Pre-commitment without Capacity Constraints: Achieving Cournot Outcomes under Bertrand Competition in Conventional Channels

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ABSTRACT

Manufacturers often devise contractual mechanisms that enable downstream dealers to earn economic profit. One such mechanism is the *two-stage ordering process with quantity discounts* that is used in a variety of industry contexts and international distribution. The authors theoretically and empirically demonstrate that the use of such a mechanism by an upstream profit-maximizing manufacturer ensures economic profits for dealers downstream. They first construct a theory model that shows how the mechanism enables the manufacturer to *control* indirectly the intensity of downstream competition between dealers. The authors then match the results of their model to a novel longitudinal data set obtained from "Computec," a leading Chinese manufacturer of a key computer accessory, and use the data to estimate the unobserved final retail prices, the price-cost markups, and the profits earned by their dealers over a one-year period. The authors show empirically that the ordering arrangement indeed is economically profitable for the dealers. Implications for research and practice in channel design and management are discussed.

Key words: Contracting; Distribution Channels; Manufacturer-Dealer Relationships; Vertical Restraints; Quantity Discounts; Quantity Pre-commitment.

INTRODUCTION

In channel relationships, the upstream firm – henceforth manufacturer – often uses economic incentives to control the actions of the downstream member – henceforth dealer (Heide 1994). These economic incentives serve as self-enforcing contracts (Dutta, Bergen, & John 1994; Klein and Murphy 1988) in that they encourage non-contractible activities and discourage shirking and free-riding by the dealers, especially in conditions where complete contracting and monitoring are costly. Towards this end, theoretical research has proposed a variety of "vertical restrictions" including minimum resale price maintenance (Telser 1960), territorial restrictions (Matthewson and Winter 1984) and slotting allowances (Shaffer 1991) to incentivize dealers. Likewise, empirical research has shown that fixed fee transfer mechanisms like franchise fees (Kaufmann and Lafontaine 1994) are indeed used strategically to let dealers earn supra-normal profits.

Imposing vertical restrictions, however, can be costly and/or infeasible in many institutional contexts. Territorial restrictions, for instance, involve significant bureaucratic and monitoring costs (Matthewson and Winter 1984) and are difficult to adapt to new circumstances. Other policies like minimum RPM and account-specific pricing can, and have, invited antitrust scrutiny in the US and other global markets. Manufacturers, in turn, have devised alternative mechanisms that are easy to implement, adaptable, and that permit them to control indirectly the intensity of downstream competition. Consider one such popular mechanism – the *two-stage ordering process with quantity discounts* – used by Computec[1], a leading Chinese manufacturer of a key computer accessory sold in China. Background information and details about the channel structure were obtained from Computec in a series of in-depth interviews, conducted over a 6 week period, with top management.

Computec operates in an environment that is competitive and yet has rapid growth potential. It sought a channel arrangement that would be flexible and would attract quality dealers willing to expend effort in activities like developing markets, training customers in the use of the product, keeping attractive premises and promoting the product. Computec's channel currently has 60 independent dealers who operate without any exclusive dealing, territorial restrictions, fixed-fee transfer, or RPM clauses. The most distinctive feature of the channel is its sales and ordering process. Sales to dealers are organized into well-defined *quarterly* cycles that consist of two distinct stages as shown in Figure 1. The first week of each cycle constitutes the *order-taking* stage. Computec announces a quantity discount schedule below a given wholesale price and its 60 dealers choose their "preorder" quantities and pay for them in full. The second, or *order-fulfillment*, stage immediately follows the order-taking stage and lasts approximately three months. Computec delivers the preorders in this stage and dealers set retail prices. If the resulting demand exceeds the amount a dealer has preordered, that dealer can purchase additional units from the manufacturer. Significantly, the manufacturer offers *no* discounts below the wholesale price on these supplemental orders. Neither does Computec accept unsold units nor can dealers negotiate the terms of the trade. Computec's management is confident that this channel arrangement provides dealers a "satisfying" amount of profits which incentivizes the dealers to undertake the desired non-contractible marketing activities. This arrangement is not unique to Computec. Two independent industry experts confirmed that Computec's major competitors use an identical 2-stage process.

<Insert Figure 1 about here>

Qualitatively similar two-stage volume commitments with quantity discount arrangements are observed in a variety of industry settings. In international markets, MNCs like Hewlett-Packard, Microsoft, and Toshiba offer quantity discounts only for pre-committed merchandise but not for supplemented orders. In the network advertising sector, advertisers get a lower media rate if they pre-commit to slots in "upfront buying" than if they buy media slots in the spot market during the actual broadcasting season. Strawberry and other produce growers in California offer wholesalers quantity discounts for orders pre-committed during the growing season but not for orders placed during the selling season. High-end fashion manufacturers often require retail chains to pre-commit to quantities at a discount that is not available on supplemental orders. Baxter International requires its distributors of recombinant hemophilia products to commit to a minimum purchase quantity with an associated discount schedule, with provisions for supplementing orders at a latter date. Further, contractual provisions in these contexts often prohibit merchandise return (with exceptions made for defective goods). Similar channel policies are also observed in the telecommunication (Alcatel-Lucent and 3com), computer servers (eRacks), and publishing (medical reference books) industries.

Our paper has two goals. First, we develop a formal model to study the two-stage ordering process with quantity discounts and its effects on downstream competition. We show theoretically how the profit-maximizing choice of discount by the manufacturer using this mechanism softens the intensity of downstream competition. Second, we use the insights from our theoretical model in conjunction with the specific institutional details observed at Computec to test whether Computec's dealers indeed earn economic profit from this arrangement. We set up an econometric model along the lines used in the New Empirical Industrial Organization (NEIO) literature (e.g., Reiss and Wolak 2005) to estimate the unobserved retail price. These estimated prices, together with the cost information we collected, enable us to calculate the economic profits that Computec actually leaves on the table for its heterogeneous group of dealers.

Our paper makes three principal contributions. First, on the theory side, we build on the literature on capacity-constrained pricing games (e.g., Kreps and Scheinkman 1983; Maggi 1996; Padmanabhan and P'ng 1997) but extend it to environments without any capacity constraints on the producer. We model the two-stage ordering process and show how the downstream competition depends endogenously on the level of discount offered by the manufacturer for preorders. Specifically, we show that if the manufacturer offers a sufficiently small quantity discount the downstream competition results in the same prices as a one-shot Bertrand game; in contrast, if the manufacturer offers a sufficiently large discount the downstream competition is equivalent to a one-shot Cournot game. Without a detailed institutional analysis of the ordering process, researchers would assume that price-setting dealers are involved in Bertrand competition. This could result in serious error since depending on the discount schedule, dealer quantity choices in the first stage may induce them to choose second stage prices that would occur under Cournot competition instead. Together with the observation that the two-stage ordering process is used in a variety of contexts, this suggests that Cournot competition may be more common in channel settings than is commonly assumed (Coughlan and Wernerfelt 1989).

Our second contribution is empirical. Based on our theoretical insights and the institutional details of Computec's specific channel arrangement, our econometric specification and analysis demonstrates that Computec's dealers indeed earn substantial economic profits. Our work, hence, shows a workable mechanism that manufacturers can use to generate downstream profits. Moreover, our paper complements, yet contrasts, with the approach adopted by the NEIO literature in this context. Specifically, several empirical studies have demonstrated the existence of positive downstream price-cost markups (e.g., Chen, John, and Narasimhan 2009; Chintagunta 2002; Kadiyali, Chintagunta, and Vilcassim 2000; Villas-Boas and Zhao 2005; Villas-Boas 2007). Except Chintagunta (2002), however, these studies do not directly connect a specific vertical arrangement to but recover the markups and competitive intensity from the estimated parameters of their *assumed* games. The relationship between these assumed games and the underlying institutional arrangement from which the data are derived is unclear. In contrast, we link the theoretical insights from our model of the two-stage ordering process with specific institutional details to set the estimated game form *a priori*. By modeling analytically a specific channel arrangement and linking it to assembled field data for systematic empirical analyses, our paper provides a more complete understanding of *how* an institutional arrangement impacts downstream competition and markups.

