Flower Power at the Dutch Flower Auctions?

Application of an inverse almost ideal demand system

Assistant Professor Marie Steen
Department of Economics and Resource Management
Norwegian University of Life Sciences
P.o.box 5003, N-1432 Aas, NORWAY
E-mail: marie.steen@umb.no
Phone +47 64965666

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Introduction

The European market for cut flowers has shown a substantial growth over the last decade, and it seems likely to continue, making flower production an important growth sector in agriculture. In the period 1995-2003 the value of imports of cut flowers to western European countries increased by approx. 40 per cent on average, and several countries have more than doubled their imports during this period (Heinrich et al, 2004). There has been a substantial growth in imports from developing countries. In addition, European producers have been switching from more traditional agricultural products to higher value ornamental crops, due to decreasing profitability in agricultural production. In 1995, turnover as measured at the wholesale level at the Dutch Flower Auctions was approximately 1.2 billion Euro. By 2003 the figure had reached some Euro 4.3 billion (Heinrich et al, 2004). The Dutch flower auctions represent *the* major market place in European, as well as in the global flower trade. A substantial volume of trade passes through these auctions. More importantly, the auction prices to a large extent determine prices outside the auction premises. Hence, supply, demand, quantities and prices at the auctions are relevant to all European flower producers, importers and traders.

Despite its increasing importance, the markets for flowers have received little attention in the literature. Abdelmagid et. al. (1996) have studied the demand for nursery plants while Rhodus, 1989 has studied the demand for fresh flower bouquets in the US. Beyond these studies very little systematic analysis of the flower markets has been published. Given the size of the business, producers and traders should welcome such analyses.

It is also worthwhile to note that the prices of cut flowers are *extremely* volatile. The observed price volatility is, of course, mainly due to the fact that cut flowers are indeed highly perishable goods. The salvage value of yesterday's cut flowers is close to zero. Based on information regarding the price and quantity data generating processes and the underlying demand/supply schedules, producers' risk management and strategic marketing behavior may generate less volatile prices (and higher producer utility). Although there are many small price-taking producers in the flower industry, quantity variations over time may be such that on a particular day, even a relatively small producer may be big enough to influence prices. This is because of the batch character of production and the problems connected to storing cut flowers. Assume, for instance, that there are three or four large producers of a given species of flowers and a large number of small ones. *If* the large producers happen to arrive at the market place with a bulk of their production simultaneously, small producers may during subsequent weeks be *de facto* large ones. Thus, market structure in the cut flower business is not a static function of aggregated market shares. Rather, it may vary considerably over time. Strategic market behavior should therefore involve systematic surveillance of variations in traded volumes.

In this paper, I analyze price-quantity relationships for cut flowers traded at the Dutch flower auctions using an inverse almost ideal demand system. The data are weekly observations from 1993 to 2005 for three categories of cut flowers at the Dutch flower auctions.. An inverse demand system is a natural model for the price formation of quickly perishable goods like flowers, where supply in fixed in the short run and prices clear the market.

The flower market contains strong seasonal cycles. This creates an additional challenge when using high frequency data such as weekly data, in that one would like a procedure that is parsimonious when representing the seasonality. I will introduce a trigonometric representation in the demand system following the general notion of Ghysels and Osborn (2001). The trigonometric representation allows the seasonality to be represented with only two additional parameters in each demand equation. This will be compared to a standard dummy representation.

The paper proceeds as follows. First, the price and quantity data and some stylized facts from the Dutch flower auctions are presented. Then, the seasonally adjusted inverse almost ideal demand system is described and estimated. The results and are summarized in the fourth section before some concluding remarks are offered.

Data description and some stylized facts from the Dutch flower auctions

Weekly price and quantity data for week 1, 1993 trough week 21, 2005 were obtained from weekly editions of the Dutch "Vakblad voor de Blomisterij". Approximately 70 of the most important cut flower species, representing close to 100 per cent of the total value of cut flowers traded at the Dutch flower auctions, are included. The cut flowers were aggregated into four groups; the three major species, chrysanthemums, carnations and roses; and other cut flowers. Preliminary empirical results indicated that little could be gained by further disaggregation.

Table 1 summarizes the stylized facts regarding price and quantity variations of the three major cut flowers plus the prices of all other species traded lumped together (volume weighted). As can be seen, both prices and quantities vary substantially. The coefficients of variation, as regard to weekly prices, range from approx. 21 per cent (roses) to 34 per cent (carnations).

