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Empirical Analysis of Countervailing Power in Business-to-Business Bargaining

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Abstract

This paper provides a comprehensive econometric framework for the empirical analysis of countervailing power. It encompasses the two main features of pricing schemes in business-to-business relationships: nonlinear price schedules and bargaining over rents. Disentangling them is critical to the empirical identification of countervailing power. Testable predictions from the theoretical analysis for a pragmatic reduced form empirical pricing model are delineated. This model is readily implementable on the basis of transaction data, routinely collected by antitrust authorities and illustrated using data from the UK brick industry. The paper emphasizes the importance of controlling for endogeneity of volumes and established supply chains and for heterogeneity across buyers and sellers due to intrinsically unobservable outside options.

JEL Classification: D43, L11, L12, L14, L42, C23, C78

Keywords: countervailing power, bargaining, nonlinear prices, transaction panel data

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1 Introduction

Countervailing power, often referred to as buyer power, is a paramount concern in competition analysis. It is a line of inquiry in many competition investigations focussing on business-to-business (B2B) dealings. Quintessential high profile examples are the relationships between supermarkets and their suppliers.[1] Another recent topical example is the relationship between Chinese steel mills and Australian and Brazilian iron ore miners.[2]

At the center of many competition inquiries are often generic products, such as raw materials or bulk items. Then, the focus is on per unit prices, usually obtained by antitrust bodies as revenue per unit sold. This price measure typically constitutes a combination of the respective portion of a nonlinear unit price schedule and a lump sum payment, e.g. a franchise fee, rebate, retrospective quantity discounts or other incentive payment that is the outcome of bargaining over joint surplus between buyer and supplier. Hence, one of the primary difficulties in the analysis of buyer power on the basis of unit prices is the important distinction between nonlinear pricing and the appropriation of rents by means of bargaining.[3]

The conceptual contribution of this paper is a framework that connects the analysis of countervailing power[4] with the design of optimal nonlinear pricing schemes, while at the same time incorporating bargaining over rents. It thereby illuminates how buyer power is enhanced by the buyer's ability to

[1]On the European level, the European Commission considered buyer power issues in the German - Austrian merger Rewe/Meinl (1999) and the French - Spanish merger Carrefour/Promodès (2000); see also European Commission (1999). On the national level, see, for example, the recent market inquiry into UK grocery retailing by the UK Competition Commission, in particular Provisional Findings Appendix 8; the report can be downloaded from the Competition Commission website.

[2]See Financial Times UK online, 09 July 2008. In spite of shipping costs per tonne from Brazil being twice those from Australia, Brazilian and Australian miners receive the same freight-on-board price. This is interpreted as a reflection of superior negotiating power of Brazilian miners when bargaining with Chinese mills, given the size of Chinese demand for, and the limitations on Australian miners' capacity in the supply of, iron ore.

[3]See also Bonnet et al. (2010) who investigate manufacturer-retailer relationships involving nonlinear pricing. They present empirical tests of two-part tariffs with versus without retail price maintenance embedded in a structural model of competition in differentiated product markets (e.g. Berry (1994), Berry et al. (1995)) using market level data.

[4]The notion of countervailing (buyer) power was coined by Galbraith (1952) and theoretically developed in a dynamic setting by Snyder (1996); see also *infra* note 10.

switch between suppliers, and is constrained by the suppliers' outside options and capacity; in particular, one novel insight that emerges from the theoretical model and contrasts this paper with Chipty and Snyder (1999), Inderst and Wey (2007), Smith and Thanassoulis (2008) and some conventional wisdom, is that, in the face of suppliers' capacity constraints, buyer size may diminish buyer power. The theoretical model also offers supplier heterogeneity, arising from idiosyncratic outside options, as a new explanation of equilibrium price dispersion; this line of argument is particularly pertinent to the business-to-business context where traditional explanations in terms of imperfect information are implausible.[5]

The methodological contribution of the paper is a reduced form empirical approach that allows to test predictions deduced from the aforementioned theoretical framework. It permits to reject, or establish evidence consistent with, testable predictions from a model that embeds countervailing power in bilateral bargaining, heterogeneity across buyers and sellers, as well as endogenous nonlinear prices and quantities. These predictions include standard predictions of endogenous quantities[6], next to the more novel feature that the number of a buyer's transaction partners is endogenous too, because it is an equilibrium choice of the buyer. Furthermore, the theoretical model stipulates nonlinear equilibrium price schedules that reflect quantity discounts and that are uniformly lower for buyers with more (and sellers with fewer) outside options. And the model re-enforces the view that it is advantageous to have panel data for an analysis of bilateral bargaining: To the extent that outside options are often unobserved in the data or indeed intrinsically unobservable, the fact that they act as shifters to the equilibrium price schedule amounts to unobserved heterogeneity reflected in bilateral bargaining outcomes. The empirical approach advocated in this paper is easy to implement and hence does not suffer from the typical barriers to diffusion into applied competition analysis that many fully structural models and associated empirical methodologies

[5] The traditional view relates to consumer retail prices and is articulated in Salop and Stiglitz (1977, 1982), Reinganum (1979), Burdett and Judd (1983), Carlson and McAfee (1983), Hallagan and Joerding (1985), Sorensen (2000) and the ensuing literature on equilibrium price dispersion.

[6] Cf. hedonic pricing literature, e.g. Ekeland et al. (2004); in the presence of nonlinear pricing, the endogeneity of volume has the additional interpretation as arising from selection into parts of a nonlinear tariff.

propagated in the industrial organization literature[7] are fraught with.

The proposed methodology is illustrated using data from a UK Competition Commission merger inquiry in the brick manufacturing industry. While it is a unique dataset for academic research, it is the kind of data competition authorities typically have powers to request. It comprises all transactions between the main UK brick manufacturers and their customers over the period 2001-2006 and details, next to prices paid and quantities delivered, characteristics of the respective buyer and brick type, manufacturing plant and delivery locations as well as some cost and logistic information. Variation of actual (and potential) transactional relationships over time and across locations in these data permits identification of unobserved heterogeneity across buyers and manufacturers. And it allows to delineate the impact of buyers' choice options on prices obtained as bargaining outcomes, alongside the effects of transaction and business size on prices paid.

The paper proceeds as follows. After a brief review of the relevant antitrust background, section 2 outlines the theoretical model that guides the analysis; the section concludes with the main issues that an econometric analysis of countervailing power has to confront and delineates testable predictions that the theory imposes on reduced form approaches to estimate models for prices as bargaining outcomes. Section 3 is devoted to the empirical part of the paper. It presents the background for, and data used in, the applied part of the paper, and it summarizes the empirical analysis. Section 4 concludes.

1.1 Countervailing Power Analysis in Antitrust

The analysis of buyer power is often an integral part in antitrust inquiries. The UK Competition Merger Guidelines (2003, revised 2010) consider buyer power in merger assessment: Do buyers, either because of their size or commercial significance to their suppliers, have the ability to prevent the exercise of market power by suppliers? This ability, if present, is akin to Galbraith' (1952) notion of countervailing buyer power. The Competition Commission considers such countervailing power as one potential mitigating factor, next to others such as entry and switching costs, in the assessment of upstream mergers. In the competition assessment in its market investigations (Com-

[7] Cf. Reiss and Wolak (2007).

petition Commission Market Investigation Guidelines (2003)), it investigates the "relative importance [to each other] of [each firm's] business with the other party"[8]; there is an additional question whether any price reductions, obtained by virtue of buyer power, are passed on to consumers. The guidelines enumerate several factors that are viewed as potentially affecting buyers' ability to constrain suppliers: buyers' ability to find alternative suppliers; the ease with which buyers can switch suppliers; the extent to which buyers can credibly threaten to set up their own supply arrangements, e.g. by backward integration or by sponsoring entry; the extent to which buyers can impose costs on suppliers, e.g. by delaying or stopping purchases or by transferring risk. It is worth noting in this regard that a buyer's size can cut both ways: while size enhances the significance of the buyer's business vis-à-vis the supplier, it makes switching more difficult when alternative suppliers' capacities are constrained.

A prototypical conventional buyer power analysis is the Competition Commission's investigation as part of its inquiry into grocery retailing in the UK (2008). Based on their size, pricing and margins, the Commission concluded that all large retailers, wholesalers and buying groups have buyer power vis-à-vis their suppliers. However, the Commission considered that their buyer power is offset by market power of suppliers of branded goods; and that lower prices arising from buyer power in part are passed on to consumers. The Commission substantiated these findings with an analysis of panel data, which for various stock-keeping-units (SKUs) comprised yearly prices, volumes and some cost information. The Commission's methodology consisted of fixed-effects regressions of unit prices on volumes.[9]

The Commission's analysis raises several questions. Panel data methods can capture unobserved heterogeneity. The analysis modelled SKU-level idiosyncratic effects, but is this the appropriate level of heterogeneity? Moreover, does aggregation to annual data mask latent heterogeneity across time? The analysis may also raise concerns about the treatment of volumes: If business-to-business relationships involve bargaining over both volumes and prices, then volumes should be treated as endogenous regressors. Furthermore,

[8]Competition Commission Guidlines (2003) for market investigation references, paragraph 3.37.

