Intraurban Retail Price Competition: Corporate and Neighbourhood Aspects of Spatial Price Variation

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1 Introduction

Within an urban area, at any point in time, the selling price of a good frequently displays two scales of variation: large-scale variation from one part of the urban area to another and then, within this, smaller scale variation from one retailer to another. Such intraurban price variation appears to be a somewhat neglected area of study. Richardson (1978, page 3) noted that spatial price analysis was a "virtually unexploited mine of research for micro-economic theorists". The purpose of this paper is to provide a description of such variation (at several points in time) for a particular good, to propose some possible explanations for the observed variation, and to examine these explanations in the light of the empirical work.

The point of departure in dealing with intraurban price variation for the consumption sector is to consider this variation as the outcome of a process with two distinctive elements of competition: a corporate element and an individual retail-site element. At the corporate level, competition frequently takes place through an oligopolistic market in which retention of market share is a prime consideration in price setting. The consequences of any one corporation changing its general price level are uncertain and depend upon the reactions of rivals. They may follow suit or they may not, but they cannot be expected to ignore the move. Where product differentiation is relatively weak this condition will be reinforced. However, the sales of any one corporation in an urban area may be distributed over a number of retail sites. These retailers may have some freedom in setting their own prices. This introduces another form of competition at the local scale, as retailers seek to maintain an adequate level of sales while making a profit, in the face of the 'neighbourhood' distribution of prices. This competition is likely to be influenced by the distribution of retail sites—competition perhaps being greatest where sites are close together, thus weakening the 'local monopoly' effects conferred by space.

In this paper these ideas are examined in relation to the petrol retailing sector. In section 2, the two elements of competition in petrol retailing are documented in a little more detail. In the third section two spatial price interaction models are reviewed and in the fourth section some empirical results are considered. These sections focus on the individual retailer level of the process. In sections 5 and 6, corporate aspects of intraurban price variation are considered. Finally, in the appendix, the data on which this and other studies have been based are provided.

2 The structure of competition in petrol retailing—spatial implications

A number of service-sector activities (including 'fast-food' provision, grocery chains, department stores, automobile dealers, etc) appear to fit into the competitive framework outlined in the introduction; however, the petrol retailing sector provides a particularly good example, and it is that sector that is focused on in this paper.

Consider first the demand for petrol and in particular the way in which consumers purchase the good. Petrol is a homogeneous good with little brand differentiation; furthermore, there is little customer loyalty to any particular retail site (Shaw, 1974). Petrol consumers are, by definition, highly mobile, usually purchasing petrol as part of a journey to shop, work, or leisure, for example. The consequence of this is that consumers can compare prices at several sites and at low cost to themselves. The potential for consumers to be very aware of price differences is accentuated by the existence of clear and usually unambiguous price posting. A further consequence is that retail sites will tend not to have clearly differentiated market areas. If it is sensible to specify market areas at all, they are going to be interdependent and overlapping. Even if total demand is stable (for the city as a whole) that demand can be apportioned over the different retail sites in quite changeable ways.

Now consider the supply side. The structure of petrol retailing in the United Kingdom is dominated by a relatively small number of large international corporations. They fall into two groups that have been termed the 'major brand retailers' and the 'cut-pricers' (Grant, 1982). The former dominate the market and compete with one another largely on a nonprice basis to maintain market share. The latter, as their name implies, by selling often from poorer, smaller, sites with lower operating costs and by taking advantage of fluctuations in spot market prices, often undercut the majors. The latter frequently initiate price changes, seeking short-term profits or seeking to increase their market share during periods of oil surplus (Shaw, 1974). If price differences between the two groups become sufficiently great the major brand companies are forced to respond.

Market share is defined at a number of scales—national, regional, urban. Corporate regional share depends on the urban shares in the constituent urban submarkets. The urban share, in turn, depends on the shares achieved in the constituent retail sites. Attaining market shares at any one level involves summation of several submarket shares. This brings corporate strategy to the level of the individual site, and corporations frequently maintain control of site pricing (an important variable in affecting market share) by adopting a 'consignment plan' (see Schendel and Balestra, 1969). However, as Lowe (1976, page 216) notes, "while petrol companies could recommend price, they do not have full control over price policies to the consumer ... the crucial factors affecting the elasticity of demand were controlled locally and dominated by local factors". Retailers, whether independents or whether operating a franchise, enjoy some freedom in price setting, often through a 'sharing agreement' scheme (Schendel and Balestra, 1969). This, even more than the consignment plan, provides a mechanism for price 'tuning' in response to local conditions.

In summary, the nature of petrol retailing—the price autonomy of individual retailers, the corporate (market shares) policy, and the overall sectoral structure—opens up the possibility for considerable price competition and for there to be some spatial regularity in that price variation. Indeed, we might expect that these attributes will introduce the following types of regularity in the spatial price distribution.

(a) Autonomy in price setting at the local level provides the mechanism by which prices at a site can be adjusted to maintain sales volume. The fact that the market areas of retail sites overlap (or, stated differently, that groups of retailers are competing for common overlapping subsets of the population of consumers) suggests that one might anticipate some form of 'nearest-neighbour' pattern of price variation. This could take many forms: clusters of sites at a crossroad might compete strongly, as might a string of retail sites along a road. The latter effect was investigated by Robinson and Hebden (1973). But little is known about the actual structure of such intersite competition, the distances over which such effects might operate, or the intensity.

(b) Corporate policy also introduces spatial price variation. The decision to maintain market share (or not) within a city by a major brand retailer has implications for overall pricing policy within the city and for the distribution of that company's prices. However, a decision to retain (or increase) market share in the face of price competition might focus on a small number of important retail sites—for example, large sites that are particularly important in maintaining market share or sites that because of their proximity to the sites of certain other companies represent important battlegrounds.

(c) Finally, the overall sectoral structure—the coexistence and competitive relationships between the major brand retailers and the cut-pricers—means that spatial price variation is likely to be sensitive to the disposition, within the urban area, of the cut-price retailers. It is also possible that the cut-pricers will lead price changes and the major brand retailers will follow.

These considerations suggest considerable scope for different types of price response patterns given some pressure on prices to change initiated in a part of the urban area. In the next two sections models are considered and data are analysed with regard to the first component of spatial price variation—the nearest-neighbour attribute. In the two succeeding sections the discussion is extended to include the second and third components.

3 Nearest-neighbour interaction patterns—models

Two models for the investigation of nearest-neighbour interaction patterns have been proposed and I review them briefly here (for a fuller discussion see Haining, 1983; 1984).

