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IS EQUATING MARKET SHARE TO MARKET POWER A SOUND ECONOMIC PRINCIPLE?

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Abstract: There is a long history of mapping market structure into market power in economic analysis. This paper addresses the validity of this principle for both homogenous and differentiated products industries. While mapping market share dominance into market power may be acceptable for homogenous goods as a rule of thumb, it is by no means a robust result. In the case of differentiated products industries, there is no theoretical foundation for such a mapping. This paper highlights the need to move towards a structural approach to assessing market power in industries.

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JEL Classifications: K2 , L11, L25, L40, L81

1. INTRODUCTION

There is a long history of mapping market structure into market power. This idea is evident with the structure-conduct-performance paradigm of Bain in the 1950s, positing a one-way mapping from structure (concentration) to conduct (treated as a 'black box) to performance (average price-cost mark-up across companies in an industry).[1] The basic tenet that market share dominance is indicative of market

[1] The New Industrial Economics later put an engine into the conduct box, explicitly modelling firm conduct. Moreover, in the long run industrial structure was no longer treated as an exogenous determinant

power in an industry is widely used in anti-trust law. For example, as in the case of merger policy, where the screening process to determine which mergers should be investigated relies heavily on the degree of concentration in the market and the change in concentration post-merger.[2] This paper questions whether one should expect a positive and monotonic relationship between market share and power in both homogenous and differentiated products industries. Moreover, we provide a readily accessible alternative, a structural approach, to assessing market power.
Section II outlines the theoretical motivation behind the use of concentration as an indicator of market power in homogenous goods industries. We argue that while this tenet may be a good 'rule of thumb' for homogenous industries, it is not a robust result. We highlight an alternative means of assessing market power in such industries when required. Section III of this paper discusses the market structure of differentiated products industries and highlights the benefits of moving toward a structural analysis as a means of estimating market power in such industries. In a differentiated products market the competitive constraint is determined by the degree of substitutability between the various goods across market segments. A mapping between firm market share and power is theoretically and empirically shown to be more complex than a simple rule of thumb.

In section IV we outline a structural methodology that estimates market power in differentiated products industries. Within this framework one can examine the price constraining effects of firm ownership structures, and show that firm level market power and market share can be unrelated. We also outline a more simplified two step procedure that may be used as an alternative way to link estimated market power to firm size. This approach has the benefits of imposing less structure on the model and can be implemented with greater computational ease, while providing valid estimates of market power. Section V outlines the main conclusions and recommendations of this paper.

2. MARKET STRUCTURE AND MARKET POWER IN HOMOGENOUS GOODS

2.1 A Theoretical Rationale for Mapping Concentration into Market Power

There is a long history of mapping market structure into market power. Market structure ranges from the extreme of monopoly, with a single firm exercising market power and pricing based on the inverse of demand elasticity, to that of perfect competition with a large number of firms producing homogenous products with no

of firm conduct and performance, but rather an endogenous element to be explained [see Sutton (1991, 1998) for a cross-section approach. Ericson and Pakes (1995) examine dynamics in an industry specific framework]. Here we address an issue that is only relevant for the short-run. We ignore industry dynamics.

[2] Thresholds based on the level and change in concentration post-merger provide a screening rule as to whether mergers are likely to be anti-competitive and so justify investigation. See the European Communities Merger Regulation Guidelines (2002) and Competition Authority (Ireland) (2002) for more detail.

market power and marginal cost pricing. Intuitively, one might expect that as the number of firms increase in the market, price will decline toward marginal cost. In the case of a non-cooperative Cournot oligopoly this can be shown, with *N* firms in the industry, each setting output q_j as simultaneous players. The market selects the price *P* to satisfy aggregate demand given industry output *Q*. Each firms profit function and first order condition for profit maximisation is written in equations (1) and (2) respectively,

$$\pi_j(q_j) = P(Q)q_j - C_j(q_j) \quad \text{where} \quad Q = \sum_{j=1}^{N} q_j \tag{1}$$

$$\frac{\partial \pi_j}{\partial q_j} = \frac{dP}{dQ} q_j + P - MC_j(q_j) = 0 \tag{2}$$

Each firm's mark-up can thus be written as the following Lerner index,

$$\frac{P - MC_j}{P} = -\frac{dP}{dQ}\frac{Q}{P}.\frac{q_j}{Q} = \frac{s_j}{\eta} \tag{3}$$

where s_j is the firm *j* market share, and η denotes the industry demand elasticity. In the case that the *N* firms are identical in the industry, each has an identical market share of *1/N* and the price-cost mark-up is inversely related to the number of firms in the market. As *N* tends to one, and we move from oligopoly to monopoly, the price-cost mark-up increases at an increasing rate. One can expect firms to have greater market power as the number of firms in a homogenous market declines. Moreover, the price-cost mark-up under Cournot oligopoly with homogenous goods can be shown to be directly and positively linearly related to the Herfindal-Hirschmann Index (HHI): higher concentration as measured by the HHI yields higher price-cost mark-ups.[3] From equation (3) we can write the average price-cost margin in the market as,

$$\sum_j s_j \left(\frac{P - MC_j}{P} \right) = \frac{\sum_j s_j^{\,2}}{\eta} = \frac{\text{HHI}}{\eta} \tag{4}$$

The use of market concentration as measured by the HHI in applied economic analysis has a well founded theoretical motivation for homogenous good industries with each firm producing only one good.[4]

[3] The HHI is the sum of the squares of firm market share, which gives proportionately greater weight to larger players in the market. Thus, if data are unavailable for very small firms in the market the HHI of market concentration will still provide a good representation of overall concentration. The index exceeds zero and has a maximum value of 10000 (in the case of monopoly).

