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ECONOMICS

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Abstract

This paper introduces an inverse differential demand system that has exactly the same form as the corresponding direct version. Its application is illustrated with the case of Australian fruit, whose prices were substantially affected by Severe Tropical Cyclone Larry in 2006.

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1. Introduction

An inverse demand system expresses prices as a function of quantities, and can be used when markets are supplied constrained.¹ This paper introduces a case in which the form of the differential inverse is exactly the same of the corresponding direct demand system, and applies it to fruit, whose prices were substantially affected by Severe Tropical Cyclone Larry in 2006.

2. A Demand System and its Inverse

Let p_{it} , q_{it} be the price and per capita quantity consumed of good i ($i=1, \dots, n$) in period t , $M_t = \sum_{i=1}^n p_{it} q_{it}$ be total expenditure (“income” for short), $w_{it} = p_{it} q_{it} / M_t$ be the budget share of i and $\bar{w}_{it} = \frac{1}{2}(w_{it} + w_{it-1})$ be the arithmetic average of the budget share. Writing D for the log-change operator ($Dx_t = \log x_t - \log x_{t-1}$), the i^{th} demand equation of Selvanathan’s (1985) model is:

$$\bar{w}_{it}(Dq_{it} - DQ_t) = \alpha_i + \beta_i DQ_t + \kappa \bar{w}_{it}(Dp_{it} - DP_t) + \varepsilon_{it}, \quad (2.1)$$

where $DQ_t = \sum_{i=1}^n \bar{w}_{it} Dq_{it}$ and $DP_t = \sum_{i=1}^n \bar{w}_{it} Dp_{it}$ are the Divisia volume and price indexes respectively, α_i is an intercept satisfying $\sum_{i=1}^n \alpha_i = 0$, β_i is an income coefficient with $\sum_{i=1}^n \beta_i = 0$, $\kappa < 0$ is the negative of the elasticity of substitution and ε_{it} is a zero-mean disturbance term. The intercept α_i deals with the autonomous trend in consumption, and β_i relates to the impact of income [with $1 + \beta_i / \bar{w}_{it}$ the income elasticity, so good i is a luxury (necessity) if $\beta_i > 0$ (< 0)]. The attraction of model (2.1) for $i=1, \dots, n$ is threefold. First, it satisfies the three requirements of demand theory, viz., the budget constraint (which takes the form $\sum_{i=1}^n \bar{w}_{it} = 1$), homogeneity [the sum of the compensated price elasticities is zero, $\sum_{j=1}^n \eta_{ij} = 0$, $i=1, \dots, n$, with $\eta_{ij} = \kappa(\delta_{ij} - \bar{w}_{jt})$, where δ_{ij} is the Kronecker delta, that is, $\delta_{ij} = 1$ if $i=j$, 0 otherwise], and Slutsky symmetry ($\bar{w}_{it} \eta_{ij} = \bar{w}_{jt} \eta_{ji}$, $i, j=1, \dots, n$). Second, as the model has only $2n-1$ parameters (that is, $n-1$ α_i , $n-1$ β_i , plus κ), it is parsimonious. Third, is its linear structure. The latter two features are valuable when the data are not too informative.

A further attraction of model (2.1) is that its inverse is easily obtained. Write equation (2.1) for $i=1, \dots, n$ in vector form as $\bar{W}_t(D\mathbf{q}_t - \mathbf{t}DQ_t) = \boldsymbol{\alpha} + \boldsymbol{\beta}DQ_t + \boldsymbol{\Gamma}\bar{W}_t(D\mathbf{p}_t - \mathbf{t}DP_t) + \boldsymbol{\varepsilon}_t$, where $\bar{W}_t$ is a diagonal matrix with budget shares on the main diagonal, $D\mathbf{q}_t = [Dq_{it}]$, $\mathbf{t}$ is a vector of n unit

¹ See, e. g., Anderson (1980), Barten and Bettendorf (1989), Brown et al. (1995), Huang (1983), Laitinen and Theil (1979), Salvas-Bronsard et al. (1977) and Theil (1976).

elements, $\alpha = [\alpha_i]$, $\beta = [\beta_i]$, $\Gamma = \kappa I$, $Dp_i = [Dp_{it}]$ and $\epsilon_i = [\epsilon_{it}]$. The inverse system is then $\bar{W}_i(Dp_i - DP_i) = -\Gamma^{-1}[\alpha + \beta DQ_i - \bar{W}_i(Dq_i - iDQ_i) + \epsilon_i]$. As $\Gamma^{-1} = \kappa^{-1}I$, the i^{th} equation is

$$\bar{w}_{it}(Dp_{it} - DP_i) = \alpha'_i + \beta'_i DQ_i + \kappa' \bar{w}_{it}(Dq_{it} - DQ_i) + \epsilon'_i, \quad (2.2)$$

where $\alpha'_i = -\alpha_i/\kappa$, $\beta'_i = -\beta_i/\kappa$, $\kappa' = 1/\kappa$ and $\epsilon'_i = -\epsilon_{it}/\kappa$. As models (2.1) and (2.2) have exactly the same structure, it is as if when we look at (2.1) in a mirror, we see (2.2). This intriguing property does not seem to be shared by any other differential demand system.² For this reason, we can term model (2.2) for $i = 1, \dots, n$ a “self-reflective inverse demand system”.

3. Application to Fruit

We apply model (2.2) conditionally to the price formation of the $n = 7$ fruits listed in column 1 of Table 1. We use monthly data from Perth, Australia, for the period 2002 to 2006 and to account for seasonality, we use log-changes over a 12-month horizon and $\bar{w}_{it} = \frac{1}{2}(w_{it} + w_{it-12})$.³ As the supply of fruit in any month is mostly determined by previous prices and past growing conditions, rather than the current price, it would seem appropriate to treat prices as determined by the quantities available as in the inverse approach.