Our third contribution is methodological and arises from the limitations of the available data. In many sale-resale contexts (e.g., business-business sales), downstream selling prices are difficult for the upstream firm to observe. For instance, dealers may use customer-specific pricing when they sell multiple product bundles and/or offer services in addition to physical products to downstream buyers. Likewise, Computec did not have data on the final retail prices but had archival data on wholesale prices and discounts, quantities ordered and supplied to dealers, plus its own marketing expenses. Hence, unlike the estimation problem in most NEIO research on price-cost markups, we must cope with unobserved final retail prices *not* unobserved marginal costs. Our paper makes a methodological contribution by showing how longitudinal data can be used to estimate demand-side parameters that facilitate the recovery of these unobserved final prices. In particular, we begin by estimating the demand function using a fixed effect model in which the observed net wholesale prices act as a "proxy" for the final prices. Simultaneously, based on our formal model and institutional details, we specify *a priori* the inferred type of competition in the supply-side relationship. We then use the estimated slope of the demand function and this specified supply relation to calculate the final prices. We believe that our novel procedure should enable manufacturers lacking downstream data to use a more structural approach for estimating retail side outcomes like prices and profits.

The paper proceeds as follows. We first formulate and solve the model of the two-stage ordering process with quantity discounts and deduce the consequences of this specific institutional arrangement. We then present our statistical methodology and estimation results. We conclude with a discussion of our results, the limitations of our analysis, and directions for future work.

A MODEL OF A TWO-STAGE ORDERING PROCESS WITH QUANTITY DISCOUNTS

Links with Existing Literature

Our analysis of the two-stage ordering process builds on the literature on capacity-constrained pricing games pioneered by Kreps and Scheinkman (1983) for homogeneous goods and extended to differentiated products by Friedman (1988), Benassy (1989), Canoy (1996), and Vives (2001). A key feature of these models is that when capacity constraints are rigid, firms cannot, for some price profiles, satisfy the demand implied by the standard demand system. To have a well-defined game, a rationing rule that indicates how much of the constrained firm's unsatisfied demand "spills over" to each rival is necessary to specify the payoffs associated with such price profiles. The resulting "contingent demand" system then depends not merely on the prices of rival firms but, unlike the standard demand system, on their capacities as well. However, under such a contingent demand system, reaction functions in price space do not intersect for some first-stage capacity choices because they are discontinuous. As a consequence, there always exists a set of capacity choices which lead to price subgames in which there is no pure-strategy equilibrium. The only Nash equilibrium in such subgames involves probabilistic mixing over prices.[2]

Padmanabhan and P'ng (1997) recognized that downstream dealers who preorder in the first stage but cannot augment these orders in response to prices set at the second stage would behave in the same way as firms with technological capacity constraints. They studied both the case of certain demand and the case where demand might take one of two levels, "high" or "low", with known probabilities and show that even under certainty the manufacturer could *control the intensity* of the downstream competition of its dealers by permitting full refunds for returned merchandise or, alternatively, by refusing refunds. In particular, they suggest the two-stage game is equivalent to a one shot Bertrand game if returns were allowed but to a one-shot Cournot game competition in the absence of returns.

There exist, however, two problems with their conclusions. First, Wang (2004) shows that in the absence of uncertainty (which corresponds to our case), the marketing policy discussed in Padmanabhan and P'ng (1997) – returns versus no returns – turns out to have no impact on any variable in the resulting equilibrium[3]. Second, and more fundamentally, since augmenting a preorder at stage 2 is forbidden in their model, they must specify how spillover demand is allocated in order to have a well-specified model. They fail to specify such a "rationing rule". Vives (2001, p. 166) works out the solutions for the same linear demand system as Padmanabhan and P'ng (1997) for one particular rationing rule and shows that the *only* equilibrium involves mixed strategies.

Our setup is crucially distinct from the model in these papers. As documented in industry examples earlier, dealers typically *can augment* their preorders. Hence, we can avoid the theoretical complications that inevitably arise when capacity constraints are rigid.[4] Since demand can always be satisfied, it is not necessary to specify rationing rules or to consider mixed strategies. Like Maggi (1996), our dealers are duopolists selling differentiated products. To induce preordering in stage 1, the manufacturer sells the goods at a discount below the wholesale price. If these preorders are insufficient, the dealers must augment them in stage 2. Our dealers can neither return the goods to the manufacturer nor can they bargain over the discount schedule (Iyer and Villas-Boas 2003).

We investigate the consequences of preordering at a discount when one cannot return the product but must augment one's preorder at the wholesale price if demand remains unsatisfied. We show that when demand is *certain*, the downstream competition depends endogenously on the discount offered for preordering. Prior research showed that under certainty the preorders chosen coincide with the outputs firms would choose in a Cournot game. In contrast, we show that while the Cournot result obtains for sufficiently high discounts, if the discounts are sufficiently small, the amounts preordered coincide in equilibrium with what Bertrand duopolists would sell if each has a marginal cost equal to the wholesale price.

The contrast with Padmanabhan and P'ng (1997) is particularly striking as the discount in our model vanishes. Only one difference remains, then, between the case that we analyze and their case of certain demand under the policy of no returns: our dealers can augment their preorders and their dealers cannot. This single change in assumption, however, is responsible for the equilibrium switching from Cournot in their formulation to Bertrand in our formulation. Intuitively, when the discount for preorders is zero or very small, Cournot preorders would be so small that high prices would result. But these prices would not form a Nash equilibrium in the second stage since each dealer could strictly increase his profit by unilaterally undercutting his rival's price and serving the additional demand by augmenting his preorder. This Cournot outcome cannot be undermined in the Padmanabhan and P'ng case since augmenting preorders is not permitted.

Model Structure and Set-Up

Consider a monopolistic manufacturer selling its product to consumers through two competing, but symmetric, dealers. Figure 2 details the information structure and decision sequence. In stage 0, the manufacturer sets a quantity discount schedule. In stage 1 – the order-taking stage – the dealers see the discount schedule and independently and simultaneously preorder and pay for them. In stage 2 – the order-fulfillment stage – each dealer takes delivery of his preorders and then, after observing his rival's preorder, simultaneously sets his retail price. If demand for his product exceeds the preordered amount, the dealer must obtain the additional units from the manufacturer, but at the *undiscounted* wholesale price. If demand falls short of the preordered amount, the dealer cannot return the excess to the manufacturer for a refund. For simplicity, we also assume that neither dealer can store the product for sale in a subsequent sales cycle. Finally, we assume that there is no uncertainty in demand, that demand is common knowledge, and that both manufacturer and dealers maximize profits. This game structure closely resembles the institutional arrangement observed at Computec and other firms as shown in Figure 1.

<Insert Figure 2 about here>

Let k_i denote the quantity preordered by dealer i in stage 1. When placing his order, the dealer pays an amount $(w – d \cdot k_i)$ per unit preordered, where w is the fixed wholesale price and d is the discount per unit.[5] Such a linear discount schedule for pre-ordered quantities has been used in previous studies (e.g., Ingene and Parry 1995).[6] The manufacturer's total cost of production is $m\cdot(k_1 + k_2)$, where m is the exogenous constant per unit cost. For simplicity, we assume the dealer's fixed costs of operations to be zero. We assume that the dealer's demand functions are linear and given by:

(1) $$D_i(p_i, p_j) = q_i = a - p_i + bp_j, \quad i = 1,2, \text{and } i \neq j,$$

with $a>0$ and $0 \leq b < 1$. The exogenous parameter b reflects substitutability in demand. The subgame-perfect Nash equilibrium is determined using backward induction, beginning with stage 2 in Figure 2 and working backward through stage 0.

Stage 2: Dealers' Pricing Decisions.

We start by characterizing the marginal costs faced by each dealer in stage 2. Because his preordering cost is then sunk, if dealer i sells q_i units in stage 2, his marginal cost of sales (q_i for i = 1, 2) is given by:

$$\begin{aligned} MC_i &= 0 \qquad \text{for } q_i < k_i \\ &= w \qquad \text{for } q_i > k_i \end{aligned}$$

where k_i denotes the amount preordered. For every unit sold in excess of k_i, the dealer has to pay the manufacturer an undiscounted wholesale price w. Selling less than the k_i units saves the dealer nothing since refunds are not offered for unsold units. Hence, the total cost to dealer i of selling q_i units in stage 2 is kinked at $q_i = k_i$. The left and right marginal costs are 0 and w, respectively. In stage 2, the two dealers observe the amounts preordered (k_1, k_2) and each dealer chooses his own price to maximize his profits given the inherited preorders and his conjecture about his rival's price. Figure 3 depicts the situation from dealer i's perspective.

<Insert Figure 3 about here>

Given dealer j's price, dealer i faces a downward-sloping linear demand curve and his linear marginal revenue curve is twice as steep. His marginal cost of selling less than his preordered quantities is zero and of selling strictly more than his preordered quantities is the undiscounted wholesale price (w). The profit-maximizing amount to sell (q_i) occurs where marginal revenue and marginal cost curves intersect. Dealer i's best price response – his reaction function – is given by $p_i = R_i(p_j, k_i)$. It is continuous, depends on i's preorder, but is independent of j's preorder. The best price replies of the two dealers consist of three linear segments as shown in bold in Figure 4.

