Empirical analysis of countervailing power in business-to-business bargaining

Seminar Paper

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 are delineated, and a pragmatic empirical methodology is presented. It is readily implementable on the basis of transaction data, routinely collected by antitrust authorities. The empirical framework is illustrated using data from the UK brick industry. The paper emphasizes the importance of controlling for endogeneity of volumes and for heterogeneity across buyers and sellers.

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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, e.g. groceries or raw materials. 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

[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. (2004) 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.

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 switch between suppliers, and is constrained by the suppliers' outside options and capacity; in particular, in contrast to Chipty and Snyder (1999), Smith and Thanassoulis (2008) and some conventional wisdom, this paper shows 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 robust and practical econometric methodology to identify countervailing power on the basis of B2B transaction panel data. Such data are typically available in antitrust inquiries. The proposed econometric approach is grounded in the theoretical framework of B2B bargaining, highlights the importance of proper treatment of heterogeneity across bargains, and does not rely on complex identifying assumptions or restrictions that are difficult to test. Instead, the econometric methodology examines testable implications of the theory and thereby offers a robust route to the empirical identification of countervailing power. Furthermore, it is easy to implement and hence does not suffer from the typical barriers to diffusion into applied competition analysis that many other methodologies are fraught with. It is illustrated using data from a UK Competition Commission merger inquiry in the brick manufacturing industry.

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 implications for a robust empirical strategy to identify countervailing power. Section 3 is devoted to the empirical part of the paper. It presents the background for, and data used

[4]The notion of countervailing (buyer) power was coined by Galbraith (1952) and theoretically developed in a dynamic setting by Snyder (1996).

[5]The traditional view relates to 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.

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)[6] 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 (Competition Commission Market Investigation Guidelines (2003)), it investigates the relative importance to each other of each firm's business with the counterparty; 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 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

[6] At the time of writing, the Competition Commission is drafting a revision of its guidelines.

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.

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, 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. With regard to applied work, the academic literature offers very little towards a comprehensive, structural empirical framework for the analysis of buyer power.[7] Giulietti (2007) presents a reduced form anal-

[7]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 countervailing power on consumer prices.

ysis of the Italian grocery retail sector, approximating suppliers' bargaining power by a concentration measure for the respective product level industry they operate in. 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.

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.[8] Recent work by Smith and Thanassoulis (2008) demonstrates how upstream competition can endow large buyers with market power by inducing supplier-level volume uncertainty.

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 and cost estimates, with a particular focus on pricing models which feature double marginalization.

[8]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. 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.

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 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 buyer 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 that are robust across more tightly specified structural models.

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 with revenue function $F(q) = q^{\theta}$, $\theta \in (0, 1)$.

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

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 $\bar{\alpha} > \theta$ and $\bar{\beta} > 0$ that

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

This implies that $\bar{\alpha} = 2\theta$, while $\bar{\beta}$ is indeterminate, so without loss of genereality $\bar{\beta} = 1$. 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 $\left(\frac{\theta}{\bar{\alpha}}\right)^{\frac{\bar{\alpha}}{\bar{\alpha}-\theta}} = \frac{1}{4}$. $\square$.

Suppose now that the buyer faces two identical suppliers, i.e. there is upstream competition and the buyer bargains multilaterally. The buyer will find it optimal to source from both if the optimal 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 $F(q) = q^{\theta}$, $\theta \in \left(\frac{1}{2}, 1\right)$.

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[9] 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.*

[9]Cf. McAfee and Schwartz (1994); this assumption is maintained in Stole and Zwiebel 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.

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 supplier maximizes $(2q)^\theta - 2\beta q^\alpha$ over q. This yields optimal inputs $\tilde{q} = 2^{\frac{\theta-1}{\alpha-\theta}} \left(\frac{\theta}{\alpha\beta}\right)^{\frac{1}{\alpha-\theta}} = 2^{\frac{\theta-1}{\alpha-\theta}} \bar{q} < \bar{q}$ 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.