[4] For example, in merger analysis one can expect greater market power to result from the proposed merger of two or more firms in such a case. Whether this raises real competitive concerns depends upon the level of the post-merger concentration and the change in the HHI as a result of the merger. Hence, the general thresholds outlined on this basis in the screening of proposed mergers for further investigation

While the HHI as an indicator of market power in the economic analysis of homogenous good industries is a good rule of thumb and does have some theoretical underpinnings, the mapping of concentration into market power is a result that is not robust even for homogenous industries, as critiqued by Sutton (1991). There are many different ways to model firm interactions, which may not yield a positive relationship between market power and market structure. Consider for example, the special case where firm conduct is modelled under non-cooperative Bertrand oligopoly. With $N \geq 2$ firms in the industry each setting price p_j as simultaneous players, marginal cost pricing results as under perfect competition.[5] Once there is more than one firm in the market, prices become independent of the number of firms in the industry. Similarly, where collusion is sustainable the number of firms is not a good indicator of market power.

Sutton (1991) describes Cournot and Bertrand competition as merely building blocks in modelling the intensity of competition in the short run. The price-cost mark-up, for any given number of firms N in the market, depends upon the intensity of price competition, where Bertrand competition describes the most intense level of competition in the market. The levels and changes in market power depend upon how one models firm conduct, or empirically on the intensity of competition in the market. The question then arises as to how to empirically identify market conduct, or the intensity of competition, in a market as an alternative to using the HHI to indicate market power?

2.2 An Alternative to Concentration in Assessing Market Power

Sutton (1991) in a case study approach over time proxies the intensity of competition in homogenous goods industries with the degree of product differentiation due to transportation costs, or the strictness of competition policy regime.[6] This contrasts with Bresnahan (1989) who, in the *Handbook of Industrial Organization* (Schmalensee, 1989), employs a structural approach to backing out the market conduct in homogenous goods industries. He describes these *"New Empirical Industrial Organization"* (NEIO) studies as being industry specific rather than cross-section, while assuming unknown costs or market conduct.[7] The structural approach to estimating market power jointly estimates demand and supply curves, where costs and conduct are unknown. The market power parameter to be

[see European Communities Merger Regulation Guidelines (2002) and Competition Authority (Ireland) (2002)].

[5] This result holds where firms have identical costs. If firms have different costs, then there may or may not be a pure strategy equilibrium. If firms are capacity constrained, then a mixed strategy equilibrium results. If there is a two stage game, in which firms set capacity in stage 1 and then in stage 2, given their capacity, set price then the Cournot result is observed (Kreps and Scheinkman, 1983)

[6] Sutton (1991) examines the evolution of concentration in the homogeneous Salt and Sugar industries over a long period of time. The intensity of price competition will be more relaxed, allowing for higher price-cost mark-ups for any given number of firms in the market, where competition policy regimes are not strict or products are horizontally differentiated by transportation costs.

[7] The focus on a single industry where specific models of demand and supply are written for that industry is very different from the Structural-Conduct-Performance (SCP) cross-section approach previously used.

estimated is theoretically derived from the first order profit maximising conditions under different forms of firm conduct.

Given the profit function in equation (1), the first order profit maximising condition under Cournot competition in equation (2) may be re-written as,

$$P + \frac{dP}{dQ}\frac{Q}{Q}q_j - MC_j(q_j) = 0 \tag{5}$$

Under the perfectly competitive scenario, the first order profit maximising condition is written as,

$$P - MC_j(q_j) = 0 \tag{6}$$

For monopoly or joint maximising behaviour, the first order profit maximising condition is written as,

$$P + \frac{dP}{dQ}Q - MC_j(q_j) = 0 \tag{7}$$

We can thus write a general First Order Condition for these different forms of conduct as,

$$P + \frac{dP}{dQ}Q\theta - MC_j(q_j) = 0 \tag{8}$$

such that θ augments the marginal revenue of a firm depending on whether conduct is competitive (θ = 0), collusive (θ = 1), or Cournot (θ = *1/N* for the *N* firm symmetric cost Cournot conduct). Thus, θ is a market power parameter. Note that equation (8) is just a generalisation of the Lerner Index, L_j, such that,

$$L_j = \frac{P - MC_j}{P} = \frac{\theta}{\eta} \quad \Rightarrow \quad \theta = \eta L_j \tag{9}$$

where η denotes the industry demand elasticity.