We estimate equation (2.2) for $i = 1, \dots, 6$ (one equation is redundant) as a SUR system under the assumption that the disturbances are serially uncorrelated and have a constant covariance matrix. As can be seen from column 2 of Panel A of Table 1, there is little evidence of autonomous trends in the prices and a test of the joint significance of the intercepts gives $\chi^2 = 5.75$, less than the 5-percent critical value of $\chi^2(6)$ of 12.59. When the trends are suppressed, there is little change in estimates of the remaining parameters (column 5). The estimate of β'_i for bananas is negative and highly significant, mandarins and rockmelons have significantly positive β'_i , while those of the other fruits are insignificant. The parameter κ' is estimated to be -0.41 and highly significant. The

² For example, the Rotterdam model under preference independence has on the right-hand side of its i^{th} equation the change in the deflated price of good i , $z_{it} = Dp_{it} - DP'_i$, where the deflator is the Frisch price index defined as $DP'_i = \sum_{j=1}^n \theta_j Dp_{jt}$, with $\theta_j = \partial(p_j q_j) / \partial M$ is the marginal share. The reciprocal version of this model has z_{it} on the left-hand side, but not a similarly marginally-deflated quantity on the right (Theil, 1976, Sec 9.5). The same comment applies to the CBS system of Keller (1984) and Keller and van Driel (1985). It is to be noted that there is a related concept of self-duality of preferences. Preferences are self-dual if the utility function $u(q)$ has the same form as the indirect utility function $v(\tilde{p})$, where $q = [q_i]$ and $\tilde{p} = [p_i/M]$, which implies that the direct and inverse demand systems, $q = f(\tilde{p})$, $\tilde{p} = g(q)$, also have the same form by satisfying $q \equiv f(f(q))$, $\tilde{p} \equiv g(g(\tilde{p}))$. For details, see Houthakker (1965) and Sato (1976). The differences between self-duality and self-reflectivity are that (i) the former applies to levels of variables, while the latter applies to differentials; and (ii) differential demand systems are not associated with any particular algebraic form of the utility function.

³ For the sources and a listing of the data, see the Appendix.

own-price flexibilities, evaluated at mean budget shares $\bar{\bar{w}}_i$, lie between -0.3 and -0.4, which is a reasonable range. For comparison, Panel B of the table presents the estimates of the corresponding direct demand equations and the last column reveals that the own-price elasticities are scattered around -0.4. As these are too low (in absolute value) for such finely disaggregated goods as individual fruits (Clements, 2008), this would seem to favour the inverse model.⁴

4. Cyclone Larry and Fruit Eaters

In mid 2006 Severe Tropical Cyclone Larry destroyed a large part of Australia's banana plantations, which caused banana prices to increase by a factor of more than four (see Panels A and B of Figure 1) and to possibly have spillover effects on the prices of related fruits.⁵ Table 2 contains summary measures of the fruit basket. Columns 2 and 3 give the Divisia price and volume indexes, defined above, while columns 4 and 5 contain the corresponding variances:

$$V_{pt} = \sum_{i=1}^7 \bar{w}_{it} (Dp_{it} - DP_t)^2, \quad V_{qt} = \sum_{i=1}^7 \bar{w}_{it} (Dq_{it} - DQ_t)^2. \quad (4.1)$$

The Divisia price-quantity correlation, defined as $\rho_t = V_{pqt} / \sqrt{V_{pt} V_{qt}}$, where $V_{pqt} = \sum_{i=1}^7 \bar{w}_{it} (Dp_{it} - DP_t)(Dq_{it} - DQ_t)$, is given in column 6. As can be seen, the majority of the correlations are negative, indicating the tendency of consumers to move away from (toward) those fruits with above- (below-) average price increases.

As bananas account for almost 40 percent of purchases of fruit (see Table 5), the large price increases caused by Larry had substantial negative impacts on fruit eaters. But part of the reduction in consumer surplus is a transfer to surviving banana producers and if we net out the transfer, the welfare cost remains. This can be expressed as $W = -\frac{1}{2} \Delta p' S \Delta p$, where Δp is a vector of price changes attributable to Larry and S is the corresponding substitution matrix (Harberger, 1964). It can be shown (see Appendix) that Selvanathan's model implies that the welfare cost as a fraction of income takes the simple form:

$$\frac{W}{M} = -\frac{\kappa}{2} V_{pt}, \quad (4.2)$$

⁴ Consider the simple regression $y = \alpha + \beta x + \varepsilon$ and its inverse $x = \alpha' + \beta' y + \varepsilon'$. It is known (Berndt, 1976) that (i) both regressions have the same value of R^2 ; and (ii) $\hat{\beta} \cdot \hat{\beta}' = R^2$, where $\hat{\gamma}$ denotes the OLS estimate of the coefficient γ , $\gamma = \beta, \beta'$. The intuition is that if the model fits the data well, so that $R^2 \approx 1$, the observations are "close" to the regression line, the direction of minimisation of the sum of squared residuals is unimportant and the OLS estimate of the reciprocal coefficient $\hat{\beta}'$ is approximately equal to the inverse of the direct estimate $1/\hat{\beta}$; and as the quality of the fit declines, the latter approximation becomes worse. Our estimate of the elasticity of substitution and its inverse are both of the order of 0.4. Although our case is a multivariate equation system, these results could be loosely interpreted as saying that an overall measure of fit of the system is something like 0.4² or 16 percent.

⁵ Imports of bananas into Australia are prohibited by quarantine regulations.

where V_{pt} is the Divisia price variance (4.1). In words, the welfare cost is proportional to the Divisia price variance, where the proportionality factor is $-\kappa/2$. Selvanathan's model means that the cross-price terms in the general expression for the welfare cost are transformed into the Divisia price index in the variance, so that the quadratic form becomes a (weighted) sum of squares.

A back-of-the-envelope calculation is sufficient to illustrate the application of (4.2) to the cost of Larry. From Table 1, the estimate of κ' is not significantly different from minus one half, so the term $-\kappa/2 \approx 1$. Next, we interpret the increase in V_{pt} during 2006 as attributable to Larry. From Panel C of Figure 1, this increase is approximately $0.7^2 - 0.3^2 = 0.4$. Accordingly, $W/M \approx 40$ percent. In words, the lost consumer surplus not offset by transfers to surviving banana producers is roughly 40 percent of total expenditure on fruits.