3.1 *Model 1. 'Interacting-markets model'*

With this model, which I have developed elsewhere (Haining, 1983), consumer price sensitivity and the effect of such sensitivity on demand levels at each retail site are emphasised. Supply and demand functions are specified and it is assumed that

$$\boldsymbol{D}_t = \mathbf{A}\boldsymbol{p}_t + \boldsymbol{c} + \boldsymbol{u}\,, \qquad \boldsymbol{S}_t = \mathbf{B}\boldsymbol{p}_{t-1} + \boldsymbol{e}\,, \tag{1}$$

where $\boldsymbol{D}_t$ and $\boldsymbol{S}_t$ are n-dimensional demand and supply vectors at time t, and n denotes the number of retail sites. The vectors $\boldsymbol{c}$ and $\boldsymbol{e}$ are n-dimensional vectors of constants, and $\boldsymbol{p}_t$ is the vector of prices at time t. $\mathbf{A}$ and $\mathbf{B}$ are $n \times n$ ordered matrices whose rows and columns correspond with the labelling of the n markets. Finally, $\boldsymbol{u}$ is assumed to have mean vector $\boldsymbol{0}$, and variance-covariance matrix $\sigma^2\mathbf{I}$, where $\mathbf{I}$ is the identity matrix.

Writing $\mathbf{B} = \{b_{ij}\}$, we assume that

$$b_{ij}\begin{cases} > 0 & \text{if } i = j\,, \\ = 0 & \text{if } i \neq j\,, \end{cases}$$

and writing $\mathbf{A} = \{a_{ij}\}$, we assume that

$$a_{ij}\begin{cases} < 0 & \text{if } i = j\,, \\ \geqslant 0 & \text{if } i \neq j\,. \end{cases}$$

If clearance is assumed in each of the markets, that is, $\boldsymbol{D}_t - \boldsymbol{S}_t = \boldsymbol{0}$, then

$$\boldsymbol{p}_\mathrm{e} = (\mathbf{A}-\mathbf{B})^{-1}(\boldsymbol{e}-\boldsymbol{c}-\boldsymbol{u})\,, \tag{2}$$

where $\boldsymbol{p}_\mathrm{e}$ denotes the equilibrium price vector, so that the mean vector of equilibrium prices is $(\mathbf{A}-\mathbf{B})^{-1}(\boldsymbol{e}-\boldsymbol{c})$, with variance-covariance matrix $\sigma^2[(\mathbf{A}-\mathbf{B})^\mathrm{T}(\mathbf{A}-\mathbf{B})]^{-1}$. Elsewhere (Haining, 1983) it is shown that equation (2) can be rewritten expressing the equilibrium price at the ith retail outlet as a function of prices elsewhere; thus,

$$p_{i,\mathrm{e}} \propto \sum_{\substack{j=1 \\ j \neq i}}^{n} a_{ij}p_{j,\mathrm{e}} + (c_i - e_i) + u_i\,. \tag{3}$$

Equation (3) describes an autoregressive spatial scheme with nonnegative coefficients ($a_{ij} \geqslant 0$), and hence positive spatial autocorrelation at all lags. Since $(c_i - e_i) \neq 0$, the model implies the presence of site effects.

The model is simplified for empirical application by setting some of the a_{ij} to 0, reflecting assumptions about the probable structure of intersite competition and the distances over which such effects operate. Variations in the values of the nonzero a_{ij} reflect assumed differences in the intensity of interaction.

3.2 *Model 2. 'Pure competition model'*
This model, considered in more detail elsewhere (Haining, 1984), focuses on more subtle interactions within specific price bands in the overall price distribution. Supply and demand conditions are not explicitly represented in the model, the price adjustments taking place being a short-term response to the local price environment of each retailer. The model reduces the price series to a binary set with prices defined to be either within a specific price zone or outside it. Define

$$x_i = \begin{cases} 1 & \text{if the } i\text{th retail outlet charges in the price range } [s_1, s_2] \\ 0 & \text{otherwise.} \end{cases}$$

Let $\boldsymbol{x}$ denote the vector $(x_1, ..., x_n)$ describing the configuration of n binary prices. Let $\boldsymbol{x}_i = (x_1, ..., x_{i-1}, 0, x_{i+1}, ..., x_n)$. Now define 'birth-rates' and 'deathrates' as follows:

$\gamma_1(x_i = 1, \boldsymbol{x}_i)\mathrm{d}t$ = probability that site i charges in the price range $[s_1, s_2]$ at time $t + \mathrm{d}t$ given that it did not at time t.
$\gamma_0(x_i = 0, \boldsymbol{x})\mathrm{d}t$ = probability that site i does not charge in the price range $[s_1, s_2]$ at time $t + \mathrm{d}t$ given that it did at time t.

All other transitions have negligible probabilities. Assume now that these birthrates and deathrates are functions of prices elsewhere, and let

$$\gamma_1(x_i = 1, \boldsymbol{x}_i) = \exp\left(\alpha' + \sum_{\substack{j=1 \\ j \neq i}}^{n} \beta'_{ij} x_j\right),$$

$$\gamma_0(x_i = 0, \boldsymbol{x}) = \exp\left(\alpha'' + \sum_{\substack{j=1 \\ j \neq i}}^{n} \beta''_{ij} x_j\right).$$

It can be shown (see Haining, 1984) that if $\mathrm{P}(X_i = x_i|.)$ denotes the conditional probability that site i charges in the price range $[s_1, s_2]$ given the prices charged at all other (neighbouring) outlets, then setting $\alpha = (\alpha' - \alpha'')$ and $\beta = (\beta' - \beta'')$ we have

$$\mathrm{P}(X_i = x_i|.) = \exp\left[x_i\left(\alpha + \sum_{\substack{j=1 \\ j \neq i}}^{n} \beta_{ij} x_j\right)\right] \Bigg/ \left[1 + \exp\left(\alpha + \sum_{\substack{j=1 \\ j \neq i}}^{n} \beta_{ij} x_j\right)\right],$$

where β_{ij} is nonzero only if j is a neighbour of site i.

This is a model from the retailer's perspective in which his or her problem is to maintain sales volume whilst making a profit. It has parallels with the ideas of Hotelling (1929), but instead of being concerned with the problem of location (and the tendency to agglomeration as an outcome of spatial competition) this model is concerned with the problem of price selection (and the tendency for prices to cluster, for similar goods, as an outcome of intersite competition). Given the spatial distribution of the sites, it is likely that the price bands within which clustering occurs may be different in different parts of the city. The space-time structure of the model describes the ripple effects of local competition.

Models 1 and 2 both deal with the purely spatial aspects of price variation and there is no attempt to introduce the corporate level. Elsewhere (Haining, 1983) I indicate how model 1 might be adjusted when certain sites are specified as price leaders and the rest as price followers. The equilibrium prices for the former group are independent of the local price environment, whereas the prices for the latter group respond both to the price leaders and to the other price followers. This version reflects the division of the corporate structure into major brand retailers and cut-pricers, but no attempt has yet been made to fit the model.

4 Nearest-neighbour interaction patterns—empirical results

The appendix records the data collected in southwest Sheffield on individual days each month from January 1982 to January 1983 but excluding the months from April to July. [Price changes at petrol retail sites tend to be rapid (Claycamp, 1966), so that data collected on a single day should provide an adequate base.] The period was an interesting one. From January to March 1982 there was an intensifying price war. This resulted from rises in the value of sterling, declining prices on the Rotterdam spot market, and falling consumption (*Sunday Times*, 1982). From August to November 1982 prices were rising slowly and from December 1982 to January 1983 they were falling slightly (see the appendix, figures A1 and A2).