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

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 $\frac{1}{4}\left(2^{2\theta-1} - 1\right) > 0$ if $\theta > \frac{1}{2}$, while the supplier's lost profits (the RHS of the preceding equality) would be $\frac{1}{4}2^{2\theta-1}$. Hence, the supplier has more to lose from a breakdown in bargaining than the buyer and, therefore, has an incentive to offer better terms[10], 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;

[10]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 $\bar{\beta}$.

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.[11] 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 $\tilde{p}_i(\tilde{q}_i)\tilde{q}_i < \bar{p}_i(\bar{q}_i)\bar{q}_i$.

It also follows as a corollary to the two preceding propositions 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.

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.

To generalize this setup further, consider the case where the two suppliers are heterogeneous, e.g. due to different outside options[12]. Consider the following variant of the previous assumptions,

A2": The buyer faces two heterogeneous suppliers whose payment schedules

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

[12]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.

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[13]

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, 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 : 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 Propo-

[13] 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.

sition 1. Supplier 2's profit, beyond 2's outside option, is $\beta^{\delta_2}\left(\frac{\theta}{\alpha\beta}\right)^{\frac{\alpha}{\alpha-\theta}}$.[14] 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,

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

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

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

[14]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.

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. □

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 $\bar{q}_2^\star = \gamma^\star \bar{q}_1^\star$, where $\gamma^\star = \left(\frac{\beta_2^\star}{\beta_1^\star}\right)^{\frac{1}{\alpha-1}} > 1$ so that $\bar{q}_2^\star > \bar{q}_1^\star$, for $\bar{q}_1^\star = \frac{(1+\gamma^\star)^{\frac{\theta}{\alpha-\theta}}}{(\beta_1^\star + \gamma^{\star\alpha}\beta_2^\star)^{\frac{1}{\alpha-\theta}}}\left(\frac{\theta}{\alpha}\right)^{\frac{1}{\alpha-\theta}}$. 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 still mills to Australian and Brazilian miners illustrates this case.

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.

2.2 Implications for Empirical Strategy

Consider a generic equilibrium price schedule in B2B bargaining between supplier i and buyer j of the form $p_{ij}(q_{ij}; \mu_i, \mu_j)$, where μ_i and μ_j parameterize the supplier's and buyer's outside options. In particular, μ_j is a function of buyer j's access to alternative suppliers to supplier i. The preceding theoretical results suggest the following properties of equilibrium price schedules in B2B bargaining:

- Transaction volume q_{ij} is an endogenous right-hand-side variable.
- In the presence of upstream market power, equilibrium prices are nonlinear.
- In the presence of multi-sourcing, $p_{ij}(q; \mu_i, \mu_j)$ is non-decreasing in q.
- Upstream market power operates through δ_i, in the sense that enhanced outside options on the part of supplier i induce uniformly higher equilibrium prices $p_{ij}(q; \mu_i, \mu_j)$ for all q.
- Countervailing buyer power operates through μ_j, in the sense that greater switching possibilities to alternative suppliers reduce the equilibrium price schedule $p_{ij}(q; \mu_i, \mu_j)$ uniformly for all q.
- To the extent that μ_i and μ_j are private information, they constitute unobserved heterogeneity across buyers and suppliers.

These considerations suggest an econometric model for equilibrium prices in B2B bargaining of the form

$$p_{ijt} = \alpha + \mu_i + \mu_j + \beta q_{ijt} + \mathbf{x}'_{ijt}\theta + \epsilon_{ijt},$$

where t indexes transactions between i and j, $\mathbf{x}_{ijt}$ is a vector of characteristics of the respective transaction (other than volume and price), ϵ_{ijt} is a residual term, $(\alpha, \beta', \theta')$ is a vector of parameters, and μ_i and μ_j are idiosyncratic supplier and buyer effects, respectively. This model can be estimated using transaction panel data, provided instruments for the endogenous regressor q_{ijt} are available. Instruments that naturally suggest themselves are data on transaction logistics such as delivery or transport arrangements, under the identifying assumption that there is no bundling, or volumes of transactions between i and j in non-overlapping geographic markets.

