DEMAND EQUATIONS FOR SELECTED SOUTH AFRICAN AGRICULTURAL COMMODITIES[1]

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ABSTRACT

A set of demand equations for 18 South African agricultural products, representing three demand systems (red meats, fruits and vegetables), were estimated from monthly data for the period December 1982 to February 1988. Data were deflated with a commodity price index and natural logarithmic partial adjustment equations were estimated with two-stage least squares to determine demand parameters for each product. Theoretically expected results were obtained and, owing to variability in seasonal data, results were generally highly significant. Beef is confirmed as the dominant commodity in the red meat market, having cross-price flexibilities with mutton and pork of 0,30 and 0,20, respectively. All goods other than pumpkins are shown to be normal and fruits and vegetables (having many substitutes) are shown to be demand elastic. All products are normal goods, with the exception of pumpkins (income flexibility of -0,74), which are inferior. Apples and pineapples were found to be the dominant fruits and onions, tomatoes and cabbages had the most significant cross-price effects on the system of vegetable demand equations.

1. INTRODUCTION

Research in the field of demand analysis for agricultural products in South Africa is important in order to gain insight into consumer behaviour patterns. Three systems of demand were constructed from red meat, fruit and vegetable data, respectively. The time period assessed covered December 1982 to February 1988, inclusive, and monthly consumption and price data were drawn from Crops and Markets (1982 to 1988).

The two-stage least squares procedure was used to estimate 18 natural logarithmic demand equations in which the variables were deflated with a consumer price index. All equations were over-identified and autocorrelation (a common problem with time series data) was not encountered. Autoregressive partial adjustment equations were used, as long run demand parameters are more meaningful. Simultaneous equations techniques, although regarded as superior to ordinary least squares regressions for estimating systems of demand functions, have not been widely used in South Africa. Despite valuable research on the demand for dairy products (McKenzie, 1984), avocados and bananas (Chadwick, 1984), meat (Hancock, 1983) and some fruits and vegetables (Ortmann, 1982), there is still a need for research on demand for South African agricultural products.

2. THEORETICAL REQUISITES OF DEMAND THEORY

An empirical analysis of demand can achieve credibility only if it is consistent with the theoretical structure that comprises the "Law of Demand". Linking theory and analytical procedure is important, for consumer preference theories have the basic law of demand as the goal at which they are directed (Clarkson, 1963).

A utility function is the first step towards a demand function and whether it is based on a cardinal concept of utility, or the more widely accepted ordinal concept of utility, consumers rank their preferences in order and consume goods subject to budgetary constraints. Demand functions can consequently be derived (Friedman, 1963; Thomas, 1987).

In order to estimate demand schedules, a maximum variation in supply is sought and the demand schedule is fixed through inclusion of demand shifters such as income. Fortunately, when dealing with agricultural products supply is highly variable owing to weather, crop diseases, etc., and agricultural price:quantity data more often than not represent demand relationships. In this study, long run (longer than one month) demand equations were compiled by constructing autoregressive partial adjustment models, the general form of which is

$$P(t) = AB_0 + AB_1Q(t) + (1\text{-}A)P(T\text{-}1) + Ae(t) \qquad (2.1)$$

where A is the coefficient of adjustment and B's are long run parameters. When using the partial adjustment, or and autoregressive model, the Durbin Watson d-test no longer applies and the Durbin h-test is reported (Gujarati, 1978).

The aggregation problem is a theoretical stumbling block when national data are used. Results can be questioned if conclusions regarding individual consumers are drawn. The lack of a representative consumer means that consumer demand functions are not as easily interpreted as aggregate demand functions (George and King, 1971). Distribution of income also has an important structural effect on demand (Pinstrup-Anderson and Caicedo, 1978) and in South Africa, where there are widespread differences in income levels, it would be erroneous to refer to a representative, or average, consumer. In mitigation, Griliches and Grunfeld (1960) concluded "Aggregation is not necessarily bad if one is interested in the aggregates".

There are several theoretical restrictions listed by George and King (1971) and Bieri and de Janvry (1972) that apply to quantity dependent demand equations. In agriculture, the price of commodities is dependent on quantity owing to the impact of climate (Waugh, 1964) and these restrictions could not be applied to the equations listed in this study. The products were separated into three groups, namely meat, fruit and vegetables, and for research purposes were treated as separate demand systems.

