SEASONALITY IN THE DEMAND FOR BANANAS

W. Aggrey-Mensah and J. W. B. Guise*

Weekly demand functions are estimated for bananas traded on the Sydney wholesale market using data for the period 1953 to 1967. Graphs of these functions suggest that the demand for bananas varies in a systematic fashion through the year. Further research will be required before it is possible to identify the specific dynamic factors responsible for these demand shifts. However, the short-run relationships which have been estimated provide quantitive information which could be used to evaluate the potential benefits to growers of a planned marketing program.

1 INTRODUCTION

The banana industry, like many other fruit industries in Australia, regularly encounters periods of glut and low prices followed by periods of shortage and high prices. Although the effects of supply and price instability partly offset each other, they still cause considerable variations in producers' income, and in many cases the average returns do not provide a reasonable standard of living [4].

While policies to restrict supplies through acreage controls and marketing quotas have been implemented, they have met with only limited success, partly because of lack of sufficient support from growers, and partly because of inadequate market information [11]. Few studies providing quantitative information on banana marketing have been reported. Van der Meulen [16] concluded that a monthly supply to the Sydney market in excess of 60,000 cases resulted in negative marginal revenues to the industry.[1] Phillips [15] examined the aggregate Australian market and found that the per capita supply which could be expected to produce zero marginal revenue was much lower than the quantities available in recent years.[2]

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* Departments of Agricultural Economics and Economic Statistics, University of New England. The paper has benefited from comments on an earlier draft by R. M. Parish, R. R. Piggott and other colleagues of the Faculty of Agricultural Economics.

[1] This is close to the minimum monthly quantity of bananas supplied to Sydney wholesale market during the period 1953 to 1967.

[2] However, when allowance was made for the variance of the estimate it was difficult to conclude with certainty that the actual supplies were more than the market could absorb at remunerative prices. Phillips' conclusions seem to be valid even though an error was made in the adjustment of prices to the farm level.

The studies by van der Meulen and Phillips suggest that if the demand situation were more fully understood, there could be considerable scope for rationalizing supply flows to market, as a means of improving growers' returns. Attempts to regulate supply flows to the market, along lines which now seem feasible in the light of recent technological advances (controlled atmosphere storage of bananas [5, p. 37]), would require a more detailed knowledge of inter- and intra-seasonal demand relationships. This study was therefore designed to supply the quantitative data on short-run demand relations required to evaluate some of the potential benefits of supply control programmes.

It is therefore not oriented toward a direct consideration of consumers' demand (as reflected by their behaviour at the retail shop) or toward a direct analysis of the price-quantity relations encountered by growers in disposing of their crop at the farm gate. Rather, the investigation attempts a statistical derivation of demand relations facing wholesale-ripeners who sell bananas at auction markets. The results obtained should be representative of the price-quantity relations at the terminal market level, since the bulk of bananas shipped from the producing areas are sold at auction markets.

The paper is divided into three major sections: the first part discusses the rationale of the demand model used; the second part presents the empirical study undertaken, and the results derived; and the third part discusses the validity and limitations of the study.

2 THE DEMAND MODEL

In this study, demand is conceived as the price-quantity relation facing wholesale sellers at Sydney auction markets. This assumption derives its main justification from the fact that traders with experience in interpreting and forecasting aggregate demand and supply are to be found in the wholesale market.

It is also assumed that weekly prices of bananas in the wholesale market are determined mainly by changes in the quantities of ripened fruit auctioned.[3] The direction of causation is taken to be from quantities to prices. Theoretically, this implies that weekly supplies of bananas are completely inelastic with respect to current week's price, and hence that current quantity supplied may be treated as a predetermined variable. This hypothesis is supported by the fact that current supplies of bananas depend upon biological, climatic and economic conditions operating prior to harvest, which normally occurs about two weeks before the actual market transaction [1]. Although there could be some feedback

[3] Van der Meulen [16, p. 157] found that 87 per cent of the variation in average monthly wholesale prices could be accounted for by associated variation in supplies.

from current price to current supply within a given week, reservation of ripening fruit from the market is strictly limited by the extreme perishability of the crop.[4]

The set of data on prices and quantities available at annual intervals for each week of the year was considered separately for the purpose of estimating parameters for the demand functions.[5] Year-to-year shifts of the inelastic weekly supply curves, along fairly stable demand curves, were assumed to have traced out a series of price-quantity points which could be used to identify the demand curves.

In addition to supply, several other explanatory variables which could affect the price of bananas were examined. Important demand shifters considered implicitly by the use of a time trend variable were changes in population, in consumer disposable income, and in tastes. Lagged banana price was examined explicitly, since it was thought that prices might exhibit a lagged response to changes in the quantities of bananas auctioned each week [13].

Further variables which have often been considered to be important determinants of banana prices are the prices of other fruits, particularly citrus, pome and stone fruits. If these prices are related to banana prices in any significant fashion, economic theory suggests that all prices would be determined simultaneously [12]. Other fruits have been excluded from the present study because of lack of reliable data, but their theoretical importance should be recognized.[6]

In view of the above considerations, the demand model was specified as:[7]

$$(1) \qquad P_t = \beta_o + \beta_1 Q_t + \beta_2 T + \beta_3 P_{t-1} + \varepsilon_t$$
$$(\beta_o > 0;\ \beta_1 < 0;\ 0 < \beta_3 < 1)$$

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[4] The assumption that perishable crops tend to have very inelastic supply curves in the short run has been fully discussed by Fox [8] in an empirical context, and it is in accord with the Marshallian "short-run" versus "long-run" analysis of adjustment to new market equilibria.

[5] Banana quality characteristics are affected by climatic conditions; hence bananas produced at different times of the year cannot be presumed to constitute a homogeneous product in a theoretical sense. The demand for the commodity, therefore, is conceived as a series of separate, though related demands corresponding to each week of the year.

[6] The study by Phillips attempted to analyse the influence of other fruits on banana prices, without making use of simultaneous equation techniques. The estimated regression coefficients were not significantly different from zero [15, p. 7].

