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**Buying power in UK retail chains:
A residual supply approach**

by

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Abstract

The development of supermarket chains has led to substantial concentration in food supply chains, and has raised concerns not only that these companies can exploit oligopoly power, but also oligopsony power. In this paper, we specify a residual supply schedule to investigate the degree of oligopsony power in retailing. Based on the residual supply elasticity, one can also derive a Lerner-type index to measure the degree of market power. After examining the largest supermarket chains in the United Kingdom, we find no evidence of monopsony power for three key seafood products.

Keywords: Oligopsony, residual supply

Introduction

Interest in oligopsonistic market structures has increased substantially during the last decade, with the realization 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. Because of the high concentration in retailing, supermarket chains have received much attention, as exemplified by the concerns of the British Competition Commission (Competition Commission, 2000; Cooper, 2003; Smith, 2004). However, there are several other examples where the high degree of concentration in the supply chain has raised this issue, such as in Schroeter, Assam and Zhang (2000), Morrison Paul (2001) and Mingxia and Sexton (2002).

In his seminal paper, 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. Scheffer 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 paper, we develop a model to study retail competition. Two issues are of particular importance. First, the possibility that the retailers exploit market power in their sales, and second, to allow for the fact that the retailers often purchase differentiated products, such as different brands.

With respect to non-competitive behaviour by retail chains, most attention has been focused on potential market power in sales. When investigating oligopsonistic behaviour, it is also important to allow for non-competitive behaviour in the firm's sales. First, when firms are

large enough to exploit market power in purchases, it may also be the case they exploit market power in sales. Second, if they do exploit seller power, the firm's profit function needs to be redefined. 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 industry, one should also allow other agents, in addition to the sellers of the product in question, to exercise market power. This is particularly relevant when the purchase is made from producers of strong brands. 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 behaviour of retail chains, as their product range typically differ with respect to the brands and the packages that are offered. 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 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).

An interesting issue is what scope exists for an oligopsonist to exploit market power. Durham and Sexton (1992) show that if the price is completely determined by other buyers of the product, that is, there is perfect competition in buying the product, the residual supply schedule is flat and there is no scope to exploit market power. This is equivalent to the result

for oligopolists: when there is sufficient competition in the sales of a product, input factor prices will determine the output price and the residual demand schedule will be flat. These results follow from the fact that a firm operating in a competitive industry cannot have market power. However, in the case of oligopsony, the market structure of the supplier side is also of interest. In particular, if a potential oligopsonist faces competitive suppliers, there will be no scope to exploit oligopsony power. This is because with a horizontal market supply schedule, the residual supply curve must also be flat. Moreover, an industry only continues to supply its products provided that long-run marginal cost is covered. This implies that it is difficult to use buyer power in any relatively competitive industry, as the producer surplus constitutes the highest possible transfer to the oligopsonist. Of course, in the short run, the potential to exercise market power is larger, as fixed costs are then irrelevant. This point becomes particularly relevant since one can often observe that retail chains restrict the number of suppliers, e.g., by certification schemes. This may be interpreted as an attempt to limit supplier competition, thereby increasing the slope of the residual supply schedule.

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 behaviour 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).

We apply the residual supply schedule to test whether United Kingdom (UK) retail chains have market power over wholesalers in their purchases of the three largest seafood products in the UK: namely, salmon, cod and shrimp. Retail markets, in which supermarket chains operate, are often concentrated. This is partly explained by the multiple outlet operation of the largest chains. Concentration of supermarket chains and the exertion of market power have received much attention in earlier work (Cotterill, 1986; Cotterill and Haller, 1992; Cotterill and Samson, 2002; Chevalier, 1995; Chevalier and Scharfstein, 1996; Armstrong and Vickers, 2001; Pinkse, Slade and Brett, 2002). UK supermarket chains make a particularly interesting case study since they were placed under investigation by the Competition Commission in 1999 for accusations of market power abuse. The concerns were primarily with respect to market power in sales, but the report from the Competition Commission indicates that buyer power may be a bigger problem. The four largest supermarket chains—ASDA, Safeway, Sainsbury and Tesco—enjoyed a joint market share of 71.2% in 1999 (Competition Commission, 2000). Moreover, in the UK, more then 87% of seafood retail sales are made by the supermarket chains (TNS SuperPanel, 2003). There is then clear potential for exploiting oligopsony power in this particular group of products.

