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Oligopoly and Oligopsony Power
in Concentrated Supply Chains

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Oligopoly and oligopsony power in concentrated supply chains

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Abstract
During the last decades there's been increased attention on the exploitation of market power in sales as supply chains are becoming increasingly concentrated. More recently, one has realised that concentrated supply chains can enable exploitation of market power also from buyers. This implies that in many supply chains oligopolists can sell their product to oligopsonist. When investigating such supply chains, the fact that the other party also has market power must be taken into account when specifying the model to be estimated. In this paper we estimate the degree of market power in such supply chains using a system consisting of a residual demand and a residual supply equation. An empirical application is provided for the European dried salted cod market. The estimated residual demand and supply elasticities suggest that there is scope for both oligopolistic and oligopsonistic behaviour.

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I. INTRODUCTION

During the last decades there's been increased attention on the exploitation of market power in sales as supply chains are becoming increasingly concentrated (Goldberg and Knetter, 1999). More recently, the fact that concentrated supply chains also can enable exploitation of market power from buyers has also been given more attention (Shroeter, Azzam and Zhang, 2000; Cooper, 2001; Morrison Paul, 2001; Mingxia and Sexton, 2002).[1] However, this also suggests that there may be an increasing number of supply chains where oligopolists sell to oligopsonists. One possible example is when a producer of a large international brand sells its product to a large retail chain. Another is the cattle industry's rapid consolidation in recent years, where increased concentration has triggered alarms that the industry's new giants in retailing and processing could drive up food prices for consumers and drive down cattle prices for producers (Shroeter, Azzam and Zhang, 2000). Similar issues may be relevant also in an international trade setting. The Pricing-To-Market hypothesis has led to a number of studies investigating whether a country (or an industry) exploits market power in its exports (Goldberg and Knetter, 1999).[2] However, there are also several products with one or a few countries as the main importers, making also oligopsony power a relevant issue also in an international trade setting.

Starting in the 1970's, interest increased in empirical measurement of market conduct. Known collectively as the New Empirical Industrial Organization (NEIO), these studies model the margin between sales prices and production costs as an unknown parameter to be estimated.[3] We can distinguish three main approaches to estimating the degree of market power in sales. One is

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[1] There is also a some earlier papers investigating the degree of oligopsony power such as Just and Chern (1980), Schroeter (1988) and Durham and Sexton (1992).

[2] Pricing-to-market refers to the decision of a producer to change the relative price at which the product is sold in different international markets according to changes in international relative costs.

[3] See e.g. Krugman (1987), Knetter (1993) and Goldberg and Knetter (1999).

based on Appelbaum (1982), who estimates conjectural variation by estimating the conjectural elasticity in a cost function system. Bresnahan (1982) and Lau (1982) employ a second approach, specifying a model where a two-equation system allows the mark-up to be estimated. Finally Baker and Bresnahan (1988) specify a residual demand schedule where the degree of market power can be found from the inverse elasticity of residual demand faced by a firm of interest. Goldberg and Knetter (1999) extend this approach to investigate export industries that potentially exploit market power, and note that the exogeneity of exchange rates gives excellent instruments in the estimation.

When investigating oligopsony power, the same three basic approaches are used after the necessary adaptations have been carried out. For instance, Schroeter (1988) uses Appelbaum's approach to estimate the conjectural elasticity for a potential oligopsonist. Durham and Sexton (1992) follow Baker and Bresnahan and estimate a residual supply equation. Finally, Schroeter, Azzam and Zhang (2000) estimate the mark-down in a Breshnahan and Lau type of system.

Econometric methods for assessing the degree of market power typically rely on a maintained hypothesis of price-taking behaviour on the side of the market that is not of particular interest. However, supply chains increasingly move towards structures where there is potential for exploitation of market power from sellers as well as buyers, as both parties become relatively concentrated. This can potentially be the case when well established brands sell their products to large retail chains, or in an international trade setting when a good is produced and consumed in only a few countries. So far, only Schroeder, Azzam and Zhang (2000), using the Bresnahan and Lau approach, have looked at simultaneous market power on the buyer and seller side, studying the relationship between meat packers and retailers in the US.