3 Empirical Analysis

3.1 Background and Data[15]

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, as bricks are a relatively standardized product and there are several manufacturers in the UK. There are four main suppliers of bricks in the UK, and the data comprise their 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.

[15]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.

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 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 us 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 suppliers over the six year period 2001 - 2006. Table 2 shows that there is a fair amount of switching of these between the four suppliers. But often, suppliers are able to make up the loss of customers by selling increased volume to those customers who are retained, e.g. supplier 3 in the periods 2001 - 2002; or even compensating for loss of volume by raising prices on the retained volume, e.g. supplier 1 in the period 2005 - 2006. Hence, while Table 2 suggests that buyers' switching to and from suppliers is a salient feature of the UK brick industry and hence provides the kind of conditions that potentially incubate buyer power, it also provides some evidence that manufacturers' may have market power when setting prices.

Supplier	2001-02	2002-03	2003-04	2004-05	2005-06
			Customers		
Supplier 1	-0.061	0.017	0.015	-0.061	-0.045
Supplier 2	-0.119	0.099	-0.109	0.060	-0.100
Supplier 3	-0.208	0.0217	0.075	0.086	0.005
			Volume		
Supplier 1	0.046	0.046	-0.017	0.004	-0.029
Supplier 2	-0.197	0.363	-0.056	0.136	-0.0777
Supplier 3	0.001	0.030	0.010	-0.003	-0.079
			Revenue		
Supplier 1	0.084	0.113	0.044	0.006	0.0695
Supplier 2	-0.179	0.416	-0.011	0.181	-0.030
Supplier 3	0.030	0.088	0.039	0.050	-0.002

Table 2: Switching, relative to base year.

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[16] for all deliveries to their various construction sites in 2004. 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 are consistent with this pattern of prices. The construction sites are in areas with locally distinct numbers of competitors, and these may have different outside options, possibly as a consequence of their capacity utilizations.

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

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

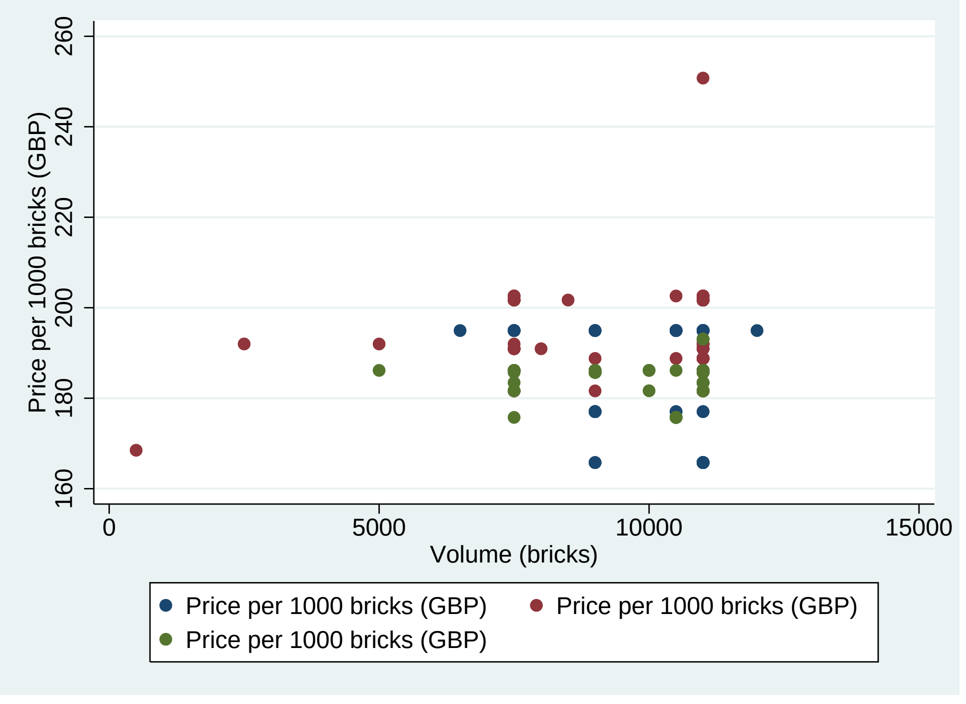

Figure 1: Price dispersion for a red multi brick; 3 national builders, 2004.