APPENDIX

Data

The price and quantity data are from the Perth Market Authority, Canning Vale, Western Australia (www.perthmarket.com.au). The prices are reported as the weekly averages, which we convert into monthly averages. The quantity data relate to gross throughput volumes, recorded in kilograms. These are converted into per capita quantities by dividing by the estimated Perth population, derived by interpolating the annual data published by the Australian Bureau of Statistics (catalogue number 3105.0.65.001). The data are listed in Tables 3-5.

Derivations

This section starts with differential demand equations and then derives the welfare cost implied by Selvanathan's model, equation (4.2) of the text.

Demand Equations

A Marshallian demand equation for good i is $q_i = q_i(M, p_1, \dots, p_n)$, which can be written in differential form as $dq_i = (\partial q_i / \partial M) dM + \sum_j (\partial q_i / \partial p_j) dp_j$. Defining s_{ij} as the compensated price slope of the demand equation and using the Slutsky decomposition $\partial q_i / \partial p_j = s_{ij} - q_j (\partial q_i / \partial M)$, we have

$$dq_i = \frac{\partial q_i}{\partial M} \left(dM - \sum_j q_j dp_j \right) + \sum_{j=1}^n s_{ij} dp_j.$$

Multiplying both sides of the above equation by p_i/M and using the identity $dx/x = d(\log x)$, we obtain

$$w_i d(\log q_i) = \theta_i d(\log Q) + \sum_{j=1}^n \pi_{ij} d(\log p_j), \quad (\text{A1})$$

where $\theta_i = \partial(p_i q_i) / \partial M$ is the i^{th} marginal share, $d(\log Q) = d(\log M) - \sum_j w_j d(\log p_j)$ and $\pi_{ij} = (p_i p_j / M) s_{ij}$ is the $(i, j)^{\text{th}}$ Slutsky coefficient. The term $d(\log Q)$ is the change in real income, that is, the change in money income, $d(\log M)$, deflated by a budget-share weighted average of the price changes, $\sum_j w_j d(\log p_j)$, which is the Divisia price index. Accordingly, the income effects of the price changes transform money income into real income.

Selvanathan's Model

Consider the i^{th} equation of the infinitesimal-change version of Selvanathan's (1985) model:

$$w_i [d(\log q_i) - d(\log Q)] = \beta_i d(\log Q) + \kappa w_i [d(\log p_i) - d(\log P)], \quad (\text{A2})$$

where $\beta_i = \theta_i - w_i$ is an income coefficient, $\kappa < 0$ is the elasticity of substitution and $d(\log P) = \sum_j w_j d(\log p_j)$ is the Divisia price index. The $(i, j)^{\text{th}}$ Slutsky coefficient implied by equation (A2) is

$$\pi_{ij} = \kappa w_i (\delta_{ij} - w_j), \quad (\text{A3})$$

where δ_{ij} is the Kronecker delta.

The Welfare Cost

If on account of some distortion, the n prices change by $dp_1, \dots, dp_n$, then Harberger's (1964) measure of the welfare cost is $W = -(1/2) \sum_i \sum_j (dp_i) s_{ij} (dp_j)$. Using $\pi_{ij} = (p_i p_j / M) s_{ij}$, this can be expressed equivalently as

$$\frac{W}{M} = -\frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n d(\log p_i) \pi_{ij} d(\log p_j). \quad (\text{A4})$$

In words, the welfare cost as a fraction of income is proportional to a quadratic form in the n price log-changes, with proportionality factor $-1/2$. The matrix in this quadratic form is the $n \times n$ Slutsky matrix $[\pi_{ij}]$. As this matrix is negative semidefinite with rank $n-1$ (it is singular because of homogeneity), the welfare cost (A4) is nonnegative; it is zero when all prices change proportionately.

When the Slutsky coefficients take the form (A3), the cost (A4) becomes

$$\frac{W}{M} = -\frac{\kappa}{2} \sum_{i=1}^n \sum_{j=1}^n d(\log p_i) w_i (\delta_{ij} - w_j) d(\log p_j) = -\frac{\kappa}{2} \sum_{i=1}^n w_i d(\log p_i) [d(\log p_i) - d(\log P)]$$

The term on the far right of the above can be written as

$$-\frac{\kappa}{2} \left\{ \sum_{i=1}^n w_i [d(\log p_i) - d(\log P)]^2 + \sum_{i=1}^n w_i d(\log P) [d(\log p_i) - d(\log P)] \right\}.$$

As $\sum_i w_i d(\log P) [d(\log p_i) - d(\log P)] = 0$, we have

$$\frac{W}{M} = -\frac{\kappa}{2} \sum_{i=1}^n w_i [d(\log p_i) - d(\log P)]^2 = -\frac{\kappa}{2} V_p,$$

where V_p is the Divisia price variance defined in equation (4.1) of the text (which has a time subscript added). This verifies equation (4.2).

An alternative way of establishing the same result is as follows. The Slutsky matrix implied by Selvanathan's model is $\Pi = \kappa W (I - \mathbf{u}'W)$, where W is an $n \times n$ diagonal matrix with the budget shares on the main diagonal, I is an identity matrix and $\mathbf{u}$ is a vector of unit elements. Let $\mathbf{p} = [d(\log p_i)]$ be a vector of the n price log-changes, so that $\mathbf{p}'W\mathbf{p} = \sum_i w_i [d(\log p_i)]^2$ and $\mathbf{p}'W\mathbf{u}'W\mathbf{p} = [d(\log P)]^2$. Then

$$\frac{W}{M} = -\frac{1}{2} \mathbf{p}'\Pi\mathbf{p} = -\frac{\kappa}{2} \mathbf{p}'W(I - \mathbf{u}'W)\mathbf{p} = -\frac{\kappa}{2} \left\{ \sum_i w_i [d(\log p_i)]^2 - [d(\log P)]^2 \right\},$$

which equals $-(\kappa/2)V_p$.

