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UPSTREAM COMPETITION AND DOWNSTREAM BUYER POWER

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Abstract

It is often claimed that large buyers wield buyer power. Existing theories of this e ect generally assume upstream monopoly. Yet the evidence is strongest with upstream competition. We show that upstream competition can yield buyer power for large buyers by generating supplier-level volume uncertainty | a feature that emerges from case study evidence of upstream competition | so the negotiated price depends on the seller's cost *expectation*. By analyzing the e ect of market structure changes on seller cost expectations the paper gives insights on three key policy-relevant questions around buyer power: (i) who wields it and under what circumstances (ii) does a downstream merger alter the buyer power of other buyers (so-called waterbed e ects); and (iii) how are the incentives to invest in upstream technology altered by the creation of large downstream rms?

Keywords: Buyer power; Waterbed e ects; Bargaining in the supply chain; Milk; Private-Label; Supermarkets.

JEL numbers: L13, L42, L66

1 Introduction

Do large buyers wield buyer power? Does the growth of large buyers a ect the prices paid by small buyers? These questions have grown in importance recently, partly as a result of the increases in retail concentration which have taken place in several economies with the emergence of large retail rms such as Wal-Mart, Carrefour, and Tesco.[1] They are also very prominent

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Department of Economics, Oxford University, Manor Road, Oxford, United Kingdom, OX1 3UQ. We are grateful to the Milk Development Council (MDC) and to the Department for the Environment, Food and Rural A airs (DEFRA) for nancial support. We are also very grateful to a number of executives in the UK milk supply chain for their insights into the bargaining process. Any errors are ours and the views contained are ours and not necessarily shared by the MDC or any other entity involved in the UK milk supply chain. We are grateful for comments from seminar participants at Essex University, London Business School, Oxford University, Warwick University, the Royal Economic Society Conference 2007, the Swiss IO Day 2007 and the CEPR Applied IO conference, Paris 2008.

[1] In the UK, the groceries market share of the four largest supermarkets is estimated to have risen from approximately 50% in 2002 to 65% now (CC 2008, Fig 3.1). In Austria the two largest food retailers together control more than 65% of the market (`European Retail Handbook 2003/4', Mintel).

now there has been very little theoretical work that establishes a source of waterbed e ects.[10] We characterize when waterbed e ects are present and when they will be of a standard type: increases in downstream concentration disadvantaging smaller downstream buyers. This is also of important policy relevance as the possibility arises that smaller buyers will be forced to exit the market.

The third main contribution is to explore the suppliers' incentive to innovate by lowering their costs. This addresses a third current policy concern that large buyers may impede the incentives of their suppliers to innovate. We show that the presence of large buyers creates a preference for technologies which increase the large buyers' buyer power and result in higher prices for smaller buyers. Thus, a vicious circle is created for the smaller buyers.

This paper develops these hypotheses though a model of a bargaining interface between multiple suppliers competing to supply a homogeneous good to multiple downstream buyers. That is we have a model of contract negotiation and not a model of procurement auctions or a model of upstream price setters. The evidence that negotiations are a very common form of contracting is strong. For instance, two major recent reports into the supermarket industry, Competition Commission (2000, 2008), do not mention auctions even once in their chapters on relationships with suppliers, and mention negotiations repeatedly. More generally *The Economist* has reported that business to business deals are predominantly via a negotiated contract and not a spot-market or auction.[11] The problem cited is that logistics and other details even for otherwise homogeneous goods are too complicated to submit to an auction and that suppliers do not wish their products to be turned into commodities and so avoid taking part in any such auctions if they can. These arguments are in line with theoretical insights of Goldberg (1977) and Manelli and Vincent (1995). A number of recent empirical studies for speci c industries (see Bajari et al (2008), Bonaccorsi et al (2000), and Le er et al (2003)) con rm the preference for negotiations over auctions if sellers are not very numerous or contracts are complicated.

The model we o er is built upon a suite of interviews we conducted with buying and selling executives in a supermarket supply chain | that for milk | as well as further case studies. These investigations highlighted the importance of uncertainty created by upstream competition, which arises as a supplier does not know in advance which buyers will approach and complete deals with her. We capture this source of uncertainty in a tractable static bargaining framework. In our model each downstream buyer wishes to source an input from one of the competing

[10]Some recent work with an upstream monopoly has given support for a waterbed e ect which derives from downstream competition e ects. See Inderst (2007) and Majumdar (2005). However there is to our knowledge no work with upstream competition.

[11]\The problem is that commodities that can be auctioned represent only a tiny fraction of all transactions. An estimated 80-90% of all business goods and services are actually traded through extended term contracts, often lasting for a year or more;" *Theav*

upstream suppliers. As in the case study evidence, the uncertainty for the suppliers is generated by not knowing which total set of contracts will be won when any individual contract is being negotiated. The model then captures the interaction of this uncertainty with the production cost and downstream market structure to generate the predictions.[12]

The rest of this paper is as follows. Two case studies are o ered in Section 2. The formal model and a motivating example is introduced in Section 3. Section 4 explores when buyer power will exist. Sections 5 and 6 analyze the e ect of changes in market structure on bargained prices and social e ciency | the analysis of waterbed e ects. Section 7 analyzes upstream investment incentives. Section 8 analyzes the robustness of the main results. Section 9 concludes.