3. RESEARCH PROCEDURE

As stated, it is more correct to specify an equation with price as the dependent variable. This implies that estimated demand parameters should be flexibilities as opposed to elasticities in a logarithmic equation. A price flexibility of demand does not approximate the inverse of its corresponding price elasticity, unless the R^2 value of an equation is close to unity (Ortmann, 1982).

With price as a dependent variable, the following explanatory variables were considered:

(i) Total consumption (in tons for fruit and vegetables and in carcasses for meat).

(ii) Real disposable income, and

(iii) Prices of related goods.

All prices were deflated using a consumer price index (Base month = August 1980) and, together with consumption figures, were obtained on a monthly basis from Crops and Markets (1982 to 1988). Real disposable income figures obtained from the Reserve Bank Quarterly Bulletin (1982 to 1988) were converted to monthly data applying equation (3.1).

$$Yn = Yb(1 + i)^{n/12}/12 \tag{3.1}$$

Yn is disposable income for the nth month and Yb is disposable income for the previous year, with i being the annual rate of increase in disposable income.

Data were changed into logarithmic form as the flexibility may be read directly from the equation. Commodities chosen represent fresh market produce and as such are fairly representative of a free market. Being perishable, fresh fruits and vegetables cannot be stored for any length of time by suppliers, implying seasonal price and quantity variations. This variability is desirable, for the more supply conditions vary, the greater the chance of estimating representative demand functions (Thomas, 1987).

Ordinary least squares (OLS) methods were used to estimate demand relationships and all variables with a t value less than 1 were discarded, as this practice maximises $\bar{R}^2$ (Haitovsky, 1969). Both price and quantity dependent equations for each of the products were estimated and, in accordance with expectations, the statistical significances of the price dependent equations were markedly better than those obtained using quantity as the dependent variable. Once it is known which products exerted significant influences on each other, the two-stage least squares (2SLS) method of estimating simultaneous equations was employed.

In a general case a system has M equations, or M endogenous (mutually dependent) variable and K exogenous (predetermined) variables. Let m be the number of endogenous and k the number of exogenous variables in a single equation.

The order condition of identifiability requires that in a system of equations, in order for an equation to be identified, the number of predetermined variables excluded from the equation must not be less than the number of endogenous variables included in that equation less one (Gujarati, 1978). That is:

$$K - k \geq m - 1$$

Table 1 shows that, according to the order condition, all of the equations are over-identified. The products were separated into three systems, comprising meat, fruit and vegetables. In each equation, regardless of the system, two of the variables can be regarded as exogenous, namely the lagged dependent variable and the quantity variable, both of which were determined prior to current prices.

For each product, the structural equation would take the following general form:

$$P_i(t) = B_o + B_jP_j(t) + \ldots B_nP_n(t) + B_iQ_i(t) + B_kP_i(t\text{-}1) + B_yY(t)$$

where $P_i \ldots P_n$ are prices of related products in the system. Q_i is consumption of the ith good and Y is disposable income. In a system of such equations, it is obvious that the two exogenous variables, P_it-1 and Q_it (the quantity and lagged price of the dependent variables) are unique in each equation. The first stage of 2SLS is to express each endogenous variable only in terms of all the exogenous variables in the whole system.

TABLE 1 Testing the equations with the order condition of identifiability

System	Dependent Variable	K - k	m - 1
1	Beef	4	3
1	Mutton	4	3
1	Pork	4	3
2	Apples	8	5
2	Pineapples	8	4
2	Pawpaws	8	2
2	Avocados	8	5
2	Guavas	8	3
3	Potatoes	18	3
3	Tomatoe	18	8
3	Onions	18	4
3	Cabbages	18	7
3	Beans	18	8
3	Peas	18	6
3	Carrots	18	4
3	Lettuces	18	7
3	Pumpkins	18	6
3	Cauliflowers	18	4

This would yield the following general reduced form equation for each product under study:

$$\hat{P}_i(t) = R_o + R_iQ_i(t) + \ldots R_nQ_n(t) + R_{n+1}P_i(t\text{-}1) + \ldots R^2_nP_n(t\text{-}1)$$

where $\hat{P}_i(t)$ is a proxy for $P_i(t)$ (also known as an instrumental variable), being highly correlated with $P_i(t)$, but not with the error term. R_o..R^2_n are the reduced form coefficients. The reduced form equations are determined using OLS with reduced form coefficients having t-values less than one being excluded. If the reduced form equations have high R^2 values, then the classical OLS estimates and 2SLS estimates will be very close (Gujarati, 1978).