θ is the equilibrium response of quantity in a firm's first order profit maximising condition, and so a conjectural variations parameter. The NEIO literature seeks to estimate this conjectural variations parameter across industries using a structural approach that jointly estimates the demand and supply curves, where costs and conduct are unknown. The demand curve to be estimated takes the form,

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 W + \varepsilon \tag{10}$$

where W represents a set of demand shifters, such as the price of other products, seasonal factors, or income. From the profit maximising general first order condition in equation (8), the supply relationship to be estimated takes the form,

$$P = -\frac{dP}{dQ}Q\theta + \beta_0 + \beta_1 Z + \omega \tag{11}$$

where Z represents set of supply shifters such as the price of factor inputs, or technology. From the demand equation in (10), *dP/dQ* is $1/\alpha_1$. Thus, the supply relationship may be re-written as,

$$P = \theta(-\tfrac{Q}{\alpha_1}) + \beta_0 + \beta_1 Z + \omega \tag{11'}$$

The parameters ε and ω in equations (10) and (11) are assumed to be demand and cost shifters respectively, whose values are known to the participants in the industry, but unknown to the analyst, i.e. unobservables, rather than "error terms".

Since P and Q are clearly endogenous, one may use an instrumental variables approach in the estimation procedure. Reasonable demand instruments include cost shifters not in demand, while reasonable cost instruments include demand shifters not in cost. However, it is theoretically (econometrically) more correct and more efficient to jointly estimate demand and costs using generalised method of moments (GMM).[8]

Thus, an estimate of market power can be found for homogenous goods industries using a structural approach as outlined above. Bresnahan (1989) documents results from industry studies that show that θ varies greatly in homogenous industries for similar concentration structures.

It is therefore apparent that the *P(N)* function mapping price-cost margins to a given number of firms in a homogenous goods market is not monotonic. While the HHI as a rule of thumb may be used as an indicator of market power, the above structural approach allows us to empirically identify market power. The results of such already call into question the use of the rule of thumb. Once one introduces differentiated goods however, mapping HHI to market power becomes even more complex.

3. MARKET STRUCTURE IN DIFFERENTIATED PRODUCTS INDUSTRIES

In differentiated products industries, firm size is no longer a good approximation of the ability to mark-up price over cost. The market is now made up of a number of products that are differentiated, either by location or some product attributes. Some products are more similar than others in terms of these attributes. The competitive constraint on a firm's pricing is now determined by the degree of substitutability between the various goods in the market. Things become even more complex in the case that firms produce multiple products in the market. The problem here is due to the complex way in which firms operate within a market: firms may specialise in producing goods with very similar attributes, or have a portfolio of goods with very different attributes, and may or may not physically locate alongside other multi-product firms producing similar or different goods. The HHI for the market tells us little about the underlying structure of such markets or the market power of firms. Firms with small market share may well be able to extract price-cost mark-ups as high as firms with large market share in such markets.

Sutton (1998) provides us with a framework for modelling firm size where firms are multi-product and operate over many market segments (based on different product

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[8] For more detail on this approach, see Bresnahan (1982, 1989) and Genesove and Mullin (1998).

attributes or geographic locations) in differentiated goods industries. He marries a game theoretic approach on firm growth with elements of the stochastic approach to provide a simple explanation of market concentration.[9] Sutton (1998) illustrates that differences in firm size emerge due to firms operating over a different number of segments in the market: big firms operate over many different product attributes/locations, while small firms specialise in just a few/one.

Empirical validations of this theory define segments in terms of geographic locations along one product dimension for the US Cement Industry (Sutton, 1998), the Spanish Retail Banking Sector (de Juan, 2003), and the Italian Motor Insurance Industry (Buzzacchi and Valletti, 2004). These studies find that while firms tend to have similar market shares within geographical locations, there are differences in firm size at the aggregate level of the market. This is due to firms operating over different numbers of geographical locations.

Allowing segments to reflect product space, Konings and Walsh (2003) find for manufacturing 4-digit SITC sectors in the UK and France that, controlling for age, firm size is mainly determined by the portfolios held over 8-digit product lines. Bigger firms in a sector produce many different product lines, while small firms specialise into one or a few product lines.

Using a rich brand level AC Nielsen panel database for all brands in the Carbonated Soft Drinks Irish retail grocery sector, Walsh and Whelan (2002a,b) find evidence for the relationship between firm size and the operation of firms over both product and location space. An interesting feature of the AC Nielsen data is their identification of various product segments within the market for Carbonated Soft Drinks, which group clusters of brands by 40 characteristics (or segments): 4 flavours (Cola, Orange, Lemonade and Mixed Fruit), 5 different packaging types (Cans, Standard Bottle, 1.5 Litre, 2 Litre and Multi-Pack of Cans) and 2 different sweeteners (diet and regular).[10] Moreover, there is information on brand store distribution or coverage (based on pure counts of stores, and size weighted by store size in terms of carbonated drinks in which the brand retails to measure effective coverage). This provides information on the heterogeneous geographic location of brands across stores in the retail grocery sector. Firms within this market operate

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[9] The stochastic approach to modelling firm growth includes Gibrat (1931), Hart and Prais (1956), Iijri and Simon (1964,1977). Dunne, Roberts and Samuelson (1988) began modelling growth as deterministic outcomes. See Sutton (1997) and Caves (1998) for an overview.