Table 1

As can be seen the coefficients of variation in quantities are between 9-18 per cent per week. Thus, on an annual basis (weekly standard deviations multiplied by the square root of 52), we have standard deviations of price and quantity changes from approximately 60 to 140 per cent! This makes cut flowers probably *the* most volatile agricultural commodity. Cereals, potatoes etc. rarely show annual standard deviation of price changes beyond 20-30 per cent. This is further demonstrated by the high-low quantity figures. For instance Pietola and Wang (2000) argue that the price of piglets are very volatile, reporting a CV of 11 % on an annual basis.

The data show clear seasonal patterns (regular calendar patterns) as shown in figure 1 below, but the patterns of the major cut flowers are different. For instance the budget share of carnations is at it's lowest in December-January, and has a well defined peak in the middle of the summer. Roses also have a low budget share in the winter rising to a high in the second and the third quarter. Chrysanthemums, on the other hand, show almost the opposite pattern as the carnations.

Figure 1

An inverse almost ideal demand system for cut flowers

Price-quantity relationships have been analyzed in an almost ideal demand (AID) system framework as developed by Deaton and Muellbauer (1980) in numerous studies. Although the almost ideal model has worked well in several applications, there are commodities for which the assumption of predetermined prices at the market level may be untenable.

Typically, the consumer is a price taker, and a regular demand system is then called for. For highly perishable goods, however, like fresh vegetables, fresh fish, or in this case, fresh flowers, supply is very inelastic in the short run and the producers are price takers. At the Dutch flower auctions, the wholesale traders offer prices for the fixed quantities of the different flower species which are sufficiently low to induce consumers to buy the available quantities, i.e. the prices are set as a function of the quantities.

Inverse demand functions, where prices are functions of quantities, provide an alternative and fully dual approach to the standard analysis of consumer demand. Inverse demand models have been applied to perishable products such as meat (e.g. Eales and Unnevehr 1994), fish (Barten and Bettendorf 1989) and vegetables (Rickertsen 1997).

Weak separability of the utility function is assumed, which means that the demand for different types of flowers can be treated isolated from the demand for other goods. Only the prices and quantities of these flowers, and the total expenditure for this group matter. Also it is assumed that collective consumer behavior for flowers can be adequately described as that of the rational representative consumer.

An inverse demand system can be derived from the direct utility function (e.g. Andresen 1980) or from the distance function (transformation function). The last approach is explained in detail in Moschini and Vissa (1992). The distance function and the cost function have some parallel features, which are useful because they imply that any standard functional form of the function can also be applied to the distance function. Moschini and Vissa (1992), and Eales and Unnevehr (1994) followed this approach and developed an inverse almost ideal demand system where the uncompensated inverse almost ideal demand functions can be written in share form as

$$w_i = \alpha_i + \sum_j \gamma_{ij}(\ln q_j) - \beta_i \ln(Q) \tag{1}$$

where w_i is the ith good's budget share, q_j is the quantiy of cutflower j and ln(Q) is a quantity index defined as

$$\ln(Q) \equiv \alpha_0 + \sum_i \alpha_i \ln(q_i) + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln(q_i)\ln(q_j) \tag{2}$$

In practice, given that quantities are properly scaled ln(Q) can be replaced by an index ln(Q*) constructed prior to estimation of the share system to yield

$$w_i = \alpha_i + \sum_j \gamma_{ij}(\ln q_j) - \beta_i \ln(Q^*) \tag{3}$$

where

$$\ln(Q^*) = \sum_i w_i \ln(q_i) \tag{4}$$

is the linear approximate quantity index, which is a geometric aggregator. Eales and Unnevehr (1994) have shown that the linear IAIDS model produces results reasonably close to the nonlinear version.

Homogeneity and symmetry restrictions are imposed. These restrictions are: $\sum \gamma_{ij} = 0$ (homogeneity); $\gamma_{ij} = \gamma_{ji}$ (symmetry); $\sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \sum_i \beta_i = 1$ (adding up).

Deaton and Muellbauer (1980) suggested that other variables could be included in the almost ideal model by allowing the constant terms in (2) and (3) to vary with them. Following this approach seasonality is introduced into the model using seasonal dummy variables as shift variables where

$$\alpha_i = \alpha_{i0} + \sum_j \theta_{ij} a_j \tag{5}$$

where j=3, 12 and 51 for quarterly, 4-weekly and weekly seasons respectively. For the adding up condidtion to hold, $\Sigma a_{i0}=1$ and $\Sigma \theta_{ij}=0$ for all j. As an alternative to seasonal dummy variables an approach using trigonometric functions to handle seasonality is presented.