The R^2s in the first stage regressions of this study were very high (ranging from 0,78 to 0,98), implying that the instrumental variables are very close to the real values they approximate.

One of the benefits of using 2SLS is that standard errors for all variables are quoted, which means that tests of significance are possible.

4. RESULTS

Table 2 shows own price and income flexibilities of demand estimated in this study as compared with other authors' findings. The findings generally support other studies. Differences might be ascribed to the fact that the equations obtained in this study were simultaneously determined using monthly data. Ortmann, Chadwick and Hancock differed in most of these respects in their analyses.

It is important to note that the flexibilities shown in Table 2 have been converted into long run estimates by dividing the computer-estimated coefficients by the coefficient of adjustment. For the remainder of this section, estimated equations for each product will be individually scrutinised. Long run demand equations are quoted with a view to assessing their economic credibility. The t statistic is shown in parentheses below estimated parameters. All variables in all equations are in natural logarithmic form and have been deflated with a CPI. The adjustment model (equation 2.1) applied in this study is similar to the Koyck model (Gujarati, 1978), the difference being that price was taken as a function of quantity and not the reverse, as in Koyck's model. The other adjustment model (adaptive expectations) does not readily apply to price dependent equations. The Koyck model, however, has weaker economic underpinnings and is more of a mathematical model. As monthly data were used in this study, the short run period was taken to be a month and the longer run to be more than a month. It is possible in the context of this definition of the difference between short and long run that the short run

TABLE 2 A summary of estimated flexibilities compared with other research findings

Product	Own price flexibility		Income flexibility	
	This study	Others	This study	Others
Beef (2)	-0.58	-0.60 to -1.37	1.34	1.12
Mutton (2)	-0.23	-0.44 to -0.63	0.34	2.27
Pork (2)	-0.31	-0.36	0.39	0.48
Apples	-0.14	0.38		
Pineapples	-0.24	0.72		
Pawpaws (1)	-0.15	-0.31	0.38	
Avocados (3)	-0.64	-0.67	0.19	0.33 to 1.07
Guavas	-0.18	0.98		
Potatoes (1)	-0.85	-1.73	1.32	
Tomatoes (1)	-0.12	-0.65	0.25	0.12
Onions (1)	-0.69	-2.36	0.31	2.34
Cabbages (1)	-0.11	-0.45	0.23	
Beans (1)	-0.27	-0.38	0.15	-0.18
Peas	-0.19	0.32		
Carrots	-0.27	0.27		
Lettuces	-0.27	0.32		
Pumpkins (1)	-0.42	-3.75	-0.74	-1.26
Cauliflowers	-0.08	0.29		

Comparisons are made with other findings, reported by: (1) Ortmann, 1982 (2) Hancock, 1983 (3) Chadwick, 1984

parameters could be more price elastic than the longer run. Shepherd (1963) has shown very short run elasticities to exceed long run elasticities as in the very short run perishable products can be stored.

4.1 Meat demand functions

(i) Beef

$$PBEE(t) = 0,70 - 0,42QBEE(t) + 0,24PMUT(t) - 0,06\ PPOR(t) + 0,96\ INCM(t) + 0,28\ PBEE(t\text{-}1) \quad (1)$$

[(-0,80) (-2,05) (3,12) (-1,05) (2,12) (9,10)]

$R^2 = 0,97$ h = 0,204 (**) DF = 57

Equation (1) shows realistic coefficients that compare with those quoted by Hancock (1983). A high R^2 and significant t values indicate a good predicting equation.

(ii) Mutton

$$PMUT(t) = -0,16 - 0,05\ QMUT(t) + 0,06\ PBEE(t) - 0,02\ PPOR(t) + 0,07\ INCM(t) + 0,80\ PMUT(t\text{-}1) \quad (2)$$

[(-0,59) (-2,55) (3,13) (1,24) (2,15) (2,62)]

$R^2 = 0,94$ h = 1,336 (**) DF = 57

Equation (2) is statistically sound and the results are comparable with those of other studies. A point of particular interest is that the beef price has a strong and highly significant effect on the mutton price (more so than the own price effect). This can be attributed to beef being the leading red meat and the fact that it therefore has a strong market influence on other red meats. The Hotelling Jureen relation (Wold and Jureen, 1962) shows that cross-price relationships are in inverse proportion to consumer expenditure on two items, supporting the finding that beef has a dominant impact on mutton prices.

