Group-Buying On The Web: A Comparison Of Price Discovery Mechanisms

Krishnan S. Anand[1] and Ravi Aron[2]
OPIM department, The Wharton School
University of Pennsylvania.

Abstract: Web-based Group-Buying mechanisms, a refinement of quantity discounting, are being used for both Business-to-Business (B2B) and Business-to-Consumer (B2C) transactions. In this paper, we survey currently operational online Group-Buying markets, and then study this phenomenon using analytical models. We surveyed over fifty active Group-Buying sites, and provide a comprehensive review of Group-Buying practices in the B2B, B2C and non-profit sectors, across three continents.

On the modeling side, we build on the coordination literature in Information Economics and the quantity-discounts literature in Operations to develop an analytical model of a monopolist who uses web-based Group-Buying mechanisms under different kinds of demand uncertainty. We derive the monopolist's optimal Group-Buying schedule, and compare his profits with those that obtain under the more conventional posted-price mechanism. We also study the effect of heterogeneity in the demand regimes, in combination with uncertainty, on the relative performance of the two mechanisms. We further study the impact of the timing of the pricing decision (vis-à-vis the production decision) by modeling it as a two-stage game between the monopolist and buyers. Finally, we investigate how Group-Buying schemes compare with posted price markets when buyers can revise their prior valuation of products based on information received from third parties (infomediaries).

In all cases, we characterize the conditions under which one mechanism outperforms the other, and those under which the posted price and Group-Buy mechanisms lead to identical seller revenues. Our results have implications for firms' choice of price discovery mechanisms in electronic markets and scheduling of production and pricing decisions in the presence (and absence) of scale economies of production.

[1] Email: anandk@wharton.upenn.edu; Tel: (215) 898 1175.
[2] Email: raviaron@wharton.upenn.edu; Tel:(215) 573 5677.

1. Introduction

Group-Buying schemes have been in vogue for very many years, particularly in the context of selling on television via the popular Home Shopping Network. Web-based variants of Group-Buying have received a lot of attention recently as part of the wave of innovative online market-based mechanisms such as auctions, reverse auctions and Priceline's 'name-your-own-price' scheme. Nevertheless, unlike in the case of auctions (which has a rich history of analytical research over more than forty years), Group-Buying sorely lacks a theoretical framework.

This paper develops analytical models of Group-Buying, building on extant academic research in the disciplines of Operations Management, Economics and Information systems. As we demonstrate, two streams of research — the quantity-discounts literature in Operations Management and the literature on price discovery under demand uncertainty in Information Economics — serve as building blocks to develop a theory of Group-Buying. We compare the performance of Group-Buying with that of the market mechanism most widely used in electronic markets — simple posted prices — and identify the conditions under which each dominates.

The remainder of this paper is organized as follows. In the next Section, we lay out our research objectives. In Section 3, we provide a comprehensive review of the current state of praxis, by surveying a variety of Group-Buying practices, world-wide, in the B2B, B2C and non-profit sectors. In Section 4, we review the relevant prior research and comment on important results that are relevant to our research. In Sections 5, 6 and 7 we develop three different analytical models of demand uncertainty and compare the performance of the two market mechanisms (Group-Buying and posted pricing) in each case. In Section 8, we discuss the managerial implications of our research and highlight possible extensions.

Section 2: Research Objectives

Our objective is to study the phenomenon, widely seen in current practice, of web-based Group-Buying. This is a specific instance of the proliferation of complex price-discovery mechanisms enabled by the Internet and the World-Wide-Web. Electronic Group-Buying market mechanisms seek to aggregate a variety of disparate buyers via the web— remotely and asynchronously— essentially by providing them price-based incentives to participate in the market and buy the good. In what is a classic volume-discounting scheme, the market operator offers buyers lower prices for higher volumes procured collectively. The Group-Buying markets that we surveyed were all characterized by prices declining in sales volumes. Further, web-based Group-Buying was almost entirely asynchronous— users have to work against some deadlines imposed by the seller, but have considerable leeway to make their bids via the internet within the week(s) during which the object is on sale. We provide a detailed exposition of several kinds of electronic Group-Buying markets in Section 3.

We know that simple posted prices are widely used in consumer sales—in traditional approaches such as retail and catalog selling, for instance, but also in web-based selling. While the web facilitates complex selling mechanisms such as Group-Buying, a larger question is how effective are such complex schemes, relative to simple posted prices, and more importantly, under what conditions do they add the most value? Our study is focused on answering two questions, both of immediate concern to current practice:

(i) Given that a firm uses the Group-Buying (volume discounting) market mechanism to sell its product(s), what is its optimal Group-Buying (price-quantity) schedule, and what are its revenues under this schedule?

(ii) How does this optimal Group-Buying schedule compare with the other widely used market mechanism, specifically, simple posted prices? Specifically, what market conditions and product characteristics would justify the use of Group-Buying over posted prices?

The practical application of insights into these two questions is obvious. To the best of our knowledge, our paper is the first in academia to (i) identify and delineate the Group-Buying market mechanism, (ii) develop analytical models of this mechanism, (iii) study the optimal such schedule under a variety of parameterized market scenarios, and (iv) analyze its performance relative to the simpler mechanism of posted prices (list prices).

3. Group-Buying: The Current State of Praxis

We quote the mission statements of two market operators that we surveyed to illustrate that volume discounting and demand aggregation are at the core of Group-Buying.

"Co-buying is co-operative shopping for the 21st century. It's a really simple way of getting better value by bringing people together via the Internet. By bringing together as many members as possible, LetsBuyIt.com can negotiate lower prices with merchant partners (also referred to as suppliers) or manufacturers. The more people, the lower the prices."

- **Letsbuyit.com**

"The more we are, the bigger the negotiation power towards trusted suppliers. The immediate result? Prices that fall without having to negotiate on your own. The more we are ("many"), the happier we are ("happy") because everyone pays less and everyone benefits from a better service."

- **The HappyMany**

In our study of *currently operational*[3] online markets, we found that Group-Buying (referred to as 'co-buying' in the above quote) is a widely deployed price-discovery mechanism in a variety of markets and contexts. These markets are not limited to a particular geographic region (such as the United States) or a particular product category. We will see that the Group-Buying mechanism is extensively used in the United States,

[3] As of mid-September 2002.

Europe (including in Germany, France and the UK) and Asia (including in India, Thailand, Singapore and Egypt). This review discusses representative, interesting examples of this deployment. Given the large number of active Group-Buying sites (well over 50), an exhaustive review is beyond the scope of this paper; however, a fairly comprehensive list of 26 representative Group-Buying websites from the B2B, B2C and non-profit sectors is provided in the Appendix at the end of this document. Group-Buying schedules are employed for branded consumer products as well as intangible services such as bandwidth and network security, in both business-to-business (B2B) and business-to-consumer (B2C) markets, and in public as well as private markets. These markets are characterized by the belief that both suppliers and buyers stand to benefit through Group-buying. Evidence of this belief is adduced by the web-sites of both buyer [IRPG, APPA, TBG, GBP][4] and supplier [LBI, THM] consortia in a variety of markets, that prominently tout the benefits of Group-Buying to their members. While we documented markets in three continents that deploy the group-buying mechanism, we have restricted the discussion below to some interesting instances that are representative of several currently operational markets, or that employ theoretically interesting variants of Group-Buying, of relevance to our modeling-based analysis.

The Group-Buying site **e.conomy,** operated by **PricewaterhouseCoopers**, is a successful market based in the US [ECON]. This B2B market allows buyers to purchase indirect goods and services such as office supplies, 'temps' (temporary staffing services), furniture, commercial print, computer hardware, software, telecommunications & connectivity, and company travel, at substantially reduced prices that result from higher purchase volumes. Members are assured of an initial maximum price (a 'price ceiling'). As they place orders, incrementing the total volume demanded, the resulting price-declines are broadcast (and available to all) until the market clears at a predetermined time. **Let'sBuyit.com**, quoted in the beginning of this Section, is a consumer group-buying market currently functional in the UK, Germany and France, that works in a manner very similar to the e.conomy model. Demand is aggregated across multiple buyers, and prices decline with increasing volumes until they reach a stable level. All buyers pay the same market-clearing price. A nuance to the standard Group-Buying mechanism that this company permits is that buyers can choose *not* to declare a price ceiling—buyers' greater risk without a price ceiling may be offset by guaranteed availability of the good at the common, lowest price. In the words of **Let'sBuyit.com**, "…Before you join a Co-buy, you need to decide whether you would like to buy at the current price – the price reached when the Co-buy closes - or at the Best Price only. If you choose to buy at the current price, you will receive the product (provided your payment details are accepted) and you will pay the closing price. If you choose to buy at the Best Price and the Best Price is not reached (i.e. the required number of participant Co-buys is not reached), you will not receive the goods. Your order will be cancelled and you will not be charged…" Product categories sold in this market include exercise equipment, consumer electronics, sport and leisure, food and wine, and jewelry.

[4] Capital letters in square parentheses refer to websites of companies listed in '*Group-Buying Markets: Citation List'* provided at the end of this document.

The **Group-Buying Partnership** in the United Kingdom is a consortium of small and medium sized businesses which negotiates volume discounts from suppliers of items such as electricity and gas, computer equipment, office supplies and vehicles, and passes these discounts on to buyers [GBP]. They claim on their web-site that "Group Buying offers a simple and cost effective opportunity for small to medium sized businesses to combine their individual buying power for the overall benefit of each individual member" [GBP]. The mechanism works through a process of demand aggregation wherein buyers commit to purchase quantities subject to certain price ceilings-- should the consortium succeed in procuring the quantities at or below these price ceilings, the buyers are obliged to follow through on their commitments. This is a direct correlate of *purchasing commitment conditional on demand realization* modeled in our paper. A different flavor of this practice can be found in the market called **Chennai Online**, which targets buyers who are redistributors [COL]. This electronic group buying market (run out of India) is a private market that allows buyers to place orders by specifying price-quantity schedules where purchase is required only if the supplier is able to meet the price specified by the buyers. What is interesting in this context is the order of events that lead to price discovery. In the case of products such as software suites for office use, magazines and periodicals from the popular press and computers (servers and PCs), the supplier announces prices at different levels of demand (price-quantity schedules) and the buyers place bids serially until the market clears at a particular price. In a second category of goods that includes kitchen appliances, computer peripherals, consumer electronics and electrical appliances, the sequence of demand solicitation and production (or procurement) of the goods is reversed. In this case, suppliers commit to a group-buying schedule and demand is realized when a stable price-quantity tuple is reached. Then, suppliers either produce the goods (kitchen appliances and computer peripherals) or buy them from third parties (consumer electronics and electrical appliances) in exact quantities. Thus, while production and inventory stocking decisions precede pricing in the first category (modeled in Case 1, Section 4 of our paper), the second category is an example of *production postponement* (the Case 2, Section 4 model).

Another version of the Group-Buying mechanism called **StockBuzz** (run out of Thailand) is operated by Asian producers of high quality yarn who sell their products to manufacturers of high-end apparel [STBZ]. The apparel manufacturers forecast demand based on a number of macroeconomic factors, past sales data, seasonality and, most importantly, retailer feedback. Since most of the manufacturers sell to the same retailers and in the same urban markets, their demand estimates tend to be highly correlated, and reflect consumer demand cycles. The yarn producers in turn face uncertainty in demand, which tends to fluctuate between a robust (high demand) regime and a weaker regime reflective of an adverse consumer demand cycle. Thus the yarn producers estimate the probabilities of these two market states, based on prior seasonal data and other available information. Using the two estimated demand schedules as guide rails, they commit to a schedule of prices for different quantities with prices declining in quantities. Buyers (apparel manufacturers) are allowed to place conditional orders which they are then obliged to honor should the price reach the levels specified in the order contract. In this case, yarn suppliers use Group buying as a response to uncertainty about which of the two states of demand will be realized (modeled in Cases 1 & 2, Section 2 of our paper).