Spatial price correlation in the data has been examined using the two models reviewed in section 3. Both models require prior specification of the structure of interaction, which involves defining for each retail site i, the set of retail sites j for which $a_{ij} \neq 0$ (model 1) or $\beta_{ij} \neq 0$ (model 2). Statistical analysis of the data, choosing different interaction rules, can indicate the types of patterns present in the data. In the case of model 1, set $a_{ij} = \rho\omega_{ij}$, and in the case of model 2, set $\beta_{ij} = \beta\omega_{ij}$ ($\alpha_{ij} = \alpha$). In both models, ω_{ij} is an a priori weight such that $\omega_{ij} = 0$ if site j is not a neighbour of site i, and $\omega_{ij} \neq 0$ otherwise. (Also, $\omega_{ii} = 0$.) By choosing different weighting schemes, we can examine different patterns of variation by estimating the value of the parameter ρ (β) and testing for significance.

The parameter ρ (β) may be significant under one type of weighting rule and not under another. In fact results reported elsewhere (Haining, 1983; 1984) indicate that pure nearest-neighbour linkage rules and linkage rules weighted by distance are not associated with significant parameter values. However, a linkage rule that links all retail sites at crossroads, and links each retail site to its two neighbours on either side of it on the main road on which it is located, does reveal significant (and positive) parameter values in some months. The conclusions reached from model 1 were as follows.
(1) Among all retail sites in southwest Sheffield, interaction effects were strongest in January and December 1982, but were otherwise not significant.
(2) Certain clusters of retail sites in particular subareas of southwest Sheffield displayed stronger pattern properties than did other clusters. This suggests that southwest Sheffield should not be considered as a single interacting market but that interaction effects are partitioned in terms of the principal routeways leading into the city.

The conclusions reached from model 2 were as follows.
(1) Some interaction effects within specific price bands were detectable in the period after August, but these were generally weak.
(2) The strongest interaction patterns associated with specific price bands were observed during the period of the intensifying price war. At the start of the period (January) significant price patterns were detected both at low price levels and at higher price levels, indicating the presence of local price competition at many levels in the price range. By March, when the price war was most intense, significant price patterns were detected only at the lowest price levels, suggesting that competition was restricted to those retail outlets active in the price war.

All these results relate to the final linkage rule linking sites at crossroads and on the same radial routeway. Other effects were noted as being important in accounting for spatial price variation; in particular, it was found that prices were consistently higher at those retail sites located off the principal radial routeways (fuller details of these results are given in Haining, 1983; 1984).

An interesting property of the data noted for the period from January to March was that the variance in prices (over the entire set) declined as the price war intensified. Both of the models discussed above can be used to offer an explanation for this. In the case of the pure competition model, it has been shown (Haining, 1985) that declining variation can be accounted for by suitably large increases in the interaction parameter (β_{ij}). This parameter supposedly measures the sensitivity of a retailer to price shifts in his or her local environment—the environment that the retailer monitors for purposes of deciding his or her own price level. Hence, this model identifies declining price variability as a consequence of the ripple effects of local competition. However, as is also shown, a necessary condition for this to occur is that intrasite or external pricing agents do not act to influence price setting at the individual site level ($\alpha_{ij} = 0$). Given the comments in the second section, this is an unsatisfactory condition. Although the ripple effects of pure competition are sufficient to explain increasing price uniformity, there are almost certainly other influences relating to the activities of the corporations themselves that should be considered.

The interacting-markets model can also account for declining price variability. In section 3 it was shown that the variance in equilibrium prices is given by $\sigma^2[(\mathbf{A}-\mathbf{B})^{\mathrm{T}}(\mathbf{A}-\mathbf{B})]^{-1}$. Take the simplest case where $a_{ij} = 0$ if $i \neq j$; then we have a set of n independent markets. Since $a_{ii} < 0$, and $b_{ii} > 0$, it follows immediately that as $|a_{ii}|$ increases, price variation decreases. This can also be seen graphically in figure 1. Now consider the full interacting-markets model and for simplicity let $a_{ii} = a$ and $b_{ii} = b$; then we can write

$$\mathbf{A} = a\mathbf{I} + \Omega \qquad \text{and} \qquad \mathbf{B} = b\mathbf{I} ,$$

where $\Omega = \{a_{ij}\}_{i \neq j}$. Rearranging terms we can write

$$\boldsymbol{p}_{\mathrm{e}} = -(a-b)^{-1}\Omega\boldsymbol{p}_{\mathrm{e}} + (a-b)^{-1}(\boldsymbol{e}-\boldsymbol{c}) - (a-b)^{-1}\boldsymbol{u} .$$

The variance in $\boldsymbol{p}_{\mathrm{e}}$ decreases if $|a|$ increases relative to $\{a_{ij}\}$. This model therefore accounts for declining price variation as a consequence of increasing consumer sensitivity to the price charged at any outlet. Put another way, if consumers become more sensitive to price differences between outlets, the effect of this will be to reduce the variation in prices across the set of retail outlets. For this to be a convincing account it must be the case that during the course of a price war, consumers become more willing to search out lower priced retail outlets. Although this hypothesis might be tested, there is currently no evidence that this is the case—although a well-reported price war (as this one was) might make consumers more aware of the best prices available and hence make them more discriminating or at least more

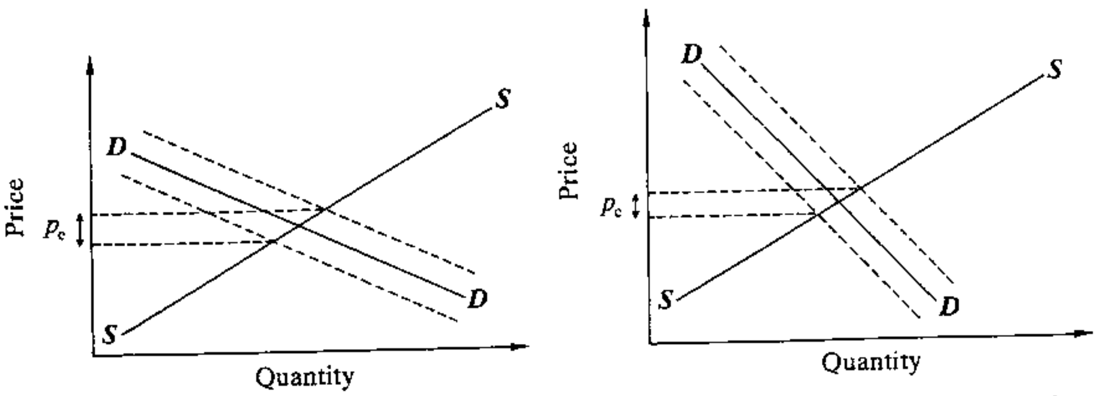

Figure 1. The effect of an increase in the slope of the demand function relative to the supply function on the variance in equilibrium prices.

interested in comparing prices, which they might ordinarily be disinclined to do. One study that may support this point is that reported by Maurizi and Kelly (1978), who showed that an effect of newly introduced price posting in a city was to reduce price variation. Media reporting of price-war price reductions in a city with petrol stations that already use price posting might be expected to have similar effects to that of newly introduced price posting in a city that has never had price posting. In both cases consumers are provided with more information with which to decide where they are going to buy.

