expectations (Model 3): Bundaberg District and Redland Shire

$$P^*_{h,i,j} = a_i + b_i\bar{P}_{m,j} + c_iP_{i,j} + d_{1,i}Z_{1,i,j} + d_{2,i}Z_{2,i,j}$$

Survey	Coefficients(1)					Statistics	
	a_i	b_i	c_i	$d_{1,i}$	$d_{2,i}$	$F^{(2)}$	$\bar{R}^2$
Bundaberg district							
First field	4.895	.756++	-.355	.014	.225	1.143	.031
	(4.047)	(.358)	(.249)	(1.433)	(.682)	(4,14)	
First telephone	3.733	.710*	-.097	.952	-2.030++	1.999+	.182
	(3.032)	(.321)	(.370)	(.775)	(.978)	(4,14)	
Second telephone	-.508	.858*	.209	.636		5.406*	.437
	(2.435)	(.328)	(.206)	(.593)		(3,14)	
Third telephone	1.842	.643	.188	.902		.814	-.036
	(5.326)	(.785)	(.394)	(1.088)		(3,13)	
Fourth telephone	2.132	.387	.360++	1.005		4.671*	.408
	(2.985)	(.515)	(.200)	(.776)		(3,13)	
Fifth telephone	3.927	.820	.139	1.105		.948	-.009
	(6.585)	(.674)	(.321)	(1.304)		(3,14)	
Sixth telephone	.869	.874+	.442+	-1.018	-1.243	3.887*	.405
	(4.107)	(.470)	(.234)	(.876)	(.983)	(4,13)	
Seventh telephone	6.550+	.389	.292	-.330		1.353	.059
	(3.538)	(.482)	(.256)	(.883)		(3,14)	
Eighth telephone	5.503	.253	.247+	1.493+		1.456	.079
	(4.860)	(.481)	(.170)	(.956)		(3,13)	
Redland Shire							
First field	3.747**	.314*	.107	.506	.522	3.772*	.368
	(1.008)	(.111)	(.109)	(.493)	(.497)	(4,15)	
First telephone	3.298+	.203+	.471	.143		1.631	.091
	(2.111)	(.134)	(.422)	(.566)		(3,16)	
Second telephone	-.251	.458**	.476*	.980++		4.446*	.352
	(2.236)	(.141)	(.185)	(.468)		(3,16)	
Third telephone	5.070**	.255*	.088	.245		2.707++	.255
	(1.450)	(.117)	(.148)	(.459)		(3,12)	
Fourth telephone	5.377*	.102	.162	-.784		1.478	.082
	(2.105)	(.132)	(.177)	(.695)		(3,13)	
Fifth telephone	4.142+	.325++	.103	2.02**		7.536**	.521
	(2.386)	(.157)	(.140)	(.562)		(3,15)	
Sixth telephone	2.494	.228	.295	1.664*		1.795+	.117
	(4.659)	(.231)	(.274)	(.764)		(3,15)	
Seventh telephone	6.224+	-.024	.308	1.508	.726	.934	-.015
	(3.988)	(.357)	(.315)	(1.239)	(2.414)	(4,14)	
Eighth telephone	11.602++	.066	.120	-.350		.206	-.152
	(5.792)	(.280)	(.216)	(1.076)		(3,15)	

(1) The figures in parentheses are standard errors.

(2) The figures in parentheses are degrees of freedom.

Symbols:

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TABLE 4

Cross-Sectional Regression Estimates Using Third Stage Rational Expectations (Model 4): Bundaberg District and Redland Shire

$$P^*_{h,i,j} = a_i + b_i P_{m,j} + c_i P_{i,j} + d_{1,i} Z_{1,i,j} + d_{2,i} Z_{2,i,j} + e_i P^*_{h,i-1,j}$$