In this paper we will model the potential interaction between sellers and buyers with potential market power using residual demand and supply schedules. The main advantages with this approach is that one can easily allow for differentiated products, and the equations to be estimated are linear. Moreover, this is the only one of the three common approaches to estimation of market power that avoids the criticism of Corts (1999), since the conduct parameter is not directly estimated. We build on the work of Baker and Bresnahan (1988) when specifying the residual demand schedule, while the residual supply schedule is based on the model introduced by Durham and Sexton (1992). We will apply the approach in an international trade setting. This requires the adaptions of Golberg and Knetter (1999) to the residual demand schedule, and similar adaptions for the residual supply schedule.

When estimating oligopoly and oligopsony models, identification is always an issue. Investigating the market structure in a supply chain where both parties potentially have market power create some extra challenges, as the oligopolist will improve its performance by recognizing that the purchases are from an oligopsonist and vice versa. This means that the oligopolist takes all the variables in the oligopsonists optimisation problem into account, including all the variables in the marginal expenditure relationship and vice versa. However, if the oligopolist (oligopsonist) is fully able to do so, there will be no variables that are unique to either of the equations in the system, and the system will be underidentified. To be able to identify the system one then has to assume that some variables are not only unique to the firm/country of interest as in Baker and Bresnahan (1988) and Goldberg and Knetter (1999), but also that some of these variables are private information. This choice is implicitly made also

when Bresnahan-Lau models are used when one is chosing which variables are to rotate demand (supply) and which are to shift demand (supply).

The approach will be applied to the supply chain for dried salted cod between Norway and Portugal. In addition to the crossing of national borders, this supply chain is of interest because while cod is consumed in only one product form in Portugal, as dried salted cod or *bacalhau,* it is imported processed at different levels. In addition to the retail form product Portugal also imports wet salted cod and frozen cod, which is processed into dried salted cod in Portugal. Norway and Portugal are the only countries in the world where dried salted cod is produced. Still, as there is a world market for frozen cod (Gordon and Hannesson, 1996; Asche, Gordon and Hannesson, 2004) and a large European market for wet salted cod (Asche, Gordon and Hannesson, 2002) the Portuguese industry does not have any restrictions with respect to obtaining the main input.[4] However, industry commentators do indicate that there is a quality difference between the domestically produced and the imported dried salted cod, and the potential for exploiting market power for Norwegian exporters will depend on the extent to which this is the case. Finally, during the last decade substantial concentration has taken place in this supply chain. Three companies currently make up over 90% of Norwegian exports to Portugal, and while concentration has historically been less on the import side, the recent growth in the supermarket chains has seen four importers making up more than three quarters of the imports.

II. THE MODEL

The model used in this paper comprises a system of two equations, a residual demand and a residual supply equation. The residual demand facing an exporter is the market demand in the

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[4] Spain, Italy and France also import substantial quantities of wet salted cod.

country of interest less the quantity supplied by producers of viable substitutes. Figure 1 shows how the residual demand schedule for the exporter's product, is derived as the difference between the market demand, and the competitors' supply. The left panel of the figure depicts the market demand curve D_{market} for the product sold in the destination country, as well as the supply curve S_{other} of all competitors outside the export source country. The right panel shows the residual demand schedule for the exporter's product, which is derived from the market demand and other firms' supply in the left panel. Along with the residual demand curve facing the exporter group of interest, D_{res}, their marginal revenue MR_{res} and marginal cost schedule MC_{exp} (with marginal costs expressed in destination market currency) are plotted.
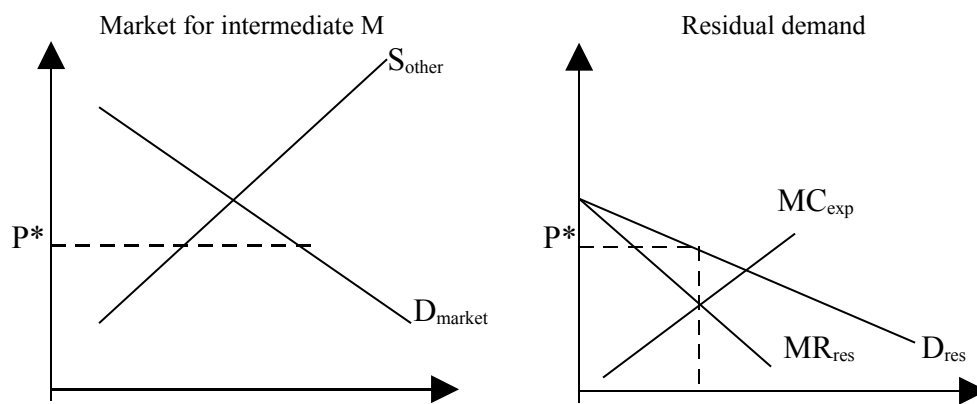
Figure 1. Market Demand and Residual Demand of Intermediate Good M.

