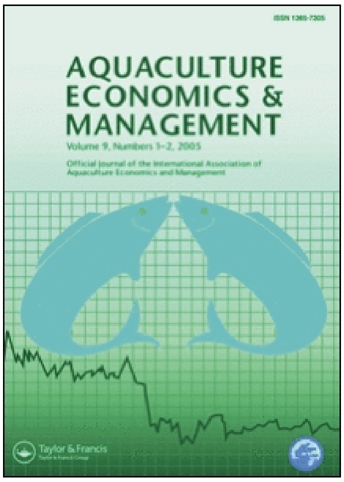


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# BUYING POWER IN UK RETAIL CHAINS: A RESIDUAL SUPPLY APPROACH

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# BUYING POWER IN UK RETAIL CHAINS: A RESIDUAL SUPPLY APPROACH

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□ *The growth of large supermarket chains has raised concerns that these companies can exploit oligopsony power. In this article, we specify a residual supply schedule to investigate the degree of oligopsony power in seafood retailing. Based on the residual supply elasticity, one can also derive a Lerner-type index to measure the degree of market power. Our empirical analysis of the largest supermarket chains in the United Kingdom provide no evidence of oligopsony power for three key seafood products, cod, salmon and shrimp.*

**Keywords** oligopsony, residual supply

## INTRODUCTION

High concentration in food supply chains has increased the awareness that a company with a high market share for a product may not only exploit market power when selling its products, but also when buying some input factors (Rogers & Sexton, 1994; Schroeter, Azzam, & Zhang, 2000; Morrison Paul, 2001; Mingxia & Sexton, 2002). Supermarket chains have received much attention, as exemplified by the concerns of the British Competition Commission (Competition Commission, 2000; Cooper, 2003; Smith, 2004). The concerns of the Competition Commission were primarily with respect to market power in sales, but their report indicates that a bigger problem can be buyer power.

We apply a residual supply schedule to test whether UK retail chains have oligopsony power over wholesalers in their purchases of the three largest seafood products in the UK: salmon, cod and shrimp. More than 87%

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of UK seafood retail sales are made by the supermarket chains (Taylor Nelson Sofres (TNS) SuperPanel, 2003). The four largest supermarket chains—ASDA, Safeway, Sainsbury and Tesco—enjoyed a joint market share of 71.2% in 1999 (Competition Commission, 2000). There is then clear potential for exploiting oligopsony power in this particular group of products. However, there are also arguments in favor of keen competition in the UK retail sector, and Fofana and Jaffry (2008) indicate that there is little evidence of buying power for salmon in the UK.

In his seminal article, Lerner (1934) relates the firm's market power in sales to the slope of the demand schedule facing the individual firm: that is, the residual demand curve. Scheffman and Spiller (1987) and Baker and Bresnahan (1988) derived models for residual demand schedules for cases where competition was spatial and in product space with differentiated products, respectively. Durham and Sexton (1992) note that a similar approach can be used to investigate oligopsonistic or buyer power, and derived a residual supply model for spatial competition with a homogenous product. In this article, we develop a model to study oligopsonistic behavior by retailers. Two issues are of particular importance. First, to allow the firm in question as well as other firms at other stages in the supply chain exploit market power, and second, to allow for the fact that the retailers often purchase differentiated products, such as different brands.

High concentration in retail markets, in which supermarket chains operate, is partly explained by the multiple outlet operation of the largest chains. Concentration of supermarket chains and the exertion of market power towards end users have received much attention in earlier work (Cotterill, 1986; Cotterill & Haller, 1992; Cotterill & Samson, 2002; Chevalier, 1995; Chevalier & Scharfstein, 1996; Armstrong & Vickers, 2001; Pinkse, Slade, & Brett, 2002).

The results from earlier market power studies of retail chains indicate that, when investigating oligopsonistic behavior of retail chains, it is important to allow for non-competitive behavior in the firm's sales. We show that this is straightforward to implement in a residual supply model, as it only influences the choice of instruments. With the concentrated structure of the food industry, one should also allow suppliers, in addition to the retailers of the product in question, to exercise market power. This is particularly relevant when the purchase is made from producers of strong brands. The residual supply model can be extended to incorporate this feature.

When investigating market power in product space, Baker and Bresnahan (1988) emphasize the importance of product differentiation and how this is easily accommodated in a residual demand model. This is equally important when investigating the buying behavior of retail chains, as their product range typically differs with respect to the brands and the packages that are offered. For little-processed seafood products where brands are of less importance, origin can play a role in product differentiation. Using a specification similar to Baker and Bresnahan (1988), the features of differentiated products are also easily implemented in a residual supply specification.