[10] To allow for flavour and diet segments is standard in the analysis of Carbonated Soft Drinks (see Sutton, 1991). Packaging format is also recognised by the industry as a crucial feature of this market. Over 90 per cent of cans and standard bottles are impulse buys distributed through small corner stores and garage forecourts rather than chain stores. In contrast, the majority of 2 litre and multi-pack cans are distributed through one-stop supermarket shopping. The 1.5 litre is somewhere between these extremes. The industry has introduced different packaging to satisfy different consumer needs within both the impulse and one-stop shopping segments (Walsh and Whelan, 1999a,b). Moreover, packaging formats exhibit very different seasonal cycles. For example, Cans peak in the summer months of June and July, when people have lunch outside in parks. In contrast, 2 Litre bottle sales peak over the winter months of December and January, the festive season.

over both the product characteristic and geographic store location segments in a very complex way. Coca-Cola Bottlers has a big market share of the retail carbonated soft drinks market in Ireland because it sells a wide range of brands across the 40 segments with different product characteristics and across many geographic store locations. Firms with a small market share of the retail carbonated soft drinks market in Ireland tend to be highly specialised, selling brands with only one product characteristic into a subset of stores. Some segments are characterised by a wide range of brands and firms, while others are not.

Figures 1 (a) and (b) show by firm size in carbonated drinks, that the market share (a) within product characteristic segments the firm has brands in and (b) within product characteristics and stores the firm has brands in, is increasing dramatically as we move down the firm ranking in carbonated drinks. Firms with a smaller share of the overall retail carbonated soft drinks market seem to hold their own in terms of market share within defined segments, while larger firms' size is due to gaining market share across many segments. This clearly will have implications for the ability of smaller firms to exercise market power. A firm that has small market share in the overall carbonated soft drinks market may be able to exercise market power if it has a large market share within the product segments or stores in which it operates. Thus, smaller firms within the product segments and stores of the market they operate in, may be able to extract rents comparable to bigger multinationals that operate across most stores and product segments. Inferring market power from the distribution of market shares is therefore ill advised in multi-product firms differentiated goods industries. [11]

The complex operation of multi-product firms over different segments in these industries means that there is no longer a good theoretical foundation for the mapping of market concentration into market power. The question now arises as to how we may map this complexity of multi-product firms operating over different segments into market power? We next introduce a structural approach that backs-out market power by simultaneously estimating a demand and pricing (supply) system for differentiated products. We then augment this framework by documenting a two-step procedure that links market power to firm size with less structure. This has the benefit of easy implementation but at the cost of having a framework that does not allow counterfactual experiments to be undertaken (for example, finding the new equilibrium in prices and market shares in the event of a change in ownership structure). Yet it can link market power to firm size, which is useful in a positive analysis of an industry and can help identify problematic mergers.

[11] This has implications for the use of the HHI as a screening device for proposed mergers. For example, a proposed merger between two firms that has little impact on the overall HHI measure of concentration for an industry, and thus would not be likely to undergo an investigation by anti-trust authorities, may actually result in a big increase in market power if the small firm is specialised into certain geographic or product segments. An investigation is desirable in the event that a merger results from the aggregation over firms with high levels of market power, irrespective of their overall share in the market. An alternative indicator of market power to the HHI is clearly desirable in the screening stage of mergers in differentiated products industries.

4. ESTIMATING MARKET POWER IN DIFFERENTIATED PRODUCTS INDUSTRIES

4.1 The Demand Equation

In order to evaluate market power where products are differentiated, it is necessary to estimate the degree of substitutability between the various goods in the market. However, estimating demand for differentiated products has a dimensionality problem. A linear demand system for J brands has J^2 price parameters to estimate. One must therefore place some structure on the estimation.

A number of alternative demand specifications have been developed to deal with this dimensionality problem by reducing the dimensionality space into a product space. Representative consumer choice models include the distance metric model (Pinkse, Slade and Brett, 2002; Pinkse and Slade 2002), or the multi-stage budgeting model (Hausman, Leonard and Zona, 1994). Representative consumer choice models allow individuals to consume more than one brand, in variable amounts. Discrete choice models, which allow for consumer heterogeneity, include the vertical model (Bresnahan, 1987), the logit or nested logit models (Berry 1994) or a random coefficient model (Berry, Levinsohn and Pakes, 1995). Consumers have the same ranking of products by quality, but are differentiated by their taste for quality. Product demand is based on the assumption that consumers choose one unit of the product that yields the highest level of utility, where products include the outside good (whose price and quantity are exogenously determined) so that consumers have the option of not purchasing a product in the market.

The vertical model is the simplest specification of demand used in this framework. Pioneering work by Bresnahan (1987) estimated competitive conduct for the differentiated automobile industry using the vertical model. This assumes that products compete only with the good located on either side of it in product space,[12] and that *all* characteristics of the product are observed (error is due only to measurement error). Generalisations of the demand function can yield more reasonable properties and thus allow for richer estimation of demand systems. In this paper we focus on the logit and nested logit models of demand. However, one may also specify a more general demand function compared with the logit and nested logit models to allow for greater variations in consumer substitution patters and a richer estimation of demand systems, as in Berry, Levinsohn and Pakes (1995).[13]

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[12] As a result, cross-price elasticities for a product j are defined only with respect to neighbouring products.