We now derive a formal model of the residual demand curve facing a particular firm or exporting country (Country 1), starting from Goldberg and Knetter's adaptation of Baker and Bresnahan's (1988) model. We will use the term country as the unit of analysis, but the model also applies to supply chains with firms in the same country. One then must remove exchange rates from the problem and change terminology to firm.

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The inverse demand function facing dominant exporter Country 1 can be expressed as

$$P_1 = P_1(Q_1, \boldsymbol{Q}, Z) \tag{1}$$

where Q_1 is the quantity and P_1 the price of Country 1's product. $\boldsymbol{Q}$ is a vector of quantities of other exporters' competing products to the same destination market and Z is a vector of exogenous variables affecting demand. Since $\boldsymbol{Q}$ may also include imperfect substitutes to Country 1's product, the model allows for product differentiation (Baker and Bresnahan, 1988).

We formulate the corresponding inverse demand equations for exporters other than Country 1

$$P_i = P_i(\boldsymbol{Q}, Q_1, Z) \qquad \text{for all i} \neq 1 \tag{2}$$

The model also includes the supply relationship for exporters other than Country 1, in the form marginal cost equals perceived marginal revenue

$$eMC_i(Q_i, \boldsymbol{W}, W_i) = PMR_i(\boldsymbol{Q}, Q_1, Z; \theta_i) \qquad \text{for all } i \neq 1, \tag{3}$$

where e is the exchange rate so the marginal cost is in the importer's currency.[5] Marginal cost is determined by quantity produced Q_i, a vector of industry-wide factor prices, $\boldsymbol{W}$, and on country specific factor prices W_i. Perceived marginal revenue depends on the quantity demanded of Country 1's product, Q_1, and all possible substitutes, $\boldsymbol{Q}$, and on exogenous variables Z, shifting the demand schedule. θ_i is a conduct variable indexing market power for all exporters, i = 1… N. Specifically;

$$PMR_i = P_i + Q_i \sum_j \left(\frac{\partial P_i}{\partial Q_j} \right) \left(\frac{\partial Q_j}{\partial Q_i} \right) \tag{4}$$

The last parenthesis in equation (4), $\partial Q_j/\partial Q_i$, is known as the conduct parameter, and is often represented with a specific parameter, θ_i. The conduct parameter gives the effect of Country i's supply on other exporters' supply. If Country 1 is a monopolist then perceived marginal revenue

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[5] The exchange rate can be set equal to one and thereby removed from the model if one is considering a supply chain consisting of different firms within the same country.

coincides with actual marginal revenue and we have $\theta_1 = 1$. If $\theta_1 = 0$, then Country 1 is a price taker, and if $0 < \theta_1 < 1$ there is some degree of oligopoly power.

To find the residual demand curve for all other countries, equations (2) and (3) are solved for **Q** to get

$$\boldsymbol{Q} = E_I(Q_1, Z, \boldsymbol{eW}, eW_I; \theta_I). \tag{5}$$

where E_I is the equilibrium quantity supplied for all markets except $i = 1$, $\boldsymbol{e}$ is the appropriate vector of exchange rates and where all right hand side variables but Q_1 are exogenous. We derive the residual demand curve for Country 1 by substituting E_I into equation (1)

$$P_1 = P_1(Q_1, E_I(Q_1, Z, \boldsymbol{eW}, eW_I; \theta_I), Z), \tag{6}$$

and substituting out redundancies

$$P_1 = D_{res1}(Q_1, Z, \boldsymbol{eW}, eW_I; \theta_I), \tag{7}$$

As price and quantity will be endogenous if country 1 has market power, equation (7) can be econometrically estimated only when at least one industry-specific variable eW_1 exists for the export county, as this will be the instrument used for identification. When the model is a double log model, the exchange rate can be separated from the industry-specific variable. As noted by Goldberg and Knetter (1999), the exchange rate will certainly be exogenous, and as it tends to have more variation than cost variables, it will be a good instrument.