As for an oligopolist, the degree of market power of an oligopsonist can be measured by a Lerner-type index, where the oligopsonist's margin is known as the markdown. The markdown measures the percentage a buyer is able to reduce the price of an input below its competitive price. An oligopsonist operates as a monopsonist on its residual supply curve, and the residual supply elasticity should accordingly be closely related to the degree of market power. However, it will provide an exact measure only if the conjectures are consistent. This relationship is similar to the oligopsony case discussed by Baker and Bresnahan (1988).

To test for oligopsony power, the residual supply model provides a single equation that can be easily estimated when given a functional form. Furthermore, it allows for differentiated inputs. This provides a different approach to testing for oligopsony power than the more common estimation of a conduct parameter. Schroeter (1988) and Morrison Paul (2001) specified the mark-up equation and a full cost function based on the approach of Appelbaum (1982). Schroeter, Azzam, and Zhang (2000) used a model similar to Bresnahan (1982) and Lau (1982). The fact that a residual supply schedule can be estimated as a single linear equation will, in many cases, make it an easier specification to use in empirical work. The specification is independent of assumptions about market structures in other markets where the firm of interest or its competitors operate, and any behavior on the buyer side, from a competitive situation to a monopsony, can be identified. Finally, estimating the residual supply curve does not require the conduct parameters to be estimated, hence one avoids the issues addressed by Corts (1999).



## Model

The residual supply curve that faces an individual firm depicts how the firm influences the input price through the quantity it purchases (Durham & Sexton, 1992). To derive residual supply, we take into account the total supply and the derived demand of all other buyers of the product. This is first shown graphically, before we set up the formal model. In Figure 1, the left panel shows the total market supply, S, and the derived demand from all other firms buying the product in question, $D_{other}$. The residual supply, $S_{residual}$, graphed in the right panel, is then given by the difference between the market supply and the other firm's derived demand.

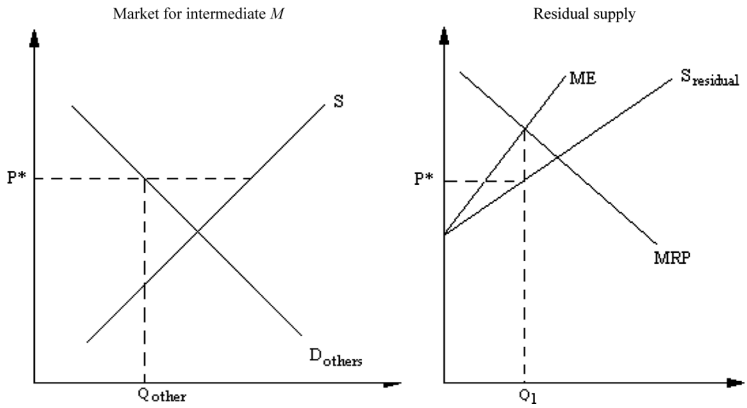


**FIGURE 1** Market supply and residual supply of intermediate good *M*.



The elasticity of the residual supply curve depends both on the market supply and the other firm's derived demand. In a competitive market, the price is completely determined by the other firm's derived demand. In this case, the residual supply curve will be flat. An upward-sloping supply curve implies that Firm 1 has some oligopsony power. With the marginal revenue product (MRP), the firm will then maximize profits by acting as a monopsonist on the marginal expenditure curve (ME), giving price P*. When the residual supply curve and the market supply curve coincide, i.e., have the same slope, the firm will be a monopsonist.

We now derive a formal model of a firm's residual supply. The basic model is similar to Durham and Sexton (1992) and Baker and Bresnahan's (1988) model of residual demand, and accordingly allows the inputs to be differentiated. It is easily extended to the case of potentially competing industries given appropriate aggregation conditions. We also allow firms to exercise market power in the markets for their final products, and to buy the product of interest from a seller that is exercising market power.

The inverse supply function for an input factor (or intermediate good) facing Firm 1, the firm of interest, is the following:

$$W_1 = W^1(Q_1, \boldsymbol{Q}, V^s), \tag{1}$$

where $W_1$ and $Q_1$ are Firm 1's input price and quantity. The vector $\boldsymbol{Q}$ is the other firm's purchases of the intermediate good, which include imperfect substitutes. The fact that the elements of the $\boldsymbol{Q}$ vector need not be perfect substitutes allows differentiated products, such as different brands, in the model. The vector $V^s$ contains the exogenous variables entering the supply equation, typically the supplier's input prices, but also other output prices if the suppliers are multi-output producers. Correspondingly, we can formulate the inverse supply facing each of the other buyers of the factor, $i = 2, \ldots, $ N, as

$$W_i = W^i(\boldsymbol{Q}, Q_1, V^s). \tag{2}$$

The derived demand schedules of firms other than Firm 1 correspond to their marginal revenue product (*MRP*) of the intermediate good. To find the market equilibrium, *MRP* is set equal to the perceived marginal expenditure (*PME*). This can be written as

$$MRP^i(Q_i, \boldsymbol{W}, P^i) = PME^i(\boldsymbol{Q}, Q_1, V^s; \lambda^i) \quad \text{for all } i \neq 1. \tag{3}$$