[13] This specification of demand allows different individuals to have different tastes for different product characteristics and, in addition, can allow for consumer heterogeneity in terms of their response to prices. The random coefficients are designed to capture variations in the substitution patterns. Although more realistic than the logit or nested logit model, the estimation procedure is not so straightforward, requiring both simulation and numerical methods. See Mariuzzo, Walsh and Whelan (2004) for an example of this

Berry (1994) develops an approach to estimating differentiated demand systems to (i) allow for more flexible substitution patterns (substitution patterns are symmetric over all product types) using the logit model, and (ii) to correct for price endogeneity, since we don't actually observe all product characteristics. The logit model defines the utility for individual *i* consuming product *j* as the mean quality of product *j* plus idiosyncratic consumer tastes for a product,

$$U_{ij} = x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij} \tag{12}$$

where x_j is a vector of observed product characteristics, p_j is the price of product *j*, ξ_j is a vector of unobservable (to the econometrician) demand characteristics. The variation in consumer tastes enters only through ε_{ij}, consumer *i*'s utility specific to product *j*, which is assumed to be an identically and independently distributed extreme value (over both products and individuals), leading the property of *Independence of Irrelevant Alternatives*.[14] This utility function can be re-written as,

$$U_{ij} = \delta_j + \varepsilon_{ij} \tag{12'}$$

where δ_j describes the mean quality of product *j*. This is a random co-efficient model, where each consumer consumes one unit of the good yielding the highest utility (including the outside good). The logit model is often used for its tractability, but the property of the *Independence of Irrelevant Alternatives* induces estimates of substitution effects that are often considered inappropriate.

The nested logit model (McFadden, 1978) is just a simple extension of the logit case, to allow for the fact that you have various segments or groups in the market.[15] Thus, the *j* brands or products are partitioned into $G+1$ groups, with $g = 0,1\ldots..G$ where the outside good *j* is the only one present in group 0. It allows for correlations in the error terms for products within a group, where groups are exogenously specified. The utility of consumer *i* for product *j* in the nested logit can thus be written,

$$U_{ij} = \delta_j + \zeta_{ig} + (1-\sigma)\varepsilon_{ij} \tag{13}$$

where $\delta_j = x_j\beta - \alpha p_j + \xi_j$. For consumer *i*, ζ_{ig} is utility common to all products within a group *g* and has a distribution function that depends on σ, with $0 \leq \sigma < 1$. Higher values of σ indicates greater substitutability of products within groups. As the parameter σ approaches one, the within group correlation of utility levels across products goes to one (products within groups are perfect substitutes). As σ tends to zero, so too does the within group correlation.[16]

methodology applied to retail carbonated soft drinks market in the estimation of market power and its use in undertaking counterfactual exercises.

[14] The fact that ε_{ij} is i.i.d. in logit models leads to the property of *Independence of Irrelevant Alternatives*, which means that the ratio of market share of any two goods does not depend on the characteristics of other goods in the market. This indicates that two goods with the same shares have the same cross-price elasticities with any other good.

[15] Individual variability now enters through the predetermined segmentation of the market, as well as through the error term which is still i.i.d. Thus we have *Independence of Irrelevant Nested Alternatives*.

[16] When $\sigma = 0$ this reduces to the ordinary logit model in equation (12), where substitution possibilities are completely symmetric, for example as when all products belong to the same group.

As shown in Berry (1994), from the defined utility function in equation (12), or more generally in (13), we can derive the product market shares which depend upon the unknown parameter vector δ (describing the mean utility level of a product), and we can treat these mean utility levels as known non-linear transformations of market shares such that δ_j can be written as the following linear demand equation,

$$\ln(s_j) - \ln(s_0) = x_j\beta - \alpha p_j + \sigma \ln(s_{jg}) + \xi_j \tag{14}$$

where s_j is product j's share of the entire market (inside plus outside goods total), s_0 is the outside goods share of the entire market, x_j is a vector of observed characteristics of product j, p_j is its price, s_{jg} is product j's share of the group g to which it belongs, and ξ_j is an unobserved (to the econometrician) product characteristic that is assumed to be mean independent of x.[17] Since prices and the within group share are endogenous variables in equation (14), they must be instrumented and the instruments need to vary by product.

The corresponding nested logit own-price and cross-price elasticities are given in equations (15) and (16) respectively,

$$\varepsilon_{jj} = \alpha p_j \left[s_j - \frac{1}{(1-\sigma)} + \frac{\sigma}{(1-\sigma)} s_{jg} \right] \tag{15}$$

$$\varepsilon_{jk} = \begin{cases} \alpha p_k \left[s_k + \dfrac{\sigma}{(1-\sigma)} s_{jg} \right] & \text{if } k \neq j \text{ and } k \in g \\ \alpha p_k s_k & \text{if } k \neq j \text{ and } k \notin g \end{cases} \tag{16}$$

It is important to note that the elasticities here refer to the percentage change in *market share* in response to a change in price. The within group correlation of utility levels, σ, and market share within the group g, s_{jg}, are important determinants of the own-price elasticity and the cross-price elasticity with respect to other products within the same group. The cross-price elasticity between j and another product k located in a different group g is independent of j.