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TABLE 1
INVERSE AND DIRECT FRUIT DEMAND EQUATIONS

(Standard errors in parenthesis)

Fruit	With intercepts			Without intercepts	
	Intercept	Scale/Income	Own-price flexibility/ elasticity of demand	Scale/Income	Own-price flexibility/ elasticity of demand
	α_i', α_i	β_i', β_i	$\kappa'(1-\bar{w}_i), \kappa(1-\bar{w}_i)$	β_i', β_i	$\kappa'(1-\bar{w}_i), \kappa(1-\bar{w}_i)$
(1)	(2)	(3)	(4)	(5)	(6)
A. Inverse: $\bar{w}_{it} \left(Dp_{it} - DP_t \right)_t = \alpha_i' + \beta_i' DQ_t + \kappa' \bar{w}_{it} \left(Dq_{it} - DQ_t \right) + \varepsilon_{it}$					
Bananas	-1.107 (1.551)	-31.608 (5.671)	-0.258 (0.027)	-30.036 (5.030)	-0.253 (0.027)
Grapes	0.452 (0.765)	2.925 (2.683)	-0.371 (0.039)	2.203 (2.342)	-0.363 (0.038)
Pears	-0.127 (0.246)	0.770 (0.873)	-0.402 (0.042)	1.018 (0.765)	-0.393 (0.041)
Apples	-1.405 (1.140)	5.616 (4.030)	-0.325 (0.034)	8.125 (3.574)	-0.319 (0.034)
Oranges	0.585 (0.950)	6.841 (3.356)	-0.368 (0.038)	5.944 (2.937)	-0.361 (0.038)
Mandarins	1.400 (0.817)	12.231 (2.830)	-0.390 (0.041)	9.840 (2.517)	-0.382 (0.040)
Rockmelons	0.203 (0.290)	3.224 (1.023)	-0.399 (0.042)	2.907 (0.888)	-0.390 (0.041)
-1/(Elasticity of substitution)	$\kappa' = -0.419 \text{ (0.044)}$			$\kappa' = -0.410 \text{ (0.043)}$	
B. Direct: $\bar{w}_{it} \left(Dq_{it} - DQ_t \right)_t = \alpha_i + \beta_i DQ_t + \kappa \bar{w}_{it} \left(Dp_{it} - DP_t \right) + \varepsilon_{it}$					
Bananas	0.919 (1.158)	18.221 (4.479)	-0.273 (0.025)	16.617 (3.976)	-0.274 (0.025)
Grapes	-0.608 (0.576)	-4.554 (2.020)	-0.392 (0.036)	-3.513 (1.775)	-0.393 (0.036)
Pears	-0.192 (0.226)	-2.822 (0.793)	-0.425 (0.039)	-2.493 (0.699)	-0.426 (0.039)
Apples	-2.573 (1.097)	-11.513 (3.862)	-0.344 (0.032)	-7.114 (3.569)	-0.345 (0.031)
Oranges	0.012 (0.709)	-6.869 (2.517)	-0.390 (0.036)	-6.882 (2.198)	-0.391 (0.036)
Mandarins	2.776 (1.311)	9.454 (4.592)	-0.413 (0.038)	4.726 (4.191)	-0.414 (0.038)
Rockmelons	-0.335 (0.315)	-1917 (1.114))	-0.422 (0.039)	-1342 (0.981)	-0.422 (0.039)
-Elasticity of substitution	$\kappa = -0.443 \text{ (0.041)}$			$\kappa = -0.444 \text{ (0.041)}$	

Note: All intercepts and scale/income coefficients and their corresponding standard errors are to be divided by 100.

FIGURE 1

QUANTITY CONSUMED AND PRICE OF BANANAS AND
DISPERSION OF FRUIT PRICES: PERTH, 2002 - 2006

TABLE 2
DIVISIA MOMENTS OF FRUIT

Month	Indexes $\times 100$		Variances $\times 100^2$		Price-quantity correlation
	Prices	Quantities	Prices	Quantities	
(1)	DP_t (2)	DQ_t (3)	V_{pt} (4)	V_{qt} (5)	ρ_t (6)
2003					
Jan	-6.95	5.70	550.79	826.73	-0.56
Feb	-23.27	21.88	409.84	274.21	-0.49
Mar	-26.69	33.53	404.40	4099.47	-0.08
April	-4.41	7.54	1388.88	1796.90	-0.45
May	-15.25	-18.75	290.26	1472.34	-0.69
June	-20.65	-5.36	646.55	1633.11	-0.02
July	-30.68	-26.59	1094.54	3376.55	-0.20
Aug	-39.62	2.27	1529.77	2164.08	-0.47
Sept	-41.45	-8.04	2444.77	1533.73	-0.28
Oct	-25.66	12.54	2128.97	769.27	-0.81
Nov	3.34	-15.10	1921.94	622.01	-0.75
Dec	-12.51	-3.18	1097.33	432.12	-0.64
2004					
Jan	-45.95	-7.74	1771.28	1974.57	-0.54
Feb	-26.15	2.35	840.39	211.07	0.05
Mar	4.03	-19.60	335.69	617.22	-0.41
April	-3.77	-29.83	842.09	1899.64	0.03
May	0.79	-11.75	173.21	524.18	-0.10
June	-6.91	-19.65	967.45	1268.19	-0.06
July	15.08	-9.83	1096.77	2271.71	-0.24
Aug	11.91	-8.73	754.34	1314.04	-0.05
Sept	12.51	-11.16	928.36	1347.76	0.00
Oct	13.78	-36.77	544.37	468.75	0.54
Nov	25.64	-4.54	1501.91	516.88	-0.77
Dec	11.71	-8.31	666.05	413.20	-0.25
2005					
Jan	21.77	-23.48	722.87	2290.98	-0.20
Feb	22.50	-25.46	355.53	1579.36	-0.09
Mar	-0.26	-8.38	285.74	951.92	-0.23
April	1.09	13.33	693.26	1556.76	0.02
May	-2.87	11.75	363.54	1861.11	-0.71
June	0.84	-2.67	325.92	261.67	-0.28
July	-16.76	-20.31	399.07	924.35	0.12
Aug	20.01	6.89	824.59	311.22	-0.15
Sept	29.76	0.09	1643.64	1261.63	-0.60
Oct	23.60	3.96	1554.15	986.34	-0.51
Nov	-36.11	6.73	2041.37	601.52	-0.68
Dec	-29.10	-26.72	2105.78	80.08	0.22
2006					
Jan	-0.62	36.99	882.35	23376.83	0.10
Feb	8.88	-25.17	1548.78	850.47	-0.33
Mar	19.88	-12.74	1384.35	602.22	-0.09
April	59.40	-29.73	4634.76	2517.26	-0.71
May	84.03	-77.12	9721.02	6317.30	-0.94
June	82.96	-54.33	9893.95	4018.19	-0.97
July	91.40	-42.81	10004.17	6956.40	-0.97
Aug	71.09	-80.09	6302.32	7077.27	-1.00
Sept	72.89	-70.58	4594.44	5106.77	-0.99
Oct	81.99	-60.68	3273.42	2911.36	-0.96
Nov	98.85	-30.49	4628.24	1371.20	-0.98
Dec	61.17	-3.21	5197.56	1229.55	-0.84
Mean	11.15	-14.03	2035.64	2225.61	-0.40