[7] An obvious alternative to this specification is the log-linear form which was also examined but, despite its theoretical attractiveness, this did not appear to show any superiority over the ordinary linear form. The latter was therefore chosen. It is recognized that curvilinearity probably characterizes the underlying relations, but within the range of observations available for these analyses, the degree of curvilinearity is apparently rather slight.

where

P_t = wholesale price of bananas in week t,
Q_t = quantity of bananas marketed in week t,
T = time trend with units equal to one year,
P_{t-1} = wholesale price of bananas in week $_{t-1}$, and
ε_t = a random normal variable.

3 DATA SERIES AND TRANSFORMATIONS

Weekly price data relating to bananas traded on the Sydney market during the period 1953 to 1967 were obtained from official records compiled by the Division of Marketing and Agricultural Economics, New South Wales Department of Agriculture. Supply data were computed from records made available by the Banana Growers' Federation Co-operative Ltd. A detailed description of the data has been given elsewhere [1], so attention will be concentrated on the preliminary transformations carried out for the present analysis.

Since it was assumed that consumers respond to the level of real prices rather than the level of nominal prices, and because demand at the wholesale level is derived from consumer retail demand, the price series was deflated using the Food Component of the Consumer Price Index for Sydney.[8]

The data on supplies represented quantities consigned to the Sydney market rather than the quantity of bananas actually traded on the wholesale market each week. Since bananas consigned to Sydney usually spend from two to five days in transit and are held in special ripening rooms for a further three to sixteen days before auctioning, the supply data was adjusted to allow for this time lag in order to arrive at a reasonable approximation to the quantities actually traded each week. Discussion with wholesale merchants indicated that the time lag involved averaged out at approximately two weeks.[9]

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[8] The decision to make an allowance for changes in the prices of bananas relative to the general price level of food stuffs may be contrasted with the assumption of van der Meulen, who suggested that buyers and sellers tend to think in terms of nominal prices [16, p. 160]. Some comparative regression results, using both real and nominal prices were calculated for the present analysis. The explanations of nominal price changes were generally less satisfactory than the explanations of real price changes, with a time trend being an important factor in the explanation of nominal price changes. Two possible reasons for the differences in findings may be the much shorter time period considered (1952–57), and the fact that van der Meulen allowed for price level change by using the Wholesale Price Index of Basic Materials and Foodstuffs (All Groups).

[9] This observation was confirmed by the spectral study which showed that the quantity series led the price series by approximately two weeks, and that short term fluctuations were more important in describing variations in the supply series than they were in describing movements in the price series. This suggests that the activities of merchants, who attempt to smooth out short-term fluctuations in the quantities of fruit sold to retailers, tend to dampen the effect of short-term variations in supplies [1].

It therefore seemed plausible to assume that the quantity of bananas marketed in any week t is made up of fractions of the quantities consigned in each of the preceding weeks; $t—1$, $t—2$ and $t—3$. Expressed algebraically this assumption could be written:

$$(2) \qquad Q_t = \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + \gamma_3 X_{t-3} \quad \begin{bmatrix} 0 < \gamma_1, \gamma_2, \gamma_3 < 1; \\ \gamma_1 + \gamma_2 + \gamma_3 = 1 \end{bmatrix}$$

where

Q_t = the quantity of bananas traded in week t,

X_{t-i} = the quantity of bananas consigned to market in week $t—i$ $(i = 1, 2, 3)$.

It was immediately apparent that a potentially large number of perceptibly different weighting patterns were feasible. As the actual series Q_t was not available, the only method of testing alternative weighting patterns was by actually computing regression equations using the alternative series for Q_t. To limit the time and resources devoted to this task, only two alternative weighting patterns, which were simple enough to be consistently applied by merchants, were arbitrarily selected. These were: $\gamma_1 = \gamma_2 = \gamma_3 = \frac{1}{3}$, and $\gamma_1 = \gamma_3 = \frac{1}{4}$, $\gamma_2 = \frac{1}{2}$. The second weighting pattern gave significantly better results than the first, and was therefore used in all the reported empirical work.

4 THE DERIVED REGRESSION EQUATIONS

The estimated regression equations are shown in tables 1 and 2. In table 1 the only explanatory variable used was the quantity of bananas marketed, whilst in table 2, other explanatory variables have been included where the partial regression coefficients were significantly different from zero at the five percent level, on the appropriate one or two-tail test.

The following notation is used to refer to the respective variables whose parameters were estimated:

P_t is an estimate of the expected wholesale price (deflated) in cents per bushel, in week t;

Q_t is the estimated quantity of bananas marketed, in units of one thousand bushels, in week t;

T is a time trend with origin in week t of 1952 and units of one year;

P_{t-1} is the lagged price (deflated).