In order to define the primitives of the demand function, or the own- and cross-price demand elasiticities for each product j, we derive estimates of α and σ from our demand equation (14). Using these demand side primitives, via an equilibrium pricing system of equations to be defined, we can then back out the price-cost mark-up (Lerner Index) for each brand j. We now consider the supply side and the Lerner Index for each product.

[17] Inverting the market share function to yield equation (14) allows one to estimate demand parameters without the need for assumptions on either the parametric distribution of the unobservables ξ_j, or on the actual process that generates prices (Berry, 1994).

4.2 The Supply Function

A fully structural approach to estimating market power requires specifying the cost function to be estimated,

$$MC_j = \beta' \overline{\omega}_j + \omega_j \tag{17}$$

where ϖ_j is a vector of observed product characteristics, and ω_j is a vector of product characteristics that are unobservable to the econometrician.

For simplicity, firstly assume single-product price setting firms and symmetry in the market. Given marginal costs c_j, a multi-product Nash equilibrium is given by the system of J first order conditions, one per product. The first order profit maximising condition for the nested logit implies that product price equals marginal cost plus a mark-up as below,

$$p_j = c_j + \left[\frac{1-\sigma}{\alpha} \Big/ \left[1 - \sigma s_{jg} - (1-\sigma) s_j\right] \right] \tag{18}$$

This can be re-written as a lerner index as follows.

$$\frac{p_j - c_j}{p_j} = \frac{1}{p_j} \left[\frac{1-\sigma}{\alpha} \Big/ \left(1 - \sigma s_{jg} - (1-\sigma) s_j\right) \right] \tag{18'}$$

The mark-up depends upon the substitution parameter σ and within group share s_{jg}. The higher σ is, the greater weight attached to within group product share. The bigger the within group product share, the higher will be the product price-cost mark-up. Thus we observe a positive relationship between size and market power within segments. If $\sigma = 0$, in the case that there is no segmentation, we have an ordinary logit result, such that the mark-up depends only on product share, s_j, and not the within group share.

In a multi-product firm setting, firms maximise the sum of profits accruing from their brands, f_j. In brand price setting, p_b, a firm takes the price of all other firms' brands as given. The firm internalises the cross-price effect on market share of the brands it owns in the price setting of an individual brand. The first order condition for each profit maximising brand will have the general form,

$$s_j + \sum_{b \in f_j} \left(p_j - c_j\right) \frac{\partial s_j}{\partial p_b} = 0 \qquad b, j \in f_j \tag{19}$$

Given marginal costs c_j, assuming multi-product price setting firms without symmetry, a multi-product Nash equilibrium is given by the system of J first order conditions. Using our demand primitives, of which we have J^2 in each period, the first order condition for the nested logit in equation (19) implies product price equals marginal cost plus a mark-up, so we get estimates of a Lerner Index per brand j.[18]

[18] This assumes that a Nash equilibrium exists. This has been proven for a general discrete choice model and assuming single product firms (Caplin and Nalebuff (1991)), and for the nested logit model with multiproduct firms in the symmetric case (Anderson and de Palma (1992)).

Thus, given the primitives of the demand system and price we will be able to calculate a marginal cost for each brand.[19]

4.3 Estimation of the Structural Model

Berry (1994) proposes the simultaneous estimation of the logit or nested logit demand equation in (14) with a specified marginal cost (supply) equation in (17). Demand and costs are jointly estimated using Generalised Method of Moments (GMM), where the set of instruments need to be jointly orthogonal to the unobservable in both equations. Since we have an endogeneity issue in the simultaneous estimation of demand and supply, we need to instrument. Demand can be instrumented using cost shifters not present in the demand equation, while supply can be instrumented using demand shifters not in the cost equation. However, various alternatives have also been suggested.[20]

Employing a structural approach to estimating market power thus requires specifying both a demand and supply function, and estimating them jointly. A key advantage of this approach is the flexibility allowed in terms of undertaking various counterfactual exercises to examine the effect that a removal of the price constraining effects of firm ownership structures (through a change in brand ownership or the merger of firms for example) would have for welfare, consumer and producer surpluses (see Ivaldi and Verboven (2000) for the use of a model of demand (Nest Logit) and supply in the Volvo/Scania case.) We now propose a more simplified methodology to link market power to firm size, which is computationally more attractive and requires less structure being imposed on the model.

4.4 A Two- Step Approach to Estimating Market Power

Without fully specifying a cost function, one can use a two step approach that links mark-ups to company size. Using observed prices p_j and the estimated demand parameters from equation (14), one can 'back out' a mark-up for each brand from a system of J profit maximising first order profit maximising conditions. One should note, however, that the demand parameters are estimated with error and hence the mark-up is also estimated with error. One may allow for first step errors in a second

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[19] Aggregating these estimates over a firm's brands gives an indicator of firm market power. This may be done by taking a strict average, median outcome, or a weighted (by brand share of firm sales) average.