TABLE 3
PRICES AND QUANTITIES CONSUMED OF SEVEN FRUITS

Month	Price (Dollars per kilogram)							Quantity (Kilograms per capita)						
	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons
2002														
Jan	2.41	2.90	1.85	3.16	0.91	3.00	0.60	1.07	0.70	0.05	0.43	0.47	0.09	0.55
Feb	2.77	1.87	1.23	3.07	0.76	2.43	0.58	0.81	0.55	0.13	0.38	0.44	0.02	0.39
Mar	2.76	1.44	0.87	1.52	0.85	1.92	0.91	0.86	0.48	0.25	0.70	0.31	0.00	0.36
April	2.27	1.60	0.75	1.46	1.02	1.82	0.71	0.78	0.40	0.25	1.09	0.32	0.06	0.23
May	2.05	2.15	0.78	1.49	1.35	2.32	0.70	0.96	0.39	0.39	1.07	0.40	0.47	0.36
June	2.72	2.90	0.84	1.50	0.92	1.81	0.69	0.85	0.09	0.23	1.12	0.50	0.37	0.25
July	2.32	2.65	1.06	1.87	0.77	1.55	1.32	0.83	0.04	0.29	1.54	1.12	0.33	0.17
Aug	2.83	2.55	0.95	1.80	0.63	2.05	1.58	0.80	0.02	0.29	0.94	0.66	0.37	0.20
Sept	2.77	2.42	0.99	2.14	0.87	1.78	0.80	0.80	0.00	0.20	0.97	0.53	0.25	0.29
Oct	2.35	2.38	1.03	1.99	0.95	1.32	1.08	1.11	0.00	0.21	0.70	0.94	0.15	0.17
Nov	1.99	2.67	1.11	1.67	1.33	1.90	1.42	0.95	0.08	0.20	0.71	0.61	0.07	0.19
Dec	2.06	4.94	1.39	2.13	1.26	2.81	1.11	1.14	0.39	0.24	0.53	0.53	0.04	0.26
2003														
Jan	2.28	3.49	1.23	1.95	0.97	2.31	0.52	1.11	0.62	0.11	0.64	0.55	0.02	0.67
Feb	2.26	1.89	0.74	1.72	0.77	1.85	0.46	1.14	0.54	0.14	0.50	0.40	0.04	0.43
Mar	1.72	1.48	0.85	1.32	0.81	1.70	0.65	1.21	0.54	0.16	0.86	0.46	0.08	0.56
April	1.36	1.65	0.64	1.95	0.90	2.55	1.30	1.09	0.42	0.26	0.70	0.39	0.18	0.24
May	1.50	2.15	0.72	1.43	1.20	1.75	1.13	1.00	0.20	0.36	0.63	0.64	0.40	0.11
June	1.76	3.41	0.76	1.26	1.23	1.35	0.63	1.01	0.06	0.27	0.56	0.75	0.39	0.13
July	1.48	2.75	0.72	1.13	1.19	1.24	0.71	1.16	0.01	0.15	0.62	0.59	0.41	0.19
Aug	1.42	2.96	0.77	1.16	1.08	1.73	0.84	1.32	0.00	0.17	0.55	0.60	0.29	0.21
Sept	1.09	2.98	0.95	1.45	1.40	1.21	0.81	1.10	0.00	0.18	0.53	0.59	0.17	0.27
Oct	1.07	3.49	1.14	1.99	1.34	1.42	1.15	1.58	0.00	0.21	0.80	0.67	0.11	0.21
Nov	1.16	4.37	1.58	2.58	1.72	1.50	1.67	1.09	0.04	0.15	0.59	0.38	0.04	0.16
Dec	1.33	3.60	2.28	3.00	1.43	1.73	1.06	1.19	0.42	0.09	0.46	0.54	0.03	0.27
2004														
Jan	0.93	1.91	2.25	1.97	1.04	1.31	0.49	1.24	0.60	0.09	0.39	0.36	0.17	0.38
Feb	1.30	1.72	1.03	1.68	0.61	0.98	0.64	1.10	0.66	0.12	0.47	0.35	0.09	0.45
Mar	1.60	1.47	0.88	1.51	0.87	1.06	1.13	1.05	0.48	0.28	0.55	0.51	0.05	0.32
April	1.50	1.90	0.82	1.93	0.94	1.11	0.63	0.70	0.33	0.20	0.53	0.39	0.04	0.49
May	1.49	2.50	0.77	1.63	0.92	1.80	1.13	0.89	0.21	0.19	0.65	0.66	0.22	0.14
June	1.31	2.42	0.84	1.89	0.89	1.41	1.22	0.74	0.15	0.18	0.45	0.44	0.40	0.08