TABLE 1

Estimated Weekly Demand Functions for Bananas

Equation Number (1)	Regression Coefficient and Standard Error (2)	R^2 (3)	*d*-Statistic (4)	Demand elasticity at the point of mean (5)
1.1	$P_1 = 596{\cdot}812 - 12{\cdot}141\ Q_1$ (84·907) (3·100)	0·541	1·792	0·818
1.2	$P_2 = 640{\cdot}854 - 14{\cdot}536\ Q_2$ (62·765) (2·407)	0·737	2·251	0·709
1.3	$P_3 = 681{\cdot}157 - 13{\cdot}367\ Q_3$ (51·156) (1·660)	0·833	0·955	0·687
1.4	$P_4 = 671{\cdot}347 - 12{\cdot}391\ Q_4$ (39·468) (1·174)	0·896	1·424	0·650
1.5	$P_5 = 717{\cdot}135 - 14{\cdot}142\ Q_5$ (42·146) (1·260)	0·907	2·092	0·546
1.6	$P_6 = 677{\cdot}704 - 12{\cdot}820\ Q_6$ (53·934) (1·567)	0·837	1·052	0·560
1.7	$P_7 = 679{\cdot}117 - 12.680\ Q_7$ (33·153) (0·921)	0·936	2·009	0·511
1.8	$P_8 = 417{\cdot}258 - 5{\cdot}882\ Q_8$ (24·749) (0·636)	0·868	2·267	0·864
1.9	$P_9 = 397{\cdot}593 - 5{\cdot}370\ Q_9$ (36·367) (0·902)	0·732	1·048	0·877
1.10	$P_{10} = 451{\cdot}052 - 6{\cdot}436\ Q_{10}$ (43·794) (1·141)	0·710	2·470	0·856
1.11	$P_{11} = 405{\cdot}674 - 5{\cdot}148\ Q_{11}$ (43·928) (1·189)	0·590	2·481	1·166
1.12	$P_{12} = 400{\cdot}914 - 4{\cdot}695\ Q_{12}$ (70·593) (1·905)	0·318	1·845	1·325
1.13	$P_{13} = 592{\cdot}734 - 9{\cdot}701\ Q_{13}$ (48·949) (1·322)	0·806	2·191	0·669
1.14	$P_{14} = 543{\cdot}895 - 7{\cdot}830\ Q_{14}$ (49·568) (1·397)	0·707	2·130	0·975
1.15	$P_{15} = 534{\cdot}016 - 7{\cdot}016\ Q_{15}$ (101·035) (3·026)	0·293	2·661	1·295
1.16	$P_{16} = 850{\cdot}565 - 16{\cdot}591\ Q_{16}$ (69·988) (2·152)	0·821	2·054	0·594
1.17	$P_{17} = 781{\cdot}629 - 14{\cdot}554\ Q_{17}$ (62·908) (1·920)	0·816	2·355	0·672
1.18	$P_{18} = 849{\cdot}952 - 16{\cdot}275\ Q_{18}$ (58·949) (1·850)	0·856	2·740	0·676
1.19	$P_{19} = 949{\cdot}535 - 20{\cdot}366\ Q_{19}$ (54·444) (1·864)	0·902	1·530	0·614
1.20	$P_{20} = 906{\cdot}808 - 20{\cdot}125\ Q_{20}$ (71·959) (2·676)	0·813	2·523	0·698
1·21	$P_{21} = 909{\cdot}791 - 20{\cdot}961\ Q_{21}$ (67·997) (2·709)	0·822	2·395	0·755
1.22	$P_{22} = 922{\cdot}806 - 22{\cdot}391\ Q_{22}$ (72·171) (2·992)	0·812	2·154	0·732
1.23	$P_{23} = 962{\cdot}845 - 23{\cdot}645\ Q_{23}$ (58·201) (2·429)	0·879	2·645	0·724
1.24	$P_{24} = 905{\cdot}735 - 21{\cdot}800\ Q_{24}$ (48·811) (2·075)	0·895	1·722	0·800
1.25	$P_{25} = 1007{\cdot}899 - 27{\cdot}738\ Q_{25}$ (60·589) (2·801)	0·883	2·440	0·714
1.26	$P_{26} = 982{\cdot}799 - 28{\cdot}084\ Q_{26}$ (82·136) (4·102)	0·783	1·842	0·787

Table 1—*continued*

Equation Number (1)	Regression Coefficient and Standard Error (2)	R^2 (3)	*d*-Statistic (4)	Demand elasticity at the point of mean (5)
1.27	$P_{27} = 993{\cdot}865 - 29{\cdot}647\, Q_{27}$ (92·429) (4·794)	0·746	2·118	0·776
1.28	$P_{28} = 969{\cdot}765 - 28{\cdot}952\, Q_{28}$ (108·946) (5·738)	0·662	2·648	0·810
1.29	$P_{29} = 1017{\cdot}956 - 31{\cdot}051\, Q_{29}$ (93·638) (4·916)	0·754	2·520	0·771
1.30	$P_{30} = 900{\cdot}715 - 25{\cdot}575\, Q_{30}$ (63·018) (3·318)	0·820	1·881	0·905
1.31	$P_{31} = 1011{\cdot}844 - 31{\cdot}042\, Q_{31}$ (81·729) (4·221)	0·806	2·755	0·733
1.32	$P_{32} = 877{\cdot}685 - 24{\cdot}282\, Q_{32}$ (49·405) (2·509)	0·878	2·650	0·895
1.33	$P_{33} = 962{\cdot}383 - 27{\cdot}824\, Q_{33}$ (46·884) (2·298)	0·919	2·624	0·755
1.34	$P_{34} = 980{\cdot}196 - 27{\cdot}798\, Q_{34}$ (57·866) (2·676)	0·892	2·213	0·687
1.35	$P_{35} = 916{\cdot}227 - 24{\cdot}484\, Q_{35}$ (74·118) (3·307)	0·808	2·442	0·734
1.36	$P_{36} = 860{\cdot}902 - 22{\cdot}140\, Q_{36}$ (79·833) (3·547)	0·750	2·575	0·793
1.37	$P_{37} = 969{\cdot}575 - 26{\cdot}477\, Q_{37}$ (85·713) (3·848)	0·785	2·752	0·696
1.38	$P_{38} = 912{\cdot}503 - 22{\cdot}989\, Q_{38}$ (65·475) (2·843)	0·834	2·451	0·780
1.39	$P_{39} = 854{\cdot}008 - 19{\cdot}514\, Q_{39}$ (49·218) (1·991)	0·881	2·152	0·845
1.40	$P_{40} = 812{\cdot}367 - 17{\cdot}415\, Q_{40}$ (56·645) (2·138)	0·836	1·727	0·844
1.41	$P_{41} = 818{\cdot}292 - 17{\cdot}382\, Q_{41}$ (54·899) (1·951)	0·859	1·664	0·746
1.42	$P_{42} = 858{\cdot}967 - 18{\cdot}862\, Q_{42}$ (78·174) (2·722)	0·787	1·876	0·643
1.43	$P_{43} = 856{\cdot}825 - 18{\cdot}712\, Q_{43}$ (70·956) (2·505)	0·811	2·702	0·673
1.44	$P_{44} = 837{\cdot}909 - 17{\cdot}667\, Q_{44}$ (75·064) (2·620)	0·778	2·167	0·713
1.45	$P_{45} = 843{\cdot}831 - 17{\cdot}365\, Q_{45}$ (27·551) (0·898)	0·966	1·998	0·640
1.46	$P_{46} = 761{\cdot}079 - 14{\cdot}544\, Q_{46}$ (54·884) (1·643)	0·858	2·164	0·622
1.47	$P_{47} = 622{\cdot}778 - 10{\cdot}654\, Q_{47}$ (60·605) (1·731)	0·744	1·617	0·711
1.48	$P_{48} = 489{\cdot}835 - 7{\cdot}396\, Q_{48}$ (52·494) (1·474)	0·659	2·657	0·889
1.49	$P_{49} = 501{\cdot}051 - 7{\cdot}862\, Q_{49}$ (58·987) (1·625)	0·643	2·256	0·773
1.50	$P_{50} = 450{\cdot}587 - 6{\cdot}483\, Q_{50}$ (45·743) (1·237)	0·679	1·798	0·901
1.51	$P_{51} = 484{\cdot}753 - 7{\cdot}325\, Q_{51}$ (52·156) (1·455)	0·661	1·369	0·887
1.52	$P_{52} = 518{\cdot}435 - 9{\cdot}126\, Q_{52}$ (61·698) (1·889)	0·642	1·093	0·760