Group-buying mechanisms are also observed in specialized markets. In the hotel and restaurant industry the **Independent Restaurant Purchasing Group** (IRPG) brings together over 3000 restaurants across the United States and negotiates volume-based discounts with suppliers on their behalf [IRPG]. IRPG argues that the benefits of its Group-Buying scheme, called the IRPG Volume Rebate Program, for its members are two-fold. Firstly, buying power is enhanced for large chains as well as small restaurants: "Our national and regional contracts are based on the total volume of our group versus that of an individual restaurant. No matter how many restaurants you have the IRPG can add strength and stability to your purchasing power." Secondly, many manufacturers insist on minimum volumes for doing business with them, out of efficiency considerations arising from their production and transaction scale economies. Smaller restaurants often find it difficult to meet these minimum criteria. As IRPG argues, "Most restaurants, by themselves, would probably not meet the manufacturer's minimum volumes. However, when combined with those of the entire membership they exceed the minimum and in many instances qualify for further "multi-unit-allowances" normally only available to large chain accounts." [IRPG]. In the skin-care product market, the market operator '**The Buying Group**' [TBG] operates a relatively straightforward group-buying scheme where buyers commit to quantities at a maximum price. The market operator then negotiates a price from suppliers for the aggregate quantity, and shares the benefits of the lower prices with the buyers (here again, we see *'procurement postponement'*, studied in Section 4 of the paper.). A noteworthy feature seen in this market is the pre-order feature wherein buyers *'express an interest'* in a product that is *not* currently featured in the market, and pay for their desired quantities upfront, at pre-specified prices. If there is enough interest, the market operator (in this case, **The Buying Group**) attempts to procure the product at a price that will make trade possible for at least some buyers. If the market operator succeeds, he charges all buyers (who are willing to pay the clearing price or more) the same floor price. If trade is not possible, the market operator refunds the buyers' paid-up amounts. The requirement that buyers commit to a quantity and price by paying the amounts upfront ensures that buyers do not make frivolous bids, and also provides an incentive for the market operator to negotiate with suppliers.

Branded consumer goods are also sold via the Group-Buying mechanism. Two companies, **McNopoly** and **Online Choice**, operate markets that allow consumers to bid for specific branded items from a menu of offered items [MPLY, OLC]. If their suppliers offer discounts that support a market-clearing price, those consumers whose bids for the products were higher than the market-clearing price are required to buy the products; the others exit the market.

Many firms operating in the non-profit sector are also using Group-Buying. We found that the **Maryland Public Service Commission** supports individual buyers in their efforts to form buying groups to negotiate better rates for higher aggregate levels of power consumption [MPSC]. Similarly, the **American Public Power Association** and the **Environmental Action Foundation** have launched a number of Group-buying initiatives that bring together consumers to negotiate lower rates with power utilities across the US [APPA].

To summarize, we find evidence of widespread deployment of Group-Buying as a price-discovery mechanism in both B2B and B2C sectors. A key feature that sets *all* Group-Buying schemes apart from other market mechanisms is suppliers' beliefs that pre-committing to a price-quantity schedule where the prices are monotonically declining in *total* purchase quantities (and not just an individual buyer's purchase quantities) will maximize supplier revenues by inducing greater buyer demand. Thus, Group-Buying is very often targeted towards buyers with low bargaining power-- individual consumers or small to medium businesses. In fact, many websites across all types of products, services and countries, explicitly and prominently claim that 'enhanced buyer bargaining power' is the single biggest advantage of Group-Buying. The market operator **Let'sBuyIt.com** summarizes this belief: "We make it easy for our members to come together online to benefit from collective purchasing power. The more members that join a Co-buy, the lower the price becomes…." [LBI]. Similarly, the Group-Buying intermediary **Printing Industries of New England (PINE)** asserts on its website, "PINE has made arrangements with several companies — companies you use in running your business — to provide discounts on their products and services. PINE combines the overall buying power of its 513 member companies to negotiate these discounts. These are discounts you may not be able to receive if you were to negotiate directly with each company" [PINE]. The construction industry's portal site in India, **BuildByte** [BBYT] puts it even more succinctly, "Bigger the volume - Lesser the price."

We saw that the Group-Buying schemes also differ in the order of events that lead to price discovery. We found that, in some cases, suppliers first commit to a price schedule leading to demand realization, and then produce (or procure) the products in volumes exactly calibrated to the realized demand. In other cases, suppliers first produce (or procure) products and then sell via a Group-Buy market through a volume discounting mechanism. *Ceteris paribus*, the former approach leads to higher supplier profits but is not always feasible due to long production/procurement leadtimes. However, the important practical question of *whether* to adopt Group-Buying when production postponement is or is not feasible hinges on the *relative* performance of Group-Buying vis-à-vis posted pricing in these two cases. Since the answer is by no means obvious, our model and analysis in Section 5 attempts to shed light on this question.

More generally, the widespread use of Group-Buying in practice is predicated on a number of unverified, seemingly 'commonsensical' assumptions (reflected above in the quotes from various companies). Our paper aims to provide a more analytical response to this discourse, and verifies the extent to which these underlying beliefs are true under various market conditions, through the artifice of mathematical modeling.

3. The Group-Buying Mechanism: Theoretical Underpinnings

The Group-Buy business model has two components: *(i)* a quantity discount scheme offered by the seller; and *(ii)* decentralized decision making by the buyers (consumers), who need to coordinate their actions to the extent possible. Thus, two streams of literature are particularly pertinent to our analysis: *(i) Quantity Discounts*; and *(ii) the Coordination Problem*. These are individually discussed below.

3.1 Quantity Discounts

Quantity (or Volume) discounts have a long and well-studied history in the context of trades between businesses. There is a rich stream of academic literature in Operations on quantity discount schemes [cf. Monahan (1984), Lee *et al.* (1986), Kohli *et al.* (1989)]. The purpose of quantity discounts is to encourage the buyer(s) to purchase more of the seller's good, or, at least, in larger batches. There are two popular forms of quantity discounts—*all-units* and *incremental* [Nahmias (1997)]. The usual structure of such schemes is that there are *breakpoints* defining changes (decreases) in the unit cost. Under *all-units*, the discount is applied to all the units in a given order; under the *incremental* discount scheme, the discount applies only to additional units beyond the breakpoint (see Nahmias (1997) for examples of each). The more popular all-units discount scheme is relevant to Group-Buy schemes employed by the Home Shopping Network, MobShop and other players. Kohli *et al.* (1989) make the strong claim in their paper that "from a transaction-efficiency perspective, the choice between incremental and all-units discounts is a matter of firm or industry practice, not a result of their desirability for the buyer, the seller, or the buyer-seller system." As we will demonstrate in the paper, this finding (which applies to quantity discounts in a traditional context) does not hold for the case of Group-Buying, where the outcomes for both buyer and seller critically hinge on the structure of the discounts offered. In fact, it is very important under the Group-Buying scheme that early bidders are not penalized by higher prices. The guarantee that early bidders, who are presumably those with higher expected utility from the good, will pay the lowest price offered to any buyer, promotes their entering the market early. This lowers prices and encourages other customers to follow suit. Thus, consumers face a *coordination* problem.

The Economic-Order-Quantity (EOQ) formula gives the optimal order quantity for a buyer who has scale economies in procurement or production; the EOQ trades off set-up costs and holding costs. Monahan (1984) extends this idea by deriving the optimal pricing schedule that a supplier should offer, given that the buyer subsequently optimizes her profits by ordering appropriate quantities. This induces EOQ-like buyer behavior, or increases the optimal order quantity over that without quantity discounts. While Monahan (1984) assumes that the supplier produces in lot sizes that mimic the buyer's orders, Lee et al. (1986) extend the analysis to the case where the supplier can use a different lot size from the buyer. This makes the supplier's analysis more challenging, since both production batch-size and frequency are now decision variables. The supplier offers a quantity discount scheme that optimizes over two different effects: *(i)* the buyer's actual orders (as in Monahan (1984)), and *(ii)* the supplier's actual production schedule, which determine his production and inventory costs. Kohli et al. (1989) analyze quantity discounts as the outcome of cooperation (through bargaining or negotiation) between buyer and supplier, and study the praetor-efficient outcomes of different axiomatic bargaining solutions due to Nash, Kalai and Smordinsky, and Eliashberg.

A common feature of the academic literature discussed above [Monahan (1984), Lee *et al*. (1986), Kohli *et al*. (1989)] is their focus on quantity discount schemes as an instrument to improve *transaction efficiency*. While this may be part of the proffered rationale for Group-Buy schemes, and more generally for all web-based models that discharge the function of *demand aggregation*, the major use in practice of Group-Buy channels has been for *price discrimination*. Economists have analyzed the use of nonlinear pricing such as quantity discounts for second-degree price discrimination [Tirole (1989)]. Group-Buying involves both waiting and uncertainty on the part of the buyers before they know the outcome (the market clearing price). Firstly, the sale has to be kept open long enough to ensure that a sufficient number of buyers arrive at the site. Secondly, the final clearing price depends on both the number of buyers who arrive on the site and their willingness to pay for the product. If there is a strong negative correlation between customer willingness-to-wait and their valuation of the good (as is often the case), higher-valued (impatient) customers could be served through retail outlets or web-based posted prices; lower-valued (patient but price-sensitive) customers could be served through Group-Buying, since they are willing to incur the additional delay that Group-Buying entails in return for a lower expected price. Many of the Group-Buy sites offer products (e.g. electronic items) that are less than state-of-the-art, at steep discounts, while the latest product is sold in more conventional ways, using web-based posted prices, or traditional channels such as bricks-and-mortar retailers. This reduces the cannibalization of the sales of high margin, high quality items by low margin items. Even in the absence of such quality-based second-degree price discrimination, Group-Buy sites could simply serve heterogeneous customers through multiple channels. Available evidence from the business press on this subject support these hypotheses.

3.2 The coordination problem

As discussed previously, a distinguishing feature of the Group-Buy business model is that the traditional quantity discount model is overlaid with a *coordination* problem among consumers. The pure coordination problem occurs when all players optimize a common objective function; in this case, the players are said to be a *team* (Marschak (1955); Marschak and Radner (1972)). Clearly, the customers under Group-Buy are not operating as a team; they maximize their expected individual surpluses from their purchases. However, each consumer's behavior (whether bidding or not bidding, and the timing of the bid) affects other consumers' surplus. Thus, the literature on externalities is of relevance to the Group-Buy problem.[5] Under *negative externalities*, each incremental customer inflicts an extra cost (or loss of benefit) on all the others. The classic example of a negative externality is the presence of congestion effects that dampen system performance: each additional customer increases the system congestion and inflicts additional delay costs on all other consumers. In contrast to such negative externalities, the coordination problem in the case of Group-Buy is more benign – a bidding consumer induces a positive externality on all other consumers, since his bid can only benefit other consumers by lowering the expected clearing price. Further, since the final clearing price

[5] There is a vast literature on externalities, a discussion of which would take us too far afield from the focus of this paper. The famous 'public good problem' of economics is an example of this, and is discussed in most graduate textbooks in economics (cf. Mas-Colell et. al (1995)).

is the same for all consumers (analogous to the *all-units* quantity discount model discussed previously, rather than the *incremental* discount model), the consumers' incentives are 'almost team-like', i.e., almost perfectly aligned. Under certain conditions, the consumer will bid for the good even above his reservation value, since his bid may induce others to bid, causing the price to fall below his reservation value. Thus, in expectation, the consumer may be better off by bidding for the good above his reservation value. The supplier can and should build this factor into his discounting schedule. The appropriate schedule can trigger an avalanche of bids due to positive externalities[6]; this feature of the Group-Buy scheme distinguishes it from all other market mechanisms, notably posted prices and auctions.

4. Models of Demand Uncertainty

A monopolist's choice of pricing mechanism is often driven by the nature of the demand uncertainty that he faces. Web-based Group-Buying schemes are predicated on offering buyers discounts for higher volumes of purchases. As discussed earlier, in a Group-Buy scheme the seller declares a price-quantity schedule, where the price drops as quantity increases. Buyers arrive at the market and declare their intent to buy at the current price point. As the quantity demanded exceeds a predetermined (and preannounced) level, the price drops to the next lower price point. This in turn encourages more buyers to bid. *All* buyers get the good at the settlement price, which is the price point at which the price stabilizes. Clearly, the settlement price is not more than (and usually less than) buyers' bids.