TABLE 3 (cont)
PRICES AND QUANTITIES CONSUMED OF SEVEN FRUITS

Month	Price (Dollars per kilogram)							Quantity (Kilograms per capita)						
	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons
July	1.65	2.69	0.93	2.00	0.69	1.72	0.91	1.00	0.07	0.25	0.47	0.57	0.28	0.13
Aug	1.51	2.99	1.08	2.00	0.76	1.78	1.03	0.97	0.03	0.14	0.55	0.66	0.31	0.17
Sept	1.37	2.65	1.20	2.09	0.84	1.53	1.02	0.97	0.00	0.21	0.34	0.50	0.37	0.13
Oct	1.51	2.90	1.33	2.20	0.93	1.67	1.15	1.22	0.00	0.18	0.45	0.36	0.11	0.21
Nov	2.19	6.63	1.37	3.56	1.12	1.23	0.99	0.82	0.05	0.25	0.56	0.40	0.07	0.21
Dec	1.99	3.85	1.20	3.43	1.15	1.26	0.83	1.12	0.32	0.19	0.46	0.43	0.02	0.29
2005														
Jan	1.50	2.18	1.15	2.70	0.98	1.05	0.73	0.77	0.53	0.13	0.32	0.47	0.01	0.39
Feb	1.72	1.76	0.63	2.44	0.97	1.91	0.68	0.95	0.46	0.12	0.39	0.35	0.00	0.29
Mar	1.58	1.42	1.01	1.24	1.24	1.89	0.95	1.02	0.46	0.15	0.46	0.51	0.00	0.38
April	1.42	1.73	0.76	1.95	0.78	3.71	0.81	1.06	0.38	0.20	0.42	0.64	0.08	0.21
May	1.16	2.58	0.75	1.66	1.28	1.97	1.06	1.44	0.22	0.20	0.45	0.36	0.39	0.22
June	1.13	2.62	0.75	1.67	1.26	1.67	1.09	0.84	0.11	0.20	0.38	0.45	0.34	0.13
July	1.30	2.65	0.83	1.40	0.89	1.36	1.07	0.71	0.02	0.15	0.39	0.60	0.35	0.10
Aug	2.35	3.08	0.92	1.65	1.19	1.66	1.43	1.06	0.01	0.23	0.62	0.59	0.31	0.22
Sept	2.63	3.08	0.80	1.50	1.14	2.20	1.27	0.91	0.00	0.22	0.59	0.48	0.19	0.18
Oct	2.61	3.16	0.85	1.55	1.15	1.55	1.93	1.06	0.00	0.17	0.57	0.70	0.15	0.12
Nov	1.53	8.50	1.05	1.45	1.34	1.32	1.95	1.04	0.04	0.17	0.66	0.40	0.07	0.11
Dec	1.24	4.42	1.08	1.21	1.46	1.33	1.01	0.90	0.26	0.12	0.32	0.28	0.01	0.24
2006														
Jan	1.35	3.10	0.95	1.70	0.73	1.19	0.91	0.71	0.40	0.09	0.34	0.27	0.93	0.18
Feb	1.73	3.25	1.45	1.70	0.68	1.38	0.77	0.56	0.33	0.12	0.42	0.32	0.02	0.25
Mar	2.49	2.09	1.15	1.44	0.63	4.74	0.70	0.74	0.46	0.23	0.55	0.47	0.00	0.21
April	5.31	1.86	0.67	3.00	0.60	1.34	1.11	0.46	0.24	0.18	0.59	0.59	0.10	0.20
May	8.44	2.58	0.75	1.63	1.09	2.19	1.12	0.28	0.21	0.20	0.39	0.54	0.26	0.05
June	9.13	2.64	0.75	1.50	1.46	1.85	1.78	0.23	0.12	0.22	0.49	0.37	0.24	0.06
July	11.65	4.23	0.84	1.47	1.39	1.24	1.17	0.16	0.02	0.20	0.62	0.66	0.33	0.14
Aug	11.32	3.99	0.89	1.50	1.31	1.57	1.42	0.19	0.01	0.19	0.62	0.60	0.31	0.19
Sept	10.58	3.99	1.03	1.73	1.31	1.82	0.99	0.22	0.00	0.19	0.54	0.50	0.22	0.20
Oct	9.66	4.65	1.76	1.80	1.64	1.90	1.14	0.36	0.00	0.18	0.59	0.60	0.13	0.16
Nov	8.00	8.88	1.74	2.45	2.31	1.59	1.13	0.53	0.05	0.18	0.60	0.42	0.06	0.15
Dec	4.92	3.40	1.75	2.93	1.10	1.39	1.38	0.56	0.33	0.14	0.42	0.41	0.02	0.25
Mean	2.85	3.00	1.05	1.90	1.07	1.76	1.02	0.89	0.23	0.19	0.59	0.51	0.18	0.24