<Insert Figure 4 about here>

Part 1: If the price charged by dealer j, p_j, is sufficiently low, the demand for dealer i's merchandise is weak and selling less than his preordered quantities is profit-maximizing for him, i.e. $q_i < k_i$. This occurs in Figure 3 when the marginal revenue curve of dealer i crosses his marginal cost curve to the left of k_i in . Note that his marginal cost in this segment is zero. Dealer i then chooses p_i to solve $\max_{p_i} \pi_i = p_i\, q_i$, where $q_i = a - p_i + b\, p_j$ and his best response to p_j is:

(2) $$r^i(p_j) = \frac{a + b\, p_j}{2}\,.$$

Part 2: If dealer j sets an intermediate price, the demand for dealer i's merchandise shifts to the right in Figure 3 and he finds it optimal to sell exactly the amount he preordered. This occurs when the marginal revenue curve crosses the vertical segment of the marginal cost curve at $q_i = k_i$. Define $p_i \equiv s^i(p_j, k_i)$. It is optimal for dealer i to charge a price that creates a downstream demand q_i that exactly equals k_i. Dealer i's reaction function in this segment can be obtained by directly substituting k_i for q_i in equation (1) to get:

(3) $$s^i(p_j; k_i) = a + b\, p_j - k_i\,.$$

Part 3: If dealer j sets a sufficiently high price, the demand for dealer i's merchandise is so large that it is profit-maximizing for him to charge a high price and supplement his preorder even though the additional quantities are charged an undiscounted wholesale price. This occurs when his marginal revenue curve intersects the marginal cost curve to the right of k_i in Figure 3. His best response to p_j can then be determined by maximizing his profit $\max_{p_i} \pi_i = p_i \cdot k_i + (p_i - w) \cdot (q_i - k_i)$ and given by:

(4) $$r^i(p_j; w) = \frac{a + b\,p_j}{2} + \frac{w}{2}.$$

The intersection of these two piecewise-linear best responses constitutes a pure-strategy Nash equilibrium in the subgame indexed by the inherited preorder pair (k_1, k_2). For each preorder pair (k_1, k_2), the best response of dealer 1 has a slope which, as can be verified from equations (2)-(4), is always strictly larger than 1 (2/b, 1/b, and 2/b for the 3 segments respectively) while the best response of dealer 2 has a slope which is always strictly smaller than 1 (b/2, b/1, and b/2, respectively). Since the best reply of dealer 1 starts out below that of dealer 2, the former will intersect the latter once and will never cross it again. Since the two best replies intersect exactly once, each of these subgames has a unique Nash equilibrium. Indeed, because the demand functions are symmetric and the cost functions are identical, this unique equilibrium involve identical prices and sales if (1) both dealers are augmenting, (2) both dealers are scrapping, or (3) both dealers preordered the same quantity and neither supplement nor scrap any of it in the final period.

<Insert Figure 5 here>

In other circumstances, however, the unique intersection can occur on any of the three segments of each reaction function. Hence, depending on the stage 1 preorders (k_1, k_2), nine qualitatively distinct types of behavior can arise in the Nash equilibrium in a price subgame: the best response of dealer 1 may be to sell (1) strictly less than, (2) strictly more than, or (3) exactly what he preordered and, at the same time, dealer 2 himself may find it optimal to take any of these actions. We now turn to an analysis of the preorder decisions in stage 1. As we will see, dealers preorder in stage 1 only what they sell in stage 2. Hence, the other qualitative possibilities mentioned above do not arise on the equilibrium path.

Stage 1: Dealers' Preorder Decisions.

As we have seen, the prices and sales in stage 2 depend on preorder quantities in stage 1. In stage 1, the manufacturer offers each dealer the same quantity discount, which increases with the size of the preorder. We assume that $C(k_i)$, the total cost to dealer i of preordering k_i units, has the following functional form: $C(k_i) = \int_{u=0}^{k_i} \max[0, w - 2\,u\,d]du.$ Hence, marginal cost decreases linearly until it reaches zero and then remains at zero for larger preorders. This eliminates the incentive to preorder more than one sells – not for strategic reasons but merely to strictly reduce total costs as one would if marginal cost was negative. To eliminate the incentive to preorder more than w/(2d) merely because it is costless to do so, we further interpret the marginal cost curve as the following limit $MC(k_i) = \lim_{\varepsilon \to 0^+} \max[\varepsilon, w - 2dk_i]$.

As we will show, for *any* discount chosen by the manufacturer, there is a unique symmetric subgame-perfect equilibrium of the two-stage game played by the dealers. Their preorders in this dynamic equilibrium can easily be characterized by means of two benchmarks: (1) the one-shot equilibrium of a Bertrand game where dealers pay the *undiscounted* wholesale price and (2) the one-shot equilibrium of a Cournot game where dealers pay the *discounted* price. We denote these preorders, respectively, as (k_1^B, k_2^B) and $(k_1^C(d), k_2^C(d))$. It is important to recognize that the Cournot benchmark, unlike the Bertrand benchmark, depends on the manufacturer's discount.

The Bertrand price pair denoted (p_1^B, p_2^B) can be obtained by solving simultaneously the equations $p_1 = r_1^B(p_2; w)$ and $p_2 = r_2^B(p_1; w)$. It is denoted by point B in Figure 5. The Bertrand benchmark quantities can be determined by substituting this pair of prices into the demand system.

The Cournot benchmark equilibrium where each dealer pays the discounted cost $C(k_i)$ to preorder k_i units can be characterized by solving each dealer's profit maximization problem:

$$\max_{k_i} k_i[p_i - (w - d\,k_i)] \text{ subject to } k_j = \bar{k}_j,$$

where $k_i = a - p_i + b\,p_j$ and $k_j = a - p_j + b\,p_i \quad (j \neq i \text{ and } i = 1,2)$. Solving the demand system to obtain dealer i's price as a function of the two preorders, substituting and differentiating, we obtain dealer i's first-order condition (for details see Appendix A):

$$\frac{\partial \pi_i}{\partial k_i} = [\frac{a(1+b)}{1-b^2} - w] + k_i[2d - \frac{2}{1-b^2}] - \frac{b\bar{k}_j}{1-b^2} = 0,$$

For any $d \in [0, \delta_k)$ where $\delta_k = \dfrac{2-b}{2(1-b^2)}$, the reaction functions in the Cournot benchmark have a unique intersection point and it corresponds to a global maximum for each dealer. The Cournot benchmark preorder increases with the manufacturer's discount (d). There are two possibilities. Either marginal cost remains strictly positive as $d \to \delta_k$ or, for a sufficiently high discount (denoted as $\hat{\delta} < \delta_k$), marginal cost reaches zero. In the latter case, the Cournot benchmark production and the associated prices are unchanged for any $d \in [\hat{\delta}, \delta_k)$. As the discount increases in this range, however, equilibrium profits increase because the unchanging preorder can be acquired more cheaply. The prices in the Cournot benchmark $(p_1^C(d), p_2^C(d))$ for one particular discount $d \in (\delta, \delta_k)$ are depicted as point C in Figure 5.

For sufficiently small discounts ($d \in [0, \delta)$), the prices in the Cournot benchmark exceed the prices in the Bertrand benchmark. For sufficiently large discounts, $d \in (\delta, \delta_k)$, prices in the Cournot benchmark are *smaller* than prices in the Bertrand benchmark. At the boundary $d = \delta$ prices in the Cournot, and the Bertrand benchmarks coincide. No discount is large enough to drive the Cournot benchmark prices down to the scrapping boundary, point A in Figure 5. Point A is the price pair which emerges when Bertrand competitors have zero marginal costs; for Cournot competitors to generate those same prices, their marginal costs would have to be negative, which is excluded under our assumptions. We analyze the two benchmarks formally in Appendix A.