[9]Details can be found in the Competition Commission's Final Report of the Grocery Market Investigation (2008), Appendix 5.3.

the caveat about the ambiguous volume effect notwithstanding, the Commission's analysis focussed on volume effects on prices as evidence of buyer power, without attempting to quantify buyer's ability to switch suppliers. But volume effects on unit prices might just reflect suppliers' nonlinear pricing and self-selection of buyers into the appropriate part of the tariff, irrespective of buyer power. Hence, this type of reduced form analysis might be critiqued along various dimensions, and it highlights that the treatment of potential heterogeneity across buyers and suppliers, endogeneity of prices and volumes and the distinction between nonlinear pricing and bargaining over rents are the primary empirical challenges of the empirical analysis of buyer power.

1.2 Related Literature

Its growing importance and policy relevance notwithstanding, the academic literature on buyer power is still relatively sparse. Inderst and Mazzarotto (2006) survey its main theoretical strands to date, as they relate to sources and consequences of, as well as policy responses to, buyer power of retailers vis-à-vis manufacturers[10]. The theoretical model in this paper offers a new theoretical perspective on the analysis of buyer power, casting the design of optimal nonlinear price schedules within the framework of co-operative bilateral bargaining, building on the general propositions in Stole and Zwiebel (1996).

With regard to applied work, the academic literature offers very little towards a comprehensive empirical framework for the analysis of buyer power that connects theory with data and estimation strategy.[11] Giulietti (2007)

[10]Inderst and Shaffer (2006), for example, consider the effect of retail mergers on product variety. The aforementioned paper by Snyder (1996) provides an explanation for discounts granted to large buyers. His analysis translates ideas in Rotemberg and Saloner (1986) into the context of an infinitely repeated game with upstream competition vis-à-vis a single downstream buyer; there, buyer size makes a seller's deviation, in the form of discounts, from upstream collusion profitable relative to possible punishment. Recent theoretical work by Smith and Thanassoulis (2008) demonstrates how upstream competition can endow large buyers with market power by inducing supplier-level volume uncertainty.

[11]There is some early nonstructural work that provides empirical evidence supporting countervailing buyer power; see Adelman (1959), Brooks (1973), Buzzell et al. (1975), Lustgarten (1975), McGukin and Chen (1976), McKie (1950), Clevenger and Campbell (1977), Boulding and Staelin (1990). Dobson and Waterson (1997) and von Ungern-Sternberg (1996) examine the effect on

presents a reduced form analysis of the Italian grocery retail sector, approximating suppliers' bargaining power by a concentration measure for the respective product level industry they operate in. The empirical analysis of this paper uses data that allow for a more detailed measure of local competition, which is especially important in industries like bricks or aggregates where transport costs are significant. Chipty and Snyder's (1999) approach exhibits more detailed structural features. It provides an empirically testable condition - concavity of the supplier's revenue function - that needs to be satisfied for larger buyers, e.g. arising from buyer mergers, to obtain lower transfer prices when bargaining over surplus with their suppliers. This framework captures the anecdotal view that larger buyers enjoy greater buyer power. It is useful when the analysis focuses on revenues for bespoke goods or services; this is the case in Chipty and Synder's application of their model to the US cable television industry. It is less suited for the typical generic goods and commodities encountered in many antitrust investigations and illustrated in the application to the brick industry presented in this paper.

While Chipty and Snyder consider the case of an upstream monopoly, Ellison and Snyder (2001) build on this approach and investigate the role of substitution possibilities as a consequence of upstream competition. They focus on price differences in wholesale pharmaceutical markets between different types of buyers, controlling for various institutional differences with regard to drug administration.[12] Using cross-section data, their analysis cannot model unobserved heterogeneity across buyers. The empirical analysis presented in this paper demonstrates that there exist circumstances in which the conclusion about buyer power critically hinges on accounting for unobserved heterogeneity.

Related work by Villas-Boas (2007) examines vertical relationships between manufacturers and retailers with limited data, when wholesale prices for transactions between them are not observed; her objective is to indirectly identify the strategic model appropriate for their interaction from demand

countervailing power on consumer prices.

[12]Drugs can be branded and subject to patent protection, branded and subject to generic competitors, or generic and subject to some form of oligopolistic competition. Buyers such as HMOs and hospitals have wider substitution possibilities through the use of restrictive formularies relative to chain drugstores and independent drugstores. Ellison and Snyder (2001) empirically examine the effects of different features of drugs on the difference in prices paid by various types of buyers.

and cost estimates, with a particular focus on pricing models which feature double marginalization. Her approach is insightful when researchers have to contend themselves with less detailed data than the ones used in this paper and those that antitrust authorities are typically in a position to request from the parties under investigation.

2 Theory

As a preamble to the theoretical section of the paper, it is worth emphasizing at the outset that the theoretical framework outlined below is a stylized characterization of generic business-to-business bargaining and not intended to capture all the intricacies of business-to-business relationships. Instead, it is intended to motivate the main issues that econometric analyses of countervailing power have to deal with. The empirical strategy proposed in this paper deliberately follows a reduced form econometric approach that is informed by the structural model, but does not suffer from the typical potential criticism of strong identifying restrictions that structural approaches rely upon. The econometric approach proposed here instead relies on testable implications stipulated by theory that are robust across more tightly specified, fully structural models.

The following subsection starts out with the simplest version of a model of bilateral B2B bargaining. It subsequently expands and generalizes this model in various directions, in order to illuminate how different modeling assumptions - about upstream competition, bargaining weights, outside options - affect the equilibrium bargaining outcomes. This subsection is followed by a discussion of testable restrictions that the theoretical considerations impose on reduced-form econometric models for unit prices of the type often encountered in antitrust investigations.

2.1 Multilateral Bargaining

To start, consider bilateral bargaining with complete information between a single buyer and suppliers of an input to the buyer's production technology. Consider the following assumptions:

A1: The buyer's production technology uses input q which induces revenue function $F(q) = \tau q^{\theta}$, $\theta \in (0,1)$ and $\tau > 0$.

A2: The buyer faces a supplier whose payment schedule for the delivery of q is given by $C(q) = \beta q^{\alpha}$, $\alpha, \beta \geq 0$. The supplier incurs zero cost of production.

A3: The buyer maximizes profits $F(q) - C(q)$; Nash bargaining over the joint surplus between buyer and supplier, with equal bargaining weights[13], induces the optimal price schedule that the supplier presents to the buyer.

Proposition 1: *Under assumptions A1-A3, the optimal nonlinear price schedule is* $\bar{p}(q) = q^{2\theta-1}$.

Proof: Bargaining over surplus is the first stage of a two-stage game between the buyer and the supplier. On the second stage, given a price schedule $p(q)$ and associated payment schedule $C(q) = p(q)q$, the buyer chooses the profit maximizing amount of inputs. This two-stage game is solved by backwards induction.

Maximizing the buyer's profits $\pi(q; \alpha, \beta) = F(q) - C(q) = \tau q^{\theta} - \beta q^{\alpha}$ over q on the second stage yields optimal inputs $\bar{q} = \left(\frac{\tau\theta}{\alpha\beta}\right)^{\frac{1}{\alpha-\theta}}$. The associated maximum profit is $\bar{q}^{\theta} - \beta\bar{q}^{\alpha} = \left(\frac{\tau\theta}{\alpha\beta}\right)^{\frac{\theta}{\alpha-\theta}} - \beta\left(\frac{\tau\theta}{\alpha\beta}\right)^{\frac{\alpha}{\alpha-\theta}} = \left(\frac{1}{\beta}\right)^{\frac{\theta}{\alpha-\theta}} \left(\frac{\tau\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \left(\frac{\alpha}{\tau\theta} - 1\right) > 0$, provided $\alpha > \tau\theta$.