When the seller knows the structure of the demand with certainty, he will not resort to a Group-Buying scheme; he can do as well by offering a fixed price that maximizes his expected revenue. This is because, when the nature of the demand (function) is known, the seller can calculate the exact settlement price from a Group-Buying scheme, and simply announce a posted price equal to that settlement price. It is only when the seller is not sure about the structure of the demand that he would resort to Group-Buy schemes. We analyze the impact of different kinds of demand uncertainty on the seller's pricing strategy and compare the performance of the two pricing mechanisms (Group-Buying and posted prices) under each.

4.1 Model of Parallel Demand Regimes

We construct a theoretical model of a monopolist-seller facing demand uncertainty. The seller has an estimate of the demand for his product (at every possible price) but does not know it exactly. The monopolist operates in one of two demand regimes (which we term high / low) each of which is equally likely. The monopolist cannot observe or infer the demand regime prior to the pricing decision. The market consists of a fixed number of buyers transacting within a single period. Each buyer demands exactly one unit of an indivisible good. The monopolist seeks to sell a quantity Q. The demand for the

[6] The term 'externalities' here should not be confused with 'network externalities', which is a demand side phenomenon under which the installed base of users of a network experience gains in value when the size of the network expands due to adoption by new buyers. Network externalities are just one of many different kinds of externalities.

monopolist's product is determined by a number of factors, including product attributes and consumer preferences, the availability of complementary or substitute products and a host of macroeconomic factors. He has to choose from one of two pricing mechanisms: Group-Buying or posted prices.

As discussed above, a general feature of all Group-Buy schemes is that the price is decreasing[7] in the *total* quantity demanded. We preserve this feature in our model, where the price schedule consists of two or more price points corresponding to different quantities demanded. Further, the *offered price*[8] should be decreasing in the quantity ordered, or equivalently, we need that $\forall (q_i, p_i)$ and $(q_j, p_j): q_j > q_i \Rightarrow p_j \le p_i$.

With the above formulation we turn to the monopolist's revenue maximization problem under Group-Buying.

We assume that demand for the good is linear, and given by: $Q(p) = a - m \cdot p$.[9] Under the ***high*** and ***low*** demand regimes, the demands are given by: $Q_h(p) = a_h^{'} - m \cdot p$ and $Q_l(p) = a_l^{'} - m \cdot p$ respectively, where $a_h^{'} > a_l^{'}$. Without loss of generality, we normalize m to 1 and the resulting demand curves are given by:

$$q = a_h - p \text{ and } q = a_l - p.$$

This formulation results in parallel demand curves for the two regimes. We will consider the case when the two regimes have non-parallel demand curves in models that follow. The two demand regimes are shown in Figure 1 below: the *high* demand regime is the outer demand curve.

[INSERT FIGURE 1 HERE]

Thus the monopolist's problem is to pick a price-quantity schedule that will maximize his expected total revenue[10] without knowing which of the two demand regimes is realized. Since there are only two demand regimes, the monopolist will pick a pair of price-quantity tuples $[(q_1, p_1), (q_2, p_2)]$, with one tuple corresponding to each regime, such that the expected revenue is maximized, subject to the condition that $q_2 > q_1$ and $p_2 \le p_1$. The notation $[(q_1, p_1), (q_2, p_2)]$ means that the seller charges the price p_1 when the total sales quantity is $\le q_1$, and p_2 when the total sales quantity is $> q_1$

[7] We do not assume monotonicity although monotonicity would strengthen our results.
[8] We distinguish between offered and realized prices here since a single price may be realized which is one of the many offered prices.
[9] The linear demand curve is of course widely used in the Economics literature, to capture the relationship between prices and quantities (cf. Tirole (1989)).
[10] Since production precedes pricing in our model, we are justified in treating the marginal cost as sunk and therefore maximizing revenues (as opposed to revenues net of cost of production). It will be clear from inspection that the solution and the ordering of market mechanisms by revenues will not change if a positive marginal cost were to be factored into the analysis. When pricing precedes production, the marginal cost might matter: in this case (studied in a later Section), our analysis assumes a non-zero marginal cost.

but $\leq q_2$. Further, *incentive compatibility constraints have to be satisfied*, to ensure that under each regime, the price-quantity pair that is operationalized is the one that the monopolist intended for that regime. Thus, under each regime, the equilibrium outcome should be that the customers, while maximizing their own value, *prefer* the price-quantity pair intended for them, rather than the alternative. The implementation of this idea, in connection with the well-known *revelation principle* of economics,[11] will become clearer in the exposition below.

The seller has two alternatives open to him: *(i)* pick the higher price point from the high demand regime (and therefore the lower price point from the lower demand regime). This would imply that he expects to realize a higher quantity of sales from the lower demand regime[12]; *(ii)* pick the lower price point (and therefore higher sales quantity) from the higher demand regime and the higher price point (and therefore lower sales quantity) from the low demand regime. Figures (2) and (3) illustrate options *(i)* and *(ii)* respectively.

Case 1: Higher price point is picked from the high demand regime (see figure 2).

[INSERT FIGURE 2 HERE]

In Figure 2, $q_1 = a_h - p_1$ and $q_2 = a_l - p_2$. The quantity q_1 acts as a limit for the higher price p_1. The seller will offer the following pricing scheme[13]:

$$\text{Price } P = \begin{cases} p_1 \text{ if quantity } q \leq q_1 = a_h - p_1, \\ p_2 \text{ otherwise,} \end{cases}$$

subject to the constraints[14] $p_1 \geq p_2$ and $q_1 \leq q_2$. Under this scheme the price (outcome) will always be p_2 irrespective of the demand regime that is realized. Consider the following two scenarios: If the lower demand regime is realized, the price that will prevail is p_2 and the quantity sold will be given by $q_2 = a_l - p_2$. If the higher demand regime is realized, then seller would want the price to remain at p_1; however, buyers in this demand curve would demand a quantity given by $q_2 = a_h - p_2$ which is greater than $a_h - p_1$. As a result, the seller would have to offer the lower price corresponding to the higher quantity level. This leads us to our first result about the seller's optimal revenue.

Lemma 1: *The seller's total revenue in expectation when he chooses the higher price point from the higher demand regime is given by:*

[11] For an excellent exposition of the Revelation Principle, see Mas-Colell et. al (1995) or Myerson (1991).
[12] A higher price implies a lower quantity and vice versa in a Group-Buy pricing schedule.
[13] It will be clear by inspection that this pricing scheme maximizes the seller's revenues under Case 1.
[14] These constraints result from the definition of Group-Buy mechanisms: higher quantities lead to lower prices.

$$p^*\left[(q_1, p_1),(q_2, p_2)\right] = \frac{(a_h + a_l)^2}{16},$$

and the optimal price P^* *is given by* $P^* = \frac{a_h + a_l}{4}$.[15] (3.1)

Remarks:

1. The above scheme is in essence a single price scheme (fixed price) since only a single price will prevail irrespective of which demand is realized.
2. We do not specify what p_1 should be since this price is never realized. By assumption of this Case, the only constraint on p_1 is that $p_1 > p_2$.

Case 2: The seller picks the lower price point from the high demand regime and the higher price point from the low demand regime.

[INSERT FIGURE 3 HERE]

In this case, the seller will offer the following pricing scheme:

$$\text{Price } P = \begin{cases} p_1 \text{ if quantity } q \le q_1 = a_l - p_2, \\ p_2 \text{ otherwise,} \end{cases}$$

subject to the constraints $p_1 \ge p_2$ and $q_1 \le q_2$.

Now the separator between the two pricing points is the quantity q'_2, which ensures that, in the event the low demand regime is realized, the price does not slide down to p_2. In this case separation of prices across the two demand regimes seems possible.[16] Of course, if the seller could maximize revenues individually in the two markets, the revenue-maximizing prices in the high and low demand markets would be, respectively, $p_1^* = \frac{a_l}{2}$ and $p_2^* = \frac{a_h}{2}$, with the corresponding sales quantities $q_1^* = \frac{a_l}{2}$ and $q_2^* = \frac{a_h}{2}$. However, this solution is infeasible under the Group-Buy mechanism, since the constraint that the price should be *decreasing* in quantity demanded is violated (since $p_1^* > p_2^*$ **and** $q_1^* > q_2^*$). Since separate maximization of revenues across the two demand regimes leads to an infeasible price-quantity schedule, we need to maximize the seller's revenue within the feasible set of prices. Lemma 2 provides the optimal solution.

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[15] Proof of this and all other propositions can be found in the additional document entitled "Proof Of All Results".

[16] Recall that the seller's objective is to implement a different price in each demand regime to optimize his total expected revenue.

Lemma 2: *The optimal (revenue-maximizing) prices and seller profits under group-buying are given by*

$$\begin{cases} p_1^* = p_2^* = \dfrac{a_l + a_h}{4} \text{ and } p_G\left[(p_1, q_1), (p_2, q_2)\right] = \dfrac{(a_l + a_h)^2}{16}, & \text{if } a_l \geq a_h\left(\sqrt{2} - 1\right); \\ p_1^* = p_2^* = \dfrac{a_h}{2} \text{ and } p_G\left[(p_1, q_1), (p_2, q_2)\right] = \dfrac{a_h^2}{8}, & \text{otherwise.} \end{cases}$$

In particular, any feasible group-buy schedule that sets the prices such that $p_1^* \neq p_2^*$ *yields revenues less than the above solution.*

Remarks: Thus the monopolist is unable to exploit the Group-Buying price schedule to implement discriminatory pricing based on which demand regime is realized. Since $p_1^* = p_2^*$ under the optimal Group-Buy scheme (i.e., the price is independent of the demand regime), the monopolist can clearly do as well using posted prices, by setting his price $p^* = p_1^* (= p_2^*)$. The seller's revenues under Group-Buying and posted prices are identical.

The following Proposition derives from Lemmas *1* and *2*.

Proposition 1: *Under the above model of demand uncertainty, the seller's revenues from Group-Buying can never exceed his revenues from simple posted prices. In fact, the optimal (revenue-maximizing) Group-Buying scheme simply mimics the optimal posted price. Any deviation from posted pricing (such as differential pricing to discriminate between realized demand regimes) will lead to sub-optimal revenues for the seller.*

Remarks:

1. The above analysis shows that the revenue from Group-Buy schemes may at best equal the revenue to the monopolist from posted pricing. However, when the two revenues are equal it is important to note that the Group-Buy scheme does in effect act as a posted price market. In Case 1, the price p_1 always slides down to p_2, thereby establishing a single-price equilibrium across the two demand regimes. In Case 2, the monopolist is able to offer a separation of prices based on quantity demanded, but the revenues from posted prices dominate the resulting revenues from Group-Buying.

4.2 Model of Intersecting Demand Regimes

In the previous section, we considered the case of demand uncertainty wherein the two demand regimes were parallel. This implied that at any price the quantity demanded under one demand regime dominated that demanded under the other. We now consider demand uncertainty where one demand regime does not universally dominate the other. Specifically, we study the case when the curves for the two demand regimes intersect: one regime may result in a higher quantity demanded for one range of prices, while the other regime may dominate over another range of prices (see Figure 4). We derive the optimal revenues from Group-Buying and posted price markets and compare the two.

[INSERT FIGURE 4 HERE]

Figure 4 shows a case of intersecting demand curves. The generic linear demand curve is given by $Q = A - mp$. Let the two curves be given by:

$q = a - m_1 p$ and $q = b - m_2 p$ *where* a>b *and* $m_1 \geq m_2$. Let $m = \frac{m_1}{m_2}$. We normalize m_2 to 1 so that the two demand curves are given by $q = a - mp$ and $q = b - p$, where $a > b$ and $m \geq 1$. Further, as seen in Figure 4, the two curves intersect only when $b > \frac{a}{m}$, and we assume that this condition holds.

Each demand regime can occur with equal likelihood, and the seller has to set prices before the demand regime is realized. Under Group-Buying, the seller picks a price-quantity schedule as before. He offers prices of p_1 and p_2 for quantities demanded up to the thresholds q_1 and q_2 respectively, where $q_1 \leq q_2$ and $p_1 \geq p_2$. We now determine the maximum revenue and the optimal values of p_1 and p_2 under Group-Buying.