TABLE 4
LOG CHANGES IN PRICES AND QUANTITIES OF SEVEN FRUITS

Month	Price							Quantity						
	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons
2003														
Jan	-5.75	18.45	-40.77	-48.27	7.07	-26.20	-13.81	4.03	-12.03	86.59	39.45	15.11	-129.49	18.87
Feb	-20.48	0.89	-50.80	-58.02	0.39	-27.27	-23.23	33.90	-1.13	9.67	26.60	-7.69	73.95	10.58
Mar	-46.96	2.98	-2.91	-14.14	-5.77	-12.49	-33.89	34.51	10.95	-43.97	21.69	37.65	549.47	44.75
April	-51.12	3.02	-16.64	29.06	-12.00	33.54	59.74	33.96	4.88	0.38	-43.54	22.28	119.42	3.21
May	-31.42	-0.16	-8.47	-3.67	-12.09	-27.75	46.84	3.73	-63.83	-6.71	-53.41	45.53	-17.10	-116.47
June	-43.67	16.27	-9.61	-17.57	28.74	-29.23	-8.71	17.04	-48.62	17.35	-69.57	40.13	6.69	-61.92
July	-45.07	3.60	-38.22	-50.84	43.47	-22.11	-61.73	33.90	-195.49	-65.16	-90.90	-63.38	21.40	8.34
Aug	-69.10	15.18	-21.33	-44.09	54.23	-16.99	-62.96	50.07	-219.23	-51.98	-54.42	-8.54	-24.93	6.64
Sept	-93.09	20.96	-3.87	-39.01	47.22	-38.73	1.94	31.70	-100.30	-10.79	-60.83	10.75	-35.64	-10.62
Oct	-79.04	38.31	9.83	-0.33	34.32	7.40	6.34	35.58	269.65	-0.01	13.58	-34.70	-34.22	20.13
Nov	-54.13	49.24	35.54	43.82	26.13	-23.64	16.42	13.33	-64.40	-26.39	-17.36	-47.84	-60.83	-17.00
Dec	-43.69	-31.62	49.15	34.48	12.35	-48.86	-4.51	3.62	7.90	-95.66	-13.28	1.45	-4.78	3.13
2004														
Jan	-89.38	-60.08	60.12	0.86	6.40	-56.96	-6.44	10.96	-3.77	-24.79	-49.70	-42.40	197.41	-57.48
Feb	-55.52	-9.69	32.63	-1.96	-22.69	-63.34	32.69	-3.39	19.10	-16.34	-6.19	-13.68	72.86	3.44
Mar	-7.49	-0.67	4.33	13.92	7.65	-46.86	55.51	-14.16	-11.86	52.90	-46.02	11.52	-59.81	-57.27
April	9.65	14.01	25.92	-1.29	4.45	-83.04	-72.60	-45.12	-23.81	-24.13	-28.04	-0.67	-165.02	70.78
May	-0.42	15.08	7.28	12.56	-26.93	2.43	0.71	-11.22	0.26	-65.80	2.82	3.07	-58.09	21.50
June	-29.70	-34.57	9.62	40.87	-32.07	4.59	65.79	-30.42	92.31	-41.33	-22.64	-53.43	2.00	-47.45
July	11.31	-2.04	25.50	57.38	-53.86	32.52	24.62	-15.39	259.89	48.67	-27.30	-2.94	-38.73	-39.29
Aug	6.34	0.86	33.65	54.62	-34.79	2.38	20.10	-30.58	279.27	-18.05	1.15	9.29	5.68	-23.58
Sept	22.91	-11.80	23.09	36.72	-50.69	24.09	22.41	-12.17	69.67	19.36	-43.86	-17.51	75.74	-72.53
Oct	34.51	-18.38	15.67	10.20	-36.89	16.30	-0.74	-25.79	-181.67	-13.47	-56.96	-62.56	4.41	1.28
Nov	63.52	41.64	-14.59	32.07	-42.82	-19.56	-52.09	-28.53	15.53	50.27	-6.30	6.82	58.01	25.90
Dec	40.06	6.50	-63.97	13.25	-21.73	-31.38	-24.73	-6.00	-27.47	72.72	-0.21	-22.31	-82.19	8.08
2005														
Jan	47.70	12.86	-67.12	31.69	-5.22	-21.53	39.95	-47.97	-10.93	39.31	-19.45	26.73	-259.55	2.78
Feb	28.27	2.39	-48.81	37.18	45.85	66.49	7.43	-14.67	-36.34	-1.28	-19.46	0.04	-377.54	-44.37
Mar	-0.97	-4.04	13.08	-19.92	35.19	57.71	-17.19	-3.19	-3.78	-59.67	-17.98	0.49	-358.60	16.71
April	-5.17	-9.41	-7.62	1.29	-18.71	120.53	25.51	41.99	13.13	-2.47	-24.32	49.22	77.46	-85.15
May	-25.26	3.29	-2.73	2.03	33.65	9.16	-6.69	48.22	6.57	5.80	-37.21	-58.95	55.34	45.13
June	-14.23	8.15	-11.54	-12.36	34.49	16.69	-11.16	12.28	-24.16	11.80	-15.82	2.33	-15.93	41.89

(continued on next page)

TABLE 4 (cont)
LOG CHANGES IN PRICES AND QUANTITIES OF SEVEN FRUITS

Month	Price							Quantity						
	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons	Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons
July	-24.46	-1.55	-12.34	-35.67	24.53	-22.95	15.89	-34.08	-137.91	-47.41	-18.05	4.31	22.47	-19.25
Aug	44.22	3.12	-15.61	-19.03	44.67	-6.89	32.42	8.91	-102.18	48.46	11.18	-10.47	1.17	26.50
Sept	65.08	15.24	-40.27	-33.33	30.23	36.20	22.32	-7.04	152.73	0.81	54.53	-4.54	-67.64	31.95
Oct	54.92	8.65	-45.51	-35.02	21.47	-7.26	52.07	-14.06	177.82	-6.94	21.96	66.88	29.13	-56.48
Nov	-36.14	24.92	-26.36	-89.59	17.69	6.51	67.50	24.15	-30.41	-37.59	16.30	-1.52	3.61	-64.60
Dec	-47.43	13.84	-10.62	-104.19	23.76	5.56	20.19	-21.94	-19.35	-45.74	-35.20	-42.60	-56.65	-20.40
2006														
Jan	-10.35	35.51	-19.11	-46.26	-29.73	12.36	21.92	-7.42	-28.98	-39.02	7.40	-55.29	430.43	-77.76
Feb	0.72	61.43	83.21	-36.21	-35.91	-32.48	11.50	-52.75	-31.04	-1.81	7.84	-9.13	226.19	-13.61
Mar	45.08	38.93	12.95	14.73	-68.31	91.99	-29.56	-31.49	0.60	40.24	18.11	-9.49	11.39	-57.58
April	131.82	7.20	-12.80	42.94	-26.65	-101.75	31.80	-82.81	-44.80	-6.07	35.35	-8.07	26.51	-3.55
May	198.39	0.00	0.00	-1.51	-16.33	10.82	5.57	-162.30	-5.74	3.05	-14.74	39.91	-37.56	-144.49
June	208.81	0.67	0.00	-10.93	15.02	10.33	49.20	-129.86	7.44	10.56	24.92	-20.38	-35.71	-74.33
July	219.69	46.71	2.00	4.66	45.13	-9.43	8.79	-149.48	18.23	23.38	45.78	9.95	-6.97	27.87
Aug	157.05	25.85	-4.24	-9.74	9.89	-5.60	-0.34	-171.33	-12.38	-18.51	0.47	1.16	-1.66	-13.92
Sept	138.99	25.85	24.78	13.98	14.00	-19.23	-25.47	-140.86	-128.53	-11.81	-7.98	5.24	17.55	10.74
Oct	130.94	38.50	73.29	14.95	35.72	20.36	-52.32	-108.62	-114.21	7.67	4.34	-14.47	-19.77	32.42
Nov	165.70	4.41	50.22	52.08	54.17	18.79	-54.56	-67.25	26.83	5.34	-9.04	5.38	-20.82	35.44
Dec	137.92	-26.28	48.35	88.69	-27.90	4.27	31.21	-46.59	21.92	17.50	25.47	38.39	80.43	6.12
Mean	21.53	8.63	0.92	-1.02	3.68	-3.97	4.87	-22.39	-4.78	-4.40	-11.06	-3.31	4.16	-13.64

Note: All entries are to be divided by 100.