Following Stole and Zwiebel (1996), Nash bargaining on the first stage induces the supplier to design the payment schedule such that the loss from a breakdown in negotiations for both parties equate, i.e. the supplier chooses $\bar{\alpha} > \tau\theta$ and $\bar{\beta} > 0$ that

$$\pi(\bar{q}; \bar{\alpha}, \bar{\beta}) = \left(\frac{\tau\theta}{\bar{\alpha}\bar{\beta}}\right)^{\frac{\theta}{\bar{\alpha}-\theta}} - \bar{\beta}\left(\frac{\tau\theta}{\bar{\alpha}\bar{\beta}}\right)^{\frac{\bar{\alpha}}{\bar{\alpha}-\theta}} = \bar{\beta}\left(\frac{\tau\theta}{\bar{\alpha}\bar{\beta}}\right)^{\frac{\bar{\alpha}}{\bar{\alpha}-\theta}}.$$

This implies that $\bar{\alpha} = 2\theta$, while $\bar{\beta}$ is indeterminate, so without loss of generality $\bar{\beta} = 1$[14]. This implies the optimal price schedule $\bar{p}(q) = \bar{C}(q)/q = \bar{\beta}q^{\bar{\alpha}}/q = q^{2\theta-1}$, and the buyer's and supplier's profits are $\left(\frac{\tau\theta}{\bar{\alpha}}\right)^{\frac{\bar{\alpha}}{\bar{\alpha}-\theta}} = \frac{\tau^2}{4}$. $\square$

A few comments may be useful to interpret this result. The revenue function $F(q) = \tau q^{\theta}$ is a surrogate of the buyer's technology to convert input q

[13]This assumption is for ease of exposition and further discussed below. Some recent structural empirical analyses of negotiated prices in specific industries find evidence to the contrary; cf. Crawford and Yurukoglu (2009), Draganska et al. (2009), and Grennan (2009).

[14]This can be viewed as a normalization; only the demand scale τ and the bargaining weights matter for the equilibrium outcomes; see also Corollary 1 below.

into a final product sold in a downstream market and of the buyer's competitive position in that downstream market which this analysis remains agnostic about. The more efficient the buyer's technology to generate revenue from using input q, i.e. the higher θ, the higher the equilibrium unit price schedule that the supplier presents to the buyer. The parameter τ can be viewed as a measure of demand for the buyer's final product sold in the downstream market. High demand downstream induces high anticipated input demand $\bar{q} = \left(\frac{\tau\theta}{\alpha\beta}\right)^{\frac{1}{\alpha-\theta}}$ and high profits for the buyer, but these higher profits are also shared by the supplier as a result of bargaining over the joint surplus. Note also that the equilibrium price schedule is deduced from anticipated demands $\bar{q}$, while the equilibrium input level demanded on the basis of the equilibrium price schedule is $\left(\frac{\tau}{2}\right)^{\frac{1}{\theta}}$; of course, anticipated and realized demand are correlated, through the demand parameter τ. This feature of the model is often borne out in applications where so-called framework agreements or list prices, offered on the basis of anticipated demand prospects, provide an indicative price schedule subject to which deliveries subsequently can be called off, next to one-off purchases at ad hoc negotiated or 'spot' prices.

The assumption of equal split in Nash bargaining may be plausible in the case of a bilateral monopoly, but less so in cases where parties negotiate bilaterally, but have differential outside options; e.g. the supplier may be able to export his product[15] and hence has less to lose in the event of a breakdown of negotiations. Proposition 1 has the following Corollary that captures the case of different bargaining weights.

Corollary 1: *Suppose A1 and A2 hold, the buyer maximizes $F(q) - C(q)$, buyer and seller Nash bargain over the joint surplus, with the buyer's loss from a breakdown of bargaining being a multiple $\delta > 1$ of the seller's loss. Then,* $\bar{p}(q) = q^{(1+\delta)\theta-1}$.

The proof follows the same steps as the one of Proposition 1. The result shows that the less the seller has to lose relative to the buyer when negotiations break down, i.e. the larger δ, the less generous the equilibrium price schedule the seller offers to the buyer.

Now consider an extension of this model that allows for upstream competition among several suppliers for the buyer's business. Suppose the buyer faces two identical suppliers, i.e. there is upstream competition and the buyer

[15] See also *supra* footnote 13.

bargains multilaterally; for simplicity, the following result reverts to the case with equal bargaining weights, while the subsequent results relaxes this assumption. The buyer will find it optimal to source from both suppliers if the optimal equilibrium payment schedule is convex, i.e. $\alpha > 1$. Therefore, consider the assumptions

A1': The buyer's production technology uses input q and induces the revenue function $F(q) = \tau q^{\theta}$, $\theta \in \left(\frac{1}{2}, 1\right)$.

A2': The buyer faces two identical suppliers whose payment schedule for the delivery of q is given by $C(q) = \beta q^{\alpha}$, $\beta \geq 0, \alpha > 1$. The suppliers incur zero cost of production.

A3': The buyer maximizes profits; Nash bargaining over the joint surplus between buyer and suppliers holding passive beliefs[16] induces the optimal price schedule that the supplier presents to the buyer.

Proposition 2: *Under assumptions A1', A2' and A3', upstream competition induces an optimal nonlinear price schedule* $\tilde{p}(q)$ *that involves* $\tilde{p}(q) < \bar{p}(q)$ *for all* $q > 0$*, where* $\bar{p}(q)$ *is given by Proposition 1.*

Proof: Since the marginal contribution to the buyer's revenue from either supplier is the same at an optimal input allocation, it must be that, with convex payments, the buyer sources the same amount from both. Hence, on the second stage, the buyer maximizes $\tau(2q)^{\theta} - 2\beta q^{\alpha}$ over q. This yields optimal input demands $\tilde{q} = 2^{\frac{\theta-1}{\alpha-\theta}} \left(\frac{\tau\theta}{\alpha\beta}\right)^{\frac{1}{\alpha-\theta}} = 2^{\frac{\theta-1}{\alpha-\theta}} \bar{q} < \bar{q}$ and $2\tilde{q} = 2^{\frac{\alpha-1}{\alpha-\theta}} \bar{q} > \bar{q}$. This implies associated maximum profits of $\pi(\tilde{q}; \alpha, \beta) = 2^{\frac{\theta(\alpha-1)}{\alpha-\theta}} \pi(\bar{q}; \alpha, \beta)$.

Consider the Nash bargaining stage where the buyer faces a supplier, holding passive beliefs. The supplier designs a price schedule with parameters $\tilde{\alpha}$ and $\tilde{\beta}$ such as to equate the loss to the buyer from breakdown with the supplier's loss of revenue, i.e.

$$2^{\frac{\theta(\alpha-1)}{\alpha-\theta}} \pi(\bar{q}; \tilde{\alpha}, \tilde{\beta}) - \frac{\tau^2}{4} = \tilde{\beta} \left(\frac{\tau\theta}{\tilde{\alpha}\tilde{\beta}}\right)^{\frac{\tilde{\alpha}}{\tilde{\alpha}-\theta}} 2^{\frac{\tilde{\alpha}(\theta-1)}{\tilde{\alpha}-\theta}}.$$

[16] Cf. McAfee and Schwartz (1994); this assumption is maintained in Stole and Zwiebel (1996) and, more generally, the literature on bargaining with multiple agents. It stipulates in this context that in any bilateral bargaining situation between a buyer and a supplier, the parties hold the belief that, should bargaining between them break down, the buyer reaches an efficient bargaining outcome with the other supplier.

Suppose the supplier were to choose $\tilde{\alpha} = 2\theta$ and $\tilde{\beta} = 1$, as in Proposition 1, i.e. as if there were no upstream competition. Then, the buyer's lost profits (the LHS of the preceding equality) would be $\frac{\tau^2}{4}\left(2^{2\theta-1} - 1\right) > 0$ if $\theta > \frac{1}{2}$, while the supplier's lost profits (the RHS of the preceding equality) would be $\frac{\tau^2}{4} 2^{2(\theta-1)}$. Hence, the supplier has more to lose from a breakdown in bargaining than the buyer and, therefore, has an incentive to offer better terms[17], i.e. $\tilde{\alpha} < \bar{\alpha}$ and $\tilde{\beta} \leq \bar{\beta}$. □

Proposition 2 shows that upstream competition endows the buyer with countervailing power vis-à-vis suppliers that permits to extract uniformly more favorable terms from them. It follows as a corollary that the buyer's profits are increased by upstream competition. This inspires the definition of countervailing buyer power in terms of equilibrium prices:

Definition: Consider a buyer who faces a nonlinear equilibrium price schedule $\bar{p}_i(q)$, $q > 0$, in the presence of an upstream monopoly of supplier i. The buyer enjoys *countervailing power* if, in equilibrium, the supplier i present the buyer with a nonlinear price schedule $\tilde{p}_i(q) < \bar{p}_i(q)$ for all $q > 0$.