Following Ghysels and Osborn (2001), using weekly data and assuming one complete seasonal cycle within a year, a trigonometric representation of deterministic seasonality is given by the following expression:

$$\alpha_i = \alpha_{i0} + \omega_{i1} \sin(2\pi u / 52) + \omega_{i2} \cos(2\pi u / 52) \tag{6}$$

where u is the number of the week. For the adding up condition to hold, $\Sigma a_{i0}=1$ and $\Sigma w_{i1}=\Sigma w_{i2}=0$.

One advantage of the trigonometric functions is that they are continuous. This fact gives us parsimony in the use of regression variables. For instance the weekly dummy variable model requires 52 variables per equation, one for each week, while the trigonometric approach only uses 2 variables per equation. This is especially important when estimating systems of equations.

Price and scale flexibilities are the natural concepts of uncompensated elasticitites for inverse demand. Price flexibilities are the price changes caused by a small change in the supplied quantity of a good and scale flexibilities are the analogs to the expenditure elasticities.

The scale flexibilities are readily computed because $f_i = \sum_j f_{ij}$ (Moschini and Vissa, 1992)

Following the approach of Moschini and Vissa (1992) we apply the flexibilitiy formulas (which are consistent with taking ln(Q*) as given in estimation):

$$f_{ij} = \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i} - \delta_{ij} \qquad (7)$$

Here δ is the Kronecker delta ($\delta_{ij} = 1$ for $i = j$ and $\delta_{ij} = 0$ otherwise)

In the present case of four groups of cut flowers, weak separability is assumed. Only the quantities and prices of the different cut flower species and the total expenditure of cut flowers matter. I also assume that collective consumer behavior for cut flowers can be adequately described as that of the rational representative consumer.

The system consists of demand for chrysanthemums, carnations, roses and "others species", respectively. The last equation was dropped in estimation due to singularity of the cross-equation covariance matrix. The system is estimated using seemingly unrelated regressions (SUR).

The system is tested for autocorrelation using a Breuch-Godfrey Score Test (Ruud 2000), p. 464. The H_0 hypotheses were strongly rejected for all groups of cut flowers, and t-values were significant for the first 2 lags.

Berndt and Savin (1975) discuss alternative specifications of the lag structure of the residuals to include in the system to correct for autocorrelation. Here, an autoregressive model is applied and the inverse LA AIDS model in (5) is replaced by

$$w_i = \alpha_i^* + \sum_j \gamma_{ij} (\ln q_j) - \beta_i \ln(Q^*) + \sum_{j=1}^{n-1} \sum_{k=1}^{p} \rho_{ijk} \hat{\tau}_{j,t-k} \qquad (8)$$

where $\sum_{j=1}^{n-1} \rho_{ij} = 0$, and n and p are the number of groups in the system and the order of lags to include, respectively.

Since the score test indicates that the first two lags are the problem, two lags of the residuals are included in the corrected model.

Economic theory implies the following restrictions on the equation system; (1) adding up, (2) homogeneity and (3) symmetry. The adding up conditions, which are automatically satisfied by the data, imply that the covariance matrix is singular. This problem can be avoided by deleting one equation from the system, and the deleted equation may be retrieved using the adding up conditions. Homogeneity and symmetry restrictions are imposed on the system.

The autoregressive model was the tested for seasonality using an F-test, and the hypothesis of no seasonality was strongly rejected. Seasonality was included in the autoregressive model in 4 different ways; weekly, 4-weekly and quarterly dummy variables, as well as the trigonometric approach. The results of the different models were compared using the Baysian Information Criterion (BIC) (Greene 2000).

Econometric results

Table 2 displays the results from the different seasonal models. We can see that the trigonometric model is producing the highest BIC value and which means it is the preferred model. The trigonometric model is used for the further estimations and to calculate the flexibilities.

Table 2

The estimated coefficients and the summary statistics from (8) are presented in table 3.

Table 3

We can see from the table that all quantity coefficients as well as the coefficients of the quantity indices are highly significant. The seasonal cycles are different for the different groups of cut flowers, and they seem to follow the cosine waves for most of them.

Table 4

Table 4 shows the price and scale flexibilities and the summary statistics. The price flexibilities show the percentage changes in the prices associated with a 1 per cent change in the supplied quantity of a group of cut flowers. All own flexibilities (quantity elasticities) are statistically significant (at 1 % level), and negative as expected, i.e. a price of a group of cut flowers is reduced when the supplied quantity of that group is increased. We, furthermore, see that the own flexibilities vary substantially across the different species, from -0.8 (chrysanthemums) to –0.3 (carnations). Thus, the demand for all cut flowers is inflexible, with carnations as the most inflexible. Taken at face value, the estimates indicate different effects from strategic marketing behavior across producers of different species. While some “concerted action” among chrysanthemum producers in terms of supply adjustments may have significant price effects, such behavior for producers of carnations seems to have less impact.