This concludes the review of findings relating to interaction patterns in intraurban price levels. A weakness with these models is their disregard of the corporate background and it is the ownership patterns of the retail sites that are considered next for further insights into the reasons for the observed spatial distribution of prices.

5 Corporate aspects of the price distribution

In this section the overall price distribution each month is considered but with reference to the prices charged by each of the companies selling petrol in southwest Sheffield. Two aspects of monthly company pricing

Table 1. Maximum number of petrol stations for each company during the survey period.

Company	Number of stations	Number of stations on main roads	Company	Number of stations	Number of stations on main roads
BP	13	10	Mobil	12	11
Burmah	1	1	Murco	5	4
Chevron	2	2	National	7	5
Elf	1	0	RP	2	0
Esso	10	6	Shaw	1	0
Fina	7	6	Shell	6	5
ICI	1	0	Texaco	4	4
Jet	5	4	Total	4	4
Major	2	1	UK	1	0

Key:
BP—The British Petroleum Company Ltd
Burmah—Burmah Oil Company Ltd
Chevron—Chevron Oil Ltd
Elf—Elf Oil Exploration and Production Ltd
Esso—Esso Petroleum Company Ltd
Fina—Petrofina (UK) Ltd
ICI—Imperial Chemical Industries PLC
Jet—Conoco (UK) Ltd
Major—Major and Company Ltd
Mobil—Mobil Oil Company Ltd
Murco—Murco Petroleum Ltd
National—National Petrochemicals Company
RP—RP Ltd
Shaw—Shaws Petroleum Ltd
Shell—Shell International Petroleum Company Ltd
Texaco—Texaco Ltd
Total—Total Oil Great Britain Ltd
UK—UK Petroleum Products Ltd

are focused on: the minimum level charged by each company and the range of prices charged by each company across its full set of retail sites. Table 1 lists the eighteen companies in southwest Sheffield and the number of their petrol stations. BP, Esso, and Mobil are the major companies in terms of number of outlets.

5.1 *Minimum price levels*

A distinction exists between the price-war period (January to March) and the later period. Whereas in the price-war period the minimum price level for the area tends to be found in the set of companies with

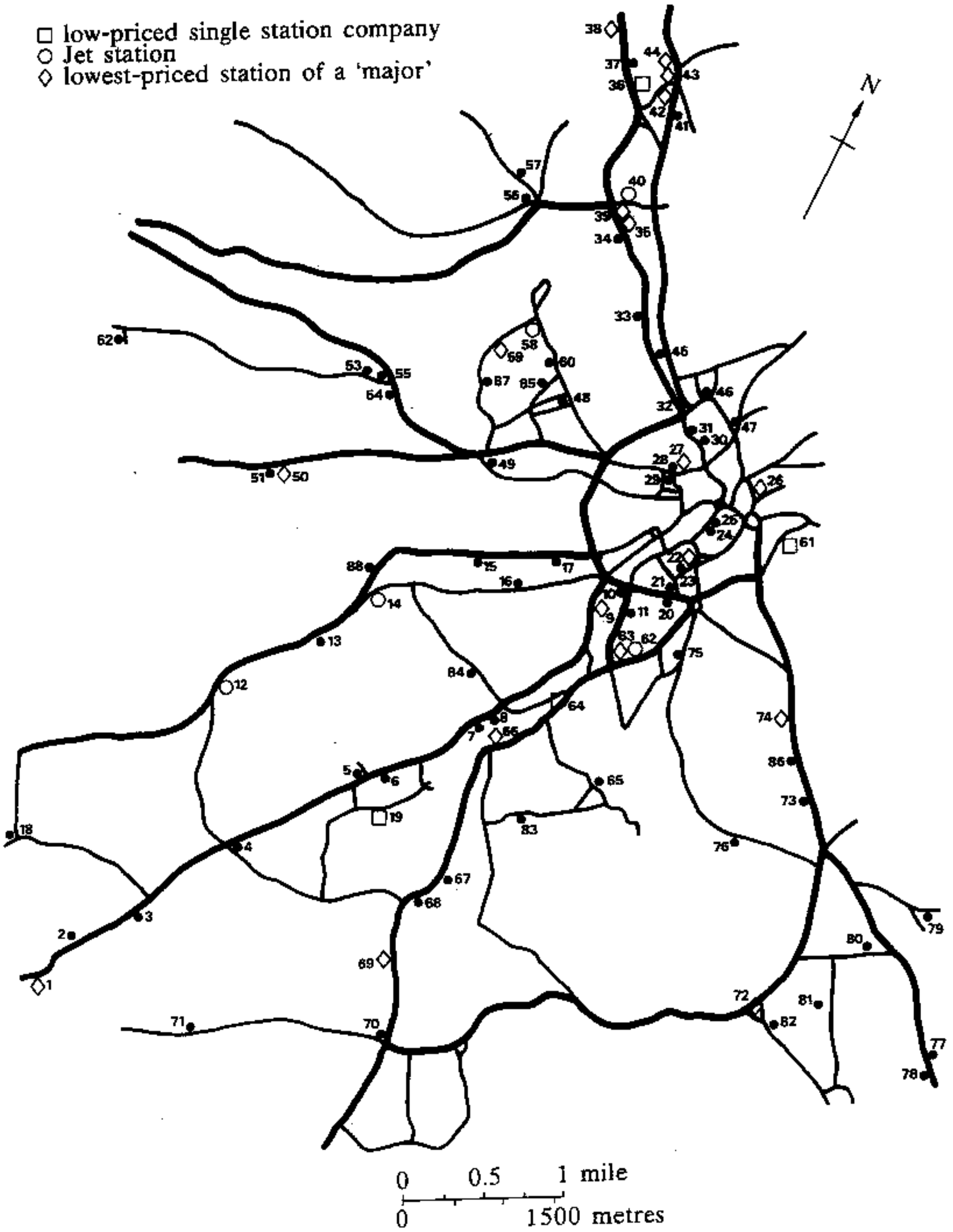

Figure 2. Location of the cheapest petrol stations for each company and for single station companies: March 1982 (also see table A1 in the appendix).

few outlets (Elf in January, Major in March), it is the major brand retailers who are setting the minimum price levels in the later part of the year. In February, one Esso station was the cheapest (slightly lower than the Elf station), and it is interesting to note that it was very close to the Elf station (see figure 2 and the appendix). The first observation accords with remarks by Schendel and Balestra (1969) that price-war leaders are frequently companies with a small representation (in terms of numbers of outlets) and that cut-price outlets are price leaders in a price war.

