CHAPTER 5

MARKET STRUCTURE AND THE RATE OF PRICE ADJUSTMENT

5.1 Introduction

The theoretical prediction of a positive link between market structure and performance is supported by evidence from the various empirical studies discussed in the previous chapters. It has been further suggested that the level of concentration has an inflationary impact via price-cost margins. The rationale behind this argument is that in the industrial sector, most of the prices are 'administered' - that is, they are often set by the manufacturers themselves particularly when they possess a certain degree of market power. Many economists suggested that the ability of firms to raise their profits actually come from the market power that they possess.

In the UK, a report by the Monopolies Commission in 1973 drew attention to the fact that prices in highly concentrated oligopolistic sectors have shown a tendency to move in parallel fashion where two or more sellers change their prices at about the same time and by the same amount or proportion[1]. In other words, price coordination or fixing is widespread in highly concentrated industries. In concentrated industries where the costs of search and

[1] See Domberger (1979).

communication among sellers are relatively low, price adjustments can be effectively coordinated and equilibrium in the industry restored fairly rapidly. Since concentration encourages price coordination, a fast rate of industry price adjustment will be anticipated. The speed of adjustment will be positively related to concentration. Therefore, if parallel pricing behaviour is a pervasive feature of highly concentrated industries, it will exacerbate inflationary pressures in the economy.

5.2 Market Structure and Pricing

Domberger (1979, 1983), provided a more direct evidence on the link between concentration and short-run price adjustment behaviour. He estimated the adjustment coefficients (λ) for a sample of industries and tested for their relationship with market structure. The methodology employed was based on a two-stage estimation procedure. In the first stage, a set of industry price equations was fitted to quarterly price and cost data from 1963 to 1974 in the UK. Quarterly time-series were used because according to Domberger (1983), monthly observation would be too short an interval while six-monthly or annual intervals between observations would be too long. In the second stage of his analysis, the relationship between λ and concentration was estimated by means of multivariate cross-section regressions. Results were reported for three alternative measures of concentration[2]. The results indicated that a consistently positive and significant relationship exists between industrial concentration and the rate of price adjustment. The relationship between the two variables was also found to be invariant with respect to the different types of concentration index used and the different years in which the index was measured.

Domberger (1979) employed both ordinary and weighted least squares estimation techniques, using the weighting scheme suggested by Saxonhouse (1977) to avoid the theoretical arguments on the validity of the homoskedasticity assumption of the equation[3]. However, the use of weighted regressions did not make much difference in terms of the empirical results obtained. This suggests that it may suffice to use ordinary least squares in the cross-section regressions. Several other non-linear functional forms were also estimated by Domberger including log-linear, semi-log and quadratic relationship, but none of these offered a better overall fit compared to the ordinary estimation.

[2] They are the Herfindahl index calculated from the 1968 Census of Production; five-firm concentration ratio for 1968 (based on output data) and five-firm concentration ratio for 1971 (based on employment data).

[3] The theoretical arguments, which have been explored in the literature (see Saxonhouse, 1977), indicated that the error term in the equation is made up of two additive components, only one of which is known to be heteroskedastic. Whether or not the error term as a whole is heteroskedastic depends on the relative weight of the two error variance components, and is therefore ultimately an empirical question.

5.3 Methodology

In this section, we attempt to estimate the relationship between the rate of price adjustment and market concentration. The methodology is based on the work of Domberger (1979,1983) who employed the Cournot-Nash solution since the firms are interdependent.

The Cournot equilibrium is a Nash equilibrium because each firm is doing the best it can, given what its competitors are doing (Mansfield, 1991). Firms in the Cournot model produce a homogeneous good and they face the same cost conditions. Hence, the profit function may be represented as:

$$\Pi = Px - cx - f \qquad (1)$$

where Π is profit, P the industry price, x the firm's output, c the unit variable cost and f the fixed cost. The first-order condition for profit maximization is

$$\frac{d\Pi}{dx} = P - c + x\,\frac{dP}{dX}\cdot\frac{dX}{dx} = 0 \qquad (2)$$

where $X = \Sigma x$ is total industry output. Setting $dX/dx = 1$, which implies that the representative firm expects no response from rivals towards its own profit-maximizing output decision. Multiplying through by x and summing over all firms in the industry yields:

$$P\,\Sigma x - \Sigma\, cx + \Sigma x^2 \frac{dP}{dX} = 0 \qquad (3)$$

This can be rewritten as:

$$PX - \Sigma cx - PX \left(- \frac{X}{P}\frac{dP}{dX}\right) \Sigma\left(\frac{x}{X}\right)^2 = 0 \qquad (4)$$