The residual supply schedule can be derived in a similar fashion. This is done in figure 2. The left panel of the figure depicts the market supply curve S_{market}, as well as the derived demand curve D_{other} from all countries (competitors) buying the product in question. The right panel shows the residual supply schedule for the exporter's product, which is derived from the market supply and other firms' demand in the left panel. The right panel plots the residual supply curve facing the

importer group of interest, S_{res}, along with their marginal expenditure curve ME and their marginal revenue product MV_{exp} (with all variables expressed in the destination market's currency).
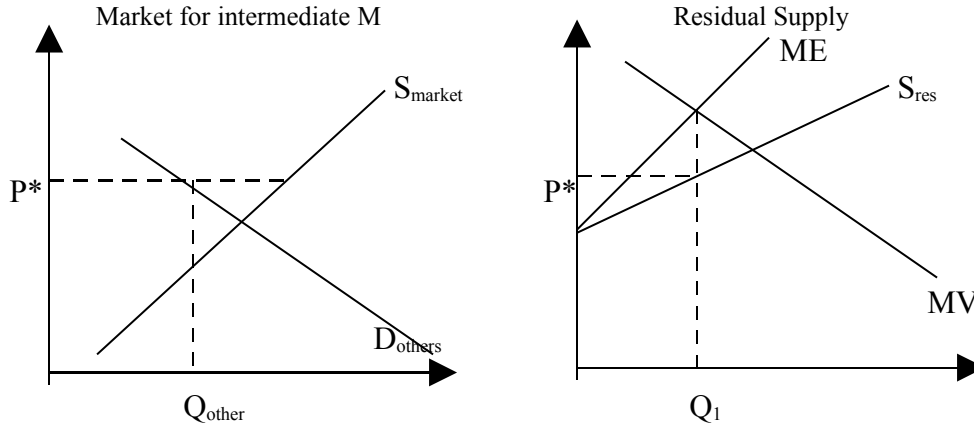
Figure 2. Market Supply and Residual Supply of Intermediate Good *M*

The industry of interest will maximise profits by acting as a monopsonist on the marginal expenditure curve derived from the residual supply equation, giving the price P*. When the residual supply curve and the market supply curve coincide the firm will be a monopsonist.

To formalize the model we adapt Durham and Sexton's (1992) residual supply model to an international trade setting following Goldberg and Knetter (1999). The inverse supply function for an input factor *M* facing a dominant importing country (Country 2) is

$$eW_2 = eW_2(Q_2, \mathbf{Q}, V_s), \tag{8}$$

where *e* is the exchange rate, Q_2 is quantity, W_2 is input price and V_s is a vector of exogenous variables affecting supply, e.g. suppliers' input prices. $\mathbf{Q}$ includes purchases of substitutes to *M* by all other countries.

Similarly, we formulate (inverse) supply relations facing buyers of factor M other than Country 2

$$eW_i = eW_i(Q, Q_2, V_s) \quad \text{for all } i \neq 2. \tag{9}$$

The model also includes the demand schedule for countries other than Country 2, in the form marginal revenue product (MRP) equal to perceived marginal expenditure (PME)

$$MRP_i(Q_i, W, P_i) = ePME_i(Q, Q_2, V_s; \lambda_i) \quad \text{for all } i \neq 2, \tag{10}$$

where marginal revenue product depends on quantity of input Q_i, a vector of industry-wide factor prices, W, and country specific sales price P_i. PME is determined by the same variables as structural supply, with an added conduct variable λ_i, indexing market power for all buyers, $i = 1 \ldots N$.

To find the residual supply curve facing country 2, we solve equations (9) and (10) for Q and we get

$$Q = E_I(Q_2, eV_S, eW, P_I; \lambda_I). \tag{11}$$

We derive the residual supply curve by substituting E_I into equation (8)

$$eW_2 = eW_2(Q_2, E_I(Q_2, eV_S, eW, P_I; \lambda_I), eV_s), \tag{12}$$

and substituting out redundancies

$$eW_2 = S^{res2}(Q_2, eV_S, eW, P_I; \lambda_I). \tag{13}$$

The residual supply curve is a function of the demanded quantity by Country 2 (Q_2), input prices for the suppliers in the importers currency, (eV_S), the input prices of other factors facing all countries buying substitutes to factor M in the importers currency (eW) and the output prices of other countries (P_I).