Lemma 3: *For the model of intersecting demand regimes described above, the profit maximizing Group-Buy price-quantity schedule is given by:*

$$\text{Price } P^* = \begin{pmatrix} p_1^* \\ p_2^* \end{pmatrix} = \begin{cases} \frac{b}{2}, & \text{if quantity demanded } q \leq b - \frac{a}{2m}; \\ \frac{a}{2m}, & \text{otherwise.} \end{cases} \qquad (3.2)$$

The seller's expected revenue is $p\left(p_1^*, p_2^*\right) = \frac{a^2 + mb^2}{8m}$.

(3.3)

Remarks:

1. The seller chooses the quantity $b - \frac{a}{2m}$ to separate the two prices. This should be seen as a preventive measure to stop the market from clearing at a sub-optimal price. This price-separation quantity can be explained as follows. The seller wants to realize (p_1, q_1) when the realized regime is $q = b - p$, and (p_2, q_2) when the realized regime is $q = a - mp$. If the demand regime given by $b - p$ is realized, the price could slide down to p_2 when the optimal price is the higher p_1 (see figure 4). At a price of p_2, the induced demand (under the regime of $q = b - p$) is

given by $q_2^{'} = b - p_2 = b - \frac{a}{2m}$. However when the seller specifies that the minimum quantity demanded (for a price of p_2 to be offered) should be greater than $b - \frac{a}{2m}$ it prevents the market from clearing at a price of p_2 under this demand regime.

2. If the demand regime given by $a - mp$ is realized, then the choice of $q_2^{'} = b - \frac{a}{2m}$ as the quantity-discount threshold will not affect the market-clearing price since the demand induced by $p_2^* = \frac{a}{2m}$ is $q_2^* = \frac{a}{2}$, and we can easily check that $q_2^* > q_2^{'} = b - \frac{a}{2m}$. Thus the choice of $q_2^{'} = b - \frac{a}{2m}$ as the quantity-discount threshold preserves the profit maximizing prices under both regimes for the seller.

We now derive the seller's optimal price and revenues under posted pricing, and compare these with the optimal prices and revenues under the Group-Buying mechanism, in the following proposition.

Proposition 2: *In the case of intersecting demand regimes,*

(i) *The profit maximizing price and revenues under posted pricing are given by* $p^* = \frac{a+b}{2(m+1)}$ and $p\left(p^*\right) = \frac{(a+b)^2}{8(m+1)}$.

(ii) *The difference in revenues between the optimal schedules for Group-Buying and posted pricing is given by* $p_g - p_p = \frac{(a-bm)^2}{8m(m+1)}$ *> 0. Thus, the revenue to the seller from Group-Buying strictly dominates the revenue from posted pricing.*

Thus, unlike the earlier case of parallel demand curves (wherein the two demand regimes had identical slopes), Group-Buying outperforms posted prices for intersecting demand curves, wherein the two demand regimes have different slopes. Group-Buying does better under greater demand heterogeneity because it enables the seller to set (non-linear) price-quantity schedules that optimize revenues under each demand regime, thus maximizing his total expected revenues. With greater heterogeneity in demand regimes, it is easier to induce a self-selective second-degree[17] price-discrimination among customers, via quantity-discount schemes.

However, when the seller relies on posted prices, the single quoted price is ineffective in exploiting the demand heterogeneity. Here, the seller is forced to make a trade-off between revenues in one demand regime and revenues in the other.

[17] See Tirole (1989).

Making this tradeoff leads to lower overall expected revenues as well. The posted price mechanism makes this tradeoff in the case of parallel demand curves as well, but since Group-Buying is also ineffective in enforcing price-discrimination (due to the homogeneity of the demand regimes), posted prices perform as well as Group-Buying in the earlier case.

We expect, therefore, that as the *heterogeneity* of the demand regimes increases, Group-Buying would become more attractive relative to posted pricing, while demand homogeneity would neutralize the advantage of pricing flexibility (enabling second-degree price discrimination) that Group-Buying pricing mechanisms offer. Since the heterogeneity in the two demand regimes stems from the difference in the slopes of the two demand curves, and $m = \frac{m_1}{m_2}$ measures this difference, we expect that the gains from Group-Buying increase in *m*. Proposition 3 below establishes that this is indeed the case.

Proposition 3: *The gains from using the Group-Buying mechanism increase as the demand heterogeneity* (m) *increases.*

Remarks:

1. Note that the demand curve given by $q = a - mp$ is anchored at the point $(a,\ 0)$ on the quantity-axis, for all *m*. As the relative-slope parameter *m* increases, this curve rotates downwards counter-clockwise (see Figure 4). Hence the quantity-price coordinate at which the two demand curves intersect, given by $(q, p) = \left(\frac{a - bm}{m-1}, \frac{a-b}{m-1}\right)$, moves down and to the right. As this happens, the dominance of the demand curve $q = b - p$ over the other ($q = a - mp$) increases; this *asymmetry of dominance* translates of course to greater demand heterogeneity. Thus, as the *asymmetry of dominance between the two demand regimes* increases (i.e., demand becomes more heterogeneous), Group-Buying schemes become more attractive relative to posted pricing.

5. Pricing and Production: Timing and Scale Economies

Our previous models implicitly assumed a certain sequence of events. For example, the assumption of zero marginal costs is reasonable when production costs are sunk; i.e., the commitment to production quantities precedes the pricing decision. When pricing follows production, there are fewer degrees of freedom in the pricing decision, under both Group-buying and posted prices. Perhaps the seller is unable to exploit the richer space of price schedules under Group-Buying (compared to posted prices), because of the limited flexibility in pricing. Put differently: under a different sequence of events, with greater freedom in the *timing of the pricing decision,* Group-Buying might outperform simple pricing. A related issue is the absence of scale economies in our previous models. After all, since Group-Buying is an extension of traditional quantity discounting, its greatest benefit might be precisely to maximally exploit scale economies.

This Section throws the spotlight on these two issues: In the relative performance of Group-Buying versus posted prices, *(i)* what is the impact of economies (or diseconomies) of scale, and *(ii)* does the order of production versus pricing matter? We analyze two different scenarios in this Section.

Scenario 1: Pricing follows production / procurement: This corresponds to the case where the firm has already committed to production or procurement, and now needs to determine the optimal price (in the case of posted prices) or price-quantity schedule (in the case of Group-Buying). Thus, when the firm determines the price or price-schedule, it has no control over production quantities. It may choose to sell less than the entire quantity available. This scenario is realistic particularly under long production or procurement lead-times, when the firm has to commit *ex ante* to purchase or production quantities.

Scenario 2: Pricing precedes production / procurement: This corresponds to the case where the firm has the option of deciding on the production quantity after determining the quantity demanded for its price or price-schedule. This is feasible when production or procurement lead-times are sufficiently small.

In a model such as ours, where the uncertainty is on the demand side rather than in production, the firm will do better when pricing precedes production/procurement (which is a form of production postponement), than when it has to commit early to production quantities, under either market mechanism. Our interest, however, is in comparing the relative performance of the two market mechanisms (posted prices and Group-Buying) under each case, to see if the order of production and pricing affects the choice of the market mechanism employed. We first analyze scenario 1, under the additional assumption of constant marginal costs.

Case 1a: Pricing follows production / procurement under constant marginal production costs:

We assume that there are two *types* of buyers (customers) in the market, and N customers of each type. As N is a multiplicative factor that characterizes all revenue expressions under both mechanisms and since we are interested in a comparative ranking of the two mechanisms we will omit N from further analysis. It is evident from inspection that this does not alter our results in any fashion. Each type of customer is homogeneous in valuation, and buys at most one unit of the good. The valuation of each type is drawn uniformly from the unit interval [0,1]; this is common knowledge. Thus, one customer type has a higher value than the other with probability *1*. We assume that the supplier is a monopolist. Production is *ex ante*; i.e., the supplier commits to the total production quantity before the revelation of demand through the price (or price-schedule). We also assume that both the supplier and the buyers are risk-neutral, and maximize their expected profits (value). We will first analyze the case of constant marginal production cost: we normalize the marginal cost to *0*.

We model the discovery of the optimal Group-Buy pricing schedule as a game between the monopolist and the buyers. The sequence of events is as follows. The monopolist determines his production quantity. Then he picks a price or price-schedule. Buyers then choose to buy or abstain. The monopolist 'folds' the expected resulting demand into the stage game(s) to arrive at the optimal price-quantity schedule. Recall that, under Group-Buying, each customer's bid creates positive externalities for all other customers (by lowering the expected price). Hence, each customer needs to factor in the probability of bidding by other customers (which is a function of their values), in determining her own bid. A customer will buy (bid) if her value is greater than the *expected* price. Thus, a customer may bid even when the current price under Group-Buying is greater than her value for the good-- this may induce other customers to bid, further lowering prices. The most general price schedule under Group-Buying for our problem may be represented as $[(p_1,q_1), p_2]$, which translates to a unit price of p_1 if the quantity demanded is $\leq q_1$, and a unit price of p_2 otherwise— the quantity discount is thus (p_1 - p_2). The following Theorem derives the unique (subgame-perfect) equilibrium for this game, under both posted prices and Group-Buying. To solve the Group-Buying problem, we employ the *Revelation Principle* (cf. Myerson (1991)). In the case of posted prices, a customer will buy the good if her value is greater than the price.

Proposition 4: *When pricing follows production, the unique subgame-perfect equilibrium and supplier profits under posted pricing and under Group-Buying are as given below.*

(i) *Posted Pricing:* $P_p^* = 0.5$ and $\boldsymbol{p}_p^* = 0.5$

(ii) *Group-Buying:* $P_{1g}^* = P_{2g}^* = 0.5$ and $\boldsymbol{p}_g^* = 0.5$

Thus the equilibrium solution as well as the supplier's profit are identical under Group-Buying and posted pricing.

Thus, the best that the supplier can do under Group-Buying with constant marginal costs is to mimic the optimal posted pricing scheme— offering quantity discounts does not improve the supplier's profits. However, an argument can be made that our assumption of constant marginal costs is suspect: as the academic literature previously surveyed (cf. Monahan (1984), Lee *et al*. (1986), Kohli *et al*. (1989)) indicates, quantity discounting (and, by extension, Group-Buying) is particularly effective under scale economies of production or procurement. We now extend the previous analysis to the case of production scale economies for the supplier.

Case 1b: Pricing follows production / procurement under production scale economies:

The model analyzed here is identical to that of the previous case (with identical game structure), with only one difference: the supplier's production costs are given by $c(q)$. Since production precedes pricing, it is possible for the supplier to offer *0,1* or *2* units under each market mechanism, depending on which of these is optimal. The production quantity is a decision variable, but once decided upon, production costs are *sunk* for the pricing problem. We do not impose any restrictions on *c(q)*, although we would expect that *c(0) = 0*, and *c(.)* is increasing in *q*.[18] The table below summarizes the results of the analysis under both pricing mechanisms.

Market Mechanism	**Equilibrium Solution for *q=1***	**Supplier Profits for *q=1***	**Equilibrium Solution for *q=2***	**Supplier Profits for *q=2***
Posted Prices	$P_p^* = \frac{1}{\sqrt{3}}$	$p_p^* = \frac{2}{3\sqrt{3}} - c(1)$	$P_p^* = 0.5$	$p_p^* = 0.5 - c(2)$
Group-Buying	$P_{1g}^* = \frac{1}{\sqrt{3}}$	$p_g^* = \frac{2}{3\sqrt{3}} - c(1)$	$P_{1g}^* = P_{2g}^* = 0.5$	$p_g^* = 0.5 - c(2)$

Table 1: Solution and Profits for *Case 1b*

As Table 1 shows, for each possible production quantity (*q = 1* or *2*), the equilibrium solution and supplier profits are *identical* under both posted prices and Group-Buying. While the cost structure determines the optimal production quantity (*0, 1* or *2*) and profits under each mechanism, Group-Buying does *not* do better than posted prices under every arbitrary cost-structure. In fact, the maximum profits under Group-Buying are achieved by mimicking the posted price mechanism thereby *resulting in a single price equilibrium even under the Group-Buying scheme.*

Thus, surprisingly, although Group-Buying is an extension of traditional quantity discounts with coordination among multiple buyers, its advantage (if any) does *not* derive from production (or, procurement) scale economies. However, one could argue that since production costs are 'sunk' before making the pricing decision, the preceding model does not provide adequate scope for the firm to exploit the generality of the Group-Buying mechanism. More specifically, if production decisions could be made contingent on the information revealed by the pricing mechanism, would Group-Buying outperform simple posted prices? This question is addressed below by reversing the sequence of production and pricing. We initially focus on the case of constant marginal costs, and then analyze the case of scale economies.