TABLE 2

Revised Estimates of Weekly Demand Functions for Bananas

Equation No. and Week Reference	Regression Coefficients and Standard Errors	R^2	d-Statistic
2.1	$P_1 = 280.523 - 7.152\,Q_1 + 5.781\,T + 0.604\,P_{52}$ (131.805) (3.201) (2.480) (0.248)	0.777	2.642
2.3	$P_3 = 366.438 - 8.024\,Q_3 + 0.537\,P_2$ (113.585) (2.229) (0.181)	0.904	1.383
2.5	$P_5 = 381.875 - 7.761\,Q_5 + 0.476\,P_4$ (151.973) (3.014) (0.209)	0.935	2.049
2.6	$P_6 = 698.117 - 12.299\,Q_6 - 4.757\,T$ (46.202) (1.338) (1.898)	0.893	1.707
2.7	$P_7 = 523.154 - 9.913\,Q_7 + 0.238\,P_6$ (82.818) (1.601) (0.118)	0.952	1.599
2.8	$P_8 = 214.415 - 2.784\,Q_8 + 0.370\,P_7$ (44.194) (0.742) (0.076)	0.956	1.814
2.9	$P_9 = 407.479 - 4.835\,Q_9 - 3.862\,T$ (31.841) (0.816) (1.682)	0.814	1.280
2.13	$P_{13} = 399.089 - 7.208\,Q_{13} + 0.447\,P_{12}$ (95.483) (1.592) (0.197)	0.864	2.250
2.17	$P_{17} = 431.984 - 8.804\,Q_{17} + 0.520\,P_{16}$ (142.174) (2.694) (0.197)	0.883	2.333
2.18	$P_{18} = 404.696 - 8.129\,Q_{18} + 0.609\,P_{17}$ (111.312) (2.263) (0.143)	0.943	2.238
2.20	$P_{20} = 525.925 - 12.504\,Q_{20} + 0.494\,P_{19}$ (108.023) (2.657) (0.125)	0.919	2.794
2.23	$P_{23} = 543.192 - 13.906\,Q_{23} + 0.487\,P_{22}$ (123.619) (3.217) (0.135)	0.942	2.542
2.24	$P_{24} = 510.619 - 12.531\,Q_{24} + 0.448\,P_{23}$ (152.834) (3.857) (0.167)	0.934	2.357
2.29	$P_{29} = 314.454 - 10.986\,Q_{29} + 0.766\,P_{28}$ (118.428) (3.942) (0.119)	0.945	2.227
2.30	$P_{30} = 388.429 - 9.870\,Q_{30} + 0.501\,P_{29}$ (104.790) (3.569) (0.096)	0.945	1.138
2.31	$P_{31} = 514.924 - 18.326\,Q_{31} + 0.602\,P_{30}$ (181.358) (5.479) (0.205)	0.887	2.880
2.32	$P_{32} = 320.364 - 7.780\,Q_{32} + 0.567\,P_{31}$ (86.011) (2.725) (0.084)	0.975	1.909
2.33	$P_{33} = 490.802 - 15.361\,Q_{33} + 0.545\,P_{32}$ (201.213) (5.570) (0.228)	0.945	2.348
2.39	$P_{39} = 333.344 - 7.990\,Q_{39} + 0.618\,P_{38}$ (102.262) (2.455) (0.117)	0.964	1.678
2.41	$P_{41} = 352.718 - 7.912\,Q_{41} + 0.566\,P_{40}$ (160.723) (3.503) (0.188)	0.920	2.068
2.43	$P_{43} = 321.100 - 6.996\,Q_{43} + 0.640\,P_{42}$ (105.003) (2.542) (0.116)	0.946	2.093
2.45	$P_{45} = 665.591 - 13.950\,Q_{45} + 0.221\,P_{44}$ (57.834) (1.236) (0.067)	0.982	2.323
2.50	$P_{50} = 277.220 - 3.940\,Q_{50} + 0.368\,P_{49}$ (95.338) (1.682) (0.182)	0.760	2.452
2.52	$P_{52} = 228.292 - 4.857\,Q_{52} + 0.677\,P_{51}$ (97.642) (1.895) (0.201)	0.816	1.100

All the estimated regression coefficients in table 1 exhibit theoretically appropriate signs—supply and prices are negatively related. Standard errors—shown in parenthesis under the respective parameter estimates—are all significant at the one per cent level.

The coefficients of multiple determination, R^2, (shown in column (3), table 1), are generally good, except for a few weeks when trains were cancelled due to holidays—for example, Easter, Christmas and long weekends. The results show that approximately 78 per cent of the variation in the average weekly wholesale prices could be explained by changes in the quantity variable.[10]

To test the reliability of the usual significance tests, the residuals determined from each equation were tested for the presence of serial correlation. The tests were inconclusive in four instances,[11] but there was no evidence of serial correlation in the remaining equations. The absence of any significant serial correlations in the residuals allows one to have more confidence in the estimates of regression coefficients using the method of least squares.[12]

Price elasticities of demand at the point of means for each of the 52 weeks are listed under column (5), table 1. The mean point elasticities ranged from $-0{\cdot}5$ (equation 1.7) to $-1{\cdot}3$ (equation 1.12). Except for weeks 11, 12 and 15, the mean elasticities were generally less than unity for most of the year.