All cross flexibilities are highly significant, and all but carnation versus chrysanthemums are negative, which means that price of one group of cut flowers is reduced when the supplied quantity of another group of cut flowers is increased. That is, chrysanthemum and carnations seem to be quantity-complements while the rest appear to be quantity-substitutes.

Furthermore, for chrysanthemums, roses and “others”, each of the cross-flexibilities has a lower numerical value than the corresponding own price elasticity, implying that the increased supply of a cut flower mostly affects the price of that cut flower itself. But for carnations it actually seems to be the case that increased supply of carnations affects the prices of chrysanthemums, roses and “others” more that it affects the price of carnations themselves. For instance, a 10 per cent increase in the supply of carnations will reduce the price of roses by more than 5 per cent.

The scale flexibility shows the percentage change in the price of a species in response to a proportionate increase in the supply of all cut flowers. The scale flexibilities range from -.9 (roses) to -1.3 (carnations). The hypothesis of homothetic preferences are rejected for all groups of flowers.

Conclusions

Flower production is an important growth sector in agriculture, but despite this, the markets for flowers have so far received little attention in the literature. The aim of this paper is to provide some information on price-quantity relationships for cut flowers traded at the Dutch flower auctions. The major findings presented in this paper may be summarized as follows. Prices and quantities in the market for cut flowers are extremely volatile in the short run. The results show that weekly cut flower consumption can be modeled using an inverse linear version of the almost ideal demand system. To handle seasonal patterns, trigonometric functions can be recommended as a flexible and inexpensive alternative, which in this study clearly outperformed standard seasonal dummy models. The parsimony in use of regression variables is especially important when estimating systems of equations.

The estimated price and scale flexibilities are all strongly statistically significant and they seem plausible. Based on these estimates, a potential for strategic marketing or market timing seems to exist. Thus, if a producer is able to predict quantities supplied subsequent weeks he or she may be able to skim profits by adjusting lights and temperature in order to hit short-term price peaks (or also avoid weeks with excess supply and depressed prices). This means that utilizing this information, in given weeks even relatively small producers may be big enough to influence the prices, i.e. there is at least a potential for "flower power" at the Dutch Flower Auctions.

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Tables

Table 1. Prices* and quantities major species, week 1, 1993 – week 21, 2005

	Prices, weekly observations			Weekly quantities (1000 stems)			Highest and lowest quantities observed (weekly)	
	Mean	**Std.dev.**	**Coeff. of variation**	**Mean**	**Std. Dev.**	**Coeff. of variation**	**Highest**	**Lowest**
Chrysant.	21.7	7.32	33.73	26305	5188	13.3	39014	5522
Carnations	12.4	2.94	23.70	12319	6063	18.0	33693	1130
Roses	19.3	5.53	28.65	58867	12121	10.5	115551	16194
Others	19.0	3.99	21.00	118290	36386	8.7	417041	33210

*Prices are measured in Eurocents per stem

Table 2. Baysian information criterion values for different seasonal models

Seasonal model	Number of parameters estimated	BIC
Sin/cos	36	-26.24625
4 seasons	39	-26.09681
13 seasons	66	-26.08487
52 seasons	183	-25.67211

Table 3. Coefficients and summary stastistics of the LA/IAIDS system

	γ_{ij}				SIN	COS	β_I
Chrysanthemums	0.031***	0.007***	-0.016***	-0.022***	-0.006***	0.012***	-0.032***
	(5.98)	(6.74)	(-4.0)	(-5.65)	(-4.33)	(9.40)	(-7.74)
Carnations (Dianthus)	0.007***	0.027***	-0.012***	-0.021***	0.001*	-0.009***	-0.011***
	(6.74)	(57.90)	(-10.41)	(-17.35)	(2.33)	(-18.27)	(-6.37)
Roses	-0.016***	-0.012***	0.093***	-0.065***	0.003	-0.009***	0.023***
	(-4.0)	(-10.41)	(15.80)	(-12.70)	(1.28)	(-5.05)	(3.67)
Other species	-0.022***	-0.021***	-0.065***	0.108***	0.002	0.005**	0.020**
	(-5.65)	(-17.35)	(-12.70)	(17.75)	(1.06)	(2.68)	(3.22)