3.2 Methodology and Results

The empirical methodology aims at uncovering the reduced form relationship between brick price and various determinants of price. The specific focus thereby is on the question whether buyers who have established a greater number of contractual relationships in the period 2001-2006 - as an indication of their switching possibilities - benefit from lower prices, on average. The empirical analysis attempts to control for various characteristics of the transaction. First, there may be volume effects when price schedules are potentially nonlinear. 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 given discounts to capture their business. 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.

In light of the foregoing theoretical analysis, transaction volume may be endogenous. The analysis therefore, next to ordinary regressions, presents results obtained from instrumenting volume. The decision to have the bricks delivered is likely to be correlated with the transaction size, but, in the absence of bundling, uncorrelated with the transaction price which is net of delivery costs. Therefore, a variable indicating whether the transaction volume was arranged to be delivered, as opposed to being picked up, is used as instrument for volume, next to time trends captured by month and year. First stage regressions are also in the appendix.

Moreover, 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. Panel data permit to control for buyer specific effects if they are present. Hence, the empirical analysis in addition presents panel data estimators that exploit the entire richness of the data.

Table 3 presents the estimation results from different estimation methodologies.[17] Two main conclusions emerge when comparing the columns of the table. First, comparing standard with instrumental variables regressions, failure to instrument transaction volume induces a downward bias, in absolute value, of the distance and multi-sourcing effects. The source of the bias is

[17]The various acronyms are: OLS - ordinary least squares; IV/2SLS - instrumental variables/2-stage least squares; RE - random effects panel data estimator; BE - between effects estimator.

	Price per 1k bricks									
	OLS	IV/2SLS	RE	BE	IV, BE	OLS	IV/2SLS	RE	BE	IV, BE
Supplier 2	-	-	-	-	-	-152.734***	-241.288***	-411.24 ***	-313.102**	-886.255***
	-	-	-	-	-	(20.247)	(20.704)	(113.323)	(148.138)	(163.588)
Supplier 1	-	-	-	-	-	-161.075***	-161.075***	-327.710**	-160.214	-926.606***
	-	-	-	-	-	(26.227)	(26.381)	(168.489)	(355.583)	(371.260)
week	0.541***	0.373***	0.574***	-	-	0.526***	0.356***	0.572***	-	-
	(0.077)	(0.077)	(0.081)	-	-	(0.077)	(0.077)	(0.081)	-	-
Volume	-0.063***	0.007*	-0.072***	-0.183***	0.070**	-0.061***	0.007*	-0.072***	-0.172***	0.104***
	(0.002)	(0.004)	(0.002)	(0.018)	(0.034)	(0.002)	(0.004)	(0.002)	(0.019)	(0.036)
distance	-0.380	-1.799***	-0.019	-0.916	-8.413***	-0.004	-1.195***	0.089	-0.253	-1.756
	(0.390)	(0.396)	(0.469)	(2.758)	(2.921)	(0.413)	(0.418)	(0.475)	(4.492)	(4.566)
sourcing	-23.255***	-37.032***	-81.441	-35.913	-283.930*	47.655***	72.815***	89.001	68.183	114.837
	(5.270)	(5.316)	(108.062)	(167.257)	(171.954)	(11.378)	(11.454)	(118.624)	(188.698)	(191.758)
extruded	-111.623***	-66.595***	-69.049***	-678.588***	-836.253***	-102.172***	-53.751***	-68.043***	-655.565***	-765.662***
	(15.195)	(15.357)	(16.634)	(139.946)	(143.082)	(15.244)	(15.425)	(16.636)	(140.360)	(143.115)
engineering	-57.638 **	-218.712***	-17.243	-55.923	-920.774***	-67.602**	-227.878***	-17.890	-52.953	-932.777***
	(27.181)	(28.228)	(29.890)	(292.519)	(312.150)	(27.207)	(28.287)	(29.892)	(293.035)	(313.542)
constant	794.751 ***	423.487***	1009.102***	2054.644***	1458.645***	746.965***	365.962***	951.470***	1956.799***	1075.753***
	(14.060)	(29.639)	(128.248)	(207.901)	(221.216)	(26.002)	(31.725)	(130.605)	(226.322)	(250.164)