III. IDENTIFICATION AND MEASUREMENT OF MARKET POWER

When estimating oligopoly and oligopsony models, identification is always an issue. In Breshnahan and Lau type of models this is obtained by splitting the exogenous demand (supply) variables that face the oligopolist (oligopsonist) into two groups, a set of variables that shifts the schedule and another set of variables that rotates the schedule. As economic theory gives no guidance with respect to which variables shift and which variables rotate, this choice is somewhat arbitrary in empirical analysis. In residual demand (supply) equations, there must be some variables unique to the potential oligopolist (oligopsonits) to identify the schedule (Baker and Bresnahan, 1988; Durham and Sexton, 1992). These variables will then play the same roles as the rotating variables in identifying the equations.

Identification in a setting where there is potential for market power on both sides becomes even more challenging as the potential oligopolist (oligopsonist) then will try to obtain information about the variables in the oligopolist's marginal revenue (oligopsonist's marginal expenditure) equation, as profits will increase if the other parties actions are being taken into account. This implies that if the equations are to be identified, one must assume that there are some variables that not only are unique to the party of interest, but that some of these remain unknown to the other agent. As noted by Baker and Bresnahan (1988), one can of course wonder how the econometrican comes to know such variables However, there are certainly a number of cases where such information is not available in the public domain or that it only becomes available after such a long time lag that it is no longer very relevant in the decision process. Alternatively, one can assume sufficiently inconsistent conjectures, so that there is some variable in the oligopsonist's (oligopolist's) optimistaion problem that is not taken into account by the oligopolist (oligopsonist). Shroeter, Azzam and Zang (2000) implicitly make this assumption as the rotating variables are not taken into acount by the other party. This also indicates that when

estimating systems where there are potential to exploit market power for both suppliers and buyers using the Bresnahan-Lau model or Scroeter, Azzam and Zhang (2000), one should be careful when choosing which variables measure the rotation, and which variables measures the shift of the demand and supply relationships.

Let us then turn to the issue of measuring the degree of market power. The problem of the dominant exporter is one of maximising profits given the slope of the residual demand function. From this point of view, the market power of the dominant exporter will be measured by the reciprocal of the price elasticity of the residual demand function using a Lerner index;

$$\frac{(p - mc)}{p} = \frac{1}{\eta} \tag{14}$$

where η is the residual demand elasticity, p is output price and mc is marginal cost. The index will provide an exact measure of the markup if the industry's conjectures are consistent (Goldberg and Knetter, 1999). If the conjectures are not consistent, the measure is still likely to be close to the true degree of market power.

A similar measure can be used to measure the degree of oligopsony power. The degree of market power then, is decided by the markdown of the factor price w_m below the marginal value product of the factor. With the production function $f(x_1, x_2, .., x_n, x_m)$, the degree of market power is given by

$$\frac{pf_m - w_m}{w_m} = \frac{1}{K}, \tag{15}$$

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where K is the residual supply elasticity faced by the importer, p is the output price and w_m is the input price for input m. Again, if the importer's conjecture about other buyers' response is consistent the residual supply elasticity will provide an exact measure of the markdown.

IV. DATA AND EMPIRICAL SPECIFICATION

We will use a double log functional form to estimate the relationships. This allows us to separate the exchange rates from the different variables of interest (Goldber and Knetter, 1999). The following variables are used to specify the residual demand and residual supply functions: The endogenous variables are the import price in Euros/kg (P^{DSC}) and the quantity in tonnes of dry salted cod from Norway to Portugal (Q^{DSC}). The Portuguese import price of wet salted cod, P^{SC} in euro/kg is the price of the main input factor for the Portuguese dried salted cod industry, and is accordingly a shifter for competitors' supply. This also provides the alternative market for Norwegian exporters, as they do not have to process the fish into dried salted cod but can stop after wet salting it, and as such it is a shifter for competitors' demand for Portuguese importers of dried salted cod. The exchange rate between Euro and Icelandic kroners, *EURICE*, also shifts supply of competing products, as Iceland is the largest exporter of wet salted cod to Portugal. The import demand and export supply variables can be derived from, respectively, the importers and exporters profit maximization problems. In addition to the endogenous price and quantity variables, the Portuguese retail price (P^R), wage index *(W)*, and consumer price index (*CPI*), all in euro/kg, represents the shifters in the import demand. The ex. vessel price of cod in Norway (P^{ExV}) the exchange rate between Euros and Norwegian kroner (*EURNOR*), and the price for dried salted cod in Brazil (P^{BRA}) are the supply shifters in the export supply. We do not include the price of more input factors apart from the raw fish price, since this is the main cost component, making up about 80% of total cost (Toft and Bjørndal, 1997).