(iii) Pork

$$PPOR(T) = 1,47 - 0,16\ QPOR(t) + 0,09\ PBEE(t) - 0,03\ PMUT(t) + 0,18\ INCM(t) + 0,49\ PPOR(t\text{-}1) \quad (3)$$

[(1,44) (-1,92) (2,75) (-1,69) (2,47) (5,12)]

$R^2 = 0,88$ h = 0,888 (**) DF = 57

The interpretation of equation (3) is similar to the mutton equation, showing beef to be the predominant force in the red meat market that is identified as a substitute for both mutton and pork. The own price flexibility of -0,16 is lower than the -0,36 estimated by Hancock (1983), as is the income flexibility.

Substitutes that can be identified as related variables in an equation are preceded by a positive (+) sign. The logic behind this is that if in equation (3) the beef price were to rise by one per cent, there would be a 0,09% increase in the pork price arising out of an increase in pork consumption. Conversely, related variables preceded by a negative (-) sign are complements. In empirical demand studies, cross flexibilities are usually estimated between price of A and price of B (Buse, 1958) and not between price of A and consumption of B, as shown in textbooks.

4.2 Fruit demand functions

(i) Apples

$$PAPP(t) = -1,49 - 0,09\ QAPP(t) + 0,46\ PIN(t) + 0,19\ PORA(T) + 0,09\ PPRS(T) + 0,10\ PPAW(t) + 0,23\ INCM(t) + 1,61\ PAPP(t\ \text{-}1) \quad (4)$$

[(-1,28) (-2,04) (7,78) (2,94) (2,11) (1,72) (1,69)(-2,37)]

$R^2 = 0,89$ h = 0,00 (**) DF = 55

No comparable estimates were reviewed for apples. Equation (4) shows the demand for apples to be price elastic. All other fruits in equation (4) are identified as substitutes, with a particularly strong cross-effect coming from pineapples.

(ii) Pineapples

$$PPIN(t) = 0,35 - 0,07\ QPIN(t) + 0,21\ PAPP(t) + 0,05\ PBAN(T) - 0,02\ PGUA(t) + 0,21\ INCM(t) + 0,72\ PPIN(t\text{-}1) \quad (5)$$

[(3,04) (4,66) (11,16) (1,89) (-1,89) (2,17) (4,26)]

$R^2 = 0,88$ h = 0,051 (**) DF = 56

As with apples, there are no estimates on South African pineapple demand with which equation (5) can be compared. The significance of apples as a substitute (t = 11,2) is again borne out in this equation and it is apparent that the demand for pineapples is demand elastic.

(iii) Pawpaws

PPAW(t) = -0,01 - 0,07 QPAW(t) - 0,04 PGUA(t) + 0,17 INCM(t) + 0,54 PPAW(t-1) (6)

[(-0,14) (-4,55) (-1,91) (3,27) (4,38)]

R^2 = 0,59 h = 1,476 (**) DF = 58

Equation (6) shows a lower coefficient than Ortmann's (1982). However, it would appear that pawpaws are a price elastic, normal product.

(iv) Avocados

PAVO(t) = 1,86 - 0,15 PAVO(t) + 0,09 PAPP(t) + 0,07 PPRS(t) - 0,04 PBAN(t) - 0,08 PPAW(t) + 0,05 INCM(t) + 0,76 PAVO(t-1) (7)

[(3,47) (-2,09) (2,31) (1,81) (-1,44) (-2,53) (2,49) (2,96)]

R^2 = 0,78 h = 1,652 (**) DF = 55

The estimates shown in (7) compare favourably with Chadwick's (1984). Apples and pears are identified as substitutes and bananas and pawpaws are complements.

(v) Guavas

PGUA(t) = -3,75 - 0,09 QGUA(t) - 0,37 PPIN(t) - 0,30 PORA(t) + 0,50 INCM(t) - 0,49 PGUA(t-1) (8)

[(-2,98) (-2,60) (-4,79) (-1,77) (5,91) (-3,01)]

R^2 = 0,63 h = 0,712 (**) DF = 57

Pineapples and oranges are significant complements for guavas and no comparisons with other authors are possible.