To verify that for any $d \in (\delta, \delta_k)$, the quantities sold in the Cournot benchmark $(k_1^C(d), k_2^C(d))$ constitute equilibrium preorders in the two-stage game, we show that no dealer can profitably alter his preorder. Suppose, without loss of generality, that dealer 1 unilaterally deviates. As proved in B1 of Appendix B, regardless of the size of dealer 1's preorder in the prior stage dealer 2 will continue to sell his entire preorder. If dealer 1 deviates to preorder less than some threshold amount, $k_1^{min} < k_1^C(d)$, the price will remain at $\bar{p}_1$ since both dealers recognize that dealer 1 will augment such a small preorder in the second stage. Similarly, if dealer 1 preorders more than some threshold amount, $k_1^{max} > k_1^C(d)$, the price will remain at $\underline{p}_1$ since both dealers recognize that dealer 1 will scrap part of such a large preorder in the second stage. [7] Dealer 1 will therefore anticipate that, in the neighborhood of $k_1^C(d)$, his price is decreasing in his own deviation but his price cannot exceed a ceiling ($\bar{p}_1$) or fall beneath a floor ($\underline{p}_1$). Figure 6 depicts this situation.

<Insert Figure 6 here>

For preorder deviations in the neighborhood of $k_1^C(d)$, dealer 1's profit will coincide with the profits of player 1 in the Cournot benchmark when player 2 sells $k_2^C(d)$. Dealer 1's profit in the two-stage game, therefore, peaks at $k_1^C(d)$ exactly as in the benchmark. Preorder deviations above k_1^{max} in the two-stage game are unprofitable since they generate even smaller profits than k_1^{max} – the price, sales, and gross revenue remain the same but the costs are strictly higher because of the extra preorders, which are paid for but then scrapped. Similarly, preorder deviations below k_1^{min} in the two-stage game, generate even smaller profits than k_1^{min} – the price, sales and gross revenue remain the same but the costs are strictly higher because the insufficient preorders must be augmented in stage 2 at the undiscounted wholesale price. A typical price pair which results when the manufacturer's discount is in the Cournot regime is depicted as point C in Figure 5.

To verify that, for any $d \in [0, \delta)$, the quantities sold in the Bertrand benchmark (k_1^B, k_2^B) constitute equilibrium preorders in the two-stage game, we show that no dealer can profitably alter his preorder. Suppose, without loss of generality, that dealer 1 unilaterally deviates. As proved in B2 of Appendix B, dealer 2 will continue to sell his entire preorder regardless of the size of dealer 1's deviation in the prior stage.

For any given $d \in (0, \delta)$, dealer 1's profit function has an upward-pointing cusp at k_1^B (see Figure B1 in Appendix B). It is, therefore, unprofitable to preorder a different amount. To verify that to the left of the cusp, the profit function is strictly increasing in preorders, note that gross revenue is constant in this region but for every unit that dealer 1 fails to preorder at the discounted price it orders in the subsequent stage at the higher, undiscounted price. Formally, the left derivative of the profit function at k_1^B is minus the sum of the derivatives of his cost of preordering and his cost of augmenting, $\frac{\partial[-k_1(w - dk_1) - (k_1^B - k_1)w]}{\partial k_1} = 2dk_1$, which is strictly positive and increasing both in d and in k. To verify that the profit function is weakly decreasing to the right of the cusp, note that the right derivative of the profit function at any given d is $\frac{\partial[p_1(k_1) \cdot k_1 - (w - dk_1)k_1]}{\partial k_1}$ $= p_1(k_1) + k_1 p'_1(k_1) - (w - 2dk_1)$. At $d = \delta$ and $k_1^C(d) = k_1^B$, this derivative is zero. But as d *decreases* from δ, this right-derivative at the unchanged k_1^B becomes negative. Hence, deviating *locally* by ordering more than k_1^B cannot be optimal for any $d \le \delta$. As for any *nonlocal* deviation that is so large that dealer 1 would find scrapping a portion of the preorder to be optimal, his profit would be even lower than when he deviated to the boundary of the scrapping region since the gross revenue is the same but the cost of preordering the extra amount which is scrapped is larger. The price pair which results when the manufacturer's discount is in the Bertrand regime is depicted as point B in Figure 5.

To verify that there are no other symmetric subgame-perfect equilibria, we show that any other symmetric preorder pair would invite a unilateral deviation. The lemma proved in Appendix C greatly simplifies our task by eliminating *a priori* two intervals of candidate equilibria. It shows that no preorder will be augmented or scrapped in equilibrium. This makes intuitive sense. For, suppose the pair of preorders chosen at the first stage led one of the dealers to scrap (augment) in the second stage. That dealer could instead unilaterally reduce his preorder by the amount that he was scrapping (increase his preorder by the amount he was augmenting) without altering his price, unit sales, or gross revenue in the second phase. Since his costs would be strictly lower, however, his deviation would be strictly profitable. In essence, to verify whether there is a second symmetric subgame-perfect equilibrium, we need only check preorders (1) on the augmentation boundary, (2) on the scrapping boundary and (3) in the open interval in between.

Consider any pair of symmetric preorders ($k_1 = k_2 = k$) in this open interval. Given the first-order condition derived earlier, for a local increase in dealer 1's preorder, the effect on its profits is given by $\frac{\partial \pi_i}{\partial k_i} = [\frac{a(1+b)}{1-b^2} - w] + k[2d - \frac{(2+b)}{1-b^2}]$. This function has one root at $k = k^C(d)$ and, for any $d \in (0, \delta_k)$, decreases linearly in k; hence it has no other root.[8] We use this function to show that the equilibrium is unique for any manufacturer's discount $d \in (0, \delta_k)$. We consider in turn three cases: $d \in (\delta, \delta_k)$, $d \in (0, \delta)$, and d=δ.

For any $d \in (\delta, \delta_k)$, the Cournot benchmark will lie in the interior of the region between the augmentation and scrapping boundary. For discounts in this range, preorders at the Cournot benchmark ($k_i = k^C(d)$) arise in one subgame-perfect equilibrium. Any preorder pair larger (smaller) than the Cournot benchmark cannot be an equilibrium since the derivative shown above would be strictly negative (positive), implying that dealer 1 could strictly raise his profits by preordering marginally less (more). In the case of preorders on the scrapping boundary, the equation gives the left-derivative, which will be strictly negative; hence dealer 1 would always have a unilateral incentive to reduce his preorder. In the case of preorders on the augmentation boundary, the equation gives the right-derivative, which will be strictly positive for any $d \in (\delta, \delta_k)$; hence dealer 1 would always have a unilateral incentive to increase his preorder. It follows then that there is a unique symmetric subgame- perfect equilibrium for manufacturer discounts $d \in (\delta, \delta_k)$.

We have already shown that for any $d \in (0, \delta)$, preorders at the Bertrand benchmark (k^B) arise in one subgame-perfect equilibrium. The only other candidates for additional equilibria are larger preorders. But the equation would be strictly negative when evaluated at any such point, implying that dealer 1 could always strictly improve his profits by marginally reducing his preorder unilaterally. It remains to show that there exists a unique pair of preorders when $d = \delta$. In that case, the Cournot benchmark coincides with the augmentation boundary. Here the equation will be strictly negative when evaluated at any larger pair of preorders. Since dealer 1 could then strictly increase his payoff by marginally reducing his preorder unilaterally, there can be no equilibrium involving preorders in this range. We formalize this discussion in the following proposition:

Proposition 1: *For any discount chosen by the manufacturer, there exists a unique symmetric subgame-perfect equilibrium. Prices, quantities, and profits in that equilibrium are as follows:*

(*i*): *If* $d \in [0, \delta]$, *then for* $i = 1,2$:

Prices: $p_i^B = \dfrac{a+w}{2-b}$; *Quantities:* $k_i^B = q_i^B = \dfrac{a-(1-b)w}{2-b}$; *Profits:* $\pi_i^B(d) = \dfrac{(1-d)(a-(1-b)w)^2}{(2-b+2d-2b\,d)^2}$.

(*ii*): *If* $d \in [\delta, \min(\hat{\delta}, \delta_k))$, then *for* $i = 1,2$:

Prices: $p_i^C(d) = \dfrac{a(1-2(1-b^2)d)+(1-b^2)w}{(1-b)(2+b-2(1-b^2)d)}$;

Quantities: $k_i^C(d) = q_i^C(d) = \dfrac{(1+b)(a-(1-b)w)}{(2+b-2(1-b^2)d)}$

Profits: $\pi_i^C(d) = \dfrac{(1+b)(1-(1-b^2)d)(a-(1-b)w)^2}{(1-b)\,(2+b-2d(1-b^2))^2}$.

(*iii*): *If* $d \in [\hat{\delta}, \delta_k)$, *then for* $i = 1,2$:

Prices: $p_i^C(d) = \dfrac{a}{(1-b)(2+b)}$; *Quantities:* $k_i^C(d) = q_i^C(d) = \dfrac{a(1+b)}{2+b}$

Profits: $\pi_i^C(d) = \dfrac{a^2(1+b)}{(1-b)\,(2+b)^2} - \dfrac{w^2}{4d}$.