In the previous section the decline in price variation during the price war was noted and explanations were offered in terms of the ripple effects of local competition and increasing consumer price sensitivity. The corporate aspects of this changing price variation are also revealing. There is evidence of convergence in the range of minimum prices charged by the major companies. Table 2 shows that the price spread of minimum prices for companies with five or more outlets went from 0.6 pence in January to 0.2 pence in March. In February this rose to

Table 2. Minimum company prices each month.

Company[a]	Minimum company prices (in pence)[b]								
	Jan.	Feb.	Mar.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
UK	161.0	156.0	148.0	171.0	172.0	174.0	177.0	174.0	169.0
Shaw	160.0	152.0	145.0	161.0	170.5	171.5	175.5	175.0	163.5
Elf	**153.9**	148.9	141.9	157.9	169.9	171.9	174.9	173.9	163.9
Burmah	156.0	152.0	142.0	159.0	170.0	173.0	178.0	178.0	164.0
ICI	155.0	152.0	142.0	158.0	170.0	172.0	176.0	175.0	164.6
Major	157.0	152.0	**141.0**	162.0	170.0	173.0	178.0	175.0	164.0
Chevron	155.9	151.9	141.9	**157.8**	170.5	**170.0**	174.6	175.0	165.5
RP	159.0	159.0	152.0	168.0	172.0	175.5	178.0	178.0	168.0
Texaco	154.5	150.0	141.9	157.9	169.6	171.5	175.5	173.5	162.9
Total	154.5	149.5	145.9	159.6	170.0	171.9	175.5	174.1	164.1
Jet	154.4	149.6	141.8	**157.8**	169.6	170.5	174.0	**173.0**	**162.8**
Murco	154.8	150.0	142.0	159.0	**169.5**	171.5	174.0	174.5	163.5
Shell	154.6	149.6	141.9	**157.8**	169.6	**170.0**	**173.7**	173.7	**162.8**
National	155.0	150.0	142.0	158.0	170.0	172.0	174.0	174.0	165.0
Fina	154.6	149.5	141.9	159.6	170.5	**170.0**	174.6	173.2	163.7
Esso	154.6	**148.7**	141.9	**157.8**	169.6	170.5	174.6	173.7	**162.8**
Mobil	154.6	149.6	141.8	**157.8**	170.5	171.0	174.6	174.6	**162.8**
BP	155.0	149.6	141.9	**157.8**	170.0	172.0	175.0	174.6	163.0
Price spread across companies with 5 or more stations	0.6	1.3[c]	0.2	1.8	1.0	2.0	1.3	1.6	2.2

[a]See key to table 1. [b]Figures in bold are the smallest for each month.
[c]This figure is 0.5 if Esso is excluded.

1.3 pence because of the (anomalous) Esso station. Excluding that one station reduces the February price range to 0.5 pence. Later in the year minimum price ranges were substantially higher (table 2). There is some evidence, therefore, that the decline in price variation during the price war owed something to the ripple effects of *intercompany* (rather than just intersite) competition and the consequent convergence in prices. This also appears to be the case for the August data (six companies charging the same minimum) and again in January 1983 (four companies charging the same minimum), which coincides with a second period of falling prices. Note, however, that this time the lower prices appear to have been led by the major companies.

5.2 *Price ranges*
The range in prices offered by each company across its set of retail sites is now considered. General conclusions are difficult to extract, but there is some evidence that as prices rise, the price range for a major company increases, and that as prices fall the reverse occurs, but this is certainly not true for all companies. For Mobil, for example, the nine cheapest outlets have a price range of 3.2 pence in January 1982, 2.4 pence in February, and 0.5 pence in March. The range rises to 1.8 pence in August, rises further to 2.3 pence in November (when prices are at a maximum), and then falls (for the cheapest eight outlets) in January 1983. Table 3 shows the number of companies charging under 142.0 pence in March, and it is evident that for most companies a large number of their outlets are charging within a very narrow price band during the period of intense price competition.

The tentative conclusion from this data is that both the sectoral structure and the structure of intercompany competition are important in accounting for changes and (at any one time) price variation.

Table 3. Number of stations charging 142.0 pence or less, for each company (March).

Company[a]	Number of stations	% of total	Company[a]	Number of stations	% of total
BP	4	30.7	Mobil	8	72.2
Burmah	1	100.0	Murco	2	40.0
Chevron	2	100.0	National	2	28.5
Elf	1	100.0	RP	0	0.0
Esso	3	42.8	Shaw	0	0.0
Fina	3	50.0	Shell	4	66.6
ICI	1	100.0	Texaco	2	66.6
Jet	5	100.0	Total	1	25.0
Major	1	50.0	UK	1	100.0

[a]See key to table 1.

Sectoral structure (and the activities of the cut-pricers) seems to be important in driving down prices, whereas intercompany competition is important in closing the price range.

6 Corporate aspects of spatial price variation

In this section, I comment on the spatial distribution of minimum prices charged by each company. The intention is to draw together the corporate and neighbourhood aspects of spatial price variation. It has already been noted, in section 5, that in February the lowest priced Esso station (site 74) was that Esso retailer closest to the price leader at that time—the Elf station at site 61. Now, however, I explore minimum company-price patterns for March 1982—the month of intensive price competition.

Figure 2 shows the locations of the eighty-eight service stations and the locations of all the single outlet stations that charged prices less than or equal to 142.0 pence in March. This includes site 36 (Major), which charged the lowest price in the area. These 'minor' stations, as has been suggested, appear to have been the prime movers in the price war. Also plotted on this map are the locations of the five Jet stations all of which, from table 3, have been shown to charge low prices. Identified on the same map are the locations of the cheapest outlets of all the other companies, providing that their prices lie in the lowest 50% of prices. In some cases a company has several cheapest outlets.

The map suggests the presence of a number of 'clusters'. They divide into two broad types: 'inner-area' clusters and 'outer-area' clusters. An important factor in the distribution of these clusters is the presence of a low-priced single outlet station or a Jet station, but not all such price-aggressive retail sites have generated a local response. The two Jet stations at 12 and 14 have not, nor has the ICI station at 19, which is located away from the main road and is not visible from it.

There are three, possibly four, inner-area clusters:

(1) the Fina/Mobil cluster near a Jet station (sites 35, 39, and 40);
(2) the Murco/Jet cluster (sites 58 and 59);
(3) the Esso/National cluster round the Elf station (sites 22, 26, 61, and 74);
(4) the Texaco/Total/Esso cluster round the Burmah and Jet stations (sites 9, 62, 63, 64, and 66).

These last two clusters might be considered one, being in close proximity to the outer ring road.

There are three outer-area clusters:

(a) the Fina/BP/Shell/Texaco cluster round the Major station (sites 36, 38, 42, 43, and 44);
(b) the Shell/Mobil cluster (sites 1 and 2);
(c) the Shell/Mobil/Murco cluster (sites 69, 70, and 72).