Case 2a: Pricing precedes production / procurement under constant marginal production costs:

This model is almost identical to that of *Case 1a*; the primary difference is that the sequence of events is slightly altered. As before we model the discovery of the optimal Group-Buy pricing schedule as a game between the monopolist and the buyers. The altered sequence of events is as follows. The supplier first quotes a pricing schedule, buyers respond with their purchase decision (demand is realized), and the supplier then tailors his production to exactly satisfy his commitments (orders). In this case too the optimal price schedule is discovered by backward-induction - the monopolist determines

[18] Assuming that *c(x)* is increasing in *q*, a concave *c(q)* would correspond to scale economies, and a convex *c(q)* would result in diseconomies of scale.

the optimal price-schedule that will lead to the optimal revenues in the terminal stage of the game.

Such *production postponement* is feasible when production lead-times are short enough and/or customers' willingness to wait is long enough. Since the supplier now has more options, the richness of the (non-linear) Group-Buying price schedule can perhaps be better exploited, to extract and take advantage of demand information.

We also assume that the marginal production cost is c per unit, where $0<c<1$. As before we model the discovery of the optimal pricing schedule as a game between the monopolist supplier and the buyers. The following Theorem derives the unique (subgame-perfect) equilibrium for this game, under both posted prices and Group-Buying.

Proposition 5: *When pricing precedes production, the unique subgame-perfect equilibrium and supplier profits under posted pricing and under Group-Buying are as given below.*

(iii) ***Posted Pricing:*** $P_p^* = \frac{1+c}{2}$ ***and*** $p_p^* = \frac{(1-c)^2}{2}$.

(iv) ***Group-Buying:*** $P_{1g}^* = P_{2g}^* = \frac{1+c}{2}$ ***and*** $p_g^* = \frac{(1-c)^2}{2}$.

The production quantities under each pricing scheme are determined by the realized orders. Thus the equilibrium solution as well as the supplier's profit are identical under Group-Buying and posted pricing.

We see that, in this case also, Group-Buying does not provide any *exploitable informational advantage* over simple posted pricing. Certainly, the supplier in our setting does not garner higher profits from the ability to tailor production to the demand revealed by the complex (non-linear) price schedule of Group-Buying. Finally we analyze the more complex case of scale economies when pricing precedes production in the sequence of events discussed below.

Case 2b: Pricing precedes production / procurement under production scale economies:

We now analyze the case where *(i)* there are production scale economies and *(ii)* the sequence of events is such that pricing precedes production. We assume that the cost of producing *i* units is c_i, for $i=1,2$; without loss of generality, we set $c_0 = 0$, i.e., there are no production-independent fixed costs. Thus, production scale economies are induced by *declining marginal production costs*. In our setting, the marginal cost of producing the second unit (given by $c_2 - c_1$) is not greater than the marginal cost of the first unit (given by $c_1 - c_0 = c_1$), i.e., $c_2 - c_1 \leq c_1$. The actual production quantities under each pricing scheme are determined by the realized orders.

The following Proposition derives the unique (subgame-perfect) equilibrium for this game, under both posted prices and Group-Buying.

Proposition 6: *Under production scale economies, when pricing precedes production, the unique subgame-perfect equilibrium and supplier profits under posted pricing and under Group-Buying are as given below.*

(i) ***Posted Pricing:*** $p^* = \frac{1 - c_1 + c_2}{2 - 2c_1 + c_2}$ ***and*** $p_p^* = \frac{(1-c_1)^2}{2 - 2c_1 + 2c_2}$.

(ii) ***Group-Buying:*** $p_1^* = \frac{1+c_1}{2}$ ***and***

$$p_2^* = \frac{1}{6}\left(4 + c_2 - \frac{6(1 - c_1 + c_2)}{2 - 2c_1 + c_2} - \sqrt{1 + 3(2 - c_1)c_1 + (c_2 - 4)c_2}\right)$$ ***and***

$$p_{GB} = \frac{1}{108}\left(52 - 72c_1 + 36c_1^2 - 15c_2 - 18c_1c_2 + 9c_1^2c_2 + 12c_2^2 - 2c_2^3 + 2\left(1 + 3(2 - c_1)c_1 + (c_2 - 4)c_2\right)^{3/2}\right)$$

We find that in this (final) case, the profits for the monopolist from Group-Buying dominate those under posted-pricing. As Figure 5 illustrates, Group-Buying does provide an *exploitable informational advantage* over simple posted pricing.

[INSERT FIGURE 5 HERE]

The difference in seller profits under Group-Buying and posted pricing when production costs change is a function of two factors: *(i) Absolute profitability,* which under either market mechanism is clearly a decreasing function of production costs- when costs (c_1 or c_2 or both) increase, the level of profits under both Group-Buying and Posted Pricing fall. *A drop in absolute profitability would tend to drive the profit difference down as well. (ii) Scale economies,* which also play an important role, as is obvious by comparing the results of our analysis of cases 2a and 2b (Propositions 5 and 6). Introducing scale economies while holding every other feature of the model constant resulted in Group-Buying dominating Posted Pricing. To illustrate, setting $c_2 = 2 \cdot c_1$ in Proposition 6 leads to $(c_2 - c_1) = c_1$, i.e., the marginal production cost of the first and second units cost are identical. Plugging these values into the profit expressions yields the profit expressions of Proposition 5-- *the two market mechanisms yield identical profits to the seller in this limiting case alone*. Further, the *degree* of economies achieved due to scale (which, in the absence of fixed costs, is measured by the concavity of costs, i.e., how steeply the marginal costs of production fall) is *increasing* in c_1 and *decreasing* in c_2. This is easily seen, because the cost of the first production unit is c_1 and the cost of the second production unit is $c_2 - c_1$. Thus, *ceteris paribus*, as c_1 increases, the first unit costs more to produce and the second costs less—the relative production cost of the second unit versus the first also falls. Similarly, as c_2 increases, the second unit costs more to produce while the first unit costs the same, and the production cost of the second unit versus the first rises.

From the preceding discussion, it becomes clear that when c_2 increases, *both* of the above drivers- absolute profitability and scale economies- work in the same direction and drive down the profit difference, as seen in Figure 5. A more interesting case is when c_1 increases: also from the preceding discussion, the absolute profitability driver will cause the profit difference $p_g - p_p$ to fall, while the scale economies driver will cause the profit difference $p_g - p_p$ to increase in c_1. Overall, the direction of change of the profit difference when c_1 increases depends on which of the two drivers dominates. Figure 5 shows that, in fact, the difference in monopoly profits between Group-Buying and posted pricing is an increasing function of c_1 for the entire feasible range of c_1 (and c_2). Thus, surprisingly, *the impact of scale economies driver dominates the absolute profitability driver for the entire feasible range of* c_1, illustrating the significance of production scale economies when pricing precedes production.

[INSERT FIGURES 6 & 7 HERE]

Figures 6 and 7 shed further light on the behavior of prices and profits under scale economies under the two mechanisms. The cost parameter for the first unit, c_1, is set to one of three values: Low ($c_1 = 0.1$), Moderate ($c_1 = 0.25$) and High ($c_1 = 0.5$). For each fixed c_1, the cumulative production cost for two units, c_2, is varied along its entire feasible range. Figure 6 plots the optimal prices under Group-Buying and Posted Prices. It turns out that $P_1 \geq P^* \geq P_2$ in all cases, with the equality holding exactly when $c_2 = 2 \cdot c_1$. In fact, P_1 is independent of c_2, but an increasing function of c_1. Intuitively, the seller cares about the value of P_1 only when exactly one unit is sold, since this is the only scenario under which P_1 affects his revenues. But then, the only cost that matters is c_1. Both P_1^* and P_2^* are increasing in c_2, and eventually converge to P_1^* when $c_2 = 2 \cdot c_1$. Under posted pricing, *the seller has to balance out the benefit of sales at a higher price* (in the event of high customer valuations) *versus the risk of losing sales at the higher price* (in the event of low customer valuations); this tradeoff is reflected in the optimal posted price P^*. Group-Buying affords the monopolist greater flexibility. Since the probability of one customer having a high valuation and the other having a low valuation is high, the seller sets P_1^* to be high to trap the high value customer's demand when one customer has a high valuation and the other has a very low valuation. This risk is offset by the safety net of a lower P_2^*, to make the sales when both customers have moderate valuations. Of course, Group-Buying has its drawbacks-- when both customers have high valuations, the price settles down to P_2^*, leaving money on the table, and when both customers have low valuations, no sales are made. But these events have a relatively low probability. Furthermore, *the cost-savings from avoiding production pre-commitment means that these losses are less than they would have been if production commitments had to be made before orders are revealed*. Figure 7 shows that for any fixed level of c_1, the profit difference is greatest for $c_2 \approx c_1$ (maximum scale economies); it falls as c_2 increases, and eventually becomes zero when $c_2 = 2 \cdot c_1$.

To summarize, when production can be tailored to meet revealed demand, scale economies allow the exploitation of non-linear pricing under Group-Buying. Of the four cases analyzed above, this is the only one in which Group-Buying outperforms posted pricing. Clearly, revelation of demand information (through a non-linear price schedule) and the optimal exploitation of that information (via sequencing production after pricing) together play a role in driving our results. In the next Section, we throw the spotlight on the role of product information as it affects the *buyer* directly (and the seller indirectly). Information can induce customer heterogeneity, and may affect the relative performance of the two price mechanisms.

6. Information and Valuation Revision

In this final Section, we model a different kind of uncertainty where buyers revise their valuation of a product based on information received about the quality and attributes of the product. When products are characterized by complexity, with variance in the sellers' reputation for service and reliability, buyers may rely on the information provided by other buyers and product reviews available in online communities [Solomon (1999)]. Online reviews of products consist of both positive and negative information about the product. Buyers process this information resulting in a change in their valuation of the product. Some revise their valuation upward while others revise their valuation downward. We model an additional layer of complexity in that the magnitude of the impact of the information – on buyer willingness to pay is not known to the seller. There are two possible states of impact, which we call *high* and *low impact scenarios* respectively. Under the high impact scenario, the extent to which information affects buyer valuations (in either direction) is given by the parameter q. Under the low impact scenario, the extent of impact is given by l. For expositional ease, we model both scenarios as being equally likely.

We assume there are n buyers all of whom enter the market with identical initial valuations of a product given by a valuation V. As before they demand a single unit of an atomic good. The sellers of the product provide information about product features and quality ratings. Information about the reliability of the seller (reputation for prompt service, accurate order fulfillment etc.) and the experience of other buyers with the product is available at the sites of third party infomediaries (such as Epinions.com and Amazon). Once buyers process this information, they revise their priors (valuations) either upwards or downwards. The impact of the information in either (high or low impact) scenario results in a fraction f of buyers revising their valuation upwards while the remaining buyers revise it downwards. We call this ratio f the *valuation revision ratio*. Under the high impact scenario, such upward revision of priors (by a fraction f of all buyers) results in a valuation of $V+q$ while downward revision results in a valuation $V-q$. Without loss of generality, we normalize the values $\{V-q,\ V+q\}$ to $\{0,1\}$ respectively. Under the low impact scenario, buyers are less affected by the information;

as before, they revise their valuations to $V + l$ and $V- l$, where $l \leq q$. When normalized, this results in values: $\left\{\frac{1}{2} - x, \quad \frac{1}{2} + x\right\}$, where $0 \leq x \leq \frac{1}{2}$. Since x is a measure of the ratio $\frac{l}{q}$ of the two magnitudes of impact (under the two scenarios), and $l \leq q$, a higher value of x corresponds to *greater symmetry of impact* between the high and low impact scenarios (l □ q), while a lower value corresponds to greater *asymmetry of impact* (i.e., l □ q) in the two scenarios. Hence we refer to x as the *impact symmetry ratio.* Note that *higher values* of the impact symmetry ratio correspond to *lower variance* in information impact, and vice-versa.

The following two Lemmas derive the optimal prices, and corresponding seller revenues, under posted prices and Group-Buying.