2 Supermarket Procurement Case Studies

An important class of applications for the model is supermarket procurement of products where there are several potential suppliers, e.g. fresh produce, secondary brands, and private-label goods. To ensure a solid justi cation for our modeling choices we have researched two case studies: the liquid milk market and the market for private-label Carbonated Soft Drinks. In both cases the bargaining environment is very similar and motivates the model developed in the paper.

2.1 Case 1: Bargaining in the UK Liquid Milk Supply Chain[13]

Our main case study concerns the UK liquid milk market. Here we conducted interviews with a number of buying managers at major UK supermarkets and a number of sales directors at UK milk suppliers.

The UK milk supply chain provides a good example of upstream competition. The product is homogeneous to consumers[14] and there are three main competing suppliers (known as milk processors), Arla, Dairy Crest and Wiseman. The buyers are the four dominant supermarkets | ASDA/Wal-Mart, Morrison, Sainsbury, and Tesco | and some smaller supermarkets.[15]

The main features of the supermarket-supplier interface relayed to us by the industry executives are as follows: The standard supply contract in the industry is a rolling one in which

[12] Inderst and Wey (2007) and Dobson and Waterson (1997) consider simultaneous bargaining but with a monopoly supplier. That surplus shape due for example, to variable marginal costs, will alter the bargained outcome has been shown in Horn and Wolinsky (1988) and Stole and Zwiebel (1996). Supplier competition is modelled in Inderst and Wey (2003), de Fontenay and Gans (2005), Inderst (2006) and Bjørnerstedt and Stennek (2007); however as uncertainty is absent from these models, its e ects cannot be analyzed.

[13] We would like to thank all the industry executives who allowed us to interview them and released the facts which we report below.

[14] Organic milk is considered a di erent market and is supplied by a di erent supply chain.

[15] One industry source estimates that as of October 2006, the top 4 supermarkets sold 61% of the liquid milk produced in the UK. The rest is sold by smaller chain stores, doorstep delivery, and convenience stores.

Volumes Sold to the Largest Four Supermarkets				
(Units: Million Litres Per Year)				
date	Supplier 1	Supplier 2	Supplier 3	Total
12/03	585	690	870	2145
11/04	575	555	1020	2150
1/05	350	835	940	2125
10/05	430	760	920	2110
Data from Industry Sources				

Table 1: Table of Output Variability.

supermarkets need o er only 3 months notice of termination. The price per litre of milk is

	Supplier 1	Supplier 2	Supplier 3	Total
Supermarket 1		15.66	9.10	
Supermarket 2	5.08	5.61		
Supermarket 3			10.79	
Supermarket 4		1.69	2.96	
Supermarket 5	4.66		4.66	
Supermarket 6	1.90			
Supermarket 7	1.38			
Other buyers	19.37	9.21	7.94	
Total	*32.38*	*32.17*	*35.45*	*100.00*

Table 2: Table of Market Shares in October 2006.

arms length contracting are not possible. During these negotiations both parties make offers. This process was captured by the following quote: “*We [the supplier] suggest a pence per liter price X. They [the supermarket] respond by saying that is much too high, we could go to your rivals and get Y. And so it goes on.*"

Supermarkets either source from just one supplier, or divide their needs into two distinct geographical contracts and use one supplier for each of these contracts. The division is usually on a North-South basis in Great Britain so that in these cases contracts are again over discrete quantities. In October 2006 the supermarket contracts of the largest supermarkets were given by the figures in Table 2 (normalized into market shares).

From the case study we have reported we draw the following conclusions:

1. Supermarkets regularly and unilaterally start new procurement rounds at unpredictable points in time.

2. Suppliers face uncertainty regarding current tender successes and losses of existing contracts when negotiating for any given contract.

3. Negotiations are over a per unit price taking as given the required quantities.

These insights are consistent with published sources. The KPMG (2003, §178-9) report into the dairy supply chain corroborates the fact that supermarkets initiate retendering rounds with prices per unit being negotiated, and notes that this format is common across supermarket supply negotiations. The Competition Commission (2003, §5.97) merger investigation also confirms that the supermarkets were aware of their importance in the supply chain and seek to “play off the major processors [suppliers] against each other. [The national retailers] have the ability to switch volumes easily between suppliers".

2.2 Case 2: Procurement of Private-Label Carbonated Soft Drinks

The procurement process for milk appears to be shared by other supermarket private-label

per unit.

The example indicates the effect of upstream uncertainty arising from competition. This example is incomplete as the monotonic link between expected average incremental cost and the negotiated per unit input price is not modelled. We now model this link explicitly.