Stage 0: Manufacturer's Choice of Discount

The manufacturer's problem in stage 0 is to choose an optimal quantity discount such that its profit is maximized:

$$\max_{0 \le d < \delta_k} \pi_m = (w - m - d\,k_1)k_1 + (w - m - d\,k_2)k_2,$$

where, m is the manufacturer's marginal cost of production. We partition the domain into two intervals: $d \in [0, \delta]$ and $d \in (\delta, \delta_k)$. The manufacturer's optimum can occur in either interval; but if it occurs in the first interval, it must occur at d=0. This follows since, for any discount in this interval, each dealer preorders an unchanging quantity (the amount sold in the Bertrand benchmark) and hence it is more profitable for the manufacturer to offer the smallest discount in the interval. For the same reason, in the Cournot regime the manufacturer would never offer a discount above $\hat{\delta}$ in the case where $\hat{\delta} < \delta_k$. As the dealers would not respond to higher discounts in this interval, the manufacturer has no reason to offer them. We denote the manufacturer's optimal discount and associated profit in the Bertrand and Cournot regime as $d_B^* = 0$ and π_m^B and $d_C^* \in (\delta,\ \min(\hat{\delta}, \delta_k))$ and π_m^C respectively. The manufacturer compares the Bertrand and Cournot profit, i.e. π_m^B and π_m^C and chooses the discount, i.e. either at zero or at $d_C^* (> 0)$, that gives a higher profit. The corresponding discount is the optimal discount, d^*. Table 1 summarizes the algebraic expressions for these solutions. Hence, in the two-stage ordering process, we propose the following proposition:

Proposition 2: *In the two-stage ordering process,*

(*i*) *if the manufacturer chooses* $d^* = 0$*, then downstream competition is in the Bertrand regime and dealers are indifferent between preordering and waiting until stage 2 to order.*

(*ii*) *if the manufacturer chooses* $d^* > 0$, *then downstream competition is in the Cournot regime, preorders are never supplemented in stage 2, and the optimal discount* $d^* \in (\delta,\ \min(\hat{\delta}, \delta_k)]$.

It may seem counterintuitive that the profit maximum could ever occur in the Cournot regime. For, how could the manufacturer benefit from giving dealers a break on the wholesale price? The benefit of these discounts is that they motivate dealers to reduce their retail prices below what they would charge in the Bertrand regime, and this partially solves the manufacturer's double marginalization problem.

Linking Computec and the Two-Stage Ordering Game

As we can see from Figures 1 and 2, Computec's channel arrangement essentially mirrors the two-stage ordering game. This close resemblance between theory and institution enables us to test for consistency between some observable implications of the theory model and corresponding facts from Computec's channel. In particular, we observe a match on two critical aspects that enable us to deduce the type of downstream competition between the dealers.

Specifically, Proposition 2 suggests that under the 2-stage game, the manufacturer should either offer zero or positive discounts. If it offers strictly positive discounts, the downstream competition would be Cournot *and* neither dealer would order additional units in stage 2. The data obtained from Computec (details in next section) support both propositions. First, Computec *always* offers strictly positive discounts to its dealers using the 2-stage ordering process. Second, throughout our longitudinal data over 4 sales cycles, *none* of the 60 dealers supplemented its order in stage 2 at the undiscounted wholesale list price. Based on this match between theory and observation we *infer* that the downstream competition between dealers is in the *Cournot* regime.

This inference is critical because it enables us to set up *a priori* the supply specification we use to recover the unobserved retail prices, the price-cost markups and economic profits earned by the dealers. Our approach hence complements other NEIO-based work on this topic. Specifically, existing studies recover price-cost margins and intensity of competition from estimation results of *assumed* vertical games. In contrast, rather than relying on assumed game structures, we use our theoretical analysis of the *observed institutional structure* and data to infer the type of competition *a priori* and then calculate the markups. This approach enables us to tie the estimated markups to the specific vertical arrangement set by the manufacturer. We turn to this task below.

METHOD: ESTIMATING THE ECONOMIC PROFIT

Empirical Context

The data for the empirical analysis were obtained from Computec, a leading Chinese manufacturer of a key computer accessory sold locally in China. Computec sells through a network of 60 independent dealers grouped into 8 geographic sales regions. A regional manager is tasked with achieving sales quotas and coordinating the marketing activities with the dealers. Dealers operate in regions without any territorial restrictions or RPM clauses, are non-exclusive and sell multiple brands within this product category. Dealers compete in price but also provide some value-added services like pre-sale education to consumers and trade credit to second-tier retailers. As detailed earlier, Computec uses a 2-stage ordering process for these dealers. Further, with the intent of preventing stockpiling behavior, Computec changes its discount schedules from cycle to cycle. Company executives and industry experts assert that this is quite effective because dealers do not seem to engage in such behavior. In essence, the interaction between the manufacturer and dealers is a static game repeated each quarterly cycle with a different discount schedule.

Data

The proprietary data were collected onsite at Computec's headquarters in China. It covers a period of 12 months from December 2004 to November 2005 and comprises of 4 quarterly sales cycles. The archival data provide details on the quarterly discount schedules and wholesale prices offered by Computec, the monthly quantities delivered to dealers, and monthly marketing expenses of Computec. The monthly data allow us to exploit the variations arising out of seasonality. Computec's marketing expenses consisted of spending on advertising, public relations, and other promotions. These data were organized at the national, regional, and individual dealer levels. We could not get data on marketing expenditure of the dealers; however company officials believed such amounts were minimal. We provide a description of these measures below and Table 2 provides the descriptive statistics. Note that for confidentiality purposes, all prices, costs/expenses, and quantities have been re-scaled to a fictitious monetary unit expressed as Y$.

- *Quantity*: Monthly quantity *delivered* by Computec to each of its 60 dealers.
- *Net wholesale price*: Individual dealer's cost of goods (in Y$), net of the quantity discounts, for each quarterly cycle. The list wholesale price remained the same throughout the 12 months of data.
- *Wholesale market prices of competing manufacturers*: We do not have direct access to these data; hence we used the monthly selling prices (in Y$) in the Beijing wholesale market for products of Computec's two direct competitors. Beijing is the largest wholesale market of computer related

products in China and has the lowest wholesale market prices in the nation. We have a total of 12 dealer-invariant observations for each competing brand.

- *National advertising expenses*: Computec's monthly advertising expenses (in million Y$) in the national media. We have a total of 12 dealer-invariant data points.
- *National Public relations (PR) expenses*: Computec's monthly expenses on public relation activities such as press conference, exhibitions, and media relations (in million Y$). We have a total of 12 dealer-invariant data points.
- *Regional marketing expenses*: Computec's expenses (in million Y$) in outdoor displays, dealer conferences, display materials for retail outlets, and other promotional activities in each of the 8 specific regions. We have monthly observations for this measure.
- *Dealer-level marketing expenses*: Computec's sponsored expenses (in million Y$) in promotional activities such as outdoor displays, dealer conferences, display materials for retail outlets, and other promotional activities at a particular dealer. We have monthly observations for each of the 60 dealers.

<Insert Table 2 about here>

Estimation Technique

To calculate the economic rent/profits earned by Computec's dealers, we need information on retail prices, costs, and quantities. When company data are available, these profits can be calculated directly (e.g., Kaufmann and Lafontaine 1994). Often times, however, data on one of these components (e.g., dealer's costs) are not available. A structural estimation approach (e.g., Kadiyali 1996) is then used to impute these unobservable costs and final margins. We, however, have a situation where the dealer's costs are observable to the manufacturer but the retail prices (defined as the price the dealers charge consumers and other second-tier re-sellers) are not. This non-availability of retail prices is quite prevalent in a variety of sale-resale contexts and could be a result of lack of appropriate tracking and recording procedures or systems and/or strategic unwillingness on the part of the dealer to reveal retail prices. Nevertheless, our estimation problem is hence quite different from that observed in most NEIO research on price-cost markups.

To tackle this problem, we develop a technique that uses longitudinal data to recover these unobserved final prices. Specifically, we estimate the demand function using a fixed effect model in which the observed net wholesale prices act as a "proxy" for the final prices. Concurrently, based on the insights from our formal model and institutional details, we specify *a priori* the supply-side dealer competition to be equivalent to a one-shot Cournot game. We then use the estimated slope of the demand function and this specified supply relation to calculate the final prices.