	Coefficients(1)						Statistics	
	a_i	b_i	c_i	$d_{1,i}$	$d_{2,i}$	e_i	$F^{(2)}$	$\bar{R}^2$
				Bundaberg district				
First telephone	1.850 (1.888)	.208 (.221)	-.259 (.228)	.736+ (.475)	-2.742*** (.614)	.775*** (.156)	9.226*** (5,13)	.696
Second telephone	-4.401* (1.898)	.528* (.236)	.231+ (.140)	-.089 (.439)		.723** (.183)	13.153*** (4,13)	.741
Third telephone	2.416 (4.046)	-.311 (.664)	-.142 (.316)	.942 (.826)		1.257** (.387)	3.703* (4,12)	.403
Fourth telephone	1.245 (2.450)	-.109 (.368)	.552* (.120)	1.023++ (.497)		.318*** (.135)	9.865** (4,11)	.703
Fifth telephone	-3.440 (3.905)	-.035 (.406)	.267+ (.181)	1.899* (.742)		:890*** (.158)	10.235*** (4,13)	.684
Sixth telephone	.183 (3.398)	.580+ (.403)	.254 .206	-.693 (.732)	-1.280+ (.811)	.406* (.152)	5.988** (5,12)	.595
Seventh telephone	3.243+ (1.996)	-.313 (.287)	.231+ (.139)	.205 (.487)		.704*** (.119)	12.154*** (4,13)	.724
Eighth telephone	3.523 (2.679)	-.074 (.269)	-.080 (.109)	.831+ (.536)		1.026*** .183	11.544*** (4,12)	.725
				Redland Shire				
First telephone	.617 (2.016)	.057 (.124)	.378 (.356)	.400 (.434)		.563* (.202)	3.672* (4,15)	.360
Second telephone	-2.316 (1.805)	.265* (.121)	.347* (.146)	.866* (.359)		.642** (.182)	8.827*** (4,15)	.622
Third telephone	3.528** (.837)	.146* (.066)	-.134+ (.090)	.843** (.273)		.628*** (.115)	14.307*** (4,11)	.780
Fourth telephone	1.850+ (1.192)	-.134+ (.075)	-.125 (.116)	-1.658** (.419)		1.072*** (.177)	14.167*** (4,11)	.778
Fifth telephone	.104 (2.378)	.209+ (.134)	.069 (.115)	2.112*** (.458)		.697* (.237)	10.699*** (4,14)	.683
Sixth telephone	-5.488++ (2.962)	-.014 (.137)	.440* (.156)	.970* (.446)		.860*** (.149)	12.609*** (4,14)	.721
Seventh telephone	-1.316 (2.774)	-.093 (.212)	.156 (.189)	2.085* (.742)	-.415 (1.447)	1.036*** (.200)	7.512** (5,13)	.644
Eighth telephone	7.477+ (4.810)	.120 (.224)	-.008 (.177)	.924 (.952)		.555** (.180)	2.633 (4,14)	.266

(1) The figures in parentheses are standard errors

(2) The figures in parentheses are degrees of freedom

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TABLE 5

Cross-Sectional Regression Estimates Using Adaptive Expectations (Model 5): Bundaberg District and Redland Shire