Note that the outer-area clusters in the south and southwestern part of the city are not formed around minors. These peripheral sites may simply be taking advantage of their locations for incoming commuters. It may be significant, for example, that all the lowest priced Shell stations are on the periphery of the area.

There is no strong evidence for the persistence of specific intercompany rivalries, in part because of data limitations—there are not enough situations in this single study where the same pairs or groups of companies are located close to one another in different parts of the city. The only common denominator, except for those retailers in the southwest periphery of the area, is the presence of a price-aggressive minor. The presence of such a minor is not sufficient to generate a local response, however (for example, sites 12 and 14 do not appear to have triggered off a local reaction), but for inner-area sites this does appear to be a necessary condition. However, the condition is not necessary in the sense that all sites in the vicinity will respond (for example, sites 20 and 21 and sites 24 and 25 maintained relatively high prices in spite of their proximity to two competitive clusters).

Inspection of the price ranges for these clusters at other time periods in the year suggests that the intensity of competition is generally much weaker (the price range is greater). Moreover, the composition of the cluster varies. It is possible to detect the presence of a 'hard core' of competing sites within each of these clusters, so that one can infer that the larger size of the clusters during the price-war period was due to the intensity of the price competition at that time. So, for example, the inner-area cluster (1) more typically seems to involve the two Mobil stations (34 and 35) and the Jet station (40). The inner-area cluster (3) more typically consists either of the Esso station (26) competing with the Elf station (61) or the two Esso stations (26 and 74) competing against the Elf. The large inner-area cluster (4) more typically dissolves into competition between the Jet station (62) and the Texaco station (63), sometimes including the Esso station (66). In the case of the outer-area cluster (b), prices slowly diverge over the study period with the Shell station charging the lower price.

These latter results probably come closest to reflecting the persistent underlying intercompany and intersite rivalries in the southwest Sheffield area and perhaps indicate those areas (and sites) that each company recognises as crucial in maintaining its local market share. Both Shell and Esso [market leaders in the UK national market (Grant, 1982)], where they have stations, appear regularly in these hard cores. Shell, for example, is, with one exception, a regular price leader at one or both of its outlets in the outer-area cluster (a).

7 Conclusions

In this paper, I have discussed corporate and neighbourhood effects in intraurban spatial price variation for petrol retailing. The division of the petrol retailing sector into majors and cut-pricers provides an important mechanism underlying price reductions, particularly during periods of 'price warfare' between the companies. Furthermore, the locations of the cut-pricers in the urban area influence the spatial pattern of price variation. Although the existence of a low-price single outlet retailer does not automatically bring about lower prices at major retailers in the neighbourhood, nonetheless the evidence suggests that where there are large numbers of retailers in a relatively small area this can be sufficient to lead to intense intersite rivalry when there is a downward pressure on overall prices.

Over the longer term not only does spatial price variation change but the distribution of retail outlets changes as well. The long-term trend has been towards the closure of small retailers in poor locations away from main roads. Periods of intense price competition are often associated with an acceleration in this rationalisation process. An aspect of the problem not considered here but worthy of further consideration is the pattern of site closure and site takeovers. As retail outlets increasingly cluster on the principal urban routeways, one might anticipate that as long as the present corporate and sectoral structure and marketing strategies of the industry survive, the sorts of price-war patterns discussed here will become more, not less, common.

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APPENDIX

Table A1. Price data—gallon of 4 star petrol in southwest Sheffield (in pence).

Location coordinates		Station reference number[a]	Company	1982[b]								1983[b]
				January	February	March	August	September	October	November	December	January
168	5	1	15	154.6	151.0	141.9	157.8	169.6	170.0	173.7	174.6	162.8
174	43	2	10	154.6	151.0	141.9	157.8	170.5	171.0	174.6	175.0	164.6
206	74	3	12	164.0	164.0	149.0	169.0	170.0	0.0	0.0	0.0	0.0
238	144	4	3	155.9	151.9	141.9	157.8	170.5	170.0	174.6	175.0	165.5
292	220	5	12	169.9	151.0	145.0	161.0	171.0	172.0	177.0	175.0	165.0
304	228	6	6	154.6	151.0	144.6	174.1	172.3	170.0	174.6	173.2	165.5
341	281	7	10	156.0	151.9	141.9	157.8	170.5	171.9	174.6	175.0	165.5
348	290	8	1	156.0	151.0	143.7	159.6	0.0	0.0	0.0	0.0	0.0
371	388	9	17	154.5	149.5	145.9	159.6	170.0	171.9	176.0	174.1	164.1
386	397	10	1	155.0	150.0	142.0	158.0	170.0	172.0	176.0	175.0	163.0
392	391	11	10	155.0	151.4	141.9	157.8	170.5	171.9	176.9	175.0	162.8
186	228	12[c]	12	170.0	170.0	142.0	157.8	169.6	171.8	174.0	173.0	163.7
229	282	13	6	155.5	150.5	145.5	174.1	172.3	172.8	174.6	174.6	165.5
247	324	14	8	154.6	150.5	141.9	163.2	169.6	171.9	174.6	173.7	163.7
294	374	15	12	159.6	151.9	146.9	163.2	0.0	0.0	0.0	0.0	0.0
325	370	16	10	168.0	168.0	150.0	168.0	172.0	175.0	178.0	178.0	178.0
339	398	17	10	157.8	151.9	142.3	159.6	170.5	172.8	176.9	174.6	163.7
109	77	18	9	157.0	154.0	149.0	162.9	172.9	173.0	178.0	177.0	164.0
313	205	19	7	155.0	152.0	142.0	158.0	170.0	172.0	176.0	175.0	164.6
414	406	20	10	159.0	152.0	146.0	0.0	0.0	0.0	0.0	0.0	0.0
415	413	21	6	159.0	152.0	146.0	160.0	173.0	175.0	178.0	182.0	182.0
419	433	22	12	155.0	150.9	142.0	158.0	170.0	172.0	176.0	175.0	166.0
413	431	23	1	155.0	150.0	142.0	158.0	170.0	172.0	176.0	175.0	164.0
419	457	24	11	156.9	150.0	143.9	161.9	169.6	171.9	175.5	175.0	163.7
417	460	25	11	154.8	150.8	143.8	161.9	169.6	0.0	0.0	0.0	0.0
435	491	26	5	154.6	149.5	141.9	158.2	169.6	170.5	174.6	173.7	162.8
386	483	27	12	155.0	150.0	142.0	158.0	170.0	172.0	176.0	175.0	166.0

Table A1 (continued)