Turning to table 2, the R^2 values showed a significant improvement in approximately half of the weekly periods when the additional variables were added. Only in three weekly periods did the trend component appear to be important, which suggests that secular changes have not generally been of great significance. The β_1 coefficients of the equations became smaller, as one would expect, since in table 2 they represent only the short-term effect of quantity on price.[13] No inferences about serial correlations can be drawn from the Durbin-Watson statistics calculated in this instance since the presence of the lagged dependent variable invalidates the test [14].

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[10] This estimate is slightly less than van der Meulen's estimate of 87 per cent using monthly data [16, p. 157]. An explanation for this discrepancy is the tendency to suppress short-term random movements when data is aggregated. This leads to higher values for R^2 when longer time units are used.

[11] The d-statistics for equations 1.3, 1.6, 1.9 and 1.52 fall between d_U and d_L values.

[12] For a more detailed discussion of testing for autocorrelation in the error terms the reader is referred to [7].

[13] See Nerlove [13]. The expected long term adjustment coefficients, obtained when β_1 is divided by $(1 - \beta_3)$ remain fairly close to the values estimated for β_1 in table 1.

5 SEASONAL PATTERN OF DEMAND

In order to illustrate the short-term movements in the demand curves, the weeks have been subjectively grouped into five periods.[14] The corresponding demand curves are shown in figures 1 to 5 respectively. The demand curve for each week has been drawn using the mean values of prices and quantities plus and minus one standard deviation of the quantity variables.

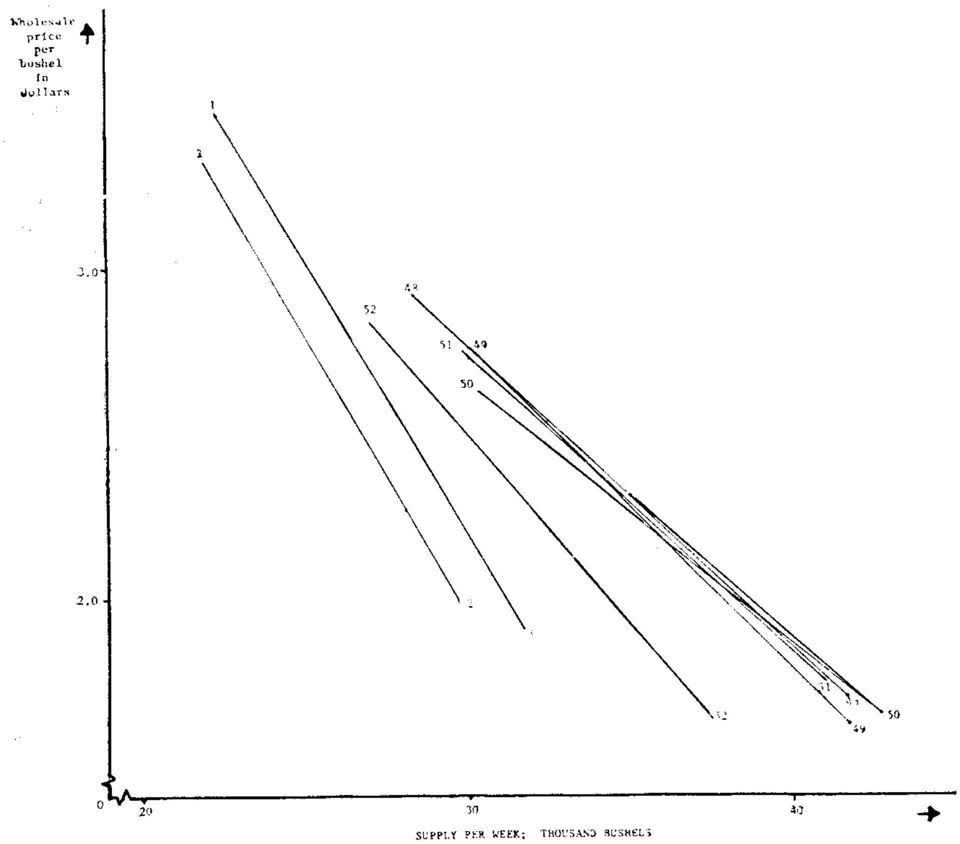

FIGURE 1: ESTIMATED DEMAND CURVES, WEEKS 49 THROUGH 2, 1953-67

The gradual movements of the curves through the seasons combine to display a total picture which seems to suggest that the demand for bananas follows a definite pattern through the year. The consistency with which this pattern is revealed is one of the most striking features of the empirically determined functions.

[14] The grouping is based largely on the intercept values, the magnitude of the partial regression coefficients for the quantity variable and the direction of movement of the curves.

For example, during the period from week 48 through week 2, the curve gradually shifts inwards with the intercept value increasing and the slope becoming steeper (figure 1). It remains fairly stable from week 3 through week 7 (figure 2), then it begins to flatten out reaching its lowest level in week 9. From then on the intercepts begin to shift upwards again, with the slope still remaining approximately the same (figure 3).