Since (X/P)(dP/dX) is the reciprocal of the price elasticity of demand η, and $\Sigma(x/X)^2$ is the Herfindahl Index, this expression can be rearranged to give the industry price-cost margin in terms of the structural variables:

$$\frac{PX - \Sigma cx}{PX} = \frac{H}{\eta} \qquad (5)$$

where $H = \Sigma(x/X)^2$ is the Herfindahl index of the concentration and $\eta = -(P/X)(dX/dP)$ is the industry price elasticity of demand[4].

The margin is positively related to the Herfindahl Index (degree of seller concentration), and inversely related to the industry's price elasticity of demand. In order to express the equilibrium price in terms of marginal costs, divide the left hand side variables by $X = \Sigma x$, so that it becomes:

[4] The lower-case letters is used to define variables at the firm level, and upper case letter is used to define industry variables.

$$\frac{P - \Sigma cx / \Sigma x}{P} = \frac{H}{\eta} \qquad (6)$$

Since $\Sigma cx/\Sigma x$ is a weighted mean (weighted by firms' output) of individual firms' unit costs, the above expression can be written more simply as:

$$\frac{P - MC}{P} = \nu \qquad (7)$$

where $\nu = H / \eta$, and $0 < \nu < 1$. ν captures the deviation of price from marginal costs and is therefore equivalent to the Lerner index of monopoly power.

Rearrange the expression for any industry i, we get

$$P_i^* = \left(\frac{1}{1-\nu_i}\right) MC_i \; ; \qquad \left(\frac{1}{1-\nu_i}\right) > 1 \qquad (8)$$

This expression defines the equilibrium price P_i^* as a multiplicative mark-up on marginal costs.

The above model decribes the static industry equilibrium but says nothing about how prices are adjusted. Hence, to capture the rate of price adjustment in the short-run, simple partial adjustment mechanism has been adopted, as shown below,

$$(P_t - P_{t-1}) = \lambda (P_t^* - P_{t-1}) \quad 0< \lambda <1, \tag{9}$$

where λ is partial adjustment coefficient and P_t^* is the equilibrium price in period t.

Equation (9) can be rewritten as:

$$P_t = \lambda P_t^* + (1 - \lambda) P_{t-1} \tag{10}$$

Substituting a linear combination of cost and demand variables for the equilibrium price P_t^* (P_t^* is the equilibrium industry price in period t where the long-run industry price consistent with current cost levels) to transform equation (10) into an estimating equation, we have

$$P_t = \lambda \beta_1 C_{1t} + \lambda \beta_2 C_{2t} + (1- \lambda)P_{t-1} , \tag{11}$$

where C_{1t} and C_{2t} represent the current cost of inputs and labour respectively.

In order to avoid the problems of multicollinearity, the first difference of the above equation is taken. The functional specification used to estimate the regression is as follows:

$$\Delta PPI_{it} = \alpha_i + \lambda_i\beta_{1i}\,\Delta PIMF_{it} + \lambda_i\beta_{2i}\,\Delta ULC_{it} + (1-\lambda_i)\,\Delta PPI_{it-1} + u_{it} \tag{12}$$

where PPI denotes the producer price index, PIMF the price index of materials and fuel, ULC the index of unit labour costs and λ the adjustment coefficient.

After obtaining the estimates of λ for the industry sample, these coefficients are then linked to the indicators of industrial structure and other explanatory variables by means of cross-section regression analysis to test the relationship between market structure and the rate of price adjustment.

Differences in the technology of production, specifically the length of the production process, are likely to be an important determinant of the observed speed of price adjustment to changes in costs. To capture this divergence in the length of the production process, that is, the gestation period between input purchases and final output deliveries, stock-output ratios for each industry is included in the analysis (Domberger, 1983, p.81).