(t-values in parentheses). β_i is the coeff. of the quantity index of equation i, and γ_{ij} is the jth quantity coefficient of equation i (i and j = chrysanthemums, carnations(Dianthus), roses, other in that given order)
* = significant at 5% level, ** = significant at 1 % level, *** = significant at 0.1 % level

Table 4. Uncompensated price flexibilities (f_{ij}) and scale flexibilities (f_i) evaluated at mean shares of w_i, t-values in parentheses.

	f_{ij}				
	Chrysanthemums	**Carnations**	**Roses**	**Others**	f_i
Chrysanthemums	-0.810***	0.040***	-0.179***	-0.283***	-1.232***
	(-21.16)	(5.13)	(-6.08)	(-10.79)	(-41.16)
Carnations	0.13***	-0.345***	-0.387***	-0.681***	-1.284***
	(4.92)	(-27.76)	(-11.84)	(-20.96)	(-28.77)
Roses	-0.046**	-0.042***	-0.640***	-0.190***	-0.917***
	(-3.06)	(-8.86)	(-28.43)	(-9.57)	(-40.58)
Others	-0.034***	-0.038***	-0.109***	-0.782***	-0.962***
	(-4.58)	(-15.19)	(-10.47)	(-72.85)	(-82.62)

* = significant at 5 % level, ** = significant at 1 % level, *** = significant at 0.1 % level

Figures

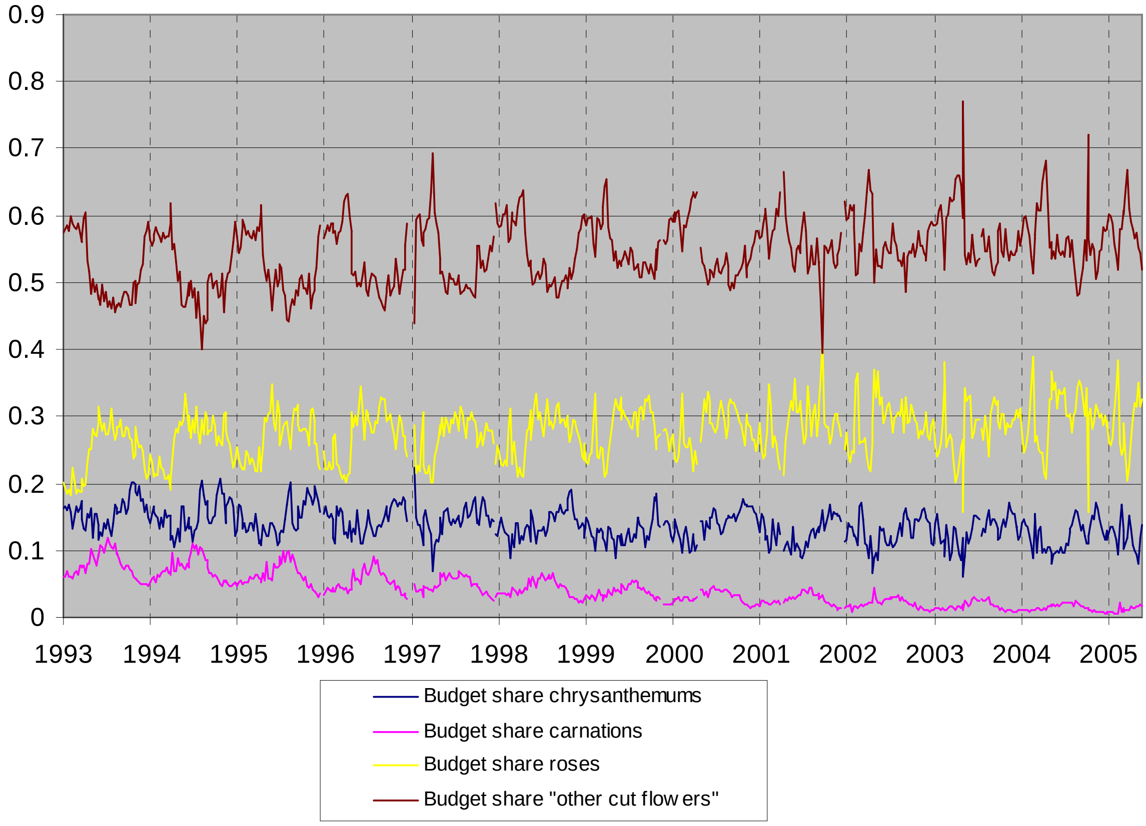

Figure 1. Budget shares of chrysanthemums, carnations, roses and other cut flowers out of the total expenditure of cut flowers from week 1-1993 to week 21-2005.