The marginal revenue product is determined by the quantity purchased of the intermediate input $Q_i$, a vector of industry-wide factor prices $\boldsymbol{W}$, and a firm-specific output price $P^i$. When buyers operate in different markets for their final products, the output prices are firm-specific information and, in general, it is not necessary to find a firm-specific factor price as in Baker and Bresnahan (1988) to derive residual demand. However, one can certainly extend the marginal revenue product by a vector of firm-specific input factor prices if that is appropriate, or add these to the model by making $P^i$ a vector. In Durham and Sexton's (1992) spatial model with homogenous products, transportation costs are employed as the firm-specific factor. In this case, the industry's common sales price becomes part of the $\boldsymbol{W}$ vector.

Perceived marginal expenditure depends on the quantity purchased of the factor, represented by $\boldsymbol{Q}$ and $Q_1$, and factor prices of the upstream firms' inputs, $V^s$. $\lambda^i$ is the conduct parameter that indexes market power for all buyers, $i = 1, \ldots, $ N. Hence, buyers of the factor other than Firm 1 can exercise market power. If $\lambda^i = 1$, perceived marginal expenditure coincides with actual marginal expenditure, i.e., firm $i$ is a monopsonist. If $0 < \lambda^i < 1$, there is evidence of oligopsony power, and with $\lambda^i = 0$, firm $i$ is a price taker. Specifically, $PME^i$ takes the form

$$PME^i = W_i + Q_i \sum_j \left(\frac{\partial W_i}{\partial Q_j}\right)\left(\frac{\partial Q_j}{\partial Q_i}\right). \tag{4}$$

The conduct parameter $\lambda^i$ is determined by the second term on the right-hand side, $\partial Q_j / \partial Q_i$. This term, which measures the effect of firm $i$'s purchases on other firms' purchases, determines whether firm $i$ potentially has market power. If $\partial Q_j / \partial Q_i = 0$, firm $i$ is a price taker and if $\partial Q_j / \partial Q_i < 0$, firm $i$ has some degree of oligopsony power. Let superscript $I$ denote a vector containing the information of all firms with the exception of Firm 1. Solving equations (2) and (3) for $\boldsymbol{Q}$, keeping $Q_1$ fixed, then gives the following:

$$\boldsymbol{Q} = E^I(Q_1, V^s, \boldsymbol{W}, P^I, \lambda^I), \tag{5}$$

where $E^I$ is the equilibrium quantity for all markets except $i=1$, where all right-hand side variables other than $Q_1$ are exogenous.

By substituting for $\boldsymbol{Q}$ from equation (5) into (1), one obtains the residual supply relationship facing Firm 1:

$$W_1 = W^1(Q_1, E^I(Q_1, V^s, \boldsymbol{W}, P^I, \lambda^I), V^s). \tag{6}$$

Substituting out the redundancies, this gives the residual supply curve facing Firm 1:

$$W_1 = S^{res1}(Q_1, V^s, \boldsymbol{W}, P^I; \lambda^I). \tag{7}$$

The residual supply curve is a function of the demanded quantity of the factor by Firm 1 ($Q_1$), input prices for the suppliers ($V^s$), the input prices of other factors facing all firms buying the factor ($\boldsymbol{W}$), and the output prices of the other firms ($P^I$). The output price of Firm 1 (and if included, other firm-specific input factors) is not included in this equation and serves as an instrument for the endogenous quantity $Q_1$. The key parameter of interest is the inverse residual supply elasticity, or the residual supply flexibility:

$$\kappa = \frac{\partial \ln\ S^{res1}}{\partial \ln\ Q_1} \tag{8}$$

This elasticity is zero if Firm 1's demanded quantity of the factor does not influence the price Firm 1 pays, or $W_1$, and accordingly, the firm has no market power. The elasticity increases in magnitude as the market power of Firm 1 increases.