Lemma 4: *In a posted price market, the following are the optimal prices and the resulting seller revenues:*

1. *If* $x \leq \frac{1-f}{2+6f}$ then $P^* = \left(\frac{1}{2} - x\right)$ and $p^* = \frac{n}{2}(1+f)(\frac{1}{2} - x)$

2. *If* $x \geq \frac{1-f}{2+6f}$ then $P^* = \left(\frac{1}{2} + x\right)$ and $p^* = fn\left(\frac{1}{2} + x\right)$.

Lemma 5: *Under the Group-Buy scheme, the following are the optimal prices and the resulting seller revenues:*

<u>**Case 1:**</u> $x \leq \frac{1}{2(1+2f)}$

Price $P^* = \begin{pmatrix} p_1^* \\ p_2^* \end{pmatrix} = \begin{cases} 1, & \text{if quantity demanded } q \leq f \cdot n; \\ \frac{1}{2} - x, & \text{otherwise;} \end{cases}$

and Revenue, $p^*\left(p_1^*, p_2^*\right) = \frac{n}{2}\left(\frac{1}{2} + f - x\right)$.

<u>**Case 2:**</u> $x > \frac{1}{2(1+2f)}$

Price $P^* = \left(\frac{1}{2} + x\right) \forall \{q_1, q_2\}$, and Revenue, $p^*\left(P^*\right) = f \cdot n\left(\frac{1}{2} + x\right)$.

Finally, we compare the seller's revenues from each of these mechanisms in the following Proposition.

Proposition 7:

(i) *The revenues to the seller from Group-Buying dominate the revenues from posted price market when* $x \le \frac{1}{2(1+2f)}$ *and*

(ii) Revenues from the two mechanisms are equal when $x > \frac{1}{2(1+2f)}$. *In this case, Group-Buying cannot do better than mimicking the posted price mechanism.*

Thus, Proposition 7 shows that the relationship between the two parameters—the *valuation revision ratio f* and the *impact symmetry ratio x* — determines whether Group-Buying does better than posted pricing or not. Further, this result is independent of other parameters of the model. Figure 8 illustrates this result graphically.

[INSERT FIGURE 8 HERE]

Figure 8 shows that Group-Buying dominates posted pricing in markets characterized by a lower buyer willingness-to-pay (where the valuation revision ratio *f* is relatively low[19]). As buyers' willingness to pay increases, Group-Buying schemes are no more attractive than fixed pricing schemes. Furthermore, as the impact symmetry ratio *x* increases (i.e., variance of information impact falls), Group-Buying ceases to be the sole dominant mechanism even under low values of the valuation revision ratio. Thus, Group-Buying emerges as the dominant option only when the product is characterized by *(i)* low willingness-to-pay on the part of the buyers, *and (ii)* high variance of information impact.

This leads us to the important question: Why did the high-profile electronic Group-Buying sites aimed at consumer aggregation fail without exception, over the past few months? Our results shed some light on the reasons.

The items offered on sale on the B2C sites discussed in our introductory remarks as well as in the Trade journals cited were mostly consumer durable goods; these are characterized by medium to high *information complexity* [Notess (2000)]. For such goods, buyers operating under *'information overload'* (i.e., overwhelmed by the combination of information complexity and *bounded rationality*) often use only a subset of the information available to them[20] [Lissack (1997)], or the ratings of other buyers and online communities, to make the purchase decision [Appelman (2001)]. This leads to the well-known *herding effect*, and, in effect, to high impact-symmetry (low variation in information impact). From our previous analysis, we know that under high impact-symmetry, Group-Buying would dominate simple posted pricing only for products for

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[19] Recall that if f is low only a small fraction of buyers revise their priors upwards while a large fraction (given by $1-f$ revise it downwards.

[20] The reader is referred to [Simon (1979) , Simon(1991)] for further reading in this context.

which buyers have a low willingness-to-pay. Thus, Group-Buy sites found themselves squeezed into categories of low-margin, relatively unprofitable products: this business model was unsustainable. In fact, our survey of the popular Group-Buy sites revealed that low-end (and low margin) consumer durables such as telephones, CD players, sunglasses and Cassette Decks were the most popular items sold. In contrast, high end durables such as luxury coffeemakers, Bose Lifestyle Home Theatre systems, high-end Nikon SLR cameras and top-of-the-line Canon camcorders were conspicuously missing on the major Group-Buy sites, while readily available through a variety of fixed-price sites.

7. Conclusion and Extensions

We began by investigating some of the reasons for operating Group-Buy pricing schemes. We explored how sellers may use Group-Buy mechanisms to respond to uncertainty in demand. Our model showed that under conditions of demand uncertainty that commonly obtain, Group-Buy schemes often do not provide higher revenues to the seller. In fact, when the seller manages to induce differential pricing (i.e., multiple price points) by using quantity-based discounts, the Group-Buy scheme is often dominated by simple pricing. In such cases, the best that the Group-Buy scheme can do is to mimic posted prices, so that the seller's revenues are the same under Group-Buying and posted pricing.

While our analysis establishes that a monopolist cannot do better than a posted price market with the Group-Buy scheme, in practice Group-Buy markets are likely to under-perform posted price markets. In our analysis, we had not considered the erosion in buyer's valuation of the product from the inefficiencies surrounding the Group-Buying process, resulting from its operational dynamics. Some of the inefficiencies associated with the Group-buy scheme are as follows: A seller has to be certain about which demand regime (and corresponding price) has been realized, before he can consummate the sales to customers. For instance when a quantity $q < q_1$ is being demanded, he cannot be certain whether the price will fall to p_2 or remain at p_1. He has to wait a while before he is able to ascertain the realized demand schedule and the price[21]. Group-Buying therefore entails a waiting period for the buyers during which the seller has not determined the equilibrium price. This delay and the resulting price-uncertainty often lead to utility decay for the buyer, and since buyers can anticipate the delay (as was the case on Mercata and MobShop) this results in an *ex ante* lower willingness-to-pay on her part and thereby shifts the demand curve downward. In reality, due to coordination, waiting and uncertainty related costs, buyers' willingness to pay for these products tend to be lower than in a posted price market where the transaction is instantaneously completed. As a result, we expect to find that the Group-Buy mechanisms under-perform posted price markets. The many examples from the trade and business presses of failures of Group-Buying schemes confirm our findings.

[21] For the seller to be sure that he can offer a price p_2 he has to wait until there is a build up in the quantity demanded so that it exceeds q_1 (where $q_1 = a_l - p_1$ or $q_2 = a_h - p_2 : q_2 > q_1$).

When buyers are heterogeneous, resulting in unusual and dissimilar demand regimes, Group-Buying does offer some advantages over posted pricing. In the presence of both demand uncertainty and heterogeneous demand regimes, the seller is able to use Group-Buying to price-discriminate and capture some of the revenues lost by setting a single price across both demand regimes. As the demand regimes become more and more similar, the situation begins to resemble the cases analyzed in Proposition 1: the advantage of Group-Buying over posted pricing shrinks and finally vanishes[22].

We find that the value of Group-Buying as a price discovery mechanism depends on the nature of the uncertainty about buyer valuations in the market. When the distribution that characterizes buyer valuations is known beforehand, sellers are almost always better off by running a posted price market—in fact, the only exception was when pricing (and order revelation) preceded production and there were scale economies. However, when the stochasticity with respect to demand is generated because buyers update their prior valuations after consuming information about the product, Group-Buying strictly outperforms posted prices for the seller, for a wide range of parameter values, and does as well (by simply mimicking the fixed pricing scheme, and providing no volume discounts) in the remaining range. Here the non-linear pricing schedule afforded by Group-Buying enables precise *exploitation of consumer heterogeneity through self-selectively induced differential pricing*. Unfortunately, the range wherein Group-Buy does strictly better than posted prices (low values of both the Valuation Revision ratio and the Impact Symmetry ratio) is also characterized by *low buyer willingness-to-pay*. As a result, Group-Buy sites found themselves cornered into selling commodity-like low-margin products such as the cheaper consumer durables.

Further, given the utility decay experienced by buyers due to the nature of the market mechanism, it becomes even clearer that buyers that will be attracted to Group-Buying site will be those that are price sensitive. This when combined with the fact that Group-Buying is a dominant scheme only when a higher proportion of the buyers have lower willingness to pay, results in a market whose revenue potential is considerably diminished. Thus, sellers that operated Group-Buying sites were impacted by two factors: the products that were sold on these sites were such that Group-Buying gave no real advantage to the seller and when Group-Buying did emerge as the dominant market mechanism, *in such of these markets the seller was hit by adverse selection* - i.e. *the conditions that made Group-Buying the dominant mechanism, made the market it itself unattractive from the standpoint of profitability.* Over the longer horizon, this business model could not be sustained.

There are practical difficulties with Group-Buy schemes that we have not modeled here explicitly but which can make the working of the scheme more inefficient. Firstly, both buyers and suppliers face increased uncertainty about the final clearing price. This is particularly a problem when customers are risk-averse, since their bids need to be based on the expected price rather than the actual price. Secondly, the entire Group-Buying

[22] For the advantage of Group-Buying to vanish, the demand regimes do not need to be *identical*. It is enough if they are *alike*, as for instance if their slopes are the same, even though they may have different offsets.

process typically takes from 10 days to a month. Typically, the sales and clearing prices are finalized on a specific day committed to by the supplier, or when transactions cease and the price stabilizes. Thus, customers have to incur the costs of delay in closing the transaction. Thirdly, customers need to make, explicitly or implicitly, fairly complex calculations in order to optimize their bidding thresholds, and to monitor the progress of the Group-Buying constantly, in order to make their bids at the right time and price. (This was reflected in our solution methodology, which finessed this problem by employing the revelation principle.) Customers might experience a disutility from this buying process; more importantly, their bounded rationality might lead to sub-optimal behavior-- and hence, sub-optimal profits to the supplier. Future research should study the effect of these factors on the effectiveness of complex market mechanisms such as Group-Buying vis-à-vis simple posted prices.

Another possible extension is the analysis of Group-Buy mechanisms when there is uncertainty about the quality of the product. When buyers can get signals about product quality from the bids made by other buyers (similar to common values auctions), Group-Buying mechanisms can be a powerful way for the seller to induce buyers to signal product quality information to each other.

There are other possible approaches to effectively employing web-based market mechanisms. It is important to point out that even if Group-Buying is not efficient as a stand-alone approach, it might be an effective auxiliary scheme when used in tandem with other market mechanisms such as posted prices and auctions. For example, the market mechanism itself could be an effective price discrimination tool. The industry, perhaps deterred by the initial wave of setbacks, has not so far experimented with such combinations. Information has become increasingly recognized as a valuable commodity and a strategic tool, particularly for web-based selling. Hence it is important for manufacturers and distributors to control the dissemination of product-based information. *Infomediaries* — online companies like *CNet* and *PDA Buzz* that trade in information –- attempt to establish the primacy of the information they provide, in part by commoditizing the physical products. Manufacturers and distributors can employ Group-Buying and other complex market-mechanisms as a strategic response to reduce competition and counter the commoditization of products induced by simple posted prices in competitive markets.