4.3 Vegetable demand equations

There are no data for the time period under study in **Crops and Markets** for such vegetables as gem squashes and cucumbers, which are common vegetables and would be expected to influence the demand for other vegetables.

(i) Potatoes

PPOT(t) = 2,30 - 0,54 QPOT(t) + 0,26 PTOM(t) + 0,10 PPUM(t) + 0,83 INCM(t) + 0,37 PPOT(t-1) (9)

[(2,56) (-3,12) (2,87) (1,83) (2,14) (9,38)]

R^2 = 0,78 h = 1,185 (**) DF = 57

The own price flexibility of -0,85 is somewhat lower than Ortmann's (1982) estimate. However, equation (9) is a valid demand equation.

(ii) Tomatoes

PTOM(t) = 1,01 - 0,05 QTOM(t) + 0,02 PPOT(t) + 0,15 PONI(t) -0,11 PCAB(t) + 0,15 PBEN(t) - 0,11 PLET(t) + 0,10 PPUM(t) +0,09 PCAU(t) + 0,10 INCM(t) + 0,61 PTOM(t-1) (10)

[(2,00) (-2,34) (1,17) (2,75) (2,31) (2,07) (2,40) (2,13) (1,89) (2,47) (3,39)]

R^2 = 0,56 h = 1,346 (**) DF = 52

Despite the relatively low R^2, there are a large number of significant complements and substitutes for tomatoes. The own price flexibility is again lower than Ortmann's estimate (1982), indicating that the demand for tomatoes is elastic (which would be expected for a product with five substitutes).

(iii) Onions

PONI(t) = 0,95 - 0,37 QONI(t) + 0,22 PCAR(t) - 0,05 PPUM(t) - 0,17 PCAU(t) + 0,17 INCM(t) + 0,46 PONI (t-1) (11)

[(2,08) (-2,48) (3,68) (1,75) (-5,67) (2,07) (5,86)]

R^2 = 0,87 h = 1,220 (**) DF = 56

All compared parameters are lower in absolute value than those computed by Ortmann (1982). Equation (11) has a very high R^2, however, and can be accepted as a sound demand equation. The relatively high own price flexibility indicates that the demand for onions is inelastic, which is not unreasonable as onions are a normal product with more complements than substitutes.

(iv) Cabbages

PCAB(t) = -0,19 - 0,05 QCAB(t) - 0,11 PTOM(t) + 0,16 PBEN(t) + 0,10 PPEA(t) + 0,18 PCAR(t) - 0,06 PLET(t) - 0,07 PPUM(t) + 0,10 INCM(t) + 0,57 PCAB(t-1) (12)

[(-0,25) (-2,55) (-2,88) (2,90) (1,09) (2,73) (-1,44) (-1,27) (2,63) (4,22)]

R^2 = 0,73 h = 1,285 (**) DF = 53

Cabbages are shown to be price elastic, with highly significant substitutes (peas and carrots). Cabbages are a normal product, and, being the cheapest vegetable, they are intuitively expected to have a low income elasticity (or high income flexibility).

(v) Green beans

PBEN(t) = 2,45 - 0,16 QBEN(t) - 0,13 PPOT(t) - 0,20 PTOM(t) + 0,09 PONI(t) + 0,29 PCAB(t) - 0,15 PPEA(t) + 0,19 PLET(t) + 0,17 PCAU(t) + 0,09 INCM(t) + 0,39 PBEN(t-1) (13)

[(2,71) (-3,01) (-2,95) (-1,72) (2,04) (3,98) (-2,21) (2,77) (4,01) (2,52) (7,00)]

R^2 = 0,76 h = 1,570 (**) DF = 52

Equation (13) shows valid estimates. It is interesting to note that peas are a complement for beans and that owing to the four highly significant substitutes (onions, lettuces, cabbages and cauliflowers) the demand for beans is fairly elastic.

(vi) Peas

QPEA(t) = 0,28 - 0.04 QPEA(t) + 0,06 PONI(t) - 0,02 PBEN(t) + 0,01 PCAR(t) - 0,05 PLET(t) + 0,07 PCAU(t) + 0,06 INCM(t) + 0,80 QPEA(t-1) (14)

[(0,92) (-4,33) (2,99) (-1,85) (1,72) (2,16) (1,92) (2,19) (2,21)]

R^2 = 0.81 h = 0,974 (**) DF = 54

No comparable estimates are available for peas. The demand for peas is estimated to be elastic. With a large number of significant cross-relationships and high R^2 equation (14) is a sound demand equation.