Location coordinates		Station reference number[a]	Company	1982[b]								1983[b]
				January	February	March	August	September	October	November	December	January
380	478	28	1	157.0	157.0	150.0	158.0	170.0	175.0	179.0	178.0	169.0
381	473	29	1	155.0	150.0	142.0	158.0	170.0	172.0	176.0	175.0	165.0
392	503	30	5	157.8	154.6	146.4	160.5	170.0	172.8	177.8	175.0	165.0
380	506	31	15	166.4	162.8	162.8	172.3	170.0	171.9	174.9	173.7	164.1
369	517	32	17	158.7	151.0	146.0	161.9	170.5	172.8	175.5	175.0	166.9
316	556	33	1	156.0	150.0	144.1	159.6	170.5	172.8	176.0	176.0	163.7
282	594	34	10	156.9	149.6	141.9	157.8	170.5	171.9	175.5	175.5	164.1
278	603	35	10	156.0	149.6	141.8	159.6	170.5	171.9	175.5	175.0	163.7
246	683	36	9	157.0	152.0	141.0	162.0	170.0	174.0	178.0	175.0	166.0
237	693	37	6	154.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
222	708	38	16	155.9	150.9	141.9	159.5	170.5	171.9	176.5	174.1	164.1
272	609	39	6	158.0	150.0	141.9	172.3	172.3	175.5	177.8	176.9	165.5
274	618	40	8	158.0	152.0	141.9	161.0	171.0	171.5	175.0	175.0	164.5
279	678	41	15	158.0	150.0	142.0	172.0	171.0	172.0	176.0	175.0	167.0
269	691	42	15	156.0	149.6	141.9	172.3	170.5	171.9	175.0	174.6	163.7
266	698	43	1	156.0	149.6	141.9	157.9	170.5	171.9	175.0	174.6	163.7
266	704	44	6	156.0	149.5	141.9	172.3	170.5	171.9	175.0	174.6	163.7
340	543	45	14	160.0	152.0	145.0	161.0	170.5	171.5	175.5	175.0	163.5
381	533	46	15	156.9	149.6	144.6	0.0	172.3	175.5	175.5	176.4	165.5
405	520	47	6	159.0	152.0	146.0	159.6	171.8	173.7	178.0	176.4	165.5
299	486	48	14	163.0	154.0	146.0	165.5	172.0	174.0	176.0	176.0	166.5
274	430	49	15	154.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
158	368	50	17	156.9	150.0	145.9	161.9	172.3	172.8	176.9	175.0	165.5
150	360	51	5	154.6	149.6	144.6	160.5	170.5	171.9	175.5	175.0	164.1
26	391	52	5	166.0	154.0	150.0	159.0	0.0	0.0	0.0	0.0	0.0
177	445	53	3	157.8	155.0	141.9	162.8	172.3	171.9	177.8	175.5	166.0
197	445	54	10	155.0	151.9	141.9	158.2	0.0	0.0	0.0	0.0	0.0

Table A1 (continued)

Location coordinates		Station reference number[a]	Company	1982[b]								1983[b]
				January	February	March	August	September	October	November	December	January
187	450	55	1	159.1	151.9	144.1	162.8	172.8	173.7	178.2	178.7	166.4
217	588	56	1	156.9	150.5	144.6	161.9	170.5	171.9	176.4	175.9	164.1
206	601	57	5	164.0	159.0	149.0	166.0	172.0	175.0	177.0	177.0	169.0
258	520	58	8	155.0	149.6	141.9	163.2	169.6	170.5	174.6	173.7	162.8
245	498	59	11	155.0	150.0	142.0	0.0	0.0	0.0	0.0	0.0	0.0
280	505	60	5	170.0	170.0	0.0	172.0	172.0	172.0	0.0	0.0	0.0
462	470	61	4	153.9	148.9	141.9	157.9	169.9	171.9	174.9	173.9	163.9
412	367	62	8	154.4	149.8	141.8	157.8	169.8	170.5	174.6	173.7	162.8
408	363	63	16	154.5	150.0	141.9	157.9	170.5	171.5	175.5	173.5	162.9
385	326	64	2	156.0	152.0	142.0	159.0	170.0	173.0	178.0	178.0	164.0
429	285	65	12	169.0	162.0	149.0	165.0	172.0	172.0	0.0	0.0	0.0
357	278	66	5	155.5	150.5	141.9	157.8	169.6	171.9	174.6	175.0	163.7
370	187	67	1	157.8	155.0	146.0	157.8	170.5	172.8	175.5	176.4	163.7
360	166	68	10	158.0	153.0	142.0	157.8	170.5	171.9	174.6	176.5	164.1
361	127	69	11	155.0	150.5	142.0	159.0	169.5	171.5	174.0	174.5	163.5
381	82	70	10	155.5	150.5	142.0	157.8	170.5	172.8	175.5	176.9	164.1
269	27	71	11	156.9	153.9	145.9	161.9	170.0	171.9	175.5	175.5	163.7
584	208	72	15	154.6	149.6	141.9	172.3	170.5	171.9	175.5	175.0	164.1
552	337	73	1	155.5	152.3	144.1	172.3	170.5	172.8	177.8	176.4	166.9
519	375	74	5	154.6	148.7	141.9	172.3	170.5	171.9	174.6	175.0	164.1
436	382	75	1	159.6	152.3	144.1	172.8	170.5	173.7	178.2	177.3	165.5
521	297	76	1	164.0	160.0	149.0	183.0	172.0	174.0	178.0	178.0	167.0
694	236	77	16	155.5	150.9	143.9	172.3	169.6	171.9	175.5	175.0	164.1
698	222	78	10	155.5	152.2	0.0	0.0	0.0	171.9	175.5	175.0	164.1
650	312	79	17	155.0	151.0	148.0	172.0	172.0	0.0	0.0	0.0	0.0
631	271	80	13	170.0	170.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
619	230	81	5	172.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A1 (continued)

Location coordinates		Station reference number[a]	Company	1982[b]								1983[b]
				January	February	March	August	September	October	November	December	January
596	203	82	13	159.0	159.0	152.0	168.0	172.0	175.5	178.0	178.0	168.0
393	243	83	18	161.0	156.0	148.0	171.0	172.0	174.0	177.0	174.0	169.0
326	310	84	12	160.0	160.0	160.0	160.0	170.0	174.0	174.0	174.0	170.0
281	491	85	6	157.0	155.0	142.0	160.0	172.0	175.0	178.0	176.0	166.0
538	357	86	5	0.0	0.0	0.0	0.0	170.5	175.0	174.6	175.0	166.0
238	485	87	6	0.0	0.0	0.0	0.0	0.0	0.0	178.0	175.0	165.0
239	331	88	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	163.8

Index to companies

1 BP	5 Esso	9 Major	13 RP	17 Total
2 Burmah	6 Fina	10 Mobil	14 Shaw	18 UK
3 Chevron	7 ICI	11 Murco	15 Shell	
4 Elf	8 Jet	12 National	16 Texaco	

[a] For the location of the station refer to figure 2.
[b] 0.0 denotes station closed.
[c] Station 12 changed to a Jet station in March 1982.