References:

1. Appelman, H., "I Scream You Scream: Consumers Vent over the Net", *The New York Times*, March 4, 2001.
2. Dennehey, M., " MobShop Closes Consumer Division" http://www.auctionwatch.com/awdaily/dailynews/january01/1-011501.html
3. Kohli, R. and Heungsoo P., "A Cooperative Game Theory Model Of Quantity Discounts", *Management Science*, Vol. 35, No: 6, Jun 1989; pp 693-707.
4. Kreps, David, *A course in Microeconomic Theory*, Princeton University Press, 1990.
5. Lee, Hau L. and Rosenblatt, M., "A Generalized Quantity Discount Pricing Model to Increase Supplier's Profits", *Management Science*, Vol. 32, No: 9, Sep 1986, pp 1177-1185.
6. Lissack, M., "Of Chaos And Complexity: Managerial Insights From A New Science", *Management Decision*, 35 (1997), 205 - 218.
7. Marschak, J. "Elements for a Theory of Teams", *Management Science 1,2*, 1955, pp 127-137.
8. Marschak, J. and Radner, R., *Economic Theory of Teams*, Yale University Press, 1972.
9. Mas-Colell, A., M.D.Whinston and J.R.Green, *Microeconomic Theory*, Oxford University Press, 1995.
10. Monahan, J.P., "A Quantity Discount pricing model to increase Vendor profits", *Management Science*, Vol. 30, No:6, June 1984, pp. 720-726.
11. Myerson, R.B., *Game Theory: Analysis of Conflict*, Harvard University Press, 1991.
12. Nahmias, Steve, *Production and Operations Analysis*. Third Edition. Irwin Series in Production Operations Management. McGraw-Hill, 1997.
13. Notess, G.R., "Web Wanderings: Consumers' Revenge: Online Product Reviews and Ratings", *EContent*, April 2000.
14. Sandoval, G., Kawamoto, D., "Mercata Shuts Doors" http://news.cnet.com/news/0-1007-200-4372403.html
15. Shankland, S., "Sun Micosystems Tries Group-buying Strategy" http://news.cnet.com/news/0-1003-200-1851571.html
16. Simon, H.A., " Rational Decision Making in Business Organizations", *The American Economic Review*, Vol. 69, No. 4. (Sep., 1979), pp. 493-513.
17. Simon, H.A., "*The Journal of Economic Perspectives*, Vol. 5, No. 2. (Spring, 1991), pp. 25-44.
18. Solomon., K, "Customer Reviews: It's All a Matter of Opinion", *The Industry Standard*, October 11, 1999.
19. Tirole, Jean, *The Theory of Industrial Organization*. The MIT Press, 1989.
20. Value America Story: http://news.cnet.com/news/0-1007-201-1518733-0.html

Group-Buying Markets Cited in Section 3: *Group-Buying: The Current State of Praxis*

APPA: The Maryland Public Service Commission: http://www.md-electric-info.com/index.html
BBYT: BuildByte Construction Portal [Indian]: http://www.buildbyte.com/
COL: Chennai Online Bazaar (India): http://chennaionline.bazaare.com/
ECON: e.Conomy – operated by PriceWaterhouse Coopers: www.e.conomy.com
GBP: The Group Buying Partnership - http://www.groupbuying.co.uk/products.htm
IRPG: Independent Restaurant Purchasing Group: http://www.independentrestaurants.com/
LBI: Let's Buy It.com – http://www.letsbuyit.com/lbisite/index.jsp
MPLY: McNopoly.com: http://www.mcnopoly.com/
MPSC: Maryland Public Service Commission: http://www.md-electric-info.com/info-center/aggregators.html
OLC: Online Choice: Online Choice: http://www.onlinechoice.com/home/default.asp
PINE: The Printing Industries of New Englnad: http://www.pine.org/MS/groupbuying.htm
TBG: The Buying Group - http://www.the-buying-group.com
THM: The Happy Many: The Happy Many: http://www.happymany.com/index_en.html
STBZ: The StockBuzz Market: www.stockbuz.com

Vide Appendix-I *for a more detailed list of Group-Buying markets.*

Appendix – I: Group-Buying Markets

Business-to-Consumer Markets in the US:

Online Choice: http://www.onlinechoice.com/home/default.asp

McNopoly.com: http://www.mcnopoly.com/

e.Conomy – PreiceWaterhouseCoopers: www.economy.com

The Happy Many: http://www.happymany.com/index_en.html.

The Buying Group: http://www.the-buying-group.com/

LetsBuyit.Com (UK, Germany, France): http://www.letsbuyit.com/\

Chennai Online Bazaar (India): http://chennaionline.bazaare.com/

Ciao.com – (A German Group-Buying directory):
http://www.ciao.com/kategorien/1,202643,218630,55164.html

From Egypt.Com [Egyptian Group-Buying Market]:
http://groupbuy.fromegypt.com/users/Default.asp

IP Circles: http://www.contractsxml.org/ecap2000/students/FINAL/f-marko-new/page3.html

Clust.Com [French Consumer Market]: http://www.clust.com/

Business-to-Business Group-Buying Markets

Independent Restaurant Purchasing Group (US):
http://www.independentrestaurants.com/

MaxGroup (US): http://www.maxgroup.com/Services/b2b_fremont.htm

Group Buying Partnership (UK): http://www.groupbuying.co.uk/

StockBuzz.Com: (Thailand): www.stockbuz.com

HCIS Group Buying: http://www.hcis.org/groupbuying.htm (B2B Health care services).

The Printing Industries of New Englnad: http://www.pine.org/MS/groupbuying.htm

Printing and Graphics Communications Association:
http://www.pgca.org/pages/groupbuy.htm

Printing and Imaging Association of Mid-America:
http://www.piamidam.org/groupbuy.php

BuildByte Construction Portal [Indian]: http://www.buildbyte.com/

ShopeMates [Group-Buying Enabler]: http://www.shopmates.com/

BazaarE.com - Group buying services for businesses (and consumers):
http://www.rekha.com/cgi-bin/search/index.cgi?ID=981843428

Group-Buying Practices in Non-Profit Organizations

1. The Maryland Public Service Commission: http://www.md-electric-info.com/index.html

2. APPA: American Public Power and Environmental Agency
http://www.appanet.org/about/why/aggregation/f_buyingpower.pdf

3. The Center for Non-Profits: http://www.njnonprofits.org/groupbuy.html

4. Master Source Corp. : http://www.mastersourcecorp.com/

Appendix 2: Figures and Diagrams

Figure 1: **Two Demand Regimes**

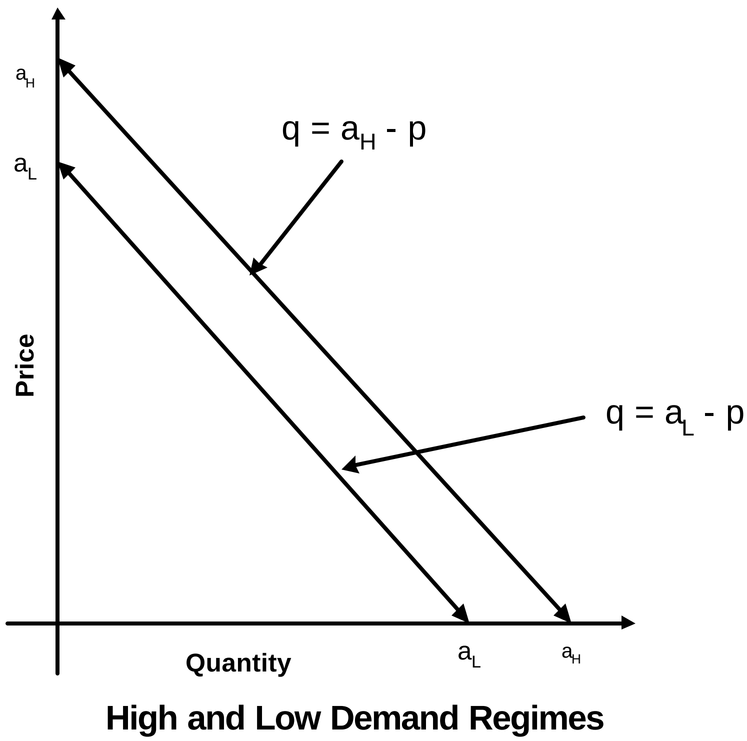


Figure 2: Higher Price Point From High Demand Regime And Lower Price Point From Low Demand Regime.

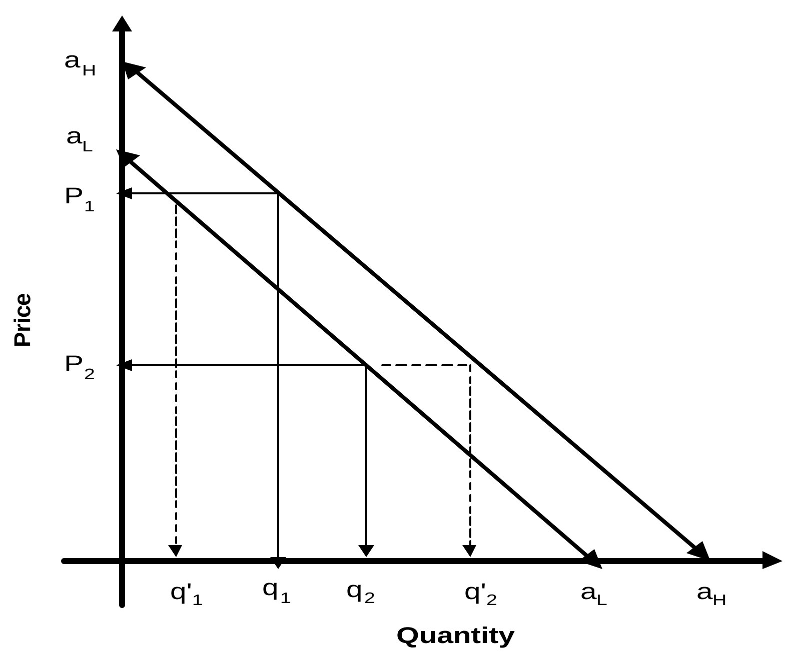


Figure 3: Higher Price Point From High Demand Regime And Lower Price Point From Low Demand Regime.

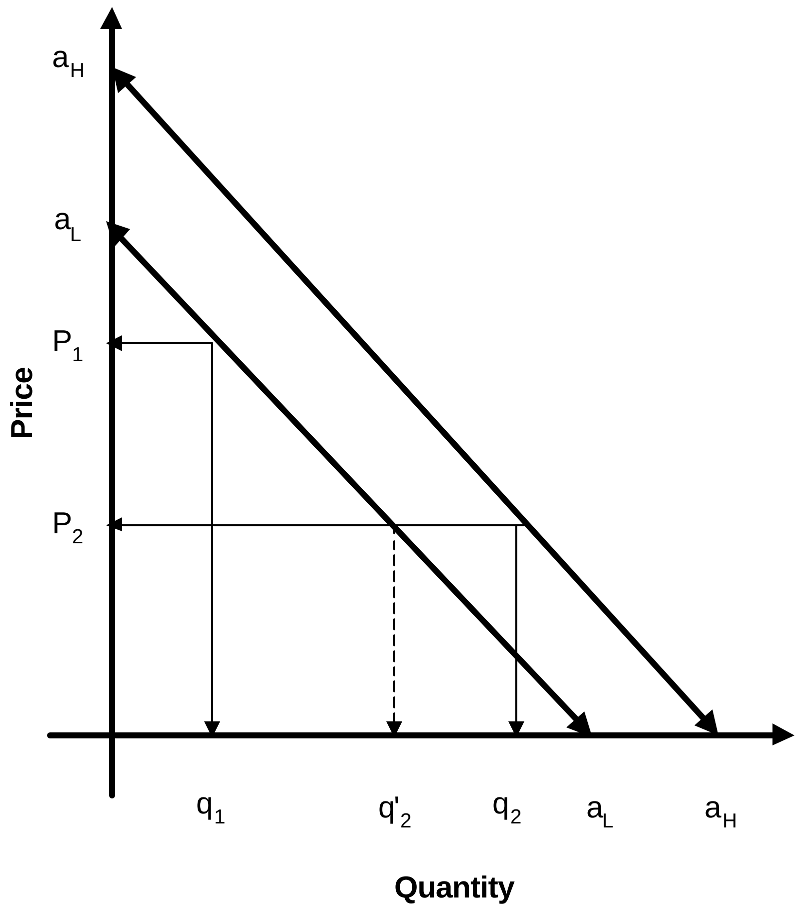


Figure 4: Intersecting Demand Curves: Neither Demand Regime Dominates The Other Universally.