Considering the equilibrium pay-off structure resulting from Proposition 2, by construction the pay-offs are balanced and efficient. Moreover, they are individually fair, i.e. they exceed the individual non-cooperation pay offs; symmetric, i.e. the equivalent suppliers receive the same pay-offs; additive across bargains; and satisfy that a supplier who does not contribute to the joint surplus receives a zero pay-off. The revenue or profit accruing to the supplier therefore has the interpretation of the supplier's Shapley value associated with the cooperative game between the buyer and the two suppliers.[18] Since $\tilde{q} < \bar{q}$, it follows that $\tilde{p}(\tilde{q})\tilde{q} < \bar{p}(\bar{q})\bar{q}$. This inspires an equivalent definition of countervailing buyer power in terms of Shapley values:

Definition: Consider supplier i's Shapley value in the cooperative game associated with the coalition including only i and the buyer, $\bar{p}_i(\bar{q}_i)\bar{q}_i$. The buyer enjoys *countervailing power* if i's Shapley value in the cooperative game associated with the coalition including, inter alia, supplier i and the buyer, $\tilde{p}_i(\tilde{q}_i)\tilde{q}_i$, satisfies $\tilde{p}_i(\tilde{q}_i)\tilde{q}_i < \bar{p}_i(\bar{q}_i)\bar{q}_i$.

[17] This can also be formally shown by noting that the derivative of the buyer's loss with respect to α and β at $\bar{\alpha}$ and $\bar{\beta}$ is negative and dominated by the derivative of the supplier's loss with respect to the payment parameters at that point, so that the values $\tilde{\alpha}$ and $\tilde{\beta}$ cannot be larger than $\bar{\alpha}$ and $\bar{\beta}$.

[18] See Myerson (1980), Hart and Mas Colell (1989), Stole and Zwiebel (1996).

A question that arises in the presence of upstream competition is whether Bertrand style price competition would not drive prices below those predicted by Proposition 2. While it is beyond the scope of this analysis to address this concern in a more comprehensive framework, results due to Kreps and Scheinkman (1983) suggest that, in industries where capacity is a strategic variable, price competition subsequent to capacity choices yields Cournot competition outcomes, with prices above marginal cost. In the kind of applications that are envisaged for this theoretical investigation, capacity typically plays an essential role, not least because it may well limit the extent to which the buyer may be able to credibly threaten to divert demand away from a supplier.

Just as Corollary 1, it also follows as a corollary to the preceding proposition that any outside options the suppliers have, such as the selling to other buyers, enhances their bargaining outcome, because such outside options reduce the loss they incur in the event of a breakdown of bargaining. To generalize this setup further, consider the case where the two suppliers are heterogeneous, e.g. due to different outside options[19]. Consider the following variant of the previous assumptions,

A2": The buyer faces two heterogeneous suppliers whose payment schedules for the delivery of q are given by $C(q) = \beta q^{\alpha}$, $\beta > 1$, $\alpha > 2\theta$, and supplier i's outside option is given by $(\beta - \beta^{\delta_i})q^{\alpha}$, $i = \{1, 2\}$, where $0 < \delta_1 < \delta_2 < 1$.

A3": The buyer maximizes profits; Nash bargaining over the joint surplus between buyer and suppliers holding passive beliefs induces the optimal price schedule that the supplier presents to the buyer, where suppliers optimize β, taken α as given[20]

In this setup, supplier 1 has a more favorable outside option.

Proposition 3: *Under assumption A1', A2" and A3", in an interior equilibrium in which the buyer sources from both suppliers, assuming it exists,*

[19]For example, this could be thought of as the buyer under consideration being located at the midpoint of a Hotelling street connecting the two suppliers, and a second buyer being located on the opposite side of the first supplier, say. The distance between supplier 1 and the second buyer is then shorter than between the second buyer and supplier 2.

[20]While this restricts the elasticity of the equilibrium payment schedules to be the same for the heterogeneous suppliers, it allows for different levels in the schedules. This restriction is for analytical convenience.

the optimal nonlinear price schedule of supplier 1, $\bar{p}_1(q)$, dominates the one for supplier 2, $\bar{p}_2(q)$, in the sense that $\bar{p}_1(q) > \bar{p}_2(q)$ for all $q > 0$.

Remark: Lemma 1 in the Appendix establishes conditions under which a dual-sourcing equilibrium exists.

Proof : For ease of exposition and to keep formulae as simple as possible, and w.l.o.g., consider the case where $\tau = 1$. At the second stage, the buyer maximizes $(q_1 + q_2)^\theta - \beta_1 q_1^\alpha - \beta_2 q_2^\alpha$. At the optimal input allocation $(\bar{q}_1, \bar{q}_2)$, the marginal contribution of the two suppliers to the buyer's revenue must be the same, so that $\bar{q}_2 = \gamma \bar{q}_1$, where $\gamma = \left(\frac{\beta_2}{\beta_1}\right)^{\frac{1}{1-\alpha}}$. Hence, the buyer maximizes $(q_1(1+\gamma))^\theta - \beta_1 q_1^\alpha - \beta_2(\gamma q_1)^\alpha$, which yields

$$\bar{q}_1 = \frac{(1+\gamma)^{\frac{\theta}{\alpha-\theta}}}{(\beta_1 + \gamma^\alpha \beta_2)^{\frac{1}{\alpha-\theta}}} \left(\frac{\theta}{\alpha}\right)^{\frac{1}{\alpha-\theta}},$$

and the buyer's profit is

$$\begin{aligned}
\pi(\bar{q}_1; \beta_1, \beta_2) &= \frac{(1+\gamma)^{\frac{\theta\alpha}{\alpha-\theta}}}{(\beta_1 + \gamma^\alpha \beta_2)^{\frac{\theta}{\alpha-\theta}}} \left[\left(\frac{\theta}{\alpha}\right)^{\frac{\theta}{\alpha-\theta}} - \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}}\right]. \\
&= \frac{(1+\gamma)^{\frac{\theta\alpha}{\alpha-\theta}}}{(\beta_1 + \gamma^\alpha \beta_2)^{\frac{\theta}{\alpha-\theta}}} \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \left(\frac{\alpha}{\theta} - 1\right).
\end{aligned}$$

Consider the Nash bargaining stage between the buyer and supplier 1, assuming passive beliefs. If bargaining breaks down, then the buyer's profit reached with supplier 2 is $\pi(\bar{q}; \alpha, \beta) = \left(\frac{\theta}{\alpha\beta}\right)^{\frac{\theta}{\alpha-\theta}} - \beta\left(\frac{\theta}{\alpha\beta}\right)^{\frac{\alpha}{\alpha-\theta}}$, as in Proposition 1. Supplier 2's profit, beyond 2's outside option, is $\beta^{\delta_2}\left(\frac{\theta}{\alpha\beta}\right)^{\frac{\alpha}{\alpha-\theta}}$.[21] Hence, supplier 2 will design a price schedule such as to equate this excess profit with $\pi(\bar{q}; \alpha, \beta)$, choosing $\beta_2 = \left(\frac{\alpha}{\theta} - 1\right)^{\frac{1}{1-\delta_2}} > 1$, i.e. ceteris paribus the higher supplier 2's outside option (the lower δ_2), the less favorable the terms offered to the buyer. The profit of the buyer under these terms is $\pi(\bar{q}; \beta_2) = \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \left(\frac{\alpha}{\theta} - 1\right)^{\frac{\theta}{(1-\delta_2)(\alpha-\theta)}}$. Hence, when bargaining with the buyer, supplier 1 will equate the loss to the buyer in the event of a breakdown,

$$\Delta\pi_2(\beta_1, \beta_2, \delta_2) = \left[\frac{(1+\gamma)^{\frac{\theta\alpha}{\alpha-\theta}}}{(\beta_1 + \gamma^\alpha \beta_2)^{\frac{\theta}{\alpha-\theta}}} \left(\frac{\alpha}{\theta} - 1\right) - \left(\frac{\alpha}{\theta} - 1\right)^{\frac{\theta}{(1-\delta_2)(\alpha-\theta)}}\right] \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \tag{1}$$

[21] This requires the implicit assumption that, once negotiations between the buyer and supplier 1 have broken down, the buyer will not re-start negotiations with supplier 1, so that supplier 2 effectively enjoys a monopoly position.

with supplier 1's loss of revenue beyond the outside option,

$$s_1(\beta_1, \beta_2, \delta_1) = \beta_1^{\delta_1} \frac{(1+\gamma)^{\frac{\theta\alpha}{\alpha-\theta}}}{(\beta_1 + \gamma^\alpha \beta_2)^{\frac{\theta}{\alpha-\theta}}} \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}}.$$

This implicitly defines supplier 1's optimal design response to supplier 2, $b_1(\beta_2; \delta_1, \delta_2)$, as the solution of

$$\Delta\pi_2(b_1(\beta_2; \delta_1, \delta_2), \beta_2, \delta_2) = s_1(b_1(\beta_2; \delta_1, \delta_2), \beta_2, \delta_1).$$

Analogous considerations with regard to Nash bargaining between the buyer and supplier 2 yield supplier 2's optimal design response to supplier 1, $b_2(\beta_1; \delta_1, \delta_2)$.