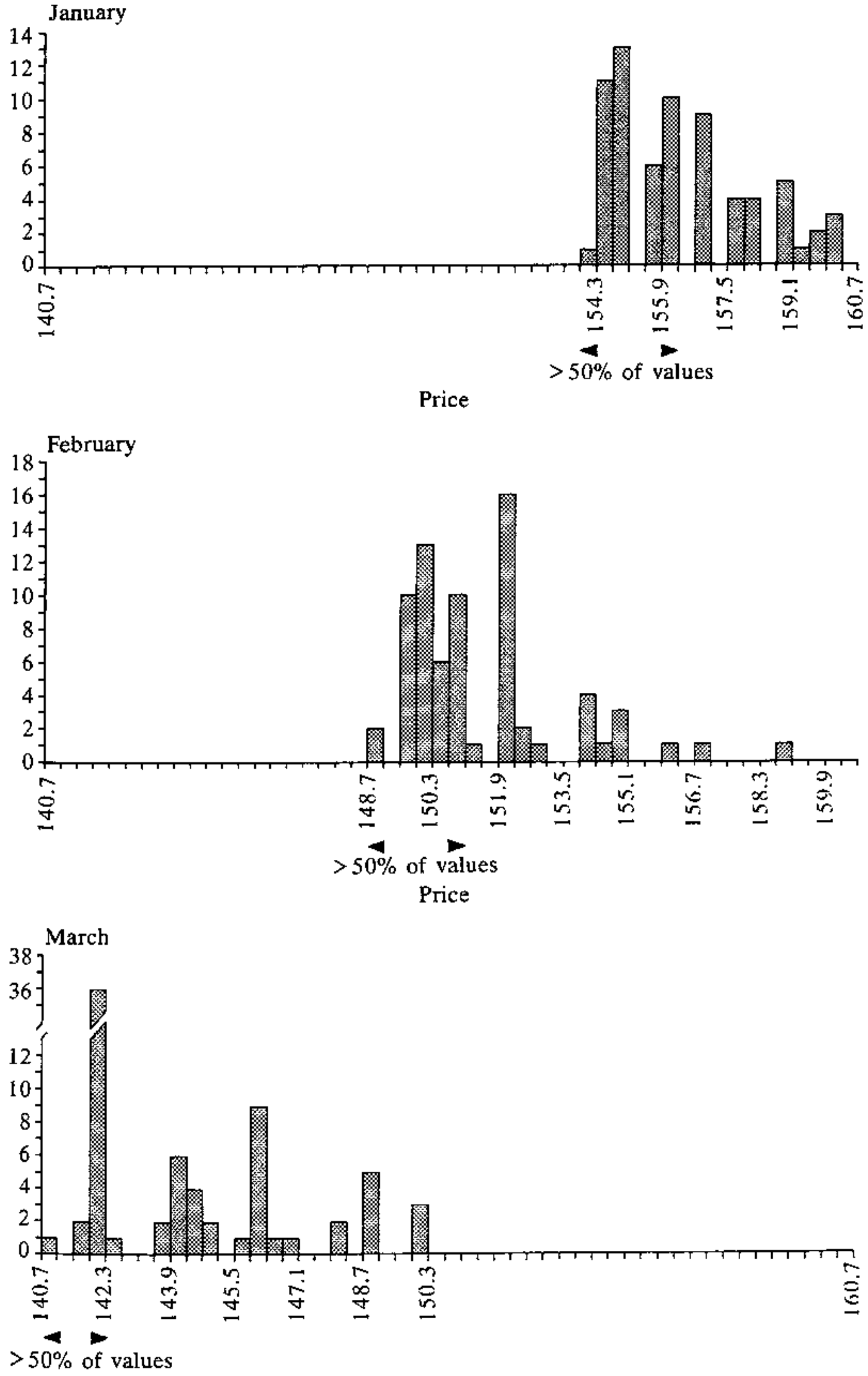

Figure A1. The distribution of petrol prices in southwest Sheffield: January to March 1982.

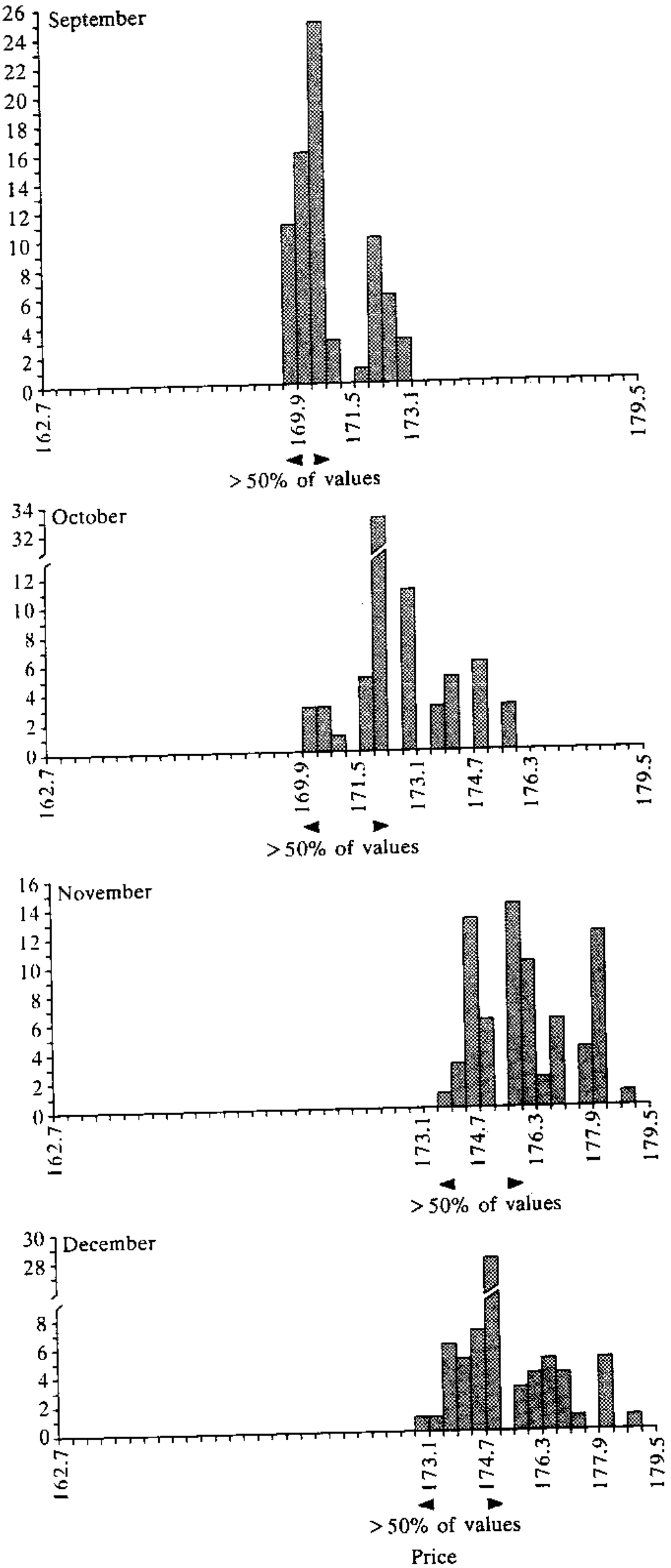

Figure A2. The distribution of petrol prices in southwest Sheffield: September to December 1982.