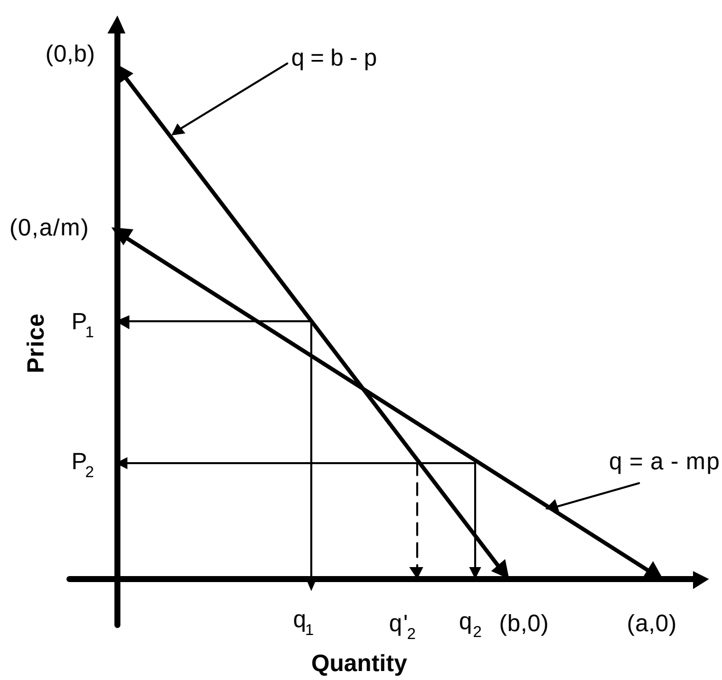


Figure 5: Profit comparisons when Pricing precedes production under Scale Economies: Group Buying (finally) does better than posted pricing for the seller. Also observe that the difference $p_{GB} - p_{PP}$ is increasing in C_1 and decreasing in C_2.

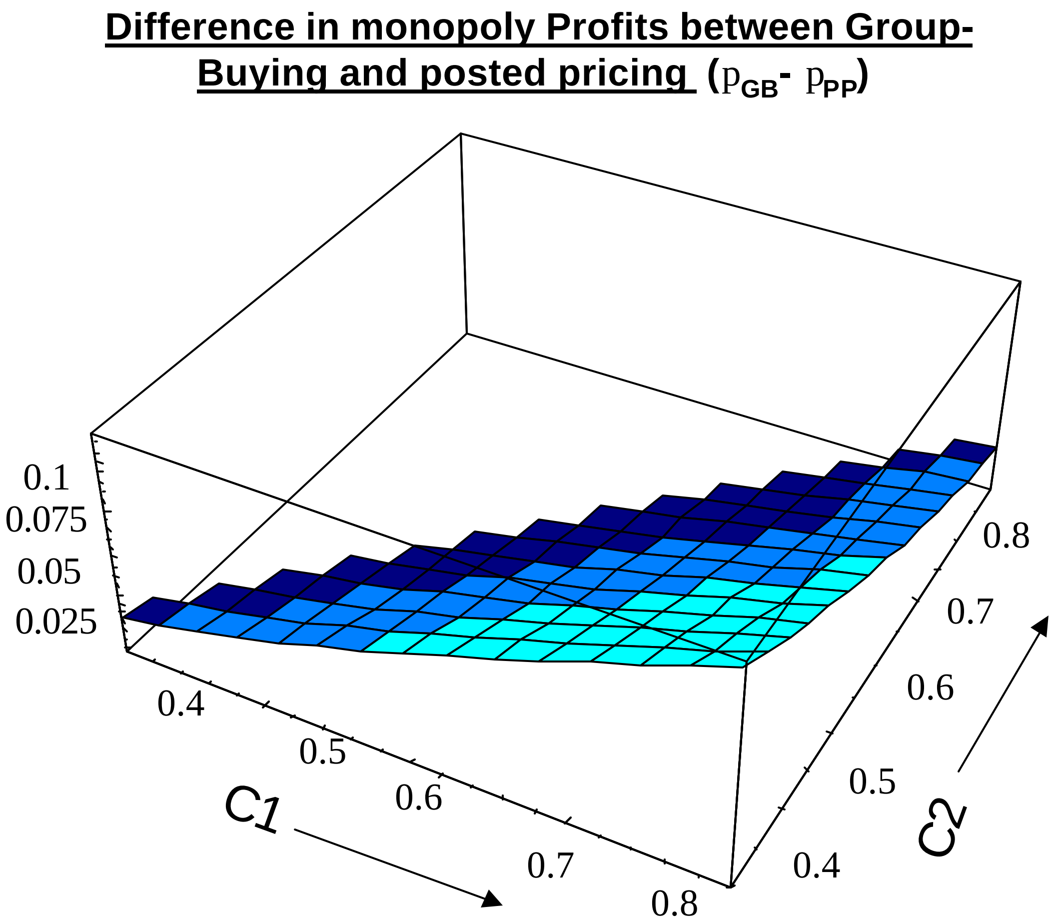
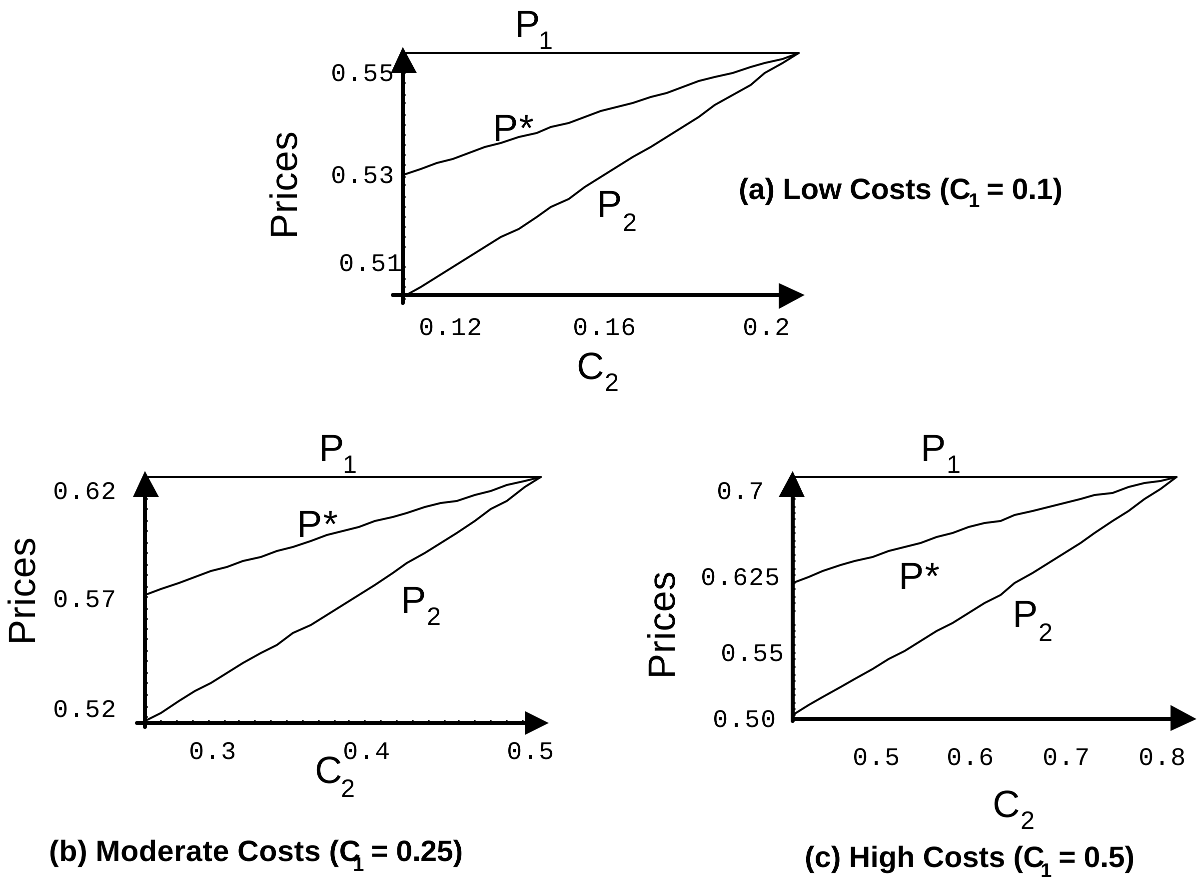
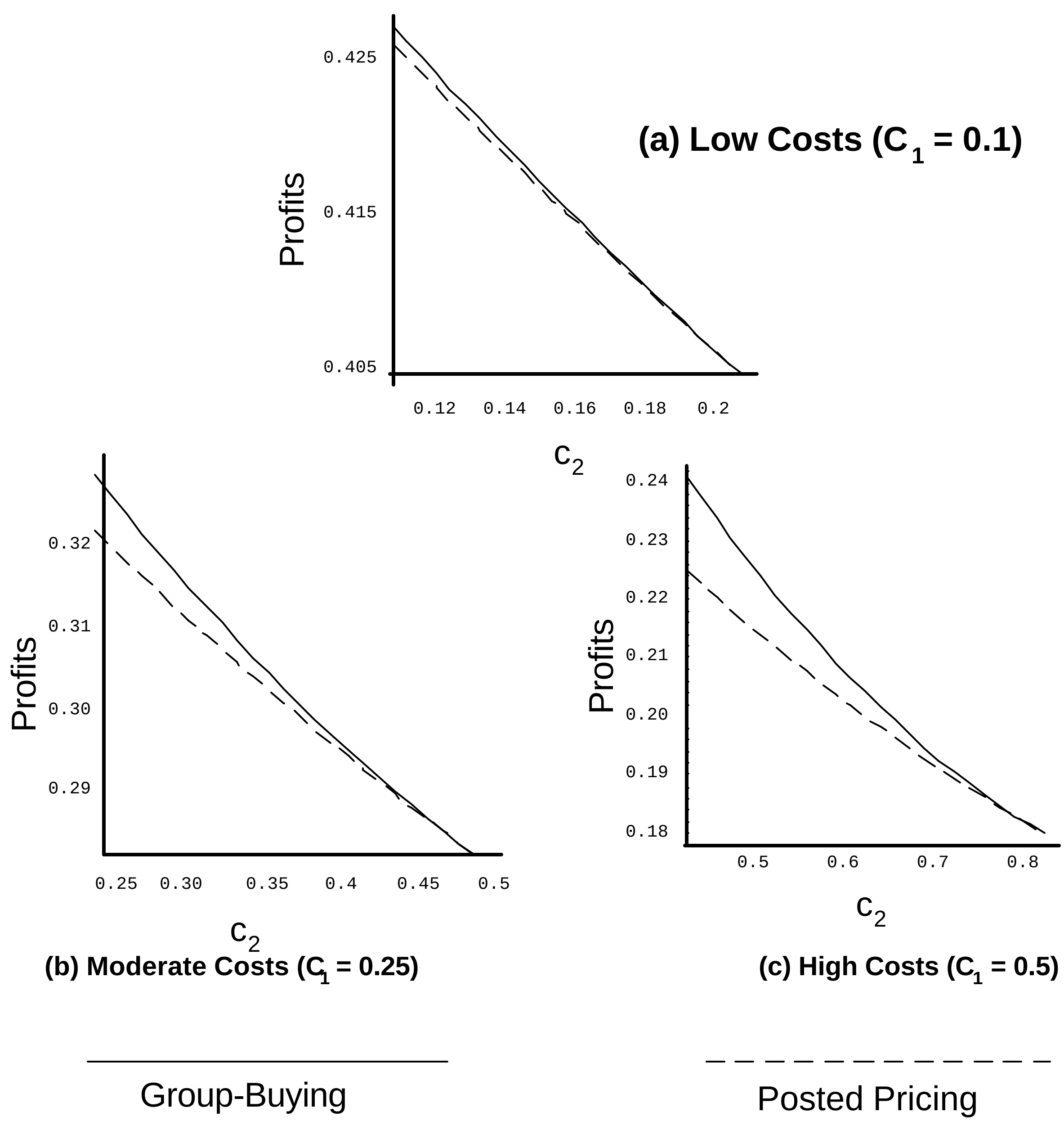


Figure 6: Price comparisons under varying costs: Figure 6 consists of three graphs that plot prices for varying costs. c_1 takes one of three values depending on the cost regime - Low ($c_1 = 0.1$), Moderate ($c_1 = 0.25$) and High ($c_1 = 0.5$) while c_2 varies[23] between c_1 and $2c_1$. P_1 and P_2 are the prices under the optimal Group-Buying schedule, while P^* is the optimal posted price.



[23] This is the range of values for c_2 that is feasible under production scale economies.

Figure 7: Profit comparisons under varying costs: c_1 takes one of three values depending on the cost regime - Low ($c_1 = 0.1$), Moderate ($c_1 = 0.25$) and High ($c_1 = 0.5$), while c_2 varies[24] between c_1 and $2c_1$.



[24] This is the range of values for c_2 that is feasible under production scale economies.

Figure 8: The two markets compared in terms of the two ratios that result due to buyers' revising their willingness to pay.