Suppose it were the case that $\beta^\star = b_1(\beta^\star; \delta_1, \delta_2) = b_2(\beta^\star; \delta_1, \delta_2)$, so that $\gamma = 1$, while $\delta_1 < \delta_2$. Then,

$$\begin{aligned}
\Delta\pi_1(\beta^\star; \delta_1, \delta_2) &= \left[\left(\frac{2^\alpha}{2\beta^\star}\right)^{\frac{\theta}{\alpha-\theta}} \left(\frac{\alpha}{\theta} - 1\right) - \left(\frac{\alpha}{\theta} - 1\right)^{\frac{\theta}{(1-\delta_2)(\alpha-\theta)}}\right] \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \\
\Delta\pi_2(\beta^\star; \delta_1, \delta_2) &= \left[\left(\frac{2^\alpha}{2\beta^\star}\right)^{\frac{\theta}{\alpha-\theta}} \left(\frac{\alpha}{\theta} - 1\right) - \left(\frac{\alpha}{\theta} - 1\right)^{\frac{\theta}{(1-\delta_1)(\alpha-\theta)}}\right] \left(\frac{\theta}{\alpha}\right)^{\frac{\theta}{\alpha-\theta}} \\
s_1(\beta^\star; \delta_1, \delta_2) &= (\beta^\star)^{\delta_1} \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \left(\frac{2^\alpha}{2\beta}\right)^{\frac{\alpha}{\alpha-\theta}} \\
s_2(\beta^\star; \delta_1, \delta_2) &= (\beta^\star)^{\delta_2} \left(\frac{\theta}{\alpha}\right)^{\frac{\alpha}{\alpha-\theta}} \left(\frac{2^\alpha}{2\beta}\right)^{\frac{\alpha}{\alpha-\theta}}
\end{aligned}$$

and $\delta_1 < \delta_2$ then implies that

$$\begin{aligned}
\Delta\pi_1(\beta^\star; \delta_1, \delta_2) &> \Delta\pi_2(\beta^\star; \delta_1, \delta_2) \\
s_1(\beta^\star; \delta_1, \delta_2) &> s_2(\beta^\star; \delta_1, \delta_2).
\end{aligned}$$

This implies that, under equal terms $\beta^\star$, the buyer loses more when negotiations with supplier 1 break down than when they break down with supplier 2, even though supplier 1 enjoys the more favorable outside option. This in turn, implies that, in equilibrium, supplier 1 chooses uniformly less favorable terms relative to those implied by $\beta^\star$, while supplier 2 ameliorates the terms offered to the buyer relative to $\beta^\star$, so that $\bar{p}_1(q) = \beta_1^\star q^\alpha > \beta_2^\star q^\alpha$ for all $q > 0$, where

$$\begin{aligned}
\beta_1^\star &= b_1\left(b_2(\beta_1^\star; \delta_1, \delta_2); \delta_1, \delta_2\right) \\
\beta_2^\star &= b_2(\beta_1^\star; \delta_1, \delta_2) < \beta_1^\star.
\end{aligned}$$

Note that, in equilibrium, it must be that $\beta_2^\star > 1$, since otherwise supplier 2's outside option would be negative, implying a gain to the supplier from breakdown of negotiations with the buyer. $\square$

Proposition 3 has the noteworthy corollary that supplier 2 may well benefit from a very favorable outside option on the part of supplier 1, which makes it easy for supplier 1 to walk away from negotiations with the buyer, approximating the situation of a single supplier, as in Proposition 1. Since $\beta_1^\star > \beta_2^\star$ and A1' and A2" imply $\alpha > 1$, it follows that $\overline{q}_2^\star = \gamma^\star \overline{q}_1^\star$, where $\gamma^\star = \left(\frac{\beta_2^\star}{\beta_1^\star}\right)^{\frac{1}{\alpha-1}} > 1$ so that $\overline{q}_2^\star > \overline{q}_1^\star$, for $\overline{q}_1^\star = \frac{(1+\gamma^\star)^{\frac{\theta}{\alpha-\theta}}}{(\beta_1^\star+\gamma^{\star\alpha}\beta_2^\star)^{\frac{1}{\alpha-\theta}}}\left(\frac{\theta}{\alpha}\right)^{\frac{1}{\alpha-\theta}}$. Therefore, the higher supplier 1's outside option, the more aggressively he can afford to price in equilibrium and, consequently, the more supplier 2 can sell and the higher supplier 2's revenues. Suppliers' capacity constraints can naturally be cast in this framework. A supplier operating at close to capacity does not suffer much from a breakdown in negotiations with the buyer. With complete information, this allows a competing supplier to price aggressively, essentially earning the shadow value of the rival's capacity constraint. The aforementioned example of equal freight-on-board iron ore prices paid by Chinese steel mills to Australian and Brazilian miners illustrates this case[22]

Furthermore, the proposition shows that supplier heterogeneity can induce dispersion of nonlinear equilibrium prices. This is different from the explanation of (retail) price dispersion as a consequence of incomplete information and search costs, and it is a plausible alternative explanation especially in the business-to-business bargaining context where search costs are typically small, at least relative to the size and value of the transaction.

The ensemble of Propositions 1 - 3 implies another remarkable corollary. It shows that, if the buyer and a supplier operate in geographically dispersed markets and meet in several different local markets which exhibit different levels of upstream competition, then this induces dispersion of nonlinear equilibrium prices across their transactions, in the sense that the same buyer pays different prices for the same quantity in different local markets. This is illustrated in the empirical section of the paper.

[22]Se empirical auction literature identified similar issues; see e.g. Bajari (1997).

2.2 Implications for Empirical Strategy

Consider a generic equilibrium price schedule in B2B bargaining between supplier i and buyer j of the form $\bar{p}_{ij}(q_{ij})$. The preceding sequence of results shows that

$$\ln(\bar{p}_{ij}(q)) = \ln(\beta_{ij}) - \alpha_{ij}\ln(q),$$

where β_{ij} and α_{ij} are parameters that capture the equilibrium bargaining outcome of the two-step game between buyer and sellers. In particular, they capture observed and unobserved heterogeneity across buyers and sellers due to differential outside options. An econometric version of this model for a specific transaction t between i and j might be

$$\ln(p_{ijt}) = \ln(\bar{p}_{ijt}(q_{ijt})) = b_{ij}(\mathbf{x}_{ijt}) - a_{ij}\ln(q_{ijt}) + \epsilon_{ijt},$$

where $\ln(\beta_{ijt})$ is cast as a function b_{ij} defined over a vector $\mathbf{x}_{ijt}$ of characteristics of the respective transactional relation between supplier i and buyer j; next to product characteristics, these can include measures quantifying the parties' outside options or switching possibilities. The function b_{ij} may incorporate transaction-independent, idiosyncratic buyer and seller effects to account for unobserved outside options. The residual term ϵ_{ijt} captures further transaction-dependent unobservables, such as unobserved product characteristics or, possibly, temporal shocks to bargaining weights[23]. These may be correlated with transaction volume q_{ijt} and endogenous components of $\mathbf{x}_{ijt}$, such as number of other established supply relationships.

The preceding theoretical results suggest the following properties of equilibrium price schedules in B2B bargaining:

- Transaction volumes q_{ijt} may be an endogenous right-hand-side variable.
- In the presence of upstream market power, equilibrium prices are nonlinear, and a_{ij} captures the degree of nonlinearity.
- Upstream market power operates i.a. through the seller idiosyncratic effect, say μ_i, in b_{ij}, in the sense that enhanced outside options on the part of supplier i induce uniformly higher equilibrium prices $\bar{p}_{ij}(q)$ for all q.

[23]On the part of seller i, a positive ϵ_{ijt} might arise from i operating close to capacity, so that the relative loss from a breakdown of bargaining is low; similarly, a negative ϵ_{ijt} might arise from i might arise from i operating with idle capacity and temporary capacity shut-downs being costly.

- Countervailing buyer power operates i.a. through the buyer idiosyncratic effect, say μ_j, in b_{ij}, in the sense that greater switching possibilities to alternative suppliers reduce the equilibrium price schedule $\bar{p}_{ij}(q)$ uniformly for all q.
- Countervailing power effects operate also through observable measures in $\mathbf{x}_{ijt}$, such as number of established alternative supplier relationships or supply chains for transaction t, and through a_{ij}.
- To the extent that μ_i and μ_j arise from information unobserved by the econometrician, they constitute unobserved heterogeneity across buyers and suppliers.