We start with a linear demand specification that is frequently used in estimating structural models (e.g., Dube and Manchanda 2005; Kadiyali 1996). Specifically, the linear demand function for the product sold by dealer i at time t is taken to be:

$$(6) \qquad q_{it} = a_i + \beta_1 p_{it} + \beta_2 p_{-it} + \sum_{r=1}^{2} \alpha_r \, p_{it}^r + \alpha_3 X_{it} + \sum_{m=1}^{3} \alpha_{m+3} X_t^m + \varepsilon_{it}, \; i=1,2,\ldots,60; \; t=1,2,\ldots,12.$$

where q_{it} is quantity demanded, p_{it} is own retail price, p_{-it} is the average retail price of i's rival dealers located in the same region (defined below), p_{it}^r is the retail price for competing brand r sold by dealer i, X_{it} is Computec's sponsored marketing expenses on dealer i, X_t^m is Computec's national-level advertising and public relations expenses and regional-level marketing expenses, α and β's are demand parameters to be estimated, a_i includes all time-invariant variables, and ε_{it} is the error term[9]. The coefficients of p_{it} and the p_{-it} represent own-price effect and peer- (or intra-brand price) effect respectively on quantity demand for each dealer. We define peer-effect as:

$p_{-it} = \frac{1}{n_g - 1} \sum_{i \neq j} p_{jt}$, where n_g is the number of dealers located in region g and i, j $\in$ g (Bresnahan 1987, p.1046; Wooldridge 2002, p.331).

Since p_{it}, p_{-it} and p_{it}^{r}'s are unobserved, we cannot directly estimate (6). Hence, we take advantage of the longitudinal nature of our data and use a fixed-effect model along with two specific assumptions on individual dealers' mark-ups. First, we assume that for the two competing brands, each dealer adds a dealer-specific markup, θ_i^r, to the observed wholesale market prices, c_t^r, to arrive at his final retail price, i.e. $p_{it}^r = c_t^r + \theta_i^r$. Second, we write the unobserved own price as a function of wholesale price and its associated dealer-specific markup, Δ_i, i.e. $p_{it} = c_{it} + \Delta_i$, where c_{it} is the observed net wholesale price (i.e. net of discounts). This additive specification has been used previously (e.g., Kadiyali et al 2000) and more crucially, fits the pricing rules used by dealers. Indeed, our field interviews revealed that the dealers markup their costs by a fixed amount, and not by a percentage[10]. Using the additive pricing rule on own price, we can then express peer-effect as

$$p_{-it} = \frac{1}{n_g - 1}\sum_{i \neq j} p_{jt} = \frac{1}{n_g - 1}\sum_{i \neq j}(c_{jt} + \Delta_{-i}) = \bar{c}_{-it} + \bar{\Delta}_{-i}.$$

Our markups, a measure of a dealer's pricing power, are also time invariant. We believe this is a reasonable assumption because our field interviews revealed that the number of dealerships used by the leading manufacturers is fairly stable. We do not restrict the relative magnitude of θ_i^r's and Δ_i; this allows the dealers to add different markups for different brands. Substituting the three expressions of final prices into (6), mean-differencing the transformed equation to remove the markup terms and other time-invariant variables, and adding a sales cycle intercept, τ, to capture any time-trend effects gives us the following equation:

$$q_{it} - \bar{q}_i = \tau + \beta_1(c_{it} - \bar{c}_i) + \beta_2(\bar{c}_{-it} - \bar{\bar{c}}_{-i}) + \sum_{r=1}^{2}\alpha_r (c_t^r - \bar{c}^r) + \alpha_3(X_{it} - \bar{X}_i) + \sum_{m=1}^{3}\alpha_{m+3}(X_t^m - \bar{X}_i^m) + (\varepsilon_{it} - \bar{\varepsilon}_i).$$

Notice that this specification helps to remove potential omitted variable bias caused by unobserved markups which are correlated with prices and marketing activities (e.g., Lal and

Narasimhan 1996). Renaming the transformed variables, we then estimate:

$$(7) \qquad \ddot{q}_{it} = \tau + \beta_1 \ddot{c}_{it} + \beta_2 \ddot{\bar{c}}_{-it} + \sum_{r=1}^{2} \alpha_r \ddot{c}_t^r + \alpha_3 \ddot{X}_{it} + \sum_{m=1}^{3} \alpha_{m+3} \ddot{X}_t^m + \ddot{\varepsilon}_{it} .$$

Note that the mean-centered wholesale prices, $\ddot{c}_{it}$, are uncorrelated with the demand errors, $\ddot{\varepsilon}_{it}$ (Berry 1994). This is supported by the results of tests for endogeneity (see Table 3). We also tried semi-log and log-log demand specifications and found similar fit to data relative to the linear specification in (7). To account for regional differences, we incorporate interactions of $\ddot{c}_{it}$ with regional dummies to obtain estimates of region-specific slopes of demand, namely $\hat{\beta}_{1g}$ respectively. These estimates are used in the supply side formulation to compute the unobserved final prices. Nevertheless, given the limited number of observations, to preserve the degrees of freedom and thus efficiency in our estimations we pool the data across regions and do *not* use regional dummies to interact with peer effects and other variables (e.g., Kumar and Leone 1988).

The close match between our theory and institutional context suggests that the downstream dealer competition is most likely to be Cournot equivalent. Hence, Computec's dealers choose quantity to maximize their profit, i.e., $\max_{q_{it}} \pi_{it} = p_{it} \cdot q_{it} - \int_0^{q_{it}} c_{it}(u)\, du$, assuming that rivals' quantities are constant. The first-order condition of dealer's profit maximization is:

$$(9) \qquad \frac{\partial \pi_{it}}{\partial q_{it}} = (p_{it} - c_{it}) + q_{it} \frac{\partial p_{it}}{\partial q_{it}}_{j} ,$$

where c_{it} is the marginal cost in month t. The partial derivative with respect to own quantity on the right hand side of (9) is the inverse of the slope of the individual dealer's demand curve at given rivals' quantity. However, because of our short-panel, we can only estimate the region-specific slope for demand but not the dealer-specific slope for demand for a representative dealer in that region. We account for this limitation in calculating individual dealers' final prices by assuming that a dealer's markup equals to the markup of the representative dealer located in the *same* region (e.g. Reiss and Wolak 2005). Further assuming the only marginal cost that a dealer incurred is his net purchase price per unit, we can *calculate* the final price, $\hat{p}_{it}^{C}$, for all dealer i's in region g, according to the following formula (see Appendix D for details) :

(10)
$$p_{it}^{C} = c_{it} - \frac{\hat{\beta}_{1g} + \hat{\beta}_{2}(\frac{n_g - 2}{n_g - 1})}{(\hat{\beta}_{1g} - \frac{\hat{\beta}_{2}}{n_g - 1})(\hat{\beta}_{1g} + \hat{\beta}_{2})} \frac{Q_g}{12 \cdot n_g}.$$

where Q_g is regional sales units over the 12-month data period. This formula is based on our inference that the competition in which Computec's dealers engage is equivalent to a one-shot *differentiated*-good Cournot game. This formulation of final prices results in a pattern of regional-level price dispersion that is equivalent (to be precise, affine-transformed) to that of dealers' net wholesale prices. This clearly requires an assumption about the nature of intra-brand competition in that region, i.e. large dealers sell at lower prices than smaller ones because the former has lower average wholesale prices than the latter. This is reasonable because the two types of dealers for Computec focus on different customer segments: second-tier re-sellers for the large dealers versus retail for the small dealers. Furthermore, our measure of marginal cost in (10) follows a more precise definition per economic theory and excludes costs that do not vary with each additional unit sale (Pindyck and Rubinfeld 2001). As such, we assume that employees' wages are short-run fixed costs and thus, the marginal selling cost is negligible. Our field interviews revealed that almost all the sales people hired by dealers are paid either pure salary or a combination of fixed salary and semi-annual or annual bonus based on company-wide profitability; hence, a sales person's incentives are not set at the unit margin. Moreover, dealers usually do not offer overtime pay even if their sales people work overtime occasionally; instead such overtime work effort by sales people is taken into account for the bonus considerations.