Table 3: Regression results; standard errors in parenthesis; instruments for Volume: month, year, delivery
* significant at 10 percent level
** significant at 5 percent level
*** significant at 1 percent level

likely to be that the size of the buyer business determines both prices and volumes. Large transactions are generated by larger businesses that entertain a larger number of supplier relationships, and these tend to get lower prices. Also, large transactions entail higher transport costs, and in order to secure such deals suppliers grant more significant discounts. Second, comparing standard with panel data estimators, failure to account for heterogeneity across buyers biases the empirical results of this analysis towards a finding of buyer power, albeit only at the 10 percent level of statistical significance. Controlling also for supplier specific effects eliminates any buyer power effect reflected in negative coefficients on the sourcing variable and captures the distance effects that were present in the first five specifications.[18] Supplier effects arise due to the different capacities and plant network configurations of the three suppliers included in the analysis: Supplier 3 is by far the largest supplier, with the largest number of plants and the widest geographic spread of its plants.[19] Hence, from a methodological point of view, accounting for both endogeneity of transaction volume and heterogeneity of buyers appears to be critical for the empirical identification of buyer power. Also, unit prices increasing in volume are in line with the theory of multilateral bargaining laid out in Section 2, and it is consistent with upstream market power in this industry. Together with the finding that multi-sourcing does not induce lower unit prices, this calls into question 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".[20]

4 Conclusions

This paper provides a comprehensive framework for the empirical analysis of buyer 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 price sched-

[18]In light of the suppliers' plant network configurations, the distance variable is highly correlated with the suppliers' capacities, measured by the number of plants they operate.

[19]Appendix B provides further details on capacity. See also the Provisional Findings report of the Competition Commission in the Wienerberger Finance Service BV / Baggeridge Brick plc (2007) inquiry.

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

ules and bargaining over rents. Disentangling these two features is critical to the empirical identification of buyer power. A structural theoretical model investigates the principal determinants of optimal pricing schemes, with buyers' switching possibilities identified as the primary source of buyer power. It forms the basis for the delineation of testable predictions that enable the empirical identification of buyer power. 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 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 for heterogeneity across buyers.

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

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. $\square$

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

B Data and Auxiliary Regressions

The data comprise roughly six hundred thousand individual contracts between UK buyers and the (three) manufacturers used in the analysis. Prices per one thousand bricks are in GBP. Volume is measured in the number of bricks. Distance is measured in kilometers between the manufacturing plant and the construction or delivery site. The sourcing variable is the number of manufacturers that the respective buyer entertains contractual relationships with during the observation horizon 2001 - 2006. There are dummy variables indicating whether the bricks of the respective transaction are of the extruded (as opposed to soft mud) variety, whether they are engineering (as opposed to facing) bricks, and whether the buyer chose to have the supplier arrange the delivery or collected the bricks.

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	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

Table B1: Summary statistics.

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

	Volume
month	2.639**
	(1.331)
year	105.661***
	(16.219)
delivery	3620.443***
	(8.843)
constant	-211541.4 ***
	(32446.6)

Table B2: First stage regression results.

* 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.[22] 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.

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