3.3 Upstream Volume Uncertainty — A Bargaining Model

We first define the ultimate disagreement outcome. If the downstream buyer should ultimately fail to agree with any of the U upstream suppliers then she can source the input at a "high" price of per unit. (High means $> C'(q)$ for all $q \in [0, Q]$). This could be through importing from a different geographical market for example.

We assume for convenience that any idiosyncratic taste shocks between suppliers and buyers are negligible so that the U upstream firms are symmetric as far as a downstream buyer is concerned. Each buyer determines the order to negotiate with the upstream firms. The buyer negotiates with one supplier at a time, approaching initially the first supplier on its list.

The negotiation between buyer and any supplier takes the form of a full information alternating offer no discounting bargaining game as in Binmore et al. (1986).[22] That is, the two parties make alternating offers and after each offer there exists a small exogenous probability ε

which would be enjoyed if the buyer moves on and bargains with the second supplier, with one fewer supplier remaining.[24] Thus we capture the idea that should negotiations with U_1 break down the downstream rm will be able to go to U_2 and derive a known surplus, so if U_1 is to win the business it must o er a price lower than by the agreed price and so we have the difference equation

$$q\left[t(n-1) - t(n)\right] = qt(n) - C(q)$$

where $t(0) = \;:$ The solution is given in the lemma. ■

Lemma 1 shows how with a single buyer the input price agreed varies with the suppliers' average costs of supplying the buyer and the number of competing suppliers. We now develop the full bargaining model with multiple buyers.

3.3.2 The Full Bargaining Model

The full bargaining model introduces supplier uncertainty about total volumes, which was identified as key in our case studies. To capture this simply and tractably we assume that all D buyers conduct negotiations for the required inputs simultaneously using the sequential scheme detailed above. Each supplier is represented by separate sales agents in each of the D possible negotiations. There is no information transfer between the different negotiations and so each of the D sequences of negotiations happen independently of each other. The sales agents maximize their firm's expected profits. If a sales agent is negotiating with a buyer they therefore know how many other suppliers this buyer could potentially source from should negotiations break down; the sales agent does not however know which of the other $D - 1$ buyers might have concluded agreements with their company for its supply. Thus total volumes are uncertain mirroring the insights from the case studies.

where

$$C_i = E\left(\text{total cost}\;\middle|\;\begin{matrix}\text{win contract}\\ \text{with type } i\end{matrix}\right) - E\left(\text{total cost}\;\middle|\;\begin{matrix}\text{lose contract}\\ \text{with type } i\end{matrix}\right)$$

Using (3) we see that the agreed price per unit for buyer i exceeds the expected average incremental costs C_i/q_i of supplying i by an amount which depends upon the number of suppliers and the ultimate outside option . Thus the expression is identical to the expression (2) for the case of a single buyer, except that the supplier now takes an *expectation* of the average incremental costs of supplying buyer i. This expectation can be expressed using the notation in (1) as follows

$$\frac{C_i}{q_i} = E_{q_{-i}}\left[I_{q_i}(q_{-i})\right]$$

where q_{-i} is the random variable denoting volumes won from the $D-1$ buyers other than i.

Note that average incremental cost is a function both of the size q_i of the buyer (which is known) and of the output q_{-i} the supplier wins from all other negotiations (which is uncertain). Therefore, the seller's expectation of average incremental costs depends not just on the size of the buyer but also, by standard risk theory, on the mean and spread of the output she might win in other negotiations and the curvature of the average incremental cost function (1) in that output. The mean and spread of the output from other buyers is determined by downstream (and upstream) market structure. The results in the rest of the paper build on these insights.

The robustness of this model is explored in Section 8 where the effect of generalizing to allow for downstream coordination, dynamic contracting, auctions and endogenous downstream demand are all explored. As long as upstream volume uncertainty remains then our results continue to hold, as indicated in the motivating example in Section 3.2 which did not rely on a specific bargaining model. We therefore offer this model as an analytically tractable way of studying the key features of buyer-seller relationships that emerged from the case studies: competing suppliers, bargaining, and uncertainty over which contracts will be won.

4 The Effect Of Buyer Size On Buyer Power

We have noted that supplier certainty and increasing returns to scale hands the greatest buyer power to small buyers (e.g. Chipty and Snyder (1999), Inderst and Wey (2007)), a result which sits at odds with policy discussion in many industries. The motivating example in Section 3.2 found the opposite: with increasing returns and upstream competition the large buyers have buyer power. In this section we establish the result for the full bargaining model, considering both increasing returns to scale and decreasing returns to scale cases.