The specification of the cross-section regression is as follows,

$$\lambda_i = a + b_1 CR_{it} + b_2\,SOR_{it} + v_i \tag{13}$$

where CR_{it} is the four-firm concentration ratio for industry i in year t, and SOR_{it} is the stock-output ratio for industry i in year t.

5.3.1 Sources of Data

The dependent variable in the regression equation is the annual producer price index (PPI) sourced from the Ministry of Finance's annual *Economic Report*[5]. The quarterly PPI was not used due to unavailability of quarterly data for material and fuel as well as unit labour costs. The PPI used for individual industries is defined by Standard International Trade Classification (SITC) [see Table 5.1]. Data for the PPI covers the period from 1981-1992[6].

Table 5.1
Industries defined by SITC

SITC Code	Description of Industries
0	Food and live animals chiefly for food
1	Beverages and tobacco
2	Crude materials inedible, except fuels
3	Mineral fuels, lubricants and related materials
4	Animal and vegetable, oil and fats
5	Chemicals and related products n.e.c.
6	Manufactured goods classified chiefly by materials
7	Machinery and transport equipment
8	Miscellaneous manufactured articles
9	Commodities and transactions not classified elsewhere in the SITC

[5] PPI is used instead of the Consumer Price Index (CPI) as it is more reflective of the prices in industrial sector. Besides, PPI and CPI have similar trend from 1979-1994.

[6] Annual PPI data were sourced from the Economic Report (1985/86, 1986/87, 1991/92, 1993/94).

On the explanatory variables side, since a price index of materials and fuel (PIMF) are not available, annual cost of inputs is taken as proxies. These are sourced from *Industrial Survey*, conducted by the Department of Statistics. The cost of inputs data are classified according to the Standard Industrial Classification (SIC) scheme. Thus, to ensure consistency with the PPI data, the cost of inputs data are reclassified in accordance with the Standard International Trade Classification (SITC) into seven groups of industries[7, 8].

The unit labour cost (ULC) is based on the annual employee costs by three-digit industry groups published by the Department of Statistic since 1981. Since the labour cost is originally classified according to SIC, reclassification into the SITC scheme is also necessary. To obtain the unit labour cost index we divide the reclassified labour cost by gross value of output.

(1) Concentration Ratio (CR)

The four-firm concentration ratio (CR4) is used as an indicator of industrial concentration. For the measurement of CR4, we use the frequency distributions of employment at the establishment level[9]. Similar to the case of

[7] The reclassification exercise was based on the recommendations of United Nations (1971). It is also possible to reclassify existing data from SIC to SITC scheme.

[8] Three industries in SITC scheme are excluded because they are not manufacture industries. They are crude materials (SITC 2), animal and vegetable, oil and fats (SITC 4) and commodities and transactions not classified elsewhere in the SITC (9).

[9] Domberger (1979) has shown that the relationship between λ and concentration was insensitive to the choice of concentration measures.

other data, the employment data was reclassified from the SIC scheme into the seven major SITC groups (consistent with the PPI classification).

The four-firm concentration ratio (CR4) is calculated as follows:-

$$CR4 = (C_m + C_n) / 2$$

$$C_m = [A - (N - 4) F] / TE$$

$$C_n = 4(A / N) / TE$$

where,

C_m = Maximum share of total employment the largest 4 establishments can have.

C_n = Minimum share of total employment the largest 4 establishment can have.

A = Total employment in the largest class size.

N = Number of establishments in the largest class size. For $N<4$, combine the top few class sizes until $N\geq 4$.

TE = Total employment of the industry.

F = Lower limit of largest class size.

The concentration ratio for 1987 is used in this study. The year 1987 was chosen because it is located at the center of the 1981-92 period. This will ensure that it will be a good representation of the coss-section for the period as a whole[10]. Underlying this decision is the assumption that the measures of

[10] Domberger (1983), p.81.

concentration for individual years are reasonable proxies for industrial structure over the entire estimation period because from Table 4.1, we find that industrial concentration changes relatively slowly over time since 1981[11].