Model

The residual supply curve that faces an individual firm depicts how the firm influences the input price through the quantity it purchases (Durham and 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 firms' derived demand. The elasticity of the residual supply curve depends both on the market supply and the other firms' derived demand. In a competitive market, the price is completely determined by the other firms' 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.
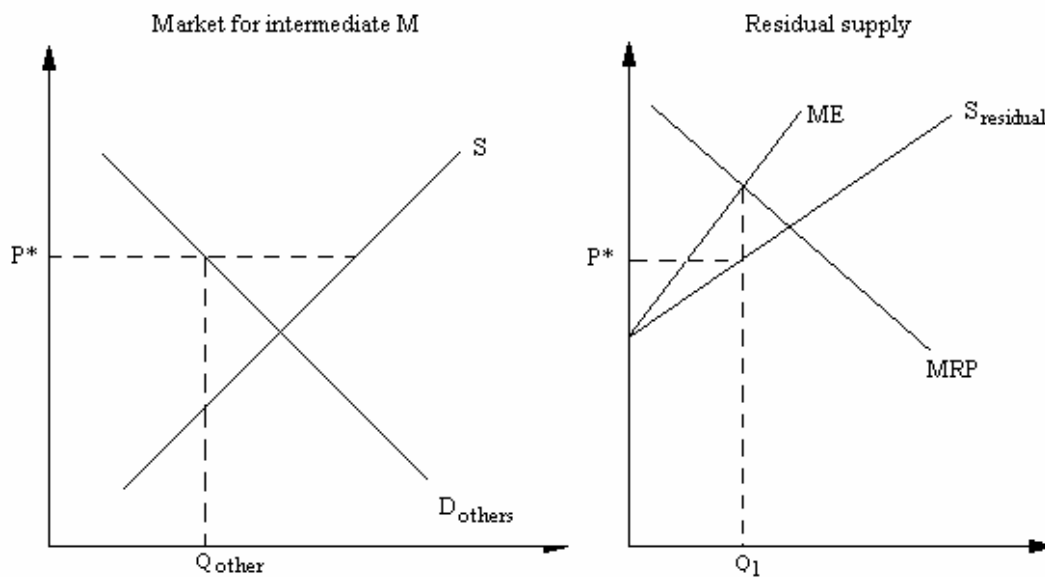

Figure 1. Market Supply and Residual Supply of Intermediate Good *M*

An interesting result that immediately follows from the figures is that if the suppliers are perfectly competitive, there is no scope to exploit oligopsony power. This is because with a horizontal market supply schedule, the residual supply curve must also be flat. This implies

there are fewer opportunities to exploit market power for a buyer than for a seller, as it is substantially more likely that the supply of a product is highly elastic because of stronger competition than when the aggregate consumer demand curve is facing a seller.[1] Moreover, with respect to oligopsony power, concentration at one stage in a supply chain may not be very problematic if the suppliers of these firms are highly competitive. Furthermore, even in industries where competition is softer, there is a clear limit to how large the transfer to the oligopsonist can be. This limit is given by the producer surplus, as all input factors must be paid at least their opportunity cost. In the short run, the scope for exploiting market power is larger than in the long run, as some costs are fixed.

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) M facing Firm 1, the firm of interest, is:

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

where W_1 and Q_1 are Firm 1's input price and quantity. The vector $\boldsymbol{Q}$ is the other firms' purchases of substitutes to the intermediate good M. The fact that the elements of the $\boldsymbol{Q}$ vector

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[1] Diminishing marginal utility and the budget constraint will make consumer demand for (virtually) all products downward sloping, and accordingly provide an opportunity for a seller to exploit market power. Hence, while it suffices to face limited competition in the sale to exploit market power for a seller, buyer power requires both limited competition from other buyers and an upward sloping supply schedule from the providers of the product in question.

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 suppliers' 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 in the market for factor M, $i = 2,\ldots,N$, 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:

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

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 factor M, represented by $\boldsymbol{Q}$ and Q_1, and factor prices of the upstream firms' inputs, V^s. λ^i is the conduct parameter that indexes market power for all buyers, $i = 1,\ldots,N$. Hence, buyers of factor M 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 λ^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:

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

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 factor M by Firm 1 (Q_1), input prices for the suppliers (V^s), the input prices of other factors facing all firms buying substitutes to factor M **(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 factor M 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:

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

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 M. 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 **Q** in equation (9) with E^I from equation (5), we obtain a new expression for M^I 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 rewritten as $MRP^1 = PME^1$, and thereby determines W_1 and Q_1.