To close the model, we formulate the derived demand relation for Firm 1:

$$MRP^1(Q_1, W, P^1) - W_1 = M^1(Q, Q_1, V^s; \lambda^1), \tag{9}$$

where $M^1(\cdot) = PME^1(\cdot) - W_1$. Since $M^1(\cdot)$ is equal to the difference between the marginal revenue product, MRP, and the price of the intermediate good, $W_1$, it provides the net benefit of acquiring an additional unit of the intermediate good. The larger the net benefit relative to the price of the intermediate $W_1$, the more buyer power Firm 1 exerts. This measure is, analogous to the mark-up in monopoly, known as the markdown. By substituting for $\boldsymbol{Q}$ in equation (9) with $E^I$ from equation (5), we obtain a new expression for $M^1$ that is entirely in ($P_1$, $Q_1$) space:

$$MRP^1(Q_1, W, P^1) - W_1 = M^1(Q_1, V^s, W, P^1; \lambda^1), \tag{9$'$}$$

where $M^1(\cdot)$ is the markdown. Equation (9′) is an equilibrium condition, which can be re-written as $MRP^1 = PME^1$, and thereby determines $W_1$ and $Q_1$.

In many cases, it is of interest to allow the potential oligopsonist to possess market power also in its output market. This is, for instance, the case if the potential oligopsonist is a supermarket chain. This can be incorporated by making the derived demand relationship for Firm 1 also a function of the variables in the perceived marginal revenue term in the firm's output market. This can be written as

$$MRP^1(Q_1, W, P^1, Y^1) - W_1 = M^1(Q_1, V^s, W, P^1; \lambda^1), \qquad (9'')$$

where $Y^i$ are the variables from the demand equation facing Firm 1 in the output market. These are typically consumers' income and the prices of potential substitutes. For the estimation of the residual supply curve, this implies that more variables have to be used as instruments. Similarly, one can also allow Firm 1's competitors for the intermediate factor to exercise market power by including variables that can influence the slope of their marginal revenue schedule in the $P^i$ vector.

If the sellers of the product in question have market power, as will be the case for suppliers of recognized brands, they incorporate variables from the buyer's optimization problem in their supply relations to assess the slope of their marginal revenue schedule. This can be the case, e.g., in the beef packer industry as in Schroeter, Azzam and Zhang (2000), or for suppliers of recognized brands (e.g., Coca-Cola), where a concentrated industry is selling to supermarket chains that potentially can exercise buyer power. To keep the different firm's residual supply schedules identified, however, the seller cannot have complete information about the buyers. So far, we have avoided the assumption of certain firm-specific costs that Baker and Bresnahan (1988) employ to identify their model, because the output price has taken this role. However, we then need to assume that the seller does not have full information. This is not a very unreasonable assumption as long as the seller cannot price discriminate and the output prices for the different buyers are not completely correlated. Assuming that oligopolistic sellers assess their market using the aggregate demand schedule, with an aggregate price P, the inverse supply function faced by Firm 1 is

$$W_1 = W^1(Q_1, \boldsymbol{Q}, V^s, W, P), \qquad (1')$$

and the residual supply curve in equation (7) will be modified only by including the price index $P$. If the different firms buying the intermediate good are selling their final products in the same competitive market and their final prices are highly correlated, there must be other firm-specific elements in the $P^1$ and $P^i$ vectors (other outputs produced or costs) to identify the model, as transportation costs in Durham and Sexton (1992).

## Measuring the Degree of Market Power

When investigating the degree of market power for a monopolist or oligopolist, a Lerner index is the most common measure. Similar measures are equally useful to measure the degree of monopsony or oligopsony power. Let a firm be able to exercise market power for input $m$. With the production function $f(x_1, x_2, \ldots, x_m)$, the degree of market power is given by

$$\frac{pf_m - w_m}{w_m} = \frac{1}{\eta}, \tag{10}$$

where $\eta$ is the supply elasticity faced by the firm, $p$ is the output price and $w_m$ is the input price for input $m$. The markdown here is decided by how much lower then the marginal value product of the factor the factor price $w_m$ is. If the firm faces an infinitely elastic supply curve, the difference between the marginal value product, $pf_m$, for factor $m$ and its price is zero. Moreover, as the supply elasticity decreases, the difference between the marginal value product and the price increases as the price of the input factor is reduced relative to the marginal value product.

For the oligopsonist, there are then two different ways to express the degree of market power using this index. In the first, the oligopsonist's degree of market power is expressed as a function of the total supply elasticity and a conduct parameter measuring the degree of competition the firm faces. The index is then

$$\frac{pf_m - w_m}{w_m} = \frac{\theta_1}{\eta}, \tag{11}$$

where $\theta_1$ is the conduct parameter that indicates the degree of competition among buyers. Alternatively, since the oligopsonist will operate as a monopsonist on its residual supply curve, the degree of market power can be expressed as

$$\frac{pf_m - w_m}{w_m} = \frac{1}{\mathrm{K}}, \tag{12}$$

where K is the residual supply elasticity.