Finally, we calculate the gross and net economic profit earned by dealer i over the 12 months of data as $\Pi_i = \sum_{t=1}^{12} (\hat{p}_{it}^{C} - c_{it}) \cdot q_{it}$ and $\Pi_i = \sum_{t=1}^{12} (\hat{p}_{it}^{C} - c_{it}) \cdot q_{it} - F_i$ respectively, where F_i includes employee salary/wages, the entrepreneur's opportunity cost of time (proxied by their second-best job), and the office/outlet rental charges. The first two items are considered as short-run fixed costs and are not part of the marginal cost. We calculate these three costs as follows. We used the China Provincial Statistical Yearbooks (2004, 2005)[11] to obtain information on the wages earned by computer engineers. Computer engineers were among the highest paid jobs across all occupations that were surveyed by the Yearbooks and we assume that the opportunity cost of the entrepreneur's time equals a computer engineer's wage in that corresponding city. The same Statistical Yearbooks also provide information on wages earned by wholesale/retail workers. Since the employees of Computec's dealers engage in wholesale and/or retail business in the computer industry, we assume that their compensation is equal to the mean wage of the computer engineers and wholesale/retail workers. The total employee wage expense of a dealer is then calculated by multiplying this wage by the number of sales people and technical support staff he hires. Estimates of the dealers' rental fees were obtained from the regional managers. The sum of the entrepreneur's opportunity cost, employee wages, and rental fees is finally weighted by the share of dealer's total business that is Computec's sales to obtain the dealer's fixed costs incurred for selling Computec's product. These costs however exclude tax- and interest expenses; hence the estimate of economic profits should be considered as pre-tax and pre-interest profit.

Empirical Results

Table 3 provides two sets of pooled demand estimates: regional and national levels. Both sets of results are qualitatively consistent. We find that as per expectations, national-level advertising and public relations, regional-level and sponsored dealer-level marketing expenses are quite effective in generating demand. More importantly for us, the coefficients of own price and peer effects (cross price of own brand), and competing brands' prices are directional correct. From the regional-level estimates on the slope of demand, dealers in Beijing, the East, and the South – the three most developed regions in the country – have significantly larger coefficient estimates on price, i.e. higher own price sensitivity, than those of the five less developed regions, suggesting that competition is more intense in these 3 regions.

<Insert Table 3 about here>

Since the demand estimates are similar and regression (1) is the most complete in its specification, we use its estimates, in conjunction with (10), to compute the average final retail price for each region. Table 4 provides the estimates. According to Computec executives, our estimates are generally consistent with their expectation which is based on anecdotal evidence on the average purchase prices obtained from the second-tier retail shops.

<Insert Table 4 about here>

Based on our estimates of the final prices and individual quantities at each dealer, we calculate the gross and net economic profit earned by each dealer in the fiscal year 2004-2005. Table 5 presents these results by region. Our results show that the average gross and net economic profit earned by a typical dealer from selling Computec's product are Y$4.53 million and Y$2.47 million respectively[12]. Note that the net economic profit over a one-year period of Y$2.47 million (approximately US$22,000) is obtained after accounting for the dealer/owner's opportunity cost of alternative employment. As Computec does not use any fixed-fee transfer mechanism to extract any part of these profits from the dealers, the dealer's *ex post* rent equals his *ex ante* rent[13]. Hence, the results show that the two-stage ordering mechanism is quite effective in generating downstream profits. We also noted that there is always a "queue" of potential dealers hoping to land a dealership from Computec, providing circumstantial evidence about the existence of this residual profit stream (e.g., Mathewson and Winter 1985, Kaufmann and Lafontaine 1994).

<Insert Table 5 about here>

An Assessment of the Effectiveness of the Two-Stage Ordering Mechanism

Computec's two-stage ordering process seems to provide economic incentives to its dealers and anecdotal evidence from both internal and external sources attests to the effectiveness of this arrangement. Our in-depth field interviews with company officials revealed that in recent years there has always been a pool of candidates hoping to land a Computec dealership. The executives also revealed that before the deployment of the current two-stage ordering process, dealer markups, especially those in the more competitive regions, were much lower than our estimates.

Unfortunately, our data do not allow us to evaluate this pre- and post-arrangement comparison econometrically. Hence, we compared the profitability of Computec's dealers to that of other information-technology distributors in China over the same period. Specifically, we use the profitability of the two largest IT distributors in China – Digital China and PCI – as benchmarks. According to their company reports, their operating margins, i.e. profit margins before interest and taxes are 1.89% (fiscal year 2005-6) and 1.35% (first 3 quarters of 2006) for Digital China and PCI respectively[14]. These numbers are significantly lower than the net profit margin of almost 6.4% that can be obtained from Tables 2 and 5 for an average Computec dealer suggesting that the two-stage ordering process used by Computec was quite effective in generating downstream profits.

DISCUSSION

Manufacturers like Computec often require their dealers to be involved in value-added market development activities like pre-sales education, customer training, and organizing trade and consumer promotions in their local areas. These activities are critical in markets with a large growth potential. Many of these marketing efforts are tedious and require local adaptation; thus it is not possible to specify all the operational details in a formal contract. Even if such desired activities could be formally contracted, a geographically dispersed dealer network and non-exclusive dealing clauses (as is the case with Computec) makes it extremely costly to monitor dealer conformity with precise contract terms. Under such circumstances, and out of the need to impose a loss on recalcitrant dealers, manufacturers often devise mechanisms that incentivize the dealers through economic profit even while the manufacturer maximizes profit (e.g., Blair and Lafontaine 2005; Klein and Murphy 1988).

In this paper we first develop a formal model of one such mechanism, i.e. the two-stage ordering process with quantity discounts that is used in a wide variety of industry contexts that shows how a manufacturer can indirectly control the intensity of downstream competition by judiciously choosing a quantity discount rate. We then match the decision structure and results of the model with actual contractual arrangements and novel data obtained from a leading Chinese manufacturer of a computer accessory marketed in China to setup a structural model that estimates the unobserved final prices and hence the economic profit earned by the dealers over a one-year period. We find that using a two-stage ordering process, this manufacturer indeed leaves significant "money on the table" across a heterogeneous group of dealers. We consider the research and managerial implications of our work below.

Implications for Research

Our paper makes important contributions to research in the study of vertical channel management. First, we show how crucial understanding the institutional context is to theory building and data interpretation. Indeed, the dataset we compiled from Computec's archives, in isolation, provides no hint about the 2-stage ordering process used by Computec. By developing a theory model that explicitly embeds this institutional detail, we show that the downstream dealer behavior is fundamentally altered. Specifically, a positive discount offered under the 2-stage ordering process could result in a downstream competition where dealers *choose quantities* in stage

1 to maximize profits and then choose prices in stage 2 to clear these quantities; in effect resulting in a Cournot rather than a Bertrand outcome even though, superficially, the dealers seem to compete in price. The appropriate choice variable in formulating the supply relation in this setting is then quantity rather than price. Without taking account of this institutional detail, a researcher might incorrectly surmise the downstream competition to be Bertrand (because dealers simultaneously choose prices) and reach the wrong conclusions. Further, given the popularity of similar policies in channel settings, our results suggest that Cournot competition might be more common in channel settings than is commonly recognized. For instance, Coughlan and Wernerfelt (1989) suggest that many industries like automotive and fashion retailing, with fairly rigid capacity constraints over long horizons, are likely to be characterized by quantity, rather than price, competition.

Second, our approach enables us link the dealer profits to a specific vertical arrangement designed by the manufacturer. Specifically, the consistency between theory and observations at Computec enables us to infer and set *a priori* the conduct regime in our structural estimation of the unobserved retail prices. This complements with existing empirical studies that focus on using *assumed* games to infer the type of vertical game being played estimation results. This approach does not inform us about the underlying vertical arrangements which are generating the data we observe. Our approach of theory models and empirical estimation not only provides insights into a particular channel policy but also allows us to unequivocally link a specific channel arrangement to assembled field data for systematic empirical analyses on downstream markups.

Our third research contribution is to develop a procedure to recover the unobserved retail prices using longitudinal data. We start with estimating the demand function using a fixed effect model in which the observed net wholesale prices act as "proxy" for the final prices. We then use theory/institutional insights to specify the supply relation (Cournot/Bertrand/monopoly etc.) *a priori* and then in conjunction with the estimated demand slope, calculate the final prices. Our novel procedure should enable researchers to model settings where the downstream prices are not observed (e.g., many business-to-business settings with customer-specific prices).

Implications for Managerial Practice

One major channel management problem besetting manufacturers worldwide is how to reduce the intensity of downstream competition so that dealers can earn “satisfying” levels of profits and continue to support the manufacturer’s products. Mechanisms like resale price maintenance, territorial restrictions, and fixed fee transfers are not feasible in many circumstances. We show that by combining quantity discounts with a two-stage ordering process a manufacturer can influence the intensity of downstream competition. We thus provide an alternative mechanism that not only creates downstream economic profits but is implementable, adaptable and not difficult to monitor. For example, discount schedules can be changed to prevent stockpiling behavior.