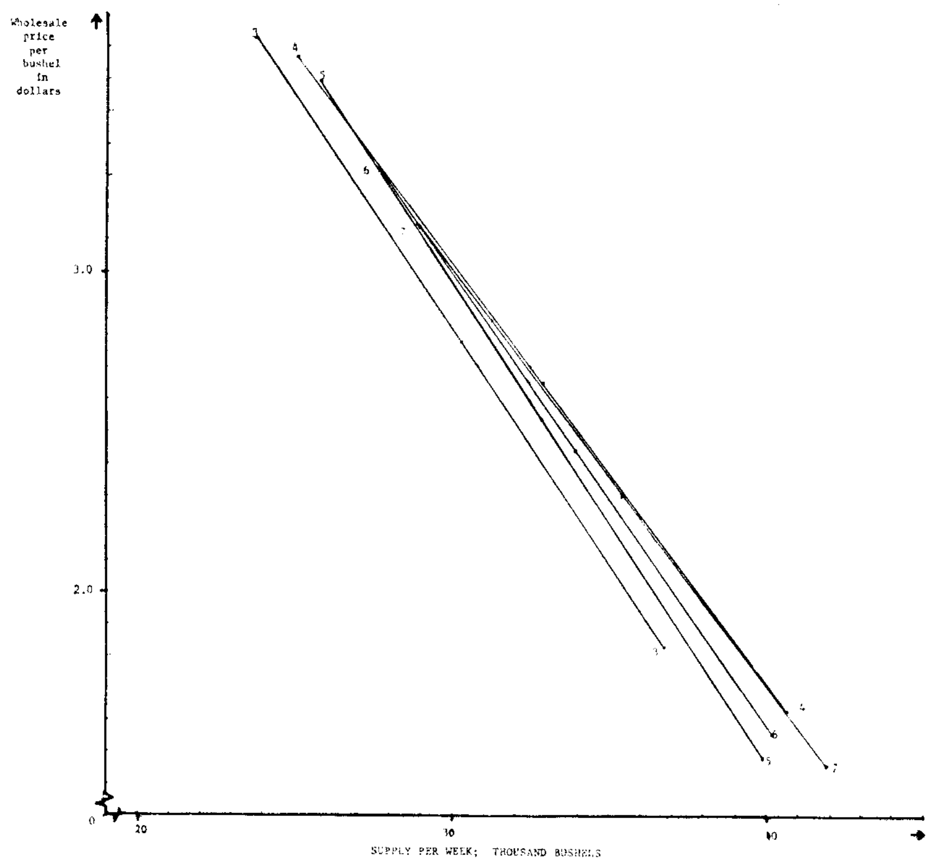

FIGURE 2 : ESTIMATED DEMAND CURVES, WEEKS 3 THROUGH 7, 1953-67

From week 16, the intercept value continues to increase, with the slope also becoming steeper until approximately week 31 (figure 4). The curve then slowly reverses again, with the intercept value decreasing and the slope becoming less steep until week 47 (figure 5). The whole cycle then recommences.

It is difficult to attribute the movements in the demand curves to specific factors because of a lack of adequate knowledge of their quantitative influence. "Knowledge of the market" provides a basis for a few general qualitative rationalizations, but only some of these can be readily

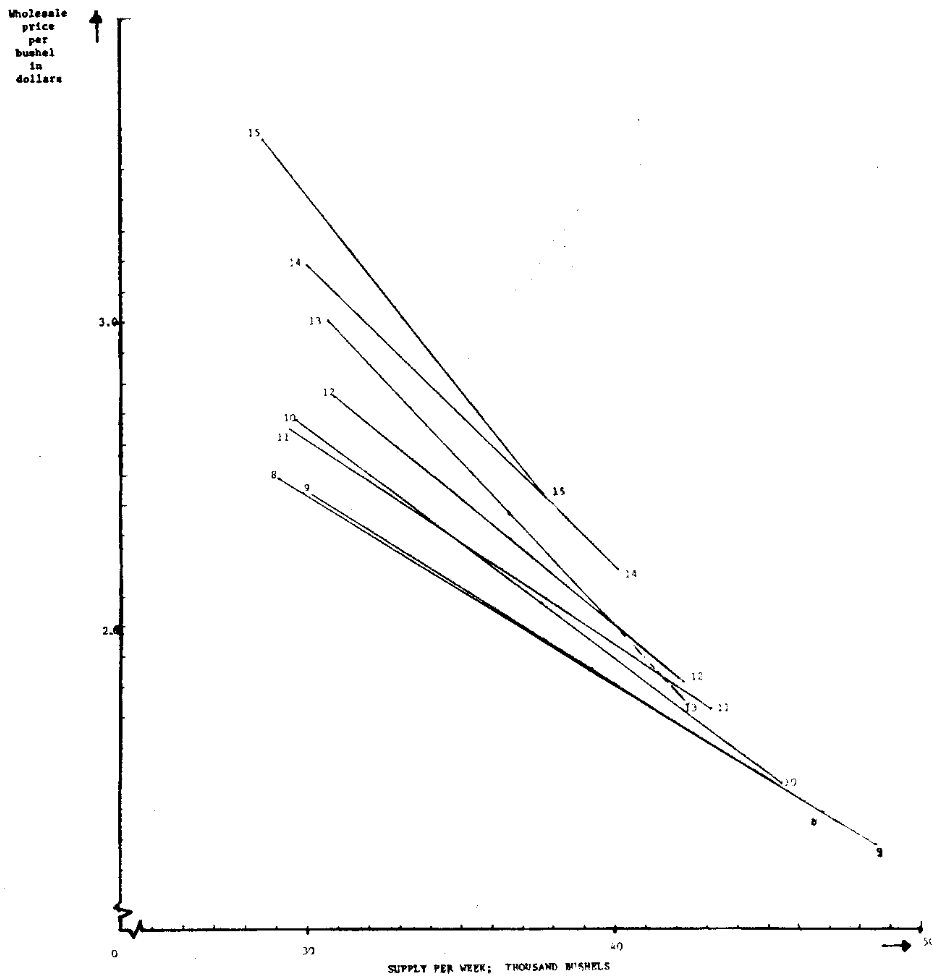

FIGURE 3 . ESTIMATED DEMAND CURVES, WEEKS 8 THROUGH 15, 1953-67

tested as hypotheses about market behaviour. Part of the movement in demand probably results from changes in fruit quality over the year and therefore should not be attributed directly to the seasonal nature of consumer behaviour.