Theorem 1 *Let there be D buyers indexed by i. Buyer i seeks to purchase q_i units. Suppose that $q_1 > q_2$.*

1. *With concave total costs (increasing returns to scale), the larger downstream buyer ($i = 1$) receives a lower input price than the smaller buyer if U is sufficiently large.*
2. *With convex total costs (decreasing returns to scale), the smaller downstream buyer ($i = 2$) receives a lower input price than the larger buyer if U is sufficiently large.*
3. *For the family of quadratic costs, $U > 2$ is sufficient to give the buyer power result.*
4. *In general a sufficient (but not necessary) condition for the buyer power result to hold is that*

$$U > 1 + \max\left(\frac{\inf C''(\cdot)}{\sup C''(\cdot)}, \frac{\sup C''(\cdot)}{\inf C''(\cdot)}\right) \quad \text{with } \sup \text{ and } \inf \text{ found over } q \in [0, Q]$$

   This bound is tight for the family of quadratic costs.

The proof of this result is given in the Appendix. Here we provide an intuitive derivation of the result using Figure 1, drawn for the case of concave costs. Consider first the $D - 2$ buyers labeled by $i \in \{3, 4, \ldots, D\}$. A given supplier might win any subset of these $D - 2$ buyers. In particular let W_j be the subset won so $W_j \subseteq \{3, 4, \ldots, D\}$. Suppose that winning W_j results in total volumes demanded of Q^j. Taking as given any realization of Q^j we consider the supplier's bargaining stance when her sales agents are negotiating with two buyers: yers: an

It is intuitive from the diagram that the result is reversed if the cost function is convex.

As the preceding logic is true for any realization of other victories W_j; the larger buyer is offered a lower input price per unit. So the large buyer negotiates a preferential deal: i.e. we have *buyer power*. Chipty and Snyder (1999) get the opposite result because they assume a monopoly supplier and in each negotiation there is no uncertainty as to whether the other buyer is served, so that all the probability weight is attached to the flatter of the two gradients and in that case (as the diagram shows) higher average incremental costs are anticipated when bargaining with the large buyer.

If negotiating with the large buyer

The above intuition captures the reasoning behind the proof of parts 1 and 2 of Theorem 1. The remaining parts of the Theorem give the number of upstream firms U needed for the buyer power results to hold. Part 3 states that for the family of quadratic costs, $U > 2$ is sufficient. Part 4 gives a sufficient condition for the general class of cost functions being considered. The theorem has particular relevance when $\max\left\{\frac{\inf C''(\ )}{\sup C''(\ )}, \frac{\sup C''(\ )}{\inf C''(\ )}\right\}$ is not too far from 1: in this case more than 2 upstream competitors is sufficient to deliver larger buyers wielding buyer power if prices to smaller buyers why did it refrain initially, i.e. before the large buyer emerged? And if upstream firms compete then how would they coordinate this price increase? In this section we provide the first analysis of these so-called waterbed effects with competing non-collusive upstream suppliers.

the variance of the supplier's volumes and thus acts as a mean preserving spread of the volumes each supplier expects. If average incremental costs are convex (whether increasing or decreasing) then the mean preserving spread has the e ect of increasing the expected average incremental

1. *If average incremental costs are convex then the downstream merger raises the input prices for all other downstream rms (a standard waterbed e ect), for any number of competing suppliers U 2.*

2. *If average incremental costs are concave then the downstream merger lowers the input prices for all other downstream rms (an inverse waterbed e ect), for any number of competing suppliers U 2.*

The reasoning is exactly as before: a merger is the logicecas

Theorem 4 *Suppose that, holding downstream volumes constant, two downstream buyers become more asymmetric. (Perhaps through a merger or by the larger buyer purchasing some sales outlets from the smaller buyer). Then:*

1. *If upstream firms have concave total cost functions (increasing returns to scale) then the increase in downstream concentration raises expected welfare by resulting in more efficient (lower cost) production.*

2. *If upstream firms have convex total cost functions (decreasing returns to scale) then the increase in downstream concentration lowers expected welfare by resulting in less efficient (higher cost) production.*

The driving force behind this result is the insight that an increase in downstream concentration, coupled with active upstream competition, leads to an increase in risk faced by the suppliers. The constant level of total downstream market demand means that expected volumes are unchanged by the change in concentration. However, the increase in downstream asymme-

To see the intuition for this result, suppose there are upstream economies of scale and note that if supplier numbers increase then a supplier's chances of securing any given other contract decline. In particular, when negotiating with the smaller buyer the chances of securing a given large contract are only $\frac{1}{U}$ and this falls as the number of competing suppliers increases. The supplier therefore puts more weight on lower volumes. To ascertain the magnitude of this e ect for the large and small buyers we now turn to the assumption that marginal costs are convex (and so average incremental costs are convex by footnote 28). If average incremental costs are convex declining a small reduction in volumes has a bigger e ect on the expected average incremental costs at low volumes than at high volumes. Hence the reduction in expected volumes pushes expected average incremental costs up more when negotiating with a small buyer than with a large buyer: and so increasing supplier numbers is much more harmful to the small than the large buyers. The reasoning for part 2, convex total cost functions, is analogous.