In the case of residual demand, Baker and Bresnahan (1988) show that the residual demand elasticity provides an exact measure of the mark-up if the conjectures are consistent. This is also the case in oligopsony. Hence, the residual supply elasticity will provide an exact measure of the markdown if the firm's conjecture about the other buyer's response is consistent. In particular, this will be the case if purchases of the factor are competitive, as the term $\partial \ln W_i/\partial \ln Q_1$ is then zero. A test of whether the residual supply elasticity is zero will accordingly always be a valid test of whether Firm 1 has market power. In other cases, one would expect a steeper residual supply curve to indicate more market power.

Another situation in which the index of market power for the oligopsonist is relevant, is the retail chain's use of so-called loss leaders. Loss leaders are products that are sold below the cost of purchase to attract customers. In France, this practice is now prohibited by law. In a residual supply framework this will show up as a negative markdown. Hence, the residual supply elasticity can also be used to investigate whether a product is a loss leader. Since the conjectures are consistent when the markdown is zero, a negative markdown can always be separated from competitive practice.

As shown by Durham and Sexton (1992), another way to derive the residual supply elasticity is by differentiating equation (7) with respect to Firm 1's quantity $Q_1$. This shows that the inverse residual supply elasticity can be formulated as a sum of elasticities that comprises direct and indirect effects on residual supply caused by changes in Firm 1's derived demand.

$$\kappa = \frac{\partial \ln S_1^{res}}{\partial \ln Q_1} = \frac{\partial \ln S_1}{\partial \ln Q_1} + \sum_i \frac{\partial \ln S_1}{\partial \ln W_i} \cdot \frac{\partial \ln W_i}{\partial \ln Q_1} \tag{13}$$

The first term on the right-hand side is the supply elasticity, $\partial \ln S_1/\partial \ln Q_1$. The two remaining terms sum the effects of the strategic interaction with other firms, $i = 1, \ldots, N$. The term $\partial \ln W_i/\partial \ln Q_1$ gives the response on other buyers' prices of Firm 1's increased purchases. This term is positive when firms compete in purchases of the intermediate good and zero otherwise. Competition reduces the supply facing Firm 1 through the term $\partial \ln S_1/\partial \ln W_1 < 0$, because other firms divert supply away from Firm 1 by offering higher prices. Consequently, the residual supply curve becomes flatter the more intense the competition is among buyers.

## UK Supermarket Sales of Seafood

During the last few decades, there has been substantial restructuring in retail sales of food in many parts of the world. Supermarkets have become larger and organized in chains, and a large proportion of retail sales in many countries are controlled by a small number of firms. This has led to substantial concerns about these firms' behavior, and particularly whether they exploit market power in sales as well as in purchases. The UK is one country where these concerns have been strong, and in 1999, the Director General of Fair Trading commissioned an investigation into the conduct of the largest supermarket chains (Competition Commission, 2000). The report found little evidence to support the claim that these firms exploit oligopoly power, but exploitation of oligopsony power remains a concern.

Seafood sales are just one area where the supermarket chains are now dominating retail sales, making up more than 80% of total retail sales for these types of products (TNS SuperPanel, 2003).[1] Because of this, seafood is one group of products where this concern appears highly relevant. In this study, we investigate whether the largest five supermarket chains exercise market power in their purchases of three of the most important seafood species in the UK: namely, cod, shrimp and salmon.[2] In 2002, the five largest supermarket chains, which we focus on here, had market shares in cod, salmon and shrimp of 58%, 70%, and 57%, respectively.

To test for market power exertion, we specify a residual supply schedule where the variables are linear in logarithms, and consequently, the estimated parameters can be directly interpreted as elasticities. The model takes the following form:

$$\ln W_{1,mt} = \mu_m + \kappa_m \ln Q_{1,mt} + \alpha'_m \ln V^s_{mt} + \beta'_m \ln W_{mt} + \gamma'_m \ln P^I_{mt} + \varepsilon_{mt}, \quad (14)$$

where $\varepsilon_{mt}$ is an iid error term, the subscript $m$ denotes a specific product, and $t$ denotes time period (month). The variable $W_{1,mt}$ is the purchase price of, respectively, cod, salmon and shrimp for the supermarket chains, and $Q$ is the quantity purchased. The vector $V^s_{mt}$ consists of exogenous variables shifting the supply of the seafood species, and $W_{mt}$ is a vector of industry-wide factor prices; in this application, a wage index along with the UK interest rate is used as an indicator of capital costs. The vector $P^I_{mt}$ consists of other retail outlets' output prices for the same seafood products.