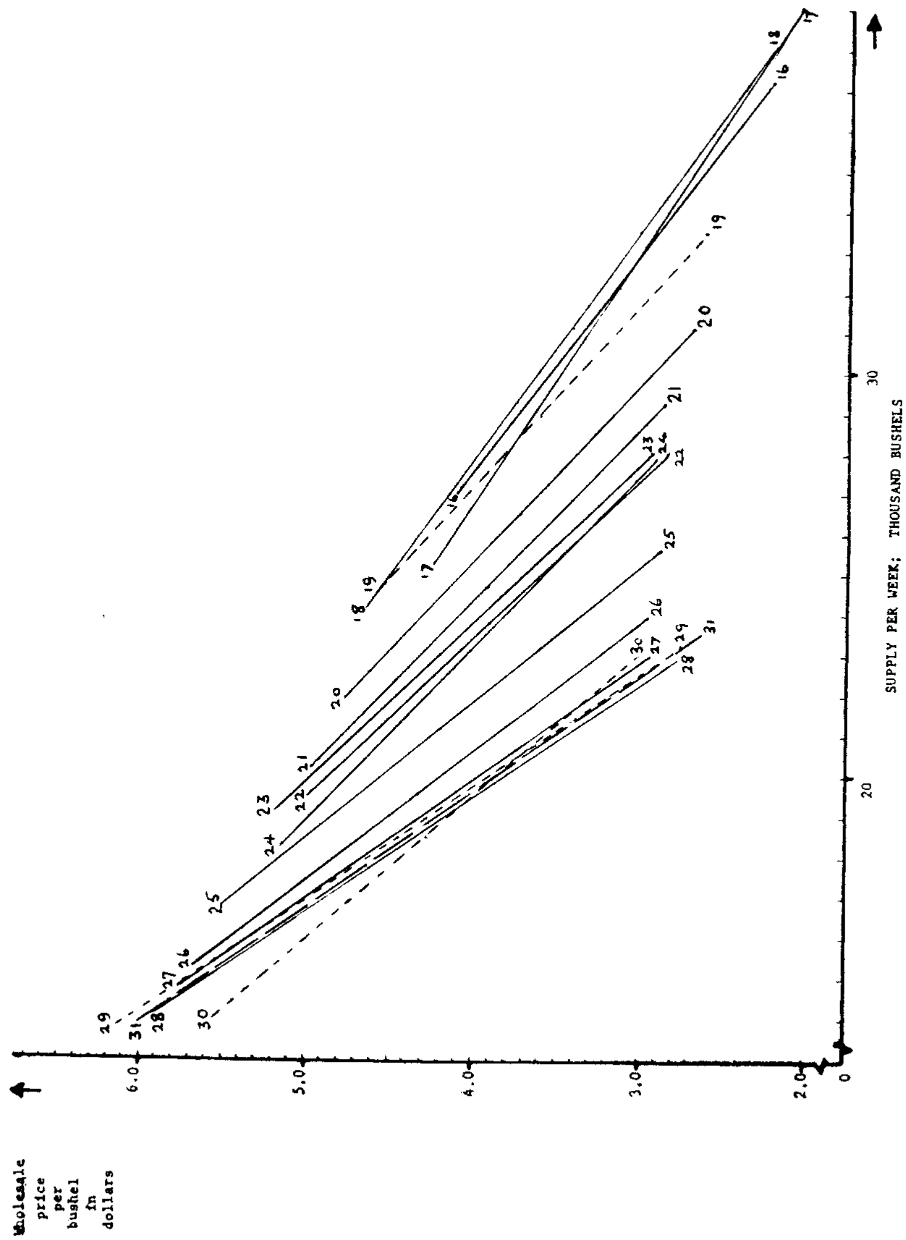

FIGURE 4 : ESTIMATED DEMAND CURVES, WEEKS 16 THROUGH 31, 1953-67

Though this distinction is theoretically important, there does not appear to be any valid way to distinguish between the two influences in the present empirical context. Quality in bananas is a composite term covering many fruit characteristics, and consumer behaviour, in attempting to translate preferences into an ordinal quality scale, is not necessarily transitive [3]. In methodological terms, therefore, fruit quality tends to be a "dialectic" rather than an "arithmomorphic" concept [9]. Even if a satisfactory quality scale for individuals could be developed, there remain the aggregation problems associated with translating this scale to the "macro" situation of the market and with finding an "average" quality for all bananas marketed each week.