[20] Berry (1994) and Berry, Levinsohn and Pakes (BLP) (1995) suggest rival product characteristics as instruments for own-price, since a product j's price is affected by variations in the characteristics of competing products and are excluded from the utility function. This is not valid however, if rival characteristics enter the demand equation directly. Hausman and Taylor (1981) and Hausman, Leonard and Zona (1994) suggest prices in one segment can be used as instruments for prices in another, allowing for firm and segment fixed effects. The prices of a firm's products in other segments, after the elimination of segment and firm effects, are driven by common underlying costs correlated with product price, but uncorrelated with the disturbances in the product demand equations. A problem may arise however, if prices in other segments are correlated with unobserved product characteristics. One must test the validity of instruments used to ensure that they are uncorrelated with the error. This may be done by assessing the correlation between instruments and residuals, taking into account the fact that the residuals are estimates of errors.

step estimation that models the factors, including firm rank, that drive the estimated product mark-ups. This was the approach undertaken in Mariuzzo, Walsh and Whelan (2003).[21]

They estimate nested logit demand equation (14) from a linear instrumental variables regression of the difference in the log of market share between the product *j* and the outside good[22], on product characteristics[23], prices, and the log of within group share.[24] They enrich the Berry (1994) model by allowing for location convenience, with a fraction D_j of consumers facing transportation costs or disutility in buying product *j*, while a fraction $1 - D_j$ have no transportation costs in buying the same product.[25] The property of the nested logit model that leads to *Independence of Irrelevant Nested Alternatives* will thus be partly relaxed. The utility will be different amongst the fraction $1 - D_j$ of consumers that find the product available and thus have no transportation costs in buying the product, compared with the fraction D_j of consumers that have to incur transportation costs or disutility in buying the product.

Aggregating over both consumer groups allows one to define the unknown parameter vector δ, describing the mean utility or quality of a product *j*. Thus, they actually estimate[26],

$$\ln(s_j) - \ln(s_0) = x_j\beta - \alpha p_j + (\alpha - \alpha_1)\ln(D_j)p_j - \beta_1 \ln(D_j) + \sigma \ln(s_{jg}) + \xi_j \quad (20)$$

The price effect is thus augmented by the distance measure, D_j, to product *j*. The corresponding nested own- and cross-price elasticities can be written as for equations (15) and (16), but the α term is now product specific: $\alpha_j = \alpha + (\alpha - \alpha_1)$ $\ln D_j$,.[27]

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[21] They use an AC Nielsen panel database of all brands in the Carbonated Soft Drinks Irish retail grocery sector, roughly 12,000 stores, providing data on 178 brands, identified for 13 firms and 40 product (flavour, packaging, and diet) characteristics for 28 bi-monthly periods (June/July 1992 to April/May 1997). Data include brand level information on the per litre brand price, quantity, sales value, store coverage (based on pure counts of stores, and size weighted by store size in terms of carbonated drinks in which the brand retails to measure effective coverage), forward shelf allocation, firm attachment and product characteristics.

[22] The entire market is the sum of carbonated sales over all brands (inside goods) and total sales of the outside good. Mariuzzo, Walsh and Whelan (2003) define this as 330ml carbonates per day for the population of Ireland

[23] The observed product characteristics for each product (or brand) *j* include Flavour, Packaging, Sweetener, Season, Season X Packaging (to control for the fact that different packaging formats have different cycles) and Firm Ownership dummies.

[24] The groups imposed on the model are the 40 segments provided by AC Nielsen: 4 flavours (Cola, Orange, Lemonade and Mixed Fruit), 5 different packaging types (Cans, Standard Bottle, 1.5 Litre, 2 Litre and Multi-Pack of Cans) and 2 different sweeteners (diet and regular).

[25] Their empirical proxy for D_j, or distance to a store, is one minus the effective product coverage of stores (the weighted percentage of stores that carry the product or brand *j*, where each store is weighted by its share of total carbonated soft drink sales in the market). The greater the effective product coverage of stores, the higher the fraction of consumers that face no transportation costs in buying the product.

[26] They use $\ln(D_j)$ in their empirical work.

[27] The own-price elasticity now includes α_j in the own-price and α_k in the cross-price elasticity terms.

Estimates of α_j and σ from equation (20) are obtained using instrumental variables, since product price and within group share are endogenous variables.[28] A just identified equation can be estimated with a simple IV estimator. Mariuzzo, Walsh and Whelan (2003) estimate the primitives of the model in the refined equations (15) and (16), and assuming multi-product price setting firms without symmetry in the market, derive estimates of a Lerner Index per brand j. Although no structure is imposed on marginal cost, the primitives are likely to be estimated with error and so product mark-ups are backed out with error. Mariuzzo, Walsh and Whelan (2003) allow for this error in their second step estimation on the factors that drive the estimated mark-up, including firm rank, by including an error correction term (absolute deviation of the residual for brand j from the mean, taken from the demand model). The results indicate that market power does not vary systematically with firm size. Rather, the mark-up varies by packaging, with 1.5 and 2-litre bottles earning greater mark-ups than cans and the standard bottle. Diet drinks seem to also get a premium, while Lemonade seems to have higher mark-ups compared to other flavours. The product characteristics of a brand are more important for rent extraction than firm attachment. Clearly smaller firms within the product segments and stores of the market they operate in, extract rents comparable to bigger multinationals that operate across most stores and product segments. Inferring market power from the distribution of market shares is therefore ill advised in multi-product firms differentiated goods industries, as highlighted in section III of the paper.