To conclude this section we turn our attention to the question of whether an increase in the number of suppliers unambiguously leads to lower input prices for downstream buyers. The answer is not necessarily. Consider an increase in supplier numbers. Recall that we impose that suppliers are symmetric. For any buyer of given size, this has two e ects on the actual level of the input prices. First, in Lemma 2 it increases the number of upstream rms left to bargain with before sourcing at the expensive marginal cost of . Thus input prices fall towards the expected average incremental cost ($\frac{C_i}{q_i}$ in equation (3)). This e ect is always negative pushing down on input prices. Second, as the number of suppliers rises, each supplier expects to serve smaller total volumes for the reasons outlined in the proof of Theorem 5. This either increases or decreases expected average cost per unit, depending on the direction of returns to scale. Therefore with increasing returns to scale, smaller total volumes increase expected average costs so the two e ects push in opposite directions with ambiguous e ects for input prices. With decreasing returns to scale in upstream production smaller volumes reduce expected average costs so the two e ects work in the same direction, and input prices fall as supplier numbers rise.

7 Incentives to Invest: Endogenous Technology Choice

A concern often raised about downstream buyer power is that it may lower upstream incentives to invest in cost reducing technologies. Clearly if upstream rms extract less pro t then their incentives to invest are reduced.[32] This section addresses what endogenous technology choice the

[32] However the empirical evidence that increases in downstream concentration choke o upstream innovation is not strong. For example, in their comprehensive analysis of the UK groceries market the Competition Commission note that R&D spending on food production in the UK has been trending upwards. Competition Commission (2008), Appendix 9.2, Figure 6 and paragraph 30.

suppliers will select. To analyse cost reducing supply chain investments in the most empirically relevant way we allow rival suppliers to react to any cost reductions. This section therefore uses the *anticipatory equilibrium* described in Mas-Colell, Whinston and Green (1995, Chapter 13D).[33] This is an appropriate concept here as the innovations employed are typically not covered by patents: rather they are cost reductions due to well understood technology such as larger plants. This means that there is ample opportunity for any supplier to match the investment of a rival supplier. We analyse investments from the position that the upstream rms invest so as to maximize their individual pro ts in the expectation that pro table investments will be undertaken by all and the upstream market remains symmetric.[34] These assumptions sit well with the UK Grocery Market within which 60% of suppliers to supermarkets conduct innovation to \keep up with the market."[35]

In this section we show that as buyer concentration increases a competitive supplier would prefer to switch from convex costs to linear costs and from linear costs to concave costs. This result is perhaps particularly surprising given that rms actively seek technology yielding up-stream economies of scale which will (a) only be realized if they were to win a big contract and (b) result in the large buyers paying less (Theorem 1). The result also creates a potential new concern for welfare: a move to upstream economies of scale will make small buyers weak buyers who pay more for the input and could be driven out of business.

Theorem 6 *Suppose that industry demand is normalized to 1. Let there be one large down-stream buyer requiring volumes* q_L *2* $(0;1)$ *and suppose the remaining volume* $(1 \quad q_L)$ *is split between* D_S *equally sized small buyers where* D_S *is large. Suppose that suppliers' technology is given by a convex (decreasing returns to scale) cost function* $C(q)$ *with* $C(0) = 0$*: Normalizing a[l] costs so that zero gc7.032 -48 10.901eJ/F48 1 costs8fq*

Thus if suppliers should win less than $\frac{1}{U}$ their costs will be lowest with the benchmark convex production technology. Further if U is large then the probability of winning the large buyer is small.

The proof is provided in the appendix. Here we explain the two main forces driving Theorem 6.

The rst is that expected costs are reduced if the production technology becomes more concave. This follows as a bigger main buyer (larger q_L) corresponds to a mean preserving spread of likely business. As suppliers are symmetric, each supplier ex ante expects to supply $\frac{1}{U}$ units, and by assumption the cost for this is independent of the technology. However, as q_L increases there are increasing probabilities of either supplying very little or (less likely) supplying a great deal. If costs are concave then the greater the size of the buyer, and thus the greater the mean preserving spread, then the lower are the expected total costs.

Against this we must consider the second force: the e ect on bargained input prices of a switch to a linear and thence to a concave production technology shape. The e ect on input prices from the small buyers is to increase them as the cost function becomes more concave | however this e ect becomes small as the large buyer becomes a bigger and bigger part of the market. The upstream competition causes these input prices to be determined mostly by the marginal cost at low volumes, and this rises as the technology moves to one of upstream economies of scale (holding average production costs constant).

The input prices from the large buyer, on the other hand, are unambiguously smaller under a concave cost function, for the same reasons. So expected prices per unit decline with the big buyer if we have concave production costs. But these falls are *more than* made up for in lower expected costs if the buyer is big enough. This is because the ultimate outside option for the buyers of having to pay per unit of input places a lower bound on how far the input prices can fall. This reduces the e ect of the technology on the bargained input price; there is no similar dampening of the expected cost reduction. Thus, the suppliers would rather be more e cient in supplying the large buyer and accept lower input prices.