The data at a monthly frequency cover the period 1990 to 2002 giving a total of 156 observations. The trade data have been obtained from Eurostat and Statistics Norway, the exchange rates from the Central Bank of Norway, and the remaining data series are respectively from Statistics Norway and the Portuguese statistical agency. Table 1 reports descriptive statistics for all the variables applied for the empirical analysis.

The empirical models are specified and estimated in a log-log functional form, thus the coefficients of the price variables represent elasticities. The residual demand equation facing Norwegian exporters then takes the following form:

$$P^{DSC} = \alpha_0 + \alpha_{DSC}Q^{DSC} + \alpha_{ExV}P^{ExV} + \alpha_R P^R + \alpha_{SC}P^{SC} + \alpha_W W +$$

$$\alpha_{EUI}EURICE + \alpha_{CPI}CPI + \alpha_{8EUN}EURNOR + \varepsilon \qquad (16)$$

where ε is an error term. Compared to how one would specify this equation if one did not allow the Portuguese importers to have market power, this equation has two additional variables. These are the ex. vessel price and the exchange rate between Euros and Norwegian Kroner. That also means that these variables cannot serve as instruments. However, to identify the equation if the exporters do have market power, we need one variable that shifts the export supply, that it is reasonable to assume that the importers do not have knowledge about. We chose the export price to Brazil to play this role. This will shift export supply, and it will be known to the importers only with a substantial time lag if at all.

The residual supply equation facing the Portuguese importers can be written as:

$$P^{DSC} = \beta_0 + \beta_{DSC}Q^{DSC} + \beta_{ExV}P^{ExV} + \beta_{BRA} P^{BRA} + \beta_{SC}P^{SC} + \beta_W W +$$

$$\beta_{EUI}EURICE + \beta_{CPI}CPI + \beta_{EUN}EURNOR + \varepsilon \qquad\qquad (17)$$

In this equation, the wage and CPI in Portugal are included in addition to the variables that would be in the equation if one assumed the exporters did not have market power. The retail price in Portugal is used as the instrument, as it is likely that the exporters know it with any accuracy only with a substantial time lag. This is because official statistics are published only with a very significant time lag, and as the fish mostly are sold without packaging, it is not possible to purchase scanner data.

It is worthwhile to note that the advantage of being able to use exchange rates as instruments when investigating market power in an international trade setting disappears when both buyers and sellers can have market power. Goldberg and Knetter (1999) argue that exchange rates are powerful instruments because they are certainly exogenous in the market for any single product, and they have substantial variations. However, they are also easily observable and if the buyer (seller) takes the sellers' (buyers') marginal revenue (marginal expenditure) into account, the exchanges rates will be a part of both parties optimization problem, and can accordingly not be used as instruments.

V. EMPIRICAL RESULTS

As the two models are based on the same supply chain, shocks are likely to be correlated. It therefore seems natural to estimate the two equations in a system. The residual demand and residual supply curves are therefore estimated first by seemingly unrelated regression (SUR) and later by three-stage least squares (3SLS). Furthermore, as there was evidence of autocorrelation in both systems, heteroskedasticity and autocorrelation consistent estimates of the standard errors are reported.

The results from the SUR estimations are reported in Table 2. As one can see, both equations have a good fit with R^2s above 90%, and there are supply as well as demand shifters that are statistically significant in both equations. Both the residual demand and the residual supply elasticities are significantly different from zero, although their magnitudes are very low, indicating margins of less than 2%. Moreover, it is a concern that the residual demand elasticity is positive.

If the Norwegian exporters and Portuguese importers do have market power, the results from the SUR estimation are invalid as the estimated parameters will be inconsistent due to the simultaneity bias caused by the simultaneous setting of price and quantity. We therefore continue by estimating the system with 3SLS.

The results from the 3SLS are reported in Table 3. For both the residual demand and the residual supply model the R^2s are satisfactory with values of 0.701 and 0.886, although the explanatory power is weaker than in the SUR system. Also, here there are supply as well as demand shifters that are statistically significant in both equations. It is also of interest to note that the ex. vessel price in the residual demand equation, one of the variables that would not have been included if the sellers and the buyers were not assumed to have market power, is statistically significant. None of the variables that are included because of the potential for the sellers to exploit market power are statistically significant in the residual supply equation.