TABLE 5
CONDITIONAL BUDGET SHARES OF SEVEN FRUITS

Month		Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons	Month		Bananas	Grapes	Pears	Apples	Oranges	Mandarins	Rockmelons
2002	Jan	36.44	28.69	1.26	19.25	6.06	3.61	4.69	2005	Jan	28.18	28.46	3.70	21.12	11.31	0.32	6.90
	Feb	43.08	19.70	3.06	22.48	6.40	0.97	4.31		Feb	40.89	20.07	1.89	23.59	8.55	0.10	4.92
	Mar	48.02	14.02	4.49	21.41	5.41	0.01	6.63		Mar	40.61	16.30	3.88	14.22	15.98	0.06	8.96
	April	36.95	13.42	4.00	33.26	6.73	2.13	3.50		April	36.94	16.00	3.66	19.96	12.30	6.98	4.16
	May	29.92	12.65	4.56	24.21	8.29	16.50	3.87		May	36.49	12.33	3.23	16.13	10.18	16.54	5.09
	June	40.15	4.74	3.31	29.22	8.02	11.58	2.98		June	28.72	9.04	4.53	19.21	17.05	17.27	4.17
	July	28.15	1.48	4.56	42.29	12.61	7.59	3.32		July	33.13	1.75	4.61	19.92	19.23	17.36	4.00
	Aug	39.22	0.75	4.81	29.42	7.10	13.25	5.46		Aug	47.08	0.65	4.08	19.30	13.30	9.70	5.89
	Sept	39.35	0.02	3.46	36.96	8.25	7.79	4.17		Sept	51.57	0.11	3.74	19.08	11.72	8.93	4.85
	Oct	47.35	0.01	3.87	25.42	16.33	3.69	3.33		Oct	54.65	0.18	2.80	17.33	15.81	4.69	4.54
	Nov	40.11	4.65	4.67	24.92	17.14	2.85	5.67		Nov	40.91	8.16	4.70	24.59	13.78	2.43	5.44
	Dec	34.73	28.33	4.84	16.50	9.88	1.48	4.23		Dec	32.12	33.69	3.71	11.33	11.89	0.33	6.93
2003	Jan	36.08	30.81	2.00	17.75	7.62	0.77	4.97	2006	Jan	22.23	28.61	1.95	13.49	4.55	25.45	3.72
	Feb	49.93	19.92	2.06	16.64	6.03	1.57	3.85		Feb	28.77	32.19	5.05	21.03	6.45	0.81	5.70
	Mar	41.51	15.78	2.75	22.61	7.29	2.82	7.24		Mar	42.94	22.34	6.09	18.23	6.78	0.16	3.46
	April	30.61	14.28	3.34	28.30	7.33	9.67	6.46		April	44.51	8.11	2.24	32.23	6.42	2.43	4.07
	May	31.94	9.39	5.52	19.27	16.32	14.84	2.72		May	48.54	10.80	3.09	12.71	11.95	11.74	1.18
	June	40.12	4.48	4.66	15.94	20.83	12.05	1.92		June	47.55	7.37	3.79	16.62	12.15	10.08	2.44
	July	44.10	0.38	2.84	17.96	18.10	13.21	3.41		July	41.02	2.05	3.64	20.24	20.46	9.04	3.55
	Aug	47.09	0.14	3.36	15.96	16.28	12.66	4.51		Aug	44.66	0.81	3.56	19.25	16.26	9.87	5.59
	Sept	35.40	0.02	4.96	22.64	24.47	6.15	6.36		Sept	49.46	0.04	4.16	19.79	13.88	8.58	4.09
	Oct	35.01	0.22	4.87	33.14	18.57	3.22	4.96		Oct	55.23	0.07	5.09	16.99	15.80	3.82	3.01
	Nov	30.00	4.49	5.75	36.52	15.52	1.38	6.34		Nov	55.15	5.62	4.12	19.05	12.59	1.20	2.26
	Dec	27.23	26.15	3.56	23.87	13.28	1.01	4.89		Dec	44.72	18.02	4.01	19.82	7.38	0.43	5.63
Mean										38.94	11.40	4.06	22.49	11.68	6.74	4.68	
2004	Jan	28.62	28.27	4.95	18.93	9.24	5.43	4.56									
	Feb	35.16	27.77	3.07	19.47	5.32	2.19	7.01									
	Mar	39.08	16.27	5.70	19.17	10.33	1.13	8.31									
	April	29.13	17.57	4.62	28.64	10.34	1.10	8.60									
	May	31.70	12.21	3.43	25.06	14.33	9.48	3.79									
	June	28.74	10.42	4.44	25.00	11.58	16.82	3.01									
	July	41.03	4.87	5.78	23.51	9.94	12.03	2.86									
	Aug	36.31	2.29	3.86	27.38	12.40	13.48	4.28									
	Sept	39.01	0.03	7.51	20.86	12.25	16.53	3.81									
	Oct	47.87	0.04	6.24	26.02	8.61	4.97	6.25									
	Nov	34.41	6.43	6.64	38.19	8.75	1.64	3.94									
	Dec	36.96	20.47	3.75	26.26	8.25	0.31	4.00									

Note: All entries are to be divided by 100.