Employing a joint estimation of demand and supply has the advantage that one can undertake various counterfactual exercises. However, it does require putting more structure on the model, specifying a marginal cost function, when compared with the two step procedure outlined above. The two step procedure provides a readily accessible alternative to assessing and modelling market power that is not demanding in estimation procedures.

5. CONCLUSIONS AND RECOMMENDATIONS

This paper questions the use of market share as an indicator of market power in applied economic analysis, as used by anti-trust authorities. Techniques, a structural model, are available to empirically identify market power within homogeneous and differentiated product industries, which can prove very useful in undertaking a detailed positive economic analysis of industries.

The structural models employed in differentiated product industries to map market share into market power deal with the complex operation of multi-product firms

[28] Instruments in Mariuzzo, Walsh and Whelan (2003) include all the regressors, with the exception of p_j and $\ln(s_{jg})$; *Forward Shelving*$_{jt}$; $\ln(D_{jt})p_{jt}$); Hausman-Taylor instrumental variables (brands of the same firm in other segments) with respect to p_{jt}, $\ln(D_{jt})$, $\ln(D_{jt})p_{jt}$, and *Forward Shelving*$_{jt}$; and BLP instruments (brands of the other firms in the same segment) with respect to $\ln(D_{jt})$, *Forward Shelving*$_{jt}$ and initial period $p_{j\,t0}$.

over different segments in these industries. Specifying and jointly estimating a demand and supply function for an industry allows one to derive a Lerner Index per product. Aggregating over a firms' brands will in turn provide a measure of firm market power. A key advantage of the joint estimation is its ability to undertake various counterfactual exercises, such as the effect of a merger on the price and market shares of all firms in the industry.

However, this paper also proposes a more simplified and straightforward means of linking market power to firm size in differentiated products industries that does not impose as much structure on the model. Without fully specifying a cost function, one can use a two step procedure to back out estimates of product market power with error in the first step, and allowing for first step errors in a second step, estimate the factors, including firm size, that determine the estimated product mark-ups. This approach is relatively straightforward to implement, not requiring cumbersome estimation procedures. Compared with measures of concentration such as the HHI, the estimates of market power secured have real information in terms of the ability of firms to price above cost for each of its brands. This can lead to more accurate and informed positive analysis of industries and lead to better decisions in anti-trust analysis.

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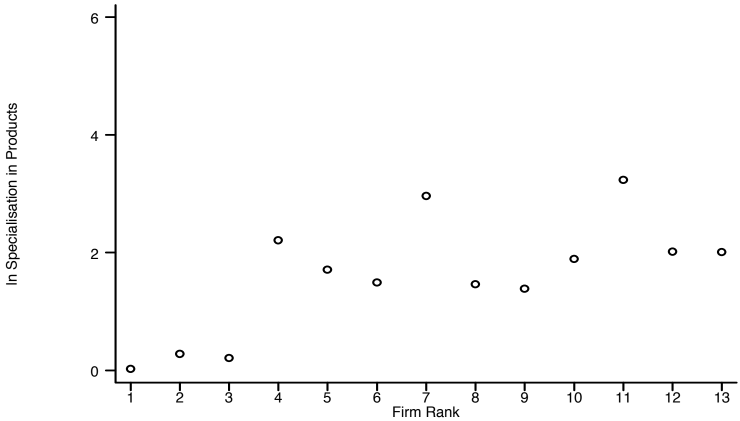
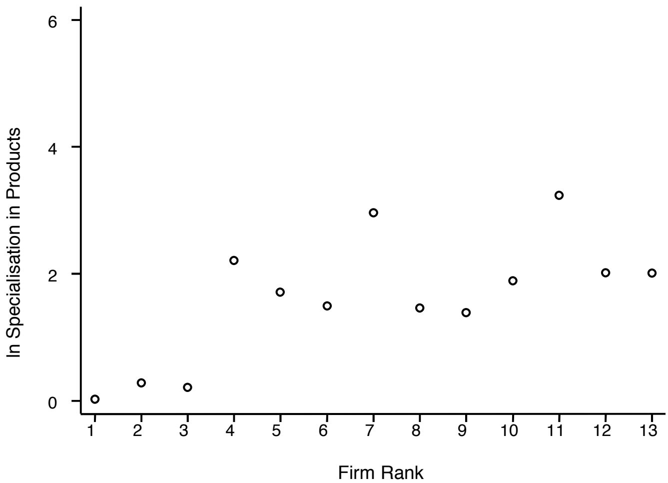
APPENDIX
TABLES AND FIGURES
Figure 1:



(a) Specialisation of firms into Product Characteristics (Market Share in Product Characteristics that a firm competes in as a percentage of the Market Share in Carbonated Soft Drinks) by firm rank, averaged over-time.



(b) Specialisation of firms into Product Characteristics and Retail Stores (Market Share in the Retail stores by Product Characteristics that a firm competes in as a percentage of the Market Share in Carbonated Soft Drinks) by firm rank, averaged over-time.