In the previous literature the shape of the cost function is often treated as exogenous. A notable exception to this is in Inderst and Wey (2007) who show that as buyer concentration increases, a monopoly supplier would prefer to switch from convex costs to linear costs.

The result that increasing downstream concentration will push upstream technology towards economies of scale has, for example, resonance in the UK milk supply (where the dominance of large buyers has increased). In this industry suppliers to supermarkets have embarked on a process of building superdairies and shutting smaller regional dairies. This move to superdairies was initiated by Wiseman and quickly copied by her rivals. These superdairies create a need for large volumes to achieve low marginal costs. Our analysis therefore predicts that this endogenous technology development has exacerbated the buyer power di erential between large and small buyers.

8 Robustness of the Bargaining Model

The bargaining model is deliberately simple to allow the insights to be displayed cleanly. However, this then raises the question of how the results might be altered if the model assumptions are changed. We here describe four possible relaxations: downstream coordination, dynamic contracting, auctions, and endogenous downstream demand.

8.1 Downstream Dynamic Contracting and Buyer Coordination

In the case of upstream technology having economies of scale two related robustness issues should be discussed. First, if contracting were sequential, so that all subsequent buyers know which supplier wins the rst contract, then, leaving all other model features unaltered, the rst buyer would recognize that she was critical to the supplier securing the full industry pro t and so she could extract most of this pro t herself through a very low per unit price.[36] Second, in a static setting, in addition to the mixed strategy equilibrium studied, coordination equilibria also exist in which buyers all play a pure strategy and coordinate their purchase decisions on a single supplier.

For both the sequential and the simultaneous coordination cases, the uncertainty in supplier volumes, which was a key feature of our case studies and has motivated our model, has been removed (in the sequential case supplier volumes are deterministic after the rst contract is are changepe w57(erate5n)-2mm8.968395-332(5ultaneo(5ul-33-33ure)-33395empirthe)-335ullitea56(motiv)595(

buyer power' and not `large buyer power'.[37] The second effect created in this dynamic context parallels that described in Figure 1. Because of the idiosyncratic taste shock, when negotiating with one buyer the supplier is uncertain of which subsequent contracts she will win. As a result, she would therefore put some weight on losing the other contracts. The greater the competition upstream the greater the weight placed on losing the subsequent contracts. Hence though the probabilities associated with losing a contract would not be $\frac{U-1}{U}$ as depicted in Figure 1, they would be large if upstream competition was great. Therefore the supplier bargaining with a buyer would discount other contracts and so consider the buyer's business as incremental — i.e. bargaining would be related to the steeper average incremental cost curves of Figure 1 and large buyers would still wield buyer power if there were upstream economies of scale.

Similarly, in the simultaneous coordination case, the introduction to the model of idiosyncratic taste shocks would again re-introduce upstream volume uncertainty and so the results we have found would continue to apply.

Therefore our results continue to hold under all equilibria with dynamic contracting and buyer coordination provided the suppliers' uncertainty about final volumes is preserved — most naturally by idiosyncratic tastes between suppliers.

8.2 Empirical Relevance of an Auction Model

A further question is why the buyers don't use reverse auctions. One response to this is empirical. Our case studies into the procurement of relatively homogeneous products found that the buyers used negotiations. This appears to be widespread for supermarket procurement: it is informative that in the Competition Commission reports into the grocery sector (2000, 2008), the chapters dealing with supplier relationships make no mention of auctions, while aiming to cover the full range of supermarket supply relationships in considerable depth. Thus for an important class of applications auctions appear not to be used.

To understand why auctions are not used an empirical literature has developed analyzing the choice between negotiations and reverse auctions. This highlights the empirical conditions under which negotiations are revealed to be preferred to auctions. This literature finds that negotiations are preferred when there are few suppliers, there are issues other than price such as quality, and where contractual design is incomplete. (See for example Bajari et al. (2008), Leffler et al. (2007), and Bonaccorsi et al. (2003)). According to *The Economist*, for example, these apply in the vast majority of circumstances, (see note 11). In the case of milk, executives noted that supply contracts required agreeing more than just price: the logistics of supply, what

[37] However if large buyers go first and are followed by small buyers then the result would be observationally equivalent to large buyer power.

have this feature. In the private label supply chains the prices were set at the start, and not at the end, of the contract. Thus the scope for hold up is heavily reduced. Further the extent of buyer specific investment is limited as the Competition Commission explicitly report (2006, para 5.21) in relation to Carbonated Soft Drinks. As these hold-up issues become less important the buyers focus more on extracting the lowest possible prices and hence seek to use threats to leave suppliers at short notice to push prices down.