(2) Adjustment Coefficient Estimate (λ)

For each industry, the adjustment coefficient estimate (λ) was obtained by regressing equation (12) over a 12-year period (1981-1992)[12].

(3) Stock-Output Ratio (SOR)

The stock-output ratio is calculated from a series of inventory data from Department of Statistics' *Industrial Survey* from 1983-1992[13].

5.3.2 The Results

The sample comprised a total of seven industries identified at SITC level (see Table 5.2). Ideally, this study should cover the three-digit manufacturing industries but our sample was ultimately restricted by the unavailability of data (due to the different classifications of SITC and SIC).

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11 See Domberger (1983), p.81.

12 Data limitation is severe as the PPI data is not available for the years before 1981.

13 No inventory data are available in 1981 and 1982.

The estimates of λ are reported in table 5.2.

Table 5.2

Estimated Adjustment Coefficients (λ) for 7 Manufacturing Industries

SITC Code	Description of Industries	λ
0	Food and live animals chiefly for food	0.4759
1	Beverages and tobacco	0.7912
3	Mineral fuels, lubricants and related materials	0.9329
5	Chemicals and related products n.e.c.	0.8105
6	Manufactured goods classified chiefly by materials	0.8612
7	Machinery and transport equipment	0.6526
8	Miscellaneous manufactured articles	-0.0502

The estimated relationship between λ and concentration ratio is as follows:

$$\lambda = 0.5165 + \underset{(0.993)}{0.7129}\,CR4 - \underset{(-0.101)}{0.2386}\,SOR \qquad (14)$$

(t-ratios in parentheses)

where λ = the rate of price adjustment

CR4 = four-firm concentration ratio in 1987

SOR = Stock-output ratio

The results seem to indicate a positive but insignificant impact of concentration on the speed of price adjustment. The estimated coefficient implies that for every one percent increase in concentration, the partial adjustment coefficient will increase by 0.7 per cent. The coefficient for the stock-output ratio displays an expected negative sign which implies that industries with large stocks of material inputs have slower price adjustment process.

The insignificant impact of concentration on the rate of price adjustment may be due to the inclusion of both high value-added and low value-added industries in mineral fuels, lubricants and related materials (SITC 3), manufactured goods classified chiefly by materials (SITC 6) and miscellaneous manufactured articles (SITC 8). Among the three groupings, SITC 6 has the most number of low value-added industries, a total of four out of six[14]. SITC 3 and SITC 8 have only one low value-added industry each[15]. Other groupings namely food and live animals (SITC 0), beverages and tobacco (SITC 1), chemicals and related products (SITC 5) and machinery and transport equipment (SITC 7) do not include any low value-added industries. Due to the problem that high value-added and low value-added industries cannot be segregated completely using our procedure of reclassification from the SIC to the SITC, we thus made an attempt to exclude only SITC 6 which has the highest number of low value-added industries from the sample. This yields a greater coefficient between the rate of price adjustment and concentration ratio.

The estimated relationship between λ and concentration ratio is as follows:

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[14] They are (a) manufactures of leather and products of leather; (b) manufactures of pottery, china and earthenware; (c) manufactures of glass and glass products; and (d) manufactures of non-ferrous metal basic industries.

[15] They are manufactures of footwear in SITC 3 and manufactures of miscellaneous products of petroleum & coal in SITC 8.

$$\lambda = 0.4481 + 1.0116CR4 - 0.7501SOR \quad (15)$$
$$\qquad\quad (1.353) \qquad (-0.321)$$

(t-ratios in parentheses)

where λ = the rate of price adjustment

CR4 = four-firm concentration ratio in 1987

SOR = Stock-output ratio

However, CR4 remains insignificant. This may largely due to the reclassification problem which has been highlighted earlier. Thus, it is possible that we may obtain a positive and significant relationship between CR4 and the rate of price adjustment if all the low value-added industries are excluded from the sample. However, this is beyond the scope of our study due to data and time constraints.

5.4 Summary

This study attempted to test the relationship between the rate of price adjustment and market structure (concentration) in Malaysia. The results indicate a positive relationship between the two variables, although the concentration ratio appears to be statistically insignificant.