In many cases, it may be of interest to allow the potential oligopsonist to possess market power in its output market. This is, for instance, the case if the potential oligopsonist is a supermarket chain. It is straightforward to incorporate 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:

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

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 product M 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 buyers' 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 firms' 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:

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

While the theory is formulated at the firm level, a substantial proportion of past studies testing for market power exertion use industry and even country level data. One can of course provide criteria that give consistent aggregation as in Appelbaum (1982), or one can interpret the estimated parameters as industry averages as in Goldberg and Knetter (1999). However, in general, when aggregated data is used, little focus is given to whether the aggregation criterion is met. We will not elaborate further on this issue here, but only note that the models can be used with aggregate data to test whether groups of firms have market power if one is willing to assume that an aggregation criterion holds or to make interpretations based directly on the aggregated data. Several studies (e.g., Steen and Salvanes (1999)) have also raised the possibility that a firm or an industry can have market power in the short run, but not in the long run. This issue is also certainly relevant in an oligopsony setting, as for instance in the

hold-up problem in relation to asset specificity (Klein, Crawford and Alchian, 1978). A similar approach to Steen and Salvanes (1999), where lagged values of the variables are included on the right-hand side, can be used to investigate such a hypothesis.

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 η 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 θ_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:

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

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 chains' 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, $i = 1,...,N$. 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' behaviour, 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).[2] 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.[3] 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:

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

where ε_{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

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[2] Murray and Fofana (2002) provide a more detailed discussion of the increased market shares of the retail chains in UK seafood retailing.
[3] The five supermarket chains are Tesco, Sainsbury, ASDA, Safeway and Somerfield.

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_{mt}^I 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 analysed 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).[4] 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 Taylor Nelson Sofres (TNS) and made available by the SeaFish Authority.[5] The data are of monthly frequency for the period from January 1991 to December 2002. Input

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[4] 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).

[5] Other retail outlets include smaller supermarket chains, co-ops, fishmongers, etc.

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, since there is virtually no domestic production in the UK, Norwegian ex-vessel prices from the Norwegian Raw Fish Organization were used, as Norway is the largest exporter.[6] 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. To control for this, a generalized method of moments (GMM) instrumental variable (IV) estimator was used.

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[6] We also tried to include prices and exchange rates for the second and third-largest suppliers (Iceland and Greenland). However, these were statistically insignificant.

Table 1. Estimation results for cod[a]

| | OLS | | IV/GMM | |
	Coeff.	S.E.	Coeff.	S.E.
lqfive	–0.029	0.112	0.108	0.124
lpoth	0.174	0.076	0.165	0.064
lpcodlnd	0.136	0.093	0.195	0.074
llnmm	1.010	0.175	1.113	0.141
lUKint	0.459	0.058	0.360	0.070
leur	–0.857	0.160	–0.563	0.196
cons	–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)

[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.
lq3five	–0.096	0.102	0.004	0.114
lp3oth	0.030	0.043	0.053	0.043
lfhp	0.712	0.303	0.813	0.268
lUKint	–0.316	0.135	–0.327	0.107
llnmm	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
cons	–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)

[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 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.
lq2five	0.062	0.089	0.083	–0.017	0.078	–0.046	0.069
lp2oth	–0.002	0.069	0.048	–0.030	0.045	–0.041	0.042
lfhpnor	0.429	0.106	0.063	0.432	0.063	0.405	0.056
llnmm	–1.120	0.279	0.360	–0.915	0.250	–0.839	0.236
lUKint	–0.354	0.133	0.136	–0.398	0.119	–0.435	0.113
cons	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)

[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.

In the IV estimation, 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 shrimps, 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.

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 ($t2$).[7] 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.

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[7] 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.

Table 3 reports the results for shrimps. 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.[8]

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

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[8] Gordon and Hannesson (1996) provide evidence of the international nature of the cod market, and Asche (2001) provides similar results for salmon.

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).[9]

In this paper, we use a residual supply schedule to investigate the degree of oligopsony power. The basic model, in which only the firm of interest can exploit oligopsony power, is extended to cases where the firm of interest also exploits market power in their product markets, as well as when they are purchasing their input factor from an oligopsonist. Furthermore, the fact that differentiated products are accommodated by the model makes it especially useful for investigating retail behaviour where many products are differentiated through branding, packaging, 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 the highly concentrated meat packer industry was not exploiting market power. 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

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[9] Cooper (2002) provides a good review of the Competition Commission's report.

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.

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