$$P^e_{h,i,j} = a_i + c_i P_{i,j} + e_i P_{h,i-1,j}$$

Survey	Coefficients(1)			Statistics		
	a_i	c_i	e_i	$F^{(2)}$	$\bar{R}^2$	t-statistic ($c_i = 1 - e_i$)
			Bundaberg District			
First telephone	1.848 (2.165)	1.837 (2.345)	.628** (.181)	6.341** (2,17)	.360	-.6368
Second telephone	-3.027+ (1.849)	.374* (.130)	.894*** (.163)	21.314*** (2,16)	.693	1.2802
Third telephone	.871 (2.961)	-.082 (.276)	1.118** (.333)	7.015** (2,15)	.414	.0834
Fourth telephone	.953 (1.711)	.320* (.125)	.543*** (.121)	16.699*** (2,14)	.662	-.7850
Fifth telephone	.071 (4.548)	.213 (.209)	.785*** (.181)	9.920** (2,16)	.498	-.0091
Sixth telephone	.005 (2.852)	.437++ (.213)	.532** (.154)	13.249*** (2,16)	.576	-.2273
Seventh telephone	2.143 (1.859)	.274** (.094)	.565*** (.090)	22.756*** (2,16)	.707	-1.2394
Eighth telephone	4.471* (2.096)	-.119++ (.062)	1.024*** (.152)	22.968*** (2,15)	.721	.5804
			Redland Shire			
First telephone	.891 (1.889)	.396 (.335)	.571** (.173)	7.373** (2,17)	.401	-.0871
Second telephone	-.027 (1.826)	.197 (.153)	.789*** (.185)	10.540** (2,17)	.501	-.0571
Third telephone	2.988* (1.122)	.066 (.095)	.560** (.135)	11.591** (2,13)	.585	-2.2617
Fourth telephone	.894 (1.845)	.239++ (.129)	.525* (.203)	7.011** (2,13)	.445	-.7764
Fifth telephone	-1.761 (3.474)	.687++ (.336)	.317++ (.152)	4.668* (2,16)	.290	.0103
Sixth telephone	-4.541+ (3.169)	.364* (.167)	.921*** (.152)	18.857*** (2,16)	.665	1.2660
Seventh telephone	-1.137 (3.171)	.280+ (.206)	.933*** (.231)	9.941** (2,16)	.498	.6899
Eighth telephone	9.571* (4.302)	.005 (.168)	.471** (.157)	4.877* (2,16)	.301	-2.2764

(1) The figures in parentheses are standard errors.

(2) The figures in parentheses are degrees of freedom.

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TABLE 6

Pooled Cross-Sectional/Time Series Regression Estimates (Models 6 to 9): Bundaberg District and Redland Shire

District	Coefficients[1]						Statistics		
	a	b	c	d_1	d_2	e	$F^{(2)}$	$\bar{R}^2$	Durbin-Watson[3]
	$P^*_{h,i,j} = a + b\bar{P}_m + cP_{i,j}$						Model 6		
Bundaberg	2.414++ (1.418)	.500** (.183)	.347*** (.029)				80.591*** (2,155)	.503	1.113
Redland Shire	3.582*** (.609)	.129+ (.083)	.358*** (.021)				142.885*** (2,166)	.628	1.169
	$P^*_{h,i,j} = a + b\bar{P}_m + cP_{i,j} + d_1Z_{1,i,j} + d_2Z_{2,i,j}$						Model 7		
Bundaberg	2.695++ (1.403)	.478** (.179)	.330*** (.029)	.576++ (.344)	-1.450** (.530)		44.235*** (4,153)	.524	1.126
Redland Shire	3.152*** (.593)	.157* (.080)	.340*** (.021)	1.046*** (.265)	.572 (.847)		82.745*** (4,164)	.661	1.321
	$P^*_{h,i,j} = a + b\bar{P}_m + cP_{i,j} + d_1Z_{1,i,j} + d_2Z_{2,i,j} + eP^*_{h,i-1,j}$						Model 8		
Bundaberg	.930 (1.067)	.094 (.141)	.173*** (.024)	.857*** (.253)	-1.747** (.507)	.656*** (.054)	95.079*** (5,132)	.774	2.267
Redland Shire	-.594 (.537)	.014 (.061)	.173*** (.020)	1.297*** (.209)	.771 (1.161)	.837*** (.065)	157.594*** (5,142)	.842	1.968
	$P^*_{h,i,j} = a + cP_{i,j} + eP^*_{h,i-1,j}$						Model 9		
Bundaberg	1.731** (.517)		.207*** (.025)			.635*** (.053)	206.359*** (2,143)	.[illegible]39	2.166
Redland Shire	-.512 (.484)		.209*** (.021)			.841*** (.071)	296.292*** (2,145)	.801	1.918

(1) The figures in parentheses are standard errors.

(2) The figures in parentheses are degrees of freedom

(3) N (i.e., sample size) for this statistic is the sum of the degrees of freedom for F plus 1

Symbols:

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** = significant at 1 per cent level using t-test or F-test; and

*** = significant at .01 per cent level using t-test or F-test.

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