While in principle it is possible to estimate an unrestricted version of the above econometric model, practitioners will often find it more practical to restrict a_{ij} to be a constant across i and j and to focus on estimates of μ_i and μ_j as evidence of countervailing power[24]. These considerations suggest an econometric model for equilibrium prices in B2B bargaining of the form

$$p_{ijt} = b + \mu_i + \mu_j + a \cdot q_{ijt} + \mathbf{x}'_{ijt}\theta + \epsilon_{ijt}.$$

This model can be estimated using transaction panel data, provided instruments for the potentially endogenous regressor q_{ijt} and, if applicable, the number of established supply chains are available. It may be worth noting that, in many applications, realized input demand q_{ijt} may be a derived demand, flowing from demand in the downstream market where the associated input price is a small component of the final good price. Then, if price is governed by a framework agreement or list price, transaction volume can plausibly be treated as exogenous. When the observed price does not result from a framework agreement or is part of an ad hoc bargaining outcome, so that volume ought to be treated as endogenous, buyer size may act as an instrument for volume: It is correlated with transaction volume, but as in this case the econometric relationship captures a one-off relationship for an ad hoc transaction, buyer size is exogenous to the bargain. Instruments that naturally suggest themselves for the number of established supplier relationships are data on transaction logistics such as free delivery or transport arrangements, under

[24]There exist panel data estimators allowing for heterogeneous coefficients, e.g. Swamy (1970). The present restriction will not impede the consistency of the estimator, even if the a_{ij} actually vary across i and j, but have the same conditional mean, given included regressors.

the identifying assumption that there is no bundling. This is often valid when suppliers offer free transport as a recognition of customer loyalty; in that case, this is clearly a strategy designed to provide incentives to customers not to switch, so it is correlated with established supply chains, but as a practically gratuitous add-on it is uncorrelated with price.

3 Empirical Analysis

3.1 Background and Data[25]

The data for the empirical part of this paper come from the UK brick industry. This sector has been the focus of a recent merger inquiry by the UK competition authorities where the question of potential countervailing buyer power was also investigated. Pre-merger, there are four main manufacturers of bricks in the UK. The data are transaction-level data and comprise the manufacturers' transactions with all their UK customers in the period 2001 - 2006. Customers are construction firms, or builders, and intermediaries, such as builders' merchants and factors (merchants specializing on bricks).

Each of the four brick manufacturers is involved in all stages of the brick manufacturing process. This process starts from extracting clay from the soil and processing it, including shaping it, and eventually burning the bricks in large furnaces or kilns. As transportation costs are significant in this industry, most manufacturing plants are close to clay deposits, and buyers favor nearby manufacturing plants. Two main types of bricks emerge from these processes: facing bricks, used as cladding material for the outside of buildings, distinguishing the more expensive soft-mud brick from the more conventional extruded variety; and engineering bricks, used to erect structures and accordingly meeting special requirements with regard to load-bearing capacity and water retention.

The industry has been experiencing some decline over the last decades. Industry sources attribute this to reductions in the number of houses built, the change in the housing mix from detached and semi-detached houses to

[25] The description of the industry background follows the UK Competition Commissions provisional findings report on Wienerberger Finance Service BV / Baggeridge Brick plc (2007), Appendix C. The report is available from the Competition Commission website.

apartments, and different choices for structural and cladding materials, such as timber, concrete blocks, steel and curtain walling (glass, laminates etc.).

With regard to the procurement of bricks, there are two primary channels. One possibility is for buyers to purchase through framework agreements at pre-determined prices. These agreements set out a matrix of prices and brick specifications, including brick type and transport costs to different locations. Prices can be quoted as ex-works or delivered prices. Buyers can thereby negotiate the terms of the agreement, including retrospective rebates, potentially on the basis of historic and prospective volumes. Eventually, once a framework is agreed upon, there is, however, no firm commitment on the part of the buyer, who can call off supplies according to the needs as they arise. Builders' merchants also use framework agreements, albeit typically with less detailed specificity. Framework agreements are typically negotiated annually.

Alternatively, bricks can be purchased ad hoc at spot prices. Buyers may still enjoy eventual retrospective rebates, and many buyers who sign framework agreements may still buy ad hoc, e.g. when a manufacturer wishes to sell off stock or a buyer experiences an unusual demand in terms of brick type, location or volume. While the main manufacturers do have price lists, these list prices do not apply to the bulk of bricks transactions.

The analysis presented here focuses on ex works prices per one thousand bricks, i.e. net of transport costs, and also net of any rebates. Since the data from one of the suppliers do not permit to separate transport costs from total transaction price, this supplier's data have been excluded from most of the analysis.

There are just below 7000 customers that purchased bricks from the four manufacturers over the six year period 2001 - 2006. Table 2 provides a broad summary of the degree of switching of customers, volume and revenue between the three manufacturers included in the empirical analysis. It shows that there is a fair amount of switching of these between the four suppliers; for example, supplier 1 lost 6.1 percent of customers in 2002, relative to 2001. But often, suppliers are able to make up the loss of customers by selling increased volume to those customers who are retained, e.g. while supplier 1 lost 6.1 percent of customers in 2002 relative to 2001, this supplier increased overall volume by 4.6 percent over the same period; the same supplier was even able to increase revenue in the face of customer and volume losses, going from 2005 to 2006 (revenue increase of 6.9 precent vis-à-vis a decline of customers by 4.5 percent and of volume by 2.9 percent, respectively), either by increasing prices or selling more expensive product varieties. Hence, while Table 2 provides evidence that buyers' switching to and from suppliers is a salient feature of the UK brick industry and hence is consistent with necessary conditions for buyers having countervailing power, such as availability of alternative suppliers and relative ease of switching, the summary statistics reported in the table also suggest that manufacturers' may have market power when setting prices.

Supplier	2001-02	2002-03	2003-04	2004-05	2005-06
Customers					
Supplier 1	-6.1	1.7	1.5	-6.1	-4.5
Supplier 2	-11.9	9.9	-10.9	6.0	-10.0
Supplier 3	-20.8	2.17	7.5	08.6	0.5
Volume					
Supplier 1	4.6	4.6	-1.7	0.4	-2.9
Supplier 2	-19.7	36.3	-5.6	13.6	-7.77
Supplier 3	0.1	3.0	1.0	-0.3	-7.9
Revenue					
Supplier 1	8.4	11.3	4.4	0.6	6.95
Supplier 2	-17.9	41.6	-1.1	18.1	-03.0
Supplier 3	3.0	8.8	3.9	5.0	-0.2

Table 2: Switching, relative to base yearn, in percent.

The data also provide an interesting illustration of price dispersion in the absence of imperfect information. Figure 1 shows the price per 1000 bricks paid by three national builders for a red multi brick[26] for all deliveries to their various construction sites in 2004[27]. This brick is manufactured by one of the four brick manufacturers, and each of this manufacturer's competitors produces an essentially equivalent brick. It is straightforward for buyers to enquire about the costs of such substitutes for this red multi brick, so imperfect information does not rationalize the price dispersion in the data. The theoretical results above suggest that different local competitive conditions around the delivery sites - in terms of number of actual or potential local competitors and associated differential bargaining weights on both sides of the bargain - are consistent with this pattern of prices. The construction sites are in areas with locally distinct numbers of competing manufacturers, inducing differential bargaining power on the side of local buyers. On the other hand, the manufacturers may have different degrees of local bargaining power due to differential outside options, possibly as a consequence of their capacity utilizations[28] or the number and size of local construction projects. Since this red multi brick is a standard and universally popular product, cost differences are an unlikely alternative explanation for this variation in prices[29], as are variations on the demand side such as taste differences.

Note that it is not possible to discern nonlinear pricing from Figure 1, even if it exists. Since the data unfortunately do not allow to identify which transactions were governed by framework agreements and which one resulted from ad hoc bargaining, for any given buyer the figure displays an array of different transaction types.

A brief description, definitions and summary statistics of the variables used in the analysis are provided in an appendix.

[26] Here, "red" refers to the bricks color, and "multi" to its non-uniform color shading.

[27] Figure 1 must be viewed in a color print.

[28] It is costly to run idle kilns, and it is costly to switch them on. Hence, a manufacturer operating with under-utilized capacity experiences a decline in bargaining power, while a manufacturer operating at capacity is in a strong bargaining position.

[29] This was confirmed in discussions with the UK Brick Development Association.