(vii) Carrots

PCAR (t) = -0,52 - 0,11 QCAR(t) + 0,30 PTOM(t) + 0,11 PCAB(t) - 0,14 PPUM(t) + 0,11 INCM(t) + 0,50 PCAR(t-1) (15)

[(-0,83) (-2,11) (3,09) (2,76) (-2,72) (1,86) (3,80)]

R^2 = 0,81 h = 1,175 DF = 56

With its accompanying high R^2, equation (15) can be considered a sound equation, showing carrots to be a normal product with tomatoes and cabbages as substitutes and pumpkins as a complement.

(viii) Lettuces

PLET(t) = 1,59 - 0,09 QLET(t) - 0,11 PONI(t) - 0,08 PCAB(t) + 0,10 PBEN(t) + 0,11 PPEA(t) + 0,22 PCAR(t) - 0,05 PPUM(T) + 0,11 INCM(t) + 0,67 PLET(t-1) (16)

[(1,99) (-3,56) (-4,42) (-2,70) (2,93) (3,03) (5,75) (1,46) (1,24) (2,34)]

R^2 = 0,83 h = 0,066 (**) DF = 53

Equation (16) is again a sound equation, showing highly significant substitutes in beans, peas and carrots and complements in onions and cabbages. These results are logical as the products complementary to lettuce are also salad vegetables and the substitutes are those vegetables that are more often cooked.

(ix) Pumpkins

PPUM(t) = -1,33 - 0,24 QPUM(t) + 0,46 PPOT(t) + 0,26 PONI(t) - 0,18 PCAB(t) + 0,44 PBEN(t) - 0,09 PPEA(t) - 0,41 INCM(t) + 0,44 PPUM(t-1) (17)

[(-1,37) (-1,77) (4,90) (1,83) (-2,95) (5,73) (-1,81) (-1,47)]

R^2 = 0,78 h = 0,790 (**) DF = 54

Equation (17) can be considered a good estimator of pumpkin demand. The most significant observation that can be made with respect to the demand for pumpkins is that they are identified as being an inferior product (denoted by a negative income parameter). This is not an unreasonable result as pumpkins are relatively cheap and are probably eaten less as income levels rise. Ortmann's (1982) result confirms this.

(x) Cauliflowers

PCAU(t) = -0,08 - 0,03 QCAU(t) + 0,21 PTOM(t) - 0,27 PONI(t) + 0,16 PPEA(t) + 0,12 INCM(t) + 0,59 PCAU(t-1) (18)

[(-0,23) -(2,19) (3,15) (-6,44) (4,24) (2,49) (4,41)]

R^2 = 0,73 h = 1,014 (**) DF = 56

Equation (18) is again a good equation, with the demand for cauliflowers shown to be elastic, having highly significant substitutes in peas and tomatoes. There are no comparable estimates, but it appears that cauliflowers are a normal product.

5. CONCLUSIONS

The results of this research can act as aids to understanding how the demand systems of meat, fruit and vegetables function. A knowledge of expected quantitative responses to general or specific price and income changes has been gained that can act as an aid to entrepreneurs and policy-makers alike. For any person in the market place, knowledge of demand schedules could reduce risk and could help to lessen fluctuations in supply and therefore prices.

The 2SLS technique is superior to OLS for estimating systems of demand equations and the results obtained in this study are sound. Specifically, the dominant role played by beef in the red meat market is confirmed with the highly significant cross-price flexibility of beef with mutton and pork. Furthermore, fruits and vegetables were found to have many substitutes and their demand was therefore generally elastic. It is interesting to note that all goods examined were normal products with the exception of pumpkins, which had an income flexibility of -0,41. Avocados are the most demand inelastic fruit and apples and pineapples are the most dominant. Onions, tomatoes and pumpkins exert the most influence in the vegetable market and peas, cabbages and cauliflowers have the most elastic demand.

The fact that salad vegetables such as lettuces, cabbages and tomatoes are shown to be complementary (with beans, cauliflower, pumpkins and peas as their substitutes) lends credibility to the estimated parameters.

6. NOTES

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