As noted above, whether the retail outlets have market power in their sales will influence the choice of appropriate instruments. Hence, potential market power in sales can be analyzed by testing whether the instruments that are related to the marginal revenue curve facing the firm are redundant. This can be done using the test for instrument relevance developed by Hall and Peixe (2003). The instruments used to investigate whether the supermarkets face a downward sloping (residual) demand schedule are an index of total retail expenditure in the UK and the Consumer Price Index (CPI).[3] Our modelling strategy is to first estimate equation (14) by ordinary least squares, which is appropriate if the retail outlets do not have any oligopsony power. We then report the results for the instrumented model to take account of retail outlets exploiting oligopsony power. Finally, we report Hall and Peixe's statistic to test whether the instruments related to market power in the sales are redundant and the estimated parameters for this model if this issue is relevant. We do not allow the suppliers of the retail chains to have market power, as there is little scope for the exploitation of market power due to the large number of potential suppliers.

Monthly data on expenditures in British pounds (GBP) and quantities (in kilograms) for the three seafood species for the five largest supermarket chains and other retail outlets have been collected by TNS and made available by the SeaFish Authority.[4] The data are of monthly frequency for the period from January 1991 to December 2002, giving 144 observations. Input prices for the suppliers of seafood are prices for UK cod landings obtained from SeaFish and farm gate prices for salmon from the Scottish Office. For shrimp, there is virtually no domestic production in the UK. We therefore use Norwegian ex-vessel prices from the Norwegian Raw Fish Organization as the input price, as Norway is the largest exporter.[5] The remaining factor prices, wages and capital cost, are common for the retailers and the suppliers. The Average Earnings Index (AEI) is published by National Statistics, UK. The interest rate series is selected using the retail banks' base rate obtained from the Bank of England. Finally, since the seafood products can also be sold in other markets, some exchange rates from the Bank of England were also used.

Estimation results from two different estimation methods (OLS and IV/GMM) are presented by product in Tables 1–3. After estimating the models using ordinary least square (OLS), tests for autocorrelation and heteroskedasticity were carried out. The tests indicate that we have problems with heteroskedasticity and autocorrelation in the shrimp model. Newey–West standard errors are therefore presented for shrimp (Table 3). If the supermarket chains have market power, quantity and price are determined simultaneously, and quantity on the right-hand side of the estimating equation is endogenous.



**TABLE 1** Estimation Results for Cod[a]

| | OLS | | IV/GMM | |
|---|---|---|---|---|
| | Coeff. | S.E. | Coeff. | S.E. |
| $Q_1$ | –0.029 | 0.112 | 0.108 | 0.124 |
| $P^I$ | 0.174* | 0.076 | 0.165 | 0.064* |
| $V_{cod}$ | 0.136 | 0.093 | 0.195 | 0.074* |
| $W_{lab}$ | 1.010* | 0.175 | 1.113 | 0.141* |
| $W_{capital}$ | 0.459* | 0.058 | 0.360 | 0.070* |
| $V_{Eur}$ | –0.857* | 0.160 | –0.563 | 0.196* |
| Intercept | –4.309* | 1.198 | –6.449 | 1.168* |
| $R^2$ | 0.704 | | BP/CW LM[c] | 2.97 (0.085) |
| AC(12)[b] | 1.19 | (0.301) | Hansen J stat | 5.939 (0.204) |

*Indicates statistically significant at a 5% level.
[a] *p*-Values for tests in parentheses.
[b] LM test of autocorrelation of order less than or equal to 12.
[c] Breusch–Pagan/Cook–Weisberg test for heteroskedasticity.

**TABLE 2** Estimation Results for Salmon[a]

| | OLS | | IV/GMM | |
|---|---|---|---|---|
| | Coeff. | S.E. | Coeff. | S.E. |
| $Q_1$ | –0.096 | 0.102 | 0.004 | 0.114 |
| $P^I$ | 0.030 | 0.043 | 0.053 | 0.043 |
| $V_{salmon}$ | 0.712* | 0.303 | 0.813* | 0.268 |
| $W_{capital}$ | –0.316 | 0.135 | –0.327* | 0.107 |
| $W_{lab}$ | 2.354* | 1.201 | 2.507* | 0.991 |
| t | –0.008 | 0.005 | –0.008* | 0.004 |
| $t^2$ | –3.48E–05 | 1.94E–05 | –3.50E–05* | 1.58E–05 |
| Intercept | –9.266 | 5.195 | –10.496* | 4.362 |
| $R^2$ | 0.548 | | BP/CW LM[c] | 0.25 (0.616) |
| AC(12)[b] | 1.36 | (0.197) | Hansen J stat | 2.447 (0.485) |

*Indicates statistically significant at a 5% level.
[a]*p*-Values for tests in parentheses.
[b]LM test of autocorrelation of order less than or equal to 12.
[c]Breusch–Pagan/Cook–Weisberg test for heteroskedasticity.