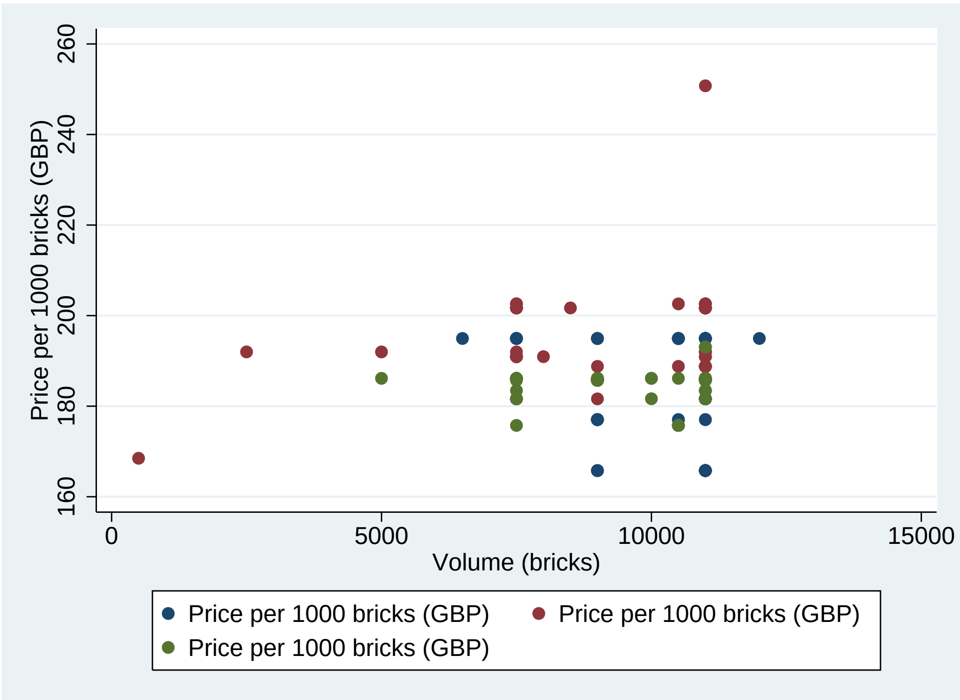

Figure 1: Price dispersion for a red multi brick; 3 national builders, 2004.

3.2 Methodology and Results

The empirical methodology aims at uncovering the reduced form relationship between brick price and various determinants of price. And it intends to test the restrictions that the theoretical considerations outlined in the previous section impose on the reduced form model specification. The specific focus thereby is on the question whether buyers who have greater switching possibilities benefit from lower prices, on average; this is captured by the coefficient on the number of the buyer's local supply chains (Comp). The empirical analysis attempts to control for various characteristics of the transaction. First, there may be volume effects when price schedules are potentially nonlinear; these should be captured by the coefficient on log transaction volume (col Vol). Second, as in this industry transport costs are significant, relative to brick price, there may be distance effects: Buyers with construction or delivery sites that are more distant to the manufacturer's plants may be incentivized by discounts to capture their business; distance effects should be reflected in the coefficient on distance between plant and delivery location (dist). Third, the analysis controls for brick attributes: On average, extruded bricks are cheaper than soft-mud bricks, and similarly engineering bricks are cheaper than facing bricks[30].

The data unfortunately do not permit to identify whether any given transaction is carried out subject to the terms of a framework agreement, or whether it is an ad hoc deal. In light of the foregoing theoretical analysis, transaction volume may be endogenous when not called off within a framework agreement, while it may be treated as exogenous when the transaction is governed by a framework agreement[31]. The analysis therefore, next to ordinary regressions, presents results obtained from instrumenting volume. As argued earlier, in the case of ad hoc bargains, firm size is exogenous to the deal, so firm size can act as instrument for volume.

The number of actual and potential supply chains is another potentially endogenous regressor, to the extent that established supply chains are choice

[30]There are further, less sizeable categories such as flattons and blues which make up the remainder.

[31]Industry sources argued that brick type and transaction volume are typically dictated by the construction design, and the cost of bricks is typically small relative to other construction costs and hence not a consideration when buying bricks.

outcomes on the part of the buyer. In this industry, where transport costs are non-negligible, free transport arranged by the manufacturer acts as an incentive scheme to reward loyalty on the part of buyers. The data record whether the manufacturer arranges the transport of any given transaction. In the absence of bundling[32], a dummy indicating manufacturer arranged delivery can act as instrument for the number of supply chains: Loyal buyers stick to fewer suppliers and are rewarded for their loyalty by free ancillary services such as delivery, and in the absence of bundling there is no correlation between delivery arrangement and brick transaction price.

First stage regressions are reported in the appendix and confirm the anticipated necessary correlations with the potentially endogenous regressors.

As is now increasingly recognized in applied demand analysis, heterogeneity across economic decision makers is an empirical regularity that should be accounted for, if possible. In the present case, as argued earlier, this is the case a fortiori due to the intrinsic unobservability of some of the bargaining parties' outside option. Transaction panel data permit to control for manufacturer and buyer specific effects if they are present.

[32]This identifying assumption was corroborated by discussions with Competition Commission staff and the UK Brick Development Association.

Price per 1k Bricks

	FE	RE	IV (1)	IV (2)	IV(3)
Supplier 2	0.042***	0.042***	0.244***	0.784***	0.424***
	(0.002)	(0.002)	(0.004)	(0.014)	(0.006)
Supplier 3	-0.089***	-0.090***	-0.012***	0.195***	-0.036***
	(0.002)	(0.002)	(0.003)	(0.008)	(0.004)
Supplier 4	0.050***	0.049***	0.056***	0.072***	0.052***
	(0.002)	(0.002)	(0.002)	(0.007)	(0.004)
dist (km)	0.000***	0.000***	-0.001***	-0.005***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Comp	-0.004***	-0.004***	-0.167***	-0.600***	-0.304***
	(0.000)	(0.000)	(0.001)	(0.008)	(0.002)
log Vol	-0.213***	-0.213***	-0.219***	-0.238***	-0.080***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
week	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
facing	-0.375***	-0.375***	-0.039***	0.853***	0.103***
	(0.002)	(0.002)	(0.003)	(0.018)	(0.004)
eng	-0.457***	-0.457***	.	1.215***	.
	(0.003)	(0.003)	.	(0.026)	.
cons	7.751***	7.537***	8.313***	9.809***	7.549***
	(0.003)	(0.007)	(0.007)	(0.031)	(0.017)

Table 3: Regression results; standard errors in parenthesis.

IV(1): Comp instrumented with buyer size.

IV(1): Comp instrumented with delivery dummy.

IV(1): Comp and log Volume instrumented with buyer size and delivery dummy.

* significant at 10 percent level

** significant at 5 percent level

*** significant at 1 percent level

Table 3 presents the estimation results from different estimation methodologies.[33] In light of the theoretical considerations stipulated in the previous section, one would expect the coefficients on log transaction volume (log Vol) to be negative in the presence of nonlinear pricing, i.e. when manufacturers have some degree of market power. Similarly, one would expect the coefficient on the number of competing suppliers (Comp) to be negative if buyers had some degree of countervailing power. The first two columns, comparing fixed and random effects estimators suggest that the random effects refinement, i.e. conditional independence of buyer idiosyncratic effects, is plausible; this is also confirmed by a Hausman test. Both estimators provide statistically significant evidence of nonlinear pricing and countervailing power, although the latter appears to be economically relatively insignificant. On the basis of these regressions, one might conclude that manufacturers enjoy relatively stronger market power, as they are able to impose nonlinear prices and experience relatively little resistance in the face of buyers with modest countervailing power.

In light of the potential endogeneity of transaction volume and the number of competing suppliers, one might worry about these estimates being biased. In particular, buyers with stronger bargaining power would be expected ceteris paribus to get lower prices, i.e. they would be associated with lower residuals in the price function. And buyers with stronger bargaining power ceteris paribus can stick to fewer suppliers and hence may not feel a need to play off competitors. Therefore, one might expect the number of competing supply chains (Comp) and the regression residuals to be positively correlated. As a consequence, this would imply that the coefficient estimate on Comp is likely biased upwards. Similarly, buyers with stronger bargaining power are more valuable to the supplier because ceteris paribus they place larger orders and generally buy more. Therefore, one might expect transaction volume and the regression residuals to be negatively correlated, and consequently this would induce the coefficient estimate on log volume to be biased downwards. The instrumental variable regressions IV(1)-(3) confirm these biases. IV(3), instrumenting the number of competing suppliers by the delivery dummy and log transaction volume by buyer size correct for these biases. The IV estimates show that the degree of countervailing power is actually significantly

[33]The various acronyms are: FE - fixed effects panel data estimator; RE - random effects panel data estimator; IV - instrumental variable panel data estimator.

more pronounced than what fixed and random effects estimates without instrumentation suggest, while the nonlinear pricing effect is economically less significant. The instrumentation strategy then draws a different picture: It suggests that buyers enjoy countervailing power arising from local competition in supply and their ability to switch, and this leads to uniformly lower price schedules that exhibit a relatively moderate degree of nonlinearity.