The main parameters of interest are the inverse residual demand (α_{DSC}) and residual supply (β_{DSC}) elasticities. In the residual demand equation the elasticity is statistically significant,

indicating that Norwegian exporters of dried salted cod exercise oligopoly power to the Portuguese market. The magnitude of the elasticity is 0.173, indicating a mark-up of 17.3 percent if the conjectures are consistent. In the residual supply equation the elasticity is also statistically significant, indicating that Portuguese importers exercise market power. However, the degree of market power is weaker as a magnitude of 0.105 suggests a 10.5 percent markdown.

It is worthwhile to note the substantial difference in the residual demand and supply elasticities between the SUR and the 3SLS estimation, indicating a substantial simultaneity bias in the SUR estimates. The residual demand elasticity changes from positive 0.016 to the expected sign, negative, and a much higher magnitude at -0.173. The residual supply elasticity increase from 0.018 to 0.105, or an increase in the indicated mark-down from 1.8% to 10.5%.

VI. CONCLUDING REMARKS

The increasing concentration in supply chains over the last few years has given rise to a growing concern regarding the possibilities for exploitation of market power in sales. Recently, there has also been increased focus on the potential for buyers to exercise market power. This raises the possibility that market power will be exercised in purchases as well as sales, for instance when the producer of a large brand sells its product to a large retail chain. In such concentrated supply chains one may accordingly observe that both seller and buyer exercise market power. This hypothesis has so far only been investigated by Shroeter, Azzam and Zhang (2000), using the framework of Bresnahan (1982) and Lau (1982).

In this paper we note that when a oligopolist sells to a oligopsonist, the oligopolist will also try to take the oligopsonist's marginal expenditure relationship into account, and similarly, an

oligopsonist will try to take the oligopolist's marginal revenue function into account. If they are completely successful in doing so, there will be no instruments to identify the equations. Hence, to estimate the degree of market power in such a setting, one must assume that the one party is not fully able to identify the other parties marginal renue/expenditure function. In the Bresnahan-Lau framework, this is implicitly done by chosing some variables to rotate the demand (supply) curve.

We formulate a model using residual demand and residual supply functions to specify respectivly the potential oligopolist's and the potential oligopsonist's problem, following respectively Baker and Bresnahan (1988) and Durham and Sexton (1993). Using this approach, one avoids the criticism of Corts of the other empirical approaches to measure the degree of market power. We apply the system in an international trade setting, and the modifications that Goldberg and Knetter (1999) introduced in a residual demand specifications are therefore used.

An empirical application was provided for the trade with dried salted cod between Norway and Portugal. Estimation results showed that both sellers and buyers exercise market power in this supply chain. If one assumes consistent conjectures, the exporters' mark-up is 17 percent over marginal costs, while the importers markdown is 10 percent below marginal value product. Hence, this supply chain provides an example where both sellers and buyers exercise market power.

In this situation where both seller and buyer have market power, the quantity traded will be lower compared to a situation where only one side had market power. If an exporter has market power there will be an incentive to try to raise prices by restricting the quantity supplied. In the case of

an oligopsonist there is also a trade-off between price paid and quantity purchased, given by the residual supply curve. Thus, in a market where both seller and buyer have market power the oligopolist's negative influence on quantity traded will be reinforced if the oligopsonist reduce the market price of the good by reducing the quantity it purchases. These market mechanisms entail a welfare loss as they result in a lower quantity available of the final product than if the market were competitive.