The IV estimates are obtained using a GMM to account for autocorrelation with Newey-West standard errors. We instrument the total quantity of the five largest supermarket chains using the retail sales price and lagged values of quantity and retail price. In the case of shrimp, the autocorrelation consistent standard errors and covariance are based on a Bartlett kernel with bandwidth two. Alternative bandwidth specifications did not alter the results significantly. After the second-stage regression, we tested for over-identification using the Hansen J-test. The test statistics suggest that over-identification is not a problem in any of the three cases.

**TABLE 3** Estimation Results for Shrimp[a]

| | OLS | | | IV/GMM | | IV/GMM-2 | |
|---|---|---|---|---|---|---|---|
| | Coeff. | S.E. | Newey–West S.E. | Coeff. | S.E. | Coeff. | S.E. |
| $Q_1$ | 0.062 | 0.089 | 0.083 | –0.017 | 0.078 | –0.046 | 0.069 |
| $P^I$ | –0.002 | 0.069 | 0.048 | –0.030 | 0.045 | –0.041 | 0.042 |
| $V_{shrimp}$ | 0.429* | 0.106 | 0.063 | 0.432* | 0.063 | 0.405* | 0.056 |
| $W_{lab}$ | –1.120* | 0.279 | 0.360 | –0.915* | 0.250 | –0.839* | 0.236 |
| $W_{capital}$ | –0.354* | 0.133 | 0.136 | –0.398* | 0.119 | –0.435* | 0.113 |
| Intercept | 3.765* | 1.001 | 0.950 | 3.298* | 0.718 | 3.126* | 0.700 |
| $R^2$ | 0.158 | | BP/CW LM[c] | 53.77 | (0.000) | | |
| AC(12)[b] | 2.00 | (0.031) | Hansen J stat | 4.729 | (0.193) | 5.251 | (0.386) |

*Indicates statistically significant at a 5% level.
[a]*p*-Values for tests in parentheses.
[b]LM test of autocorrelation of order less than or equal to 12.
[c]Breusch–Pagan/Cook–Weisberg test for heteroskedasticity.

The results for cod are presented in Table 1. With $R^2$ above 0.7, the explanatory power of the model appears reasonable. With the exception of the residual supply elasticity, all parameters are statistically significant in the IV estimates, and the magnitudes of the parameters are relatively similar to the OLS and IV estimates. The residual supply elasticity is the only parameter that is statistically insignificant at the 5% level as well as all other conventional significance levels. Hall and Peixe's test for whether the instruments for oligopoly power are redundant cannot reject the null of redundancy for any of the instruments and provides a $p$-value of 0.937 for the joint test. Hence, one can conclude that there is no evidence of oligopsony power. However, it is worthwhile to look at the magnitudes of the estimated parameters. The OLS estimate is very close to zero, although the elasticity has the wrong sign. The IV estimate of the elasticity is as high as 0.11, although statistically insignificant. As this estimate indicates a margin of 11%, the statistical precision of the parameter estimate casts some doubts with respect to our conclusion.

The results for salmon can be found in Table 2. With $R^2$ about 0.55, the explanatory power of the model is somewhat poorer than cod, but still not unreasonably low. The model specification for salmon differs from the others in that it includes both a time trend ($t$) and a squared time trend ($t2$).[6] These trends are not unreasonable since the salmon market has experienced a strong increase in supply during the last two decades due to strong productivity growth and technological change (Asche, 1997; Tveterås, 1999). Hall and Peixe's test for whether the instruments for oligopoly power are redundant cannot reject the null of redundancy for any of the instruments and provides a $p$-value of 0.125 for the joint test. Additionally for salmon, the residual supply flexibility changes sign from negative with the OLS estimate to positive with the IV estimate. Again, the flexibility is statistically insignificant in both specifications, and as it is as low as 0.004 in the IV specification, the parameter estimate does not in any way suggest economic significance. Hence, with salmon, we can clearly conclude that the large supermarket chains do not exploit oligopsony power. However, it is of interest to note that the OLS estimate is as high as −0.096, although statistically insignificant. This may indicate that loss leadership may be an issue with respect to salmon if the precision of the estimates can be increased. Largely, the results also are in accordance with Fofana and Jaffry (2008), who found statistical evidence of market power, but where the estimated parameters were so close to zero that their main conclusion was that UK retail chains did not exercise buying power for salmon.

Table 3 reports the results for shrimp. With $R^2$ of about 0.16, the explanatory power of this model is so poor that one can question whether the results have any real value. We did try to include a number of factors describing the international market for shrimp to investigate whether this could be the cause of the model's poor performance, but without any success. However, for the key parameter of interest, the model comes up with a result similar to those of the two other species. Hall and Peixe's test for whether the instrument for oligopoly power is redundant rejects the null hypothesis of redundancy for retail price as an instrument and provides a *p*-value of 0.012 for the joint test (retail price and CPI). Hence, we cannot reject the hypothesis that the retail outlets have market power in their sales of shrimp. The final column of Table 3, therefore, reports the estimation results for the residual supply equation with this instrumentation. Including instruments for oligopoly power does not influence the main results. The magnitudes of the estimates of the residual supply flexibility are small and are statistically insignificant at all conventional levels in all the three specifications.