In a homogeneous supply market one might conclude that there is very little suppliers can do to escape the forces of competition we have modeled. The best examples for our framework have involved supply chains in which final consumers were indifferent between suppliers of the input, e.g. pharmaceuticals, salt, milk, and other private label or secondary branded products. However there are cases where a supplier has been able to differentiate itself to *final* consumers; notably Intel and silicon chips.[40] Silicon chips must conform to a standard architecture and so are, in principle, substitutable. Intel has a number of competitors yet in 2006 controlled over 80% of the market in laptops and over 60% of the market in desktops.[41] How bargaining in the supply chain adapts to the evolution of a consumer branded supplier is an extension which is worthy of future research.

A Proofs Omitted From the Main Text

Proof of Theorem 1. Consider the $D-2$ retailers indexed by $i \in \{3, 4, \ldots, D\}.$ There are 2^{D-2} possible subsets of these firms. Index each of these subsets by $j.$ Let $f(j)$ be the probability an upstream supplier sees of winning exactly subset j from these $D-2$ possible buyers. Let the total demand supplied by this supplier when serving subset j be $Q^j.$ Now consider a supplier negotiating with buyer $i=1.$ We have

$$E(\text{costs}|\text{win } q_1) = \sum_{j=1}^{2^{D-2}} f(j)\left[\Pr(\text{win } q_2)\, C\left(Q^j+q_1+q_2\right) + \Pr(\text{lose } q_2)\, C\left(Q^j+q_1\right)\right]$$

$$E(\text{costs}|\text{lose } q_1) = \sum_{j=1}^{2^{D-2}} f(j)\left[\Pr(\text{win } q_2)\, C\left(Q^j+q_2\right) + \Pr(\text{lose } q_2)\, C\left(Q^j\right)\right]$$

Combining we have

$$C_1 = \sum_{j=1}^{2^{D-2}} f(j)\left[\frac{1}{U}\left(C\left(Q^j+q_1+q_2\right) - C\left(Q^j+q_2\right)\right) + \frac{U-1}{U}\left(C\left(Q^j+q_1\right) - C\left(Q^j\right)\right)\right] \qquad (4)$$

[40] For further discussion see Duguid (2006).

[41] Source: http://pcpitstop.com/research/cpuintel.asp

are concave so that $C'' < 0$: In this case a sufficient condition for (5) to be true is if

$\frac{1}{\;}$

to a lower input price for downstream buyer 2. If upstream total costs are convex (decreasing returns to scale) then the term in square brackets is positive. Hence we have the desired result as concerns the input price of other buyers. ■

Proof of Theorem 3. Suppose there are D downstream firms: buyer 1 is assumed larger than 2 ($q_1 > q_2$). Consider the $D-3$ downstream firms numbered from 4 to D. A supplier may win any subset of these $D-3$ firms. Denote the winning set W_j. There are 2^{D-3} possible such winning sets (the power set of $\{4, 5, \ldots, D\}$). Denote the probability of winning W_j by $f(j)$ and demand provided to this winning set as Q^j. Now consider some possible realization of W_j and consider the supplier negotiations with buyer q_3. By Lemma 2 the input price is proportional to $\Delta C_3/\Delta q_3$ where ΔC_3 is the difference in the expected costs incurred when q_3 is won versus not. Now note that

$$E(\text{costs} \mid \text{win } q_3) = \sum_{j=1}^{2^{D-3}} f(j) \left\{ \begin{array}{l} \Pr(\text{win } q_1 \text{ and } q_2)\, C\left(Q^j + q_1 + q_2 + q_3\right) \\ + \Pr(\text{win } q_1 \text{ only})\, C\left(Q^j + q_1 + q_3\right) \\ + \Pr(\text{win } q_2 \text{ only})\, C\left(Q^j + q_2 + q_3\right) \\ + \Pr(\text{lose } q_1 \text{ and } q_2)\, C\left(Q^j + q_3\right) \end{array} \right\},$$

Hence we have

$$\frac{\Delta C_3}{\Delta q_3} = \sum_{j=1}^{2^{D-3}} f(j) \left\{ \begin{array}{l} \frac{1}{U^2} I_{q_3}\left(Q^j + q_1 + q_2\right) + \left(\frac{U-1}{U}\right)^2 I_{q_3}\left(Q^j\right) \\ + \frac{1}{U}\frac{U-1}{U}\left(I_{q_3}\left(Q^j + q_1\right) + I_{q_3}\left(Q^j + q_2\right)\right) \end{array} \right\};$$

Using the fact that $q_1 + q_2$ is constant by assumption we have

$$\frac{\partial}{\partial q_1} t_3(U) =_{\text{sign}} \sum_{j=1}^{2^{D-3}} f(j) \frac{1}{U}\frac{U-1}{U} \frac{\partial}{\partial q_1}\left(I_{q_3}\left(Q^j + q_1\right) + I_{q_3}\left(Q^j + q_2\right)\right)$$

If I_{q_3} is convex then $q_1 > q_2$ implies that $I'_{q_3}\left(Q^j + q_1\right) > I'_{q_3}\left(Q^j + q_2\right)$ which implies that the term in braces is positive. This gives part 1 of the Theorem in which the increase in downstream concentration leads to a standard waterbed effect. The case for $I''_{q_3} < 0$ leading to the inverse waterbed effect follows identically. ■

Proof of Theorem 4. Suppose there are D downstream firms: buyer 1 is assumed larger than 2 ($q_1 > q_2$). Let $f(j)$ capture the probability of winning any given combination of the $D-2$ retailers numbered from 3 to D. The volumes supplied to these buyers in this case would be Q^j.