These findings accord with the Competition Commission's conclusion that "larger buyers do have a degree of buyer power, [...] based on the purchasing of large volumes [...] and their ability to multi-source".[34]

It may be worth noting that these results appear statistically significant even though one might worry about heteroskedasticity in the residuals as a consequence of various layers of unobserved heterogeneity. Nonetheless, the estimates are highly significant in the present application. A more refined model for the variances and covariance would enhance the efficiency of the panel data estimation and the precision of the estimator and may be useful in other applications that do not exhibit the same degree of identifying variation as the present data.

4 Conclusions

This paper provides a comprehensive framework that derives reduced form testable predictions in an empirical analysis of countervailing power that is useful for practitioners, such as competition economists in antitrust authorities. This framework encompasses the two main features of pricing schemes in business-to-business relationships: nonlinear equilibrium price schedules and bargaining over rents. Disentangling these two features is critical to the empirical identification of buyer power. A theoretical model investigates the principal determinants of optimal pricing schemes, with buyers' switching possibilities as the primary source of countervailing power. It forms the basis for the delineation of testable predictions for reduced form price regressions as they are typically carried out in antitrust investigations. The empirical part of the analysis presents an illustration of the conceptual approach offered in this paper, for the UK brick industry. It presents a reduced form methodology to estimate the impact of buyers' switching possibilities on prices. This

[34]See Competition Commission, final report on the Wienerberger / Baggeridge inquiry (2007).

methodology is readily implementable on the basis of transaction data, as they are requested routinely by antitrust authorities at the outset of their inquiries. The paper emphasizes the importance to control for endogeneity of volumes and competing supply chains, and for heterogeneity across buyers and suppliers.

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A Existence of Dual-Sourcing Equilibria

Consider equation (1). A dual-sourcing equilibrium requires that, for the optimal values of β_1 and β_2, $\Delta\pi_1$ and $\Delta\pi_2$ be positive. The more elastic the suppliers' price schedules are relative to the buyer's revenue function, i.e. the higher $\frac{\alpha}{\theta}$, the more profitable dual-sourcing will be[35]. Similarly, the more favorable the suppliers' outside options, i.e. the smaller $\max\{\delta_1, \delta_2\}$, the more the buyer benefits from dual-sourcing. The following result establishes that, under adverse circumstances for the buyer, facing suppliers with sufficiently favorable outside options, there exist ratios $\frac{\alpha}{\theta}$ that induce dual-sourcing equilibria.

Consider the following additional Assumption:

A4: $\max\{\delta_1, \delta_2\} < \bar{\delta} := \frac{\exp(1)-1}{\exp(1)}$.

[35] Of course, if $\frac{\alpha}{\theta}$ is very high, then production will no longer be profitable, so that a trivial no-trade equilibrium arises.

Lemma 1: *Under assumptions A1', A2",A3" and A4, a dual-sourcing equilibrium exist.*

Proof: It follows from equation (1) that the profit from dual-sourcing is rising in $\frac{\alpha}{\theta}$, while the profit from single-sourcing is falling as $\frac{\alpha}{\theta}$ increases, with the minimum occurring at $\frac{\alpha}{\theta} = 1 + \exp(1)$. The value of δ that equates $\frac{\theta}{(1-\delta)(\alpha-\theta)} = \frac{1}{(1-\delta)(\alpha/\theta-1)}$ at $\frac{\alpha}{\theta} = 1 + \exp(1)$ with 1 is $\bar{\delta} = \frac{\exp(1)-1}{\exp(1)}$. So $\min\{\Delta\pi_1, \Delta\pi_2\} > 0$ provided $\max\{\delta_1, \delta_2\} < \bar{\delta}$ and $\frac{(1+\gamma)^{\frac{\theta\alpha}{\alpha-\theta}}}{(\beta_1+\gamma^{\alpha}\beta_2)^{\frac{\theta}{\alpha-\theta}}} \geq 1$.

Suppose $\beta_1 = \beta_2 = \beta$ were a dual-sourcing equilibrium. Then, $\frac{(1+\gamma)^{\alpha}}{(\beta_1+\gamma^{\alpha}\beta_2)} = \frac{2^{\alpha}}{2\beta} \geq 2^{\alpha-1} > 1$. Hence, if both suppliers had equal outside options, then a dual-sourcing equilibrium exists. Now consider a slight improvement of supplier 1's outside option, say. This will slightly reduce the buyer's gain from dual-sourcing, or equivalently reduce the Shapley value accruing to supplier 1. Similarly, a slight deterioration of supplier 2's outside option, say, will slightly improve the gain from dual sourcing. Since $\Delta\pi_i$, $i = 1, 2$, is continuous in β_j, $j = 1, 2$, the necessary inequality for the existence of dual-sourcing equilibria is preserved. □

B Data and Auxiliary Regressions

The data is transaction level panel data. It comprises roughly six hundred thousand individual transactions between UK buyers and the (three) manufacturers used in the analysis over the period 2001 - 2006. The unit of observation is a transaction between a buyer and a manufacturer of a specific brick type (product code), for which - next to identity of buyer, seller and brick type - total transaction payment (net of transport costs and incentive payments), transaction volume, date, delivery location, distance between manufacturing site and delivery location, brick characteristics and logistic information are recorded. Since typically for the majority of popular bricks, a given buyer is associated with several transactions involving that brick over the observational horizon, the way in which the panel data structure is exploited in this analysis is that the cross-sectional, idiosyncratic unit of observation is a specific buyer, and the associated second dimensional unit is a specific brick, with supplier dummies to identify the counterparty in the transaction.

Prices per one thousand bricks are in GBP. Volume is measured in number of bricks. Distance is measured in kilometers between the manufacturing plant and the construction or delivery site. To capture the buyers' switching possibilities, the competition variable `Comp` records the number of competing manufacturing plants in the buyer's supply chains that produce bricks of a given type in a circle with 50km radius around the delivery site. Brick characteristics include whether the bricks of the respective transaction are of the extruded (as opposed to soft mud) variety, and whether they are engineering (as opposed to facing) bricks. The data also record whether the delivery was arranged by the manufacturer, or whether the bricks were collected by the buyer. The associated `delivery` dummy is one of the two instruments used. Buyer size `Bsize`, measured in terms of total number of bricks purchased per fiscal year, is the second instrument.

The following table provides summary statistics.

Variable	Obs.	Mean	Std.Dev.	Min	Max
Price per 1k	637015	344.802	5093.57	0.0008306	3097000
Volume	637015	5991.746	3910.012	2	264000
sourcing	637015	2.567056	1.325533	1	4
distance (km)	581112	4.089677	17.90908	0	341.3
extruded	637015	.6811441	.4660334	0	1
engineering	637015	.0723782	.2591133	0	1
`delivery`	637015	0.58792	.4922097	0	1
`Bsize`	2224914	2.35e+08	2.89e+08	0	8.05e+08
`Comp`	1698466	4.236443	4.157144	0	19

Table B1: Summary statistics.

Table B2 presents the first stage regression for the IV/2SLS estimation results presented in Table 3.

	Comp	Vol
Supplier 2	1.368***	-0.557***
	(0.016)	(0.008)
Supplier 3	0.457***	0.810***
	(0.011)	(0.006)
Supplier 4	0.076***	0.116***
	(0.011)	(0.005)
distance (km)	-0.009***	-0.002***
	(0.000)	(0.000)
week	-0.000*	0.002***
	(0.000)	(0.000)
facing	1.989***	0.774***
	(0.011)	(0.005)
eng	2.601***	2.502***
	(0.019)	(0.008)
`Bsize`	-0.000	0.000***
	(0.000)	(0.000)
`delivery`	-0.541***	0.906***
	(0.007)	(0.004)
const	4.155***	5.693***
	(0.042)	(0.016)

Table B2: First stage regression results; standard errors in parenthesis.

* significant at 10 percent level

** significant at 5 percent level

*** significant at 1 percent level

The four UK brick suppliers have different capacities. Suppliers 1 has 7 plants and supplier 2 has 20 plants. Supplier 3 is the largest supplier, with 23 plants and the largest geographic spread.[36] For the three suppliers included in the analysis, supplier 1 produced an average of 87.3 million bricks per year, supplier 2 195.2 million and supplier 3 353.7 million bricks per year.

[36]This information is sourced from the Provisional Findings report of the Competition Commission.