When comparing the results, there is little evidence of oligopsony power in the largest supermarket chains' purchases of major seafood products. As these supermarket chains have a very high share of total retail sales of seafood, this is most likely an indication of a highly competitive supply of seafood. This appears plausible given that the seafood trade is international and a high degree of concentration in one country is unlikely to be sufficient to give the buyers oligopsony power.[7]



## CONCLUDING REMARKS

The exploitation of oligopsony power is an increasingly important topic for a number of reasons. The development of supermarket chains has led to substantial concentration in the supply chain for foods, and has raised concerns that these companies can not only exploit oligopoly power, but also oligopsony power. These concerns have been brought to the forefront in the policy agenda in several countries, as exemplified by the UK Competition Commission's recent investigation (Competition Commission, 2000).[8]

In this article, we use a residual supply schedule to investigate the degree of oligopsony power exercised by retail chains when purchasing seafood products. The basic model, in which only the retailer of interest can exploit oligopsony power, is extended to cases where the firm also exploits market power in the retail markets, as well as when it is purchasing the seafood products from an oligopolist. Furthermore, the fact that differentiated products are accommodated by the model makes it especially useful for investigating retail behavior where many products are differentiated through branding, packaging, origin etc. The degree of market power for a monopsonist can be measured by a Lerner-type index, and a similar index based on the residual supply curve provides a measure of oligopsony power.

An interesting result that immediately follows from the model is that it is more difficult to exploit oligopsony power than oligopoly power. This is because it is not possible for a company that faces an infinitely elastic supply curve to exploit market power. Hence, if a potential oligopsonist faces a highly competitive supply industry, there is little or no scope for exploiting oligopsony power. This is an additional argument for antitrust authorities to be concerned with the competitiveness of suppliers. A competitive cattle industry may help explain, for example, why Morrison Paul (2001) found that market power was not a significant issue in the highly concentrated meat packer industry.

It is also well known that the supply structure in many seafood supply chains is highly competitive as shown e.g., by Asche (2001) and Fofana and Jaffry (2008) for salmon and by Asche, Roll and Trollvik (2009) for cod. The negative effect of a competitive supply industry on oligopsony power may also be one reason why firms in concentrated supply chains often engage in practices that limit the number of suppliers. Cooper's (2003) findings indicate that this may be the case for UK supermarket chains' purchasing practices. They typically certify suppliers, so as to create exclusive pools of suppliers, etc. In doing so, they also limit the number of suppliers. Such measures can be a way to change the slope of the residual supply schedule. If successful, this also increases the possibility of obtaining profit transfers from the suppliers, e.g., through shelf space fees. Such measures will, of course, be even more effective if the suppliers are obliged to make some relationship-specific investments.

The usefulness of the model is demonstrated with an application to the UK wholesale seafood market. An empirical investigation is undertaken to examine whether the UK's five largest supermarket chains are acting like oligopsonists in their purchases of three key seafood species: namely, cod, salmon and shrimp. The results indicate that they are not exploiting market power for any of these seafood products. A likely explanation is the international nature of seafood markets with low or no trade barriers, which make the supply to any specific market highly elastic.



## NOTES

1. Murray and Fofana (2002) provide a more detailed discussion of the increased market shares of the retail chains in UK seafood retailing.
2. The five supermarket chains are Tesco, Sainsbury, ASDA, Safeway and Somerfield.
3. The use of retail expenditure implies that retail sales are assumed weakly separable from all other goods in the consumer's bundle. The Consumer Price Index can be thought of as a proxy for the price of all other goods, and the very low budget share of the products used here should not introduce much bias in the proxy. The underlying theory for both assumptions can be found in Deaton and Muelbauer (1980).
4. Other retail outlets include smaller supermarket chains, co-ops, fishmongers, etc.

5. We also tried to include prices and exchange rates for the second and third-largest suppliers (Iceland and Greenland). However, these were statistically insignificant.
6. Joint Wald tests of linear and quadratic trends based on the IV/GMM estimates for cod and shrimp gave chi-squared test statistics of 3.16 and 3.76, respectively, and we concluded there were no time trends in the cod and shrimp data.
7. Gordon and Hannesson (1996) provide evidence of the international nature of the cod market, and Asche (2001) provides similar results for salmon.
8. Cooper (2002) provides a good review of the Competition Commission's report.

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