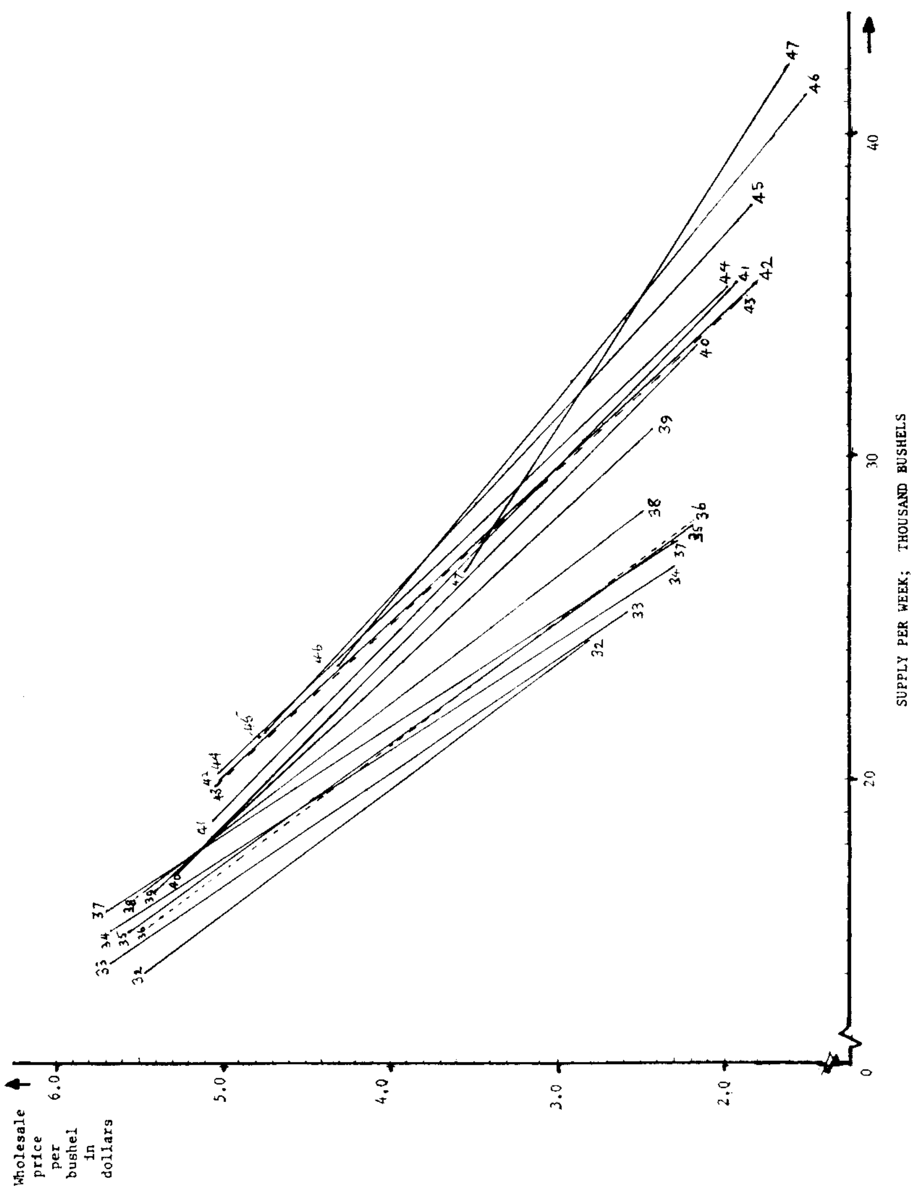

FIGURE 5 : ESTIMATED DEMAND CURVES, WEEKS 32 THROUGH 47, 1953-67

6 VALIDITY AND LIMITATIONS OF THE STUDY

Although several aspects of the demand for bananas have been investigated in this study, the foregoing discussion reveals some gaps, stemming from the fact that all variables having a significant bearing on demand could not be studied.

Only a limited number of explanatory variables were used in the study, yet it is recognized that the price of bananas—as in the case of other commodities—is determined by the combined influence of numerous factors. Some of these factors had to be omitted because satisfactory measurements could not be secured. Others were deliberately excluded since they were presumed to have only a negligible effect, or to be adequately represented by the variables already introduced. For example, the "time" variable was introduced to determine whether the aggregate effect of the neglected factors resulted in a persistent smooth time shift in the net price-quantity relation.

Several interesting issues which deserve further consideration arise from the study. The first, which has already been discussed, is the extent to which the changes in demand could be associated with variations in fruit quality. The second is the extent to which the derived regression equations differ from each other. The third is the extent to which the supply of competing fruits affects the demand for bananas. While it is not the purpose of this study to assign specific dynamic causes to the shifts in demand, some general comments on these latter issues may be useful.

No attempt was made to examine the statistical significance of the apparent differences between the weekly demand curves. The major objective of the study was to quantify the price-quantity relationships for different weeks of the year for the purpose of using this information to regulate the flow of weekly shipments, and so increase growers' net returns. For this reason, interest was centred not so much on the magnitude of the differences between consecutive demand curves, but rather on the way demand behaved as the season progressed. Direct comparison of the magnitudes of consecutive regression coefficients, using analysis of variance, is not possible in this case since there are no suitable statistical methods available which could be used to test hypotheses relating to systematic seriatim change in the values of the regression coefficients.[15]

[15] The regression coefficients of the equations estimated for successive weeks would not differ significantly in many cases when Chow's F-test is applied [6] even though tests of regression coefficients from equations several weeks apart could show up significant differences. Such tests, however, are not appropriate in this instance since the probability that this interesting dynamic pattern occurred fortuitously seems rather small. The consistent change from week to week is clearly manifested except for a few odd cases which correspond to holidays, long weekends and other extraneous factors.

A comprehensive simultaneous equations treatment of the relationships between banana prices, and supplies and prices of other fruit would appear to be a useful complement to the present study. From a theoretical viewpoint our apparent neglect of these factors is unsatisfactory. American experience, as reported by Arthur, Houck and Beckford [2] using a single equation log-linear model on annual data, did not indicate that quantities of other fruits marketed were an important factor in the determination of banana prices. A low explanatory value for prices of other fruits was likewise indicated in an Australian study by Phillips [15] which again used annual data and a single equation linear model.

While it might be expected that weekly demand relationships among competing fruits would be substantially stronger than those apparent in annual data, the tentative analyses which were undertaken in the initial stages of the present study gave rather conflicting results.[16] This could have been a result of applying single equation estimation procedures in an inappropriate situation or, alternatively, the pervasive difficulties with definitions of fruit quality may have affected the results. A third possible explanation advanced by Hoos [10, p. 431] is that ". . . goods that are competing in the consumption of the final consumer need not be competing for retailers who may strive to carry a full line of goods. In this sense two fruits may (even) tend toward being complementary for the retailer, . . . (although they compete) . . . in the demands of the final consumers".

5 CONCLUSIONS

In this study, demand was conceived as the price-quantity relation confronting wholesale-ripeners who sell bananas on Sydney auction markets. The analysis was oriented toward the problem of specifying the major variables related to variations in wholesale prices. It was assumed that the underlying unknown price-quantity relations in the market could be approximated for the period considered by simple empirical functions fitted to the available data.

The results are descriptive of the average relations (of the type specified by the equations used) existing among the selected variables during the period studied. Although the functions derived do not correspond to theoretical demand curves, they do specify relations among the selected variables which prevailed in the past and which may be assumed to describe the future if conditions remain unchanged.

[16] The effects of prices of certain other fruits (peaches, pears and plums) on demand for bananas at particular stages of the year were examined using ordinary least squares regression methods. The results obtained were highly irregular, often being of wrong sign compared with *a priori* expectations and generally of low statistical significance.

The derived regression equations provide suitable functions from which realistic forecasts can be made regarding the way prices will respond to different quantities placed on the market. If the results can be taken as representative of future behaviour on the Sydney wholesale banana market, an appraisal of supply control programmes and their anticipated effects on growers' returns becomes possible. However, this is subject to two important qualifications.

First, an empirical investigation of supply response and distribution through the year is required to complement this study. Quite obviously, a satisfactory evaluation of the potential benefits of supply control measures at the wholesale level, for anything other than the very short term, presupposes that the supply function can be approximated. For this purpose, factors affecting variations in acreage and yield—the two determinants of production of bananas—must be examined.

Second, no general conclusions can be drawn from this study alone, as it has been concerned with only one market. Such a coverage is inadequate for gauging the overall revenue effects of industry-wide policies. Similar information relating to other principal markets would also be required before appropriate policies could be formulated.

Finally, the most striking feature of the study, is the manner in which it has demonstrated that the use of shorter time units can offer some worthwile insights into the dynamic nature of a commodity market. Of perhaps equal interest are questions raised by implication, concerning the occurrence of similar interesting seasonal demand patterns in the markets for other fresh fruit.

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