The expected costs for a supplier (EC) are then given by

$$EC = \sum_{j=1}^{2^{D-2}} f(j) \left\{ \begin{array}{l} \Pr(\text{win } q_1 \text{ and } q_2)\, C\left(Q^j + q_1 + q_2\right) \\ + \Pr(\text{win } q_1 \text{ only})\, C\left(Q^j + q_1\right) \\ + \Pr(\text{win } q_2 \text{ only})\, C\left(Q^j + q_2\right) \\ + \Pr(\text{lose both } q_1 \text{ and } q_2)\, C\left(Q^j\right) \end{array} \right\}$$

Using fact that $q_1 + q_2$ is constant by assumption we have

$$\frac{\partial}{\partial q_1} EC =_{\text{sign}} \sum_{j=1}^{2^{D-2}} f(j) \left[\frac{1}{U} - \frac{U-1}{U} \right] \left[C'\left(Q^j + q_1\right) - C'\left(Q^j + q_2\right) \right]$$

As $q_1 > q_2$ by assumption then if total costs are concave ($C'' < 0$) then the brace above is negative: that is total expected costs decline. As downstream volumes are unaffected this is a positive contribution to welfare. The result for convex total costs upstream follows identically. ■

Proof of Theorem 5. Suppose $q_1 > q_2$ and that $q_D = \min \{q_3, \ldots, q_D\}$. Using (3) note that the difference in input prices agreed by large versus small buyers is given by

$$t_2(U) - t_1(U) = \underbrace{\left(1 - \frac{1}{2^U}\right)}_{(y)} \underbrace{\left(\frac{C_2}{q_2} - \frac{C_1}{q_1}\right)}_{(z)}$$

It is immediate that (y) is increasing in U. We therefore turn to (z). Let $f(j)$ be the probability of winning the set of buyers W_j out of the $D - 2$ buyers numbered from 3 to D, with associated volume Q^j. Note that $f(j)$ can be decomposed into a probability of winning $|W_j|$ buyers from the $D - 2$, which depends on the number of competing suppliers U, multiplied by the probability of winning exactly the set W_j conditional on having won E (n) 28 (um (n) 28 (um) 2

Therefore as U increases, more weight is put on the positive term suggesting that $H \quad Q^j$ rises. However, altering the number of suppliers also alters the probability of winning a contract and so alters the random variable z_U. Now recall that $z_U \quad Bin \ D \quad 2; \frac{1}{}$

small ones.

We nally turn to the case of increasing marginal costs so that $C^{00} > 0$. For large U we have $\frac{C_2}{q_2} < \frac{C_1}{q_1}$ and so $t_1(U) \quad t_2(U$

We also establish the expected costs of each supplier as

$$
\begin{aligned}
E\,(\text{costs}) &= \frac{U \quad 1}{U} G^{r} \quad \frac{1 \quad q_L}{U} \quad + \frac{1}{U} G^{r} \quad q_L + \frac{1 \quad q_L}{U} \\
&= (1 \quad r) \; \frac{U \quad 1}{U} C \quad \frac{1 \quad q_L}{U} \quad + \frac{1}{U} C \quad q_L + \frac{1 \quad q_L}{U} \quad + rC \quad \frac{1}{U}
\end{aligned}
$$

Now note that each supplier's expected pro ts are given by

[14] Dobson and Waterson (1997), \Countervailing Power and Consumer Prices", *Economic Journal*, 107, 418-430

[34] Smith and Thanassoulis (forthcoming), \Bargaining Between Retailers And Their Suppliers", in Private Labels, Brands and Competition Policy, Ezrachi and Bernitz (eds), Oxford University Press

[35] Snyder (1996), \A Dynamic Theory of Countervailing Power", *RAND Journal of Economics*, 27, 747-769

[36] Sorensen A (2003) \Insurer-Hospital Bargaining: Negotiated Discounts in Post-Deregulation Connecticut", *Journal of Industrial Economics* 51: 469-490

[37] Stole and Zwiebel (1996) \Organizational Design and Technology Choice under Intra rm Bargaining" *American Economic Review* 86:195-222

[38] von Ungern-Sternberg (1996), \Countervailing Power Revisited", *International Journal of Industrial Organisation*, 14, 507-520

[39] Wilson (1977), \A Model of Insurance Markets with Incomplete Information", *Journal of Economic Theory*, 16, 167-207