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Table 1. Summary statistics

Year		Q^{DSC}	P^{DSC}	P^{SC}	P^{ExV}	EURNOR	P^R	W	P^{BRA}	CPI	EURICE
1991	*Mean*	870.2	4.995	3.561	1.331	0.125	6.743	2.580	8.646	63.20	0.014
	Std. dev.	448.4	0.240	0.141	0.044	0.000	0.132	0.111	0.653	1.301	0.000
1992	*Mean*	1545.2	4.480	3.248	1.212	0.124	6.843	2.929	7.518	69.17	0.013
	Std. dev.	699.9	0.266	0.152	0.066	0.001	0.134	0.062	0.613	1.469	0.000
1993	*Mean*	1468.6	3.729	2.619	1.027	0.120	5.818	2.903	6.139	73.81	0.013
	Std. dev.	524.2	0.208	0.174	0.035	0.001	0.381	0.015	0.369	1.170	0.000
1994	*Mean*	1088.5	3.766	2.709	1.044	0.119	5.547	2.925	6.742	77.81	0.012
	Std. dev.	668.1	0.230	0.221	0.020	0.000	0.088	0.033	0.472	0.667	0.000
1995	*Mean*	1188.3	3.944	2.590	1.075	0.121	5.399	3.102	7.456	81.08	0.012
	Std. dev.	501.2	0.317	0.291	0.018	0.000	0.090	0.060	0 .643	0 .496	0.000
1996	*Mean*	940.5	3.516	2.456	0.952	0.122	5.025	3.329	6.594	83.56	0.012
	Std. dev.	489.4	0.170	0.151	0.030	0.001	0.126	0.073	0 .452	0 .790	0.000
1997	*Mean*	1203.5	3.732	2.750	1.196	0.125	5.421	3.583	5.902	85.51	0.012
	Std. dev.	636.1	0.492	0.114	0.248	0.002	0.125	0.056	0 .415	0.547	0.000
1998	*Mean*	1439.2	5.041	3.540	1.798	0.118	7.075	3.702	6.546	87.85	0.013
	Std. dev.	593.3	0.485	0.330	0.148	0.004	0.629	0.029	0 .481	0 .866	0.000
1999	*Mean*	1408.8	6.092	4.181	1.982	0.120	7.954	3.805	7.347	89.91	0.013
	Std. dev.	1028.9	0.306	0.531	0.092	0.003	0.190	0.031	0.366	0.617	0.000
2000	*Mean*	1566.6	6.402	4.525	2.082	0.123	8.395	3.929	7.262	92.50	0.014
	Std. dev.	961.6	0.376	0.279	0.080	0.001	0.234	0.046	0.368	1.298	0.000
2001	*Mean*	1603.7	6.495	4.826	2.125	0.124	9.256	4.120	7.853	96.51	0.011
	Std. dev.	725.2	0.578	0.215	0.082	0.002	0.179	0.058	0.365	1.058	0.001
2002	*Mean*	1842.2	5.922	4.526	2.009	0.133	9.183	4.311	7.571	100.0	0.012
	Std. dev.	564.0	0.318	0.294	0.072	0.004	0.243	0.046	0.740	1.324	0.000
Total	*Mean*	1347.1	4.843	3.461	1.486	0.123	6.841	3.343	7.172	81.39	0.013
	Std. dev.	707.2	1.146	0.871	0.461	0.004	1.425	0.605	0 .893	12.40	0.001

Table 2. SUR: Estimation results

	Residual demand			Residual supply	
	Coeff.	S.E.		Coeff.	S.E.
α_{DSC}	0.016	0.008	β_{DSC}	0.018	0.008
α_{ExV}	0.547	0.051	β_{ExV}	0.556	0.047
α_{R}	0.043	0.043	β_{BRA}	0.055	0.025
α_{SC}	0.286	0.056	β_{SC}	0.285	0.051
α_{W}	-0.248	0.198	β_{W}	-0.218	0.187
α_{EUI}	-0.007	0.116	β_{EUI}	0.008	0.110
α_{CPI}	-0.051	0.229	β_{CPI}	0.039	0.216
α_{EUN}	0.114	0.184	β_{EUN}	0.120	0.173
α_{0}	1.108	0.686	β_{0}	1.157	0.641
R^2	0.917		R^2	0.920	

Table 3: 3SLS estimation results

	Residual demand			Residual supply	
	Coeff.	S.E.		Coeff.	S.E.
α_{DSC}	-0.173	0.077	β_{DSC}	0.105	0.041
α_{ExV}	0.383	0.117	β_{ExV}	0.494	0.063
α_{R}	0.748	0.244	β_{BRA}	0.389	0.078
α_{SC}	-0.059	0.157	β_{SC}	0.207	0.068
α_{W}	-0.143	0.401	β_{W}	-0.253	0.247
α_{EUI}	0.189	0.237	β_{EUI}	0.172	0.145
α_{CPI}	0.196	0.455	β_{CPI}	0.174	0.280
α_{EUN}	-0.054	0.369	β_{EUN}	-0.042	0.227
α_{0}	1.300	1.466	β_{0}	-0.166	0.963
R^2	0.701		R^2	0.886	

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- John P. Burkett, International Trade and Factor Prices in a Model with Non-homothetic Production Functions, WP95-1, $3.
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