Second, in many contexts (e.g., manufacturers dealing with large dealers), downstream channel members are reluctant to reveal their pricing information because revealing one’s profit margin is likely to weaken one’s bargaining position in vertical relationships. Moreover, customer-specific pricing and quantity discounts also makes downstream prices difficult to obtain. Currently, under such circumstances, manufacturers only have anecdotal or small sample data on downstream prices (using, say, secret shoppers). Acquiring such information, and assessing its value, becomes increasingly difficult when dealers are geographically dispersed and logistical difficulties inhibit monitoring dealer activities (as is the case in China). Our novel estimation technique would help such manufacturers recover these unobserved downstream prices. Our method requires information on contractual arrangements, wholesale prices, quantities, and number of assigned dealers; such information is likely to be readily available in company records. Therefore, our model should appeal to those manufacturers who want to adopt a more systematic, structural approach to alleviate the asymmetric information problem.

Limitations and Directions for Future Research

Our paper obviously has limitations. On the theory side, our model is limited to the simplest setup involving three players, one manufacturer and two dealers. Permitting inter-brand competition and allowing each manufacturer to have more than two dealers would improve the realism of the model. This is not problematic in our particular context because all of Computec's major competitors, *regardless of size*, use a qualitatively similar two-stage ordering process with their dealers. As such, strategic inter-brand rivalry motives are less likely to explain the adoption of this practice. Another extension would be to permit dealers to carry inventories from one ordering cycle to the next. Another extension would be to formally compare the efficiency of the two-stage ordering process to alternative institutions which the manufacturer chose not to adopt. On the estimation side, our analysis was limited by lack of data on the dealer-level wholesale prices and discount schedules for competing brands. Hence, we cannot study issues like heterogeneity of responses across dealer and brand types that would be of substantive interest to marketing managers. Substantively, the two-stage ordering process might not be an effective rent-generating mechanism when manufacturers offer return policies at the same time: a return policy would make any pre-commitment in the first stage moot. All these limitations point to avenues for future research.

Studying the rationale for leaving "money on the table" for downstream partners is both important and challenging. It is important because, as theory suggests, these potential economic profits can motivate dealers to perform and to limit their undesirable behaviors. It is challenging because there is a lack of formal theory regarding rent creation and its relationship to self-enforcing contracts. In addition, empirical analyses require extremely detailed firm level data. As insights accumulate on the economic rationale for leaving downstream rent, it will become possible to give more valuable advice to companies about how to organize their distribution activities efficiently and to antitrust authorities about how to formulate more effective competition policies.

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TABLE 1: OPTIMAL QUANTITY DISCOUNTS AND OUTCOMES

	Bertrand Regime	Cournot Regime	
Range of quantity discount	$d \in [0, \delta]$	$d \in [\delta, \min(\hat{\delta}, \delta_k))$	$d = \hat{\delta}$
Optimal quantity discount	$d_B^* = 0$	$d_C^* = \max[\delta, \frac{(2+b)((1-b)(3w-2m)-a)}{2(1-b^2)(a+(1-b)(w-2m))}]$	$d_C^* = \hat{\delta} = \frac{w(2+b)}{2a(1+b)}$
Manufacturer's Profit	$\pi_m^B = \frac{2(w-m)(a-w(1-b))}{2-b}$	$\pi_m^C = \frac{(1+b)(a-m(1-b))^2}{4(2-b-b^2)}$	$\pi_m^C = \frac{a(1+b)(w-2m)}{(2+b)}$
Dealer Prices	$p_i^{B*} = \frac{a+w}{2-b}$	$p_i^{C*} = \frac{a(3+b)+(1-b^2)(2m-w)}{2(2-b-b^2)}$	$p_i^{C*} = \frac{a(1+b)}{2-b-b^2}$
Dealer Quantities	$k_i^{B*} = \frac{a-w(1-b)}{2-b}$	$k_i^{C*} = \frac{(1+b)(a-(1-b)(2m-w)}{2(2+b)}$	$k_i^{C*} = \frac{a(1+b)}{2(2+b)}$
Dealer Profits	$\pi_i^B = \frac{(a-(1-b)w)^2}{(2-b)^2}$	$\pi_i^C = \frac{1}{8(1-b)(2+b)^2} \times (1+b)(a-(1-b)(2m-w)) \times (a(4+b)+(1-b)(2bm-4w-3bw)$	$\pi_i^C = \frac{a(1+b)(2a-(1-b)(2+b)w)}{2(1-b)(2+b)^2}$

TABLE 2: DESCRIPTIVE STATISTICS AND CORRELATIONS TABLE

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Quantity ('000)	-							
2. Net wholesale price (Y$)	–0.41*	-						
3. Wholesale market price for competing brand # 1	0.03	–0.24*	-					
4. Wholesale market price for competing brand # 2	0.06	0.06	–0.24*	-				
5. National advertising expenses (mil Y$)	0.14*	–0.14*	0.74*	–0.18*	-			
6. National PR expenses (mil Y$)	0.02	–0.07	0.42*	0.07	0.13*	-		
7. Regional marketing expenses (mil Y$)	0.32*	–0.04	–0.11*	0.17*	0.06	–0.15*	-	
8. Dealer-level marketing expenses (mil Y$)	0.20*	–0.11*	0.02	0.07	0.12*	-0.07	-0.05	-
Mean	41.28	1401.82	1221.17	1185.75	3.94	5.17	0.033	0.034
Standard deviation	86.69	72.18	33.90	27.89	3.48	3.83	0.14	0.15
Number of observations	720	720	12	12	12	12	96	720

*: significant at 0.05.

TABLE 3: POOLED DEMAND ESTIMATION

Dependent Variable: Quantity (in '000)

Independent variables	Regional		National	
	(1)	(2)	(3)	(4)
Price for own-brand				
Beijing	-.79***	-.78***		
	(.27)	(.27)		
Northeast	-.17***	-.18***		
	(.05)	(.05)		
North	-.14***	-.139***		
	(.04)	(.04)		
Northwest	-.18**	-.18**		
	(.09)	(.08)		
East	-.32***	-.32***		
	(.08)	(.08)		
South	-.45***	-.43***		
	(.16)	(.16)		
Central	-.15***	-.16***		
	(.05)	(.05)		
Southwest	-.19***	-.20***		
	(.06)	(.06)		
National			-.33***	-.33***
			(.07)	(.07)
Price for own brand:	.13*	.137*	.24***	.25***
Competing dealers	(.08)	(.08)	(.09)	(.09)
Price for competing	.04		.03	
brand #1	(.40)		(.40)	
Price for competing	.21		.17	
brand #2	(.20)		(.20)	
National advertising‡	4.51**	5.50***	5.23***	6.02***
	(1.80)	(1.46)	(1.73)	(1.45)
National public	1.45	2.83***	1.93	3.04***
relations‡	(1.78)	(.91)	(1.76)	(.87)
Regional marketing‡	129.97**	136.34**	123.88**	129.04**
	(52.78)	(53.61)	(55.32)	(56.11)
Computec sponsored	67.74***	70.02***	66.17***	68.05***
dealer marketing‡	(25.41)	(25.02)	(25.32)	(24.99)
Sales cycle effects	Yes***	Yes***	Yes***	Yes***
R^2	.29	.29	.26	.25
F-statistics	F(19,700)=9.55	F(17,702)=9.55	F(12,707)=11.53	F(10,709)=11.98

‡ in million Y\$. Heteroskedasticity robust standard errors in parentheses. No. of observations = 720.

* p < 0.10, ** p < 0.05, *** p < 0.01.

Error term autocorrelations and endogeneity of own price are not detected at p=0.10. Testing strict endogeneity and error term correlations follow the procedures specified in Wooldridge (2002) on p.284-285 and p.275 respectively. The endogeneity test is a modified Hausman test. See also Cameron and Trivedi (2005, p.276).

TABLE 4: ESTIMATED FINAL PRICES AND ECONOMIC RENT BY REGION

	Final Prices (Y$)	
Region	**Mean**	**SD**
(1) Beijing	1514.65	100.84
(2) Northeast	1532.51	16.71
(3) North	1670.41	68.65
(4) Northwest	1683.92	31.53
(5) East	1549.22	81.98
(6) South	1568.87	92.98
(7) Central	1679.43	81.79
(8) Southwest	1556.67	64.29
National average	1589.30	99.03

TABLE 5: ESTIMATED GROSS AND NET ECONOMIC RENT (Mil Y$)

	Gross Rent†		**Net Rent**‡	
Region	**Mean**	**SD**	**Mean**	**SD**
(1) Beijing	9.24	9.69	5.06	6.44
(2) Northeast	1.68	1.44	0.26	1.48
(3) North	1.87	1.44	0.38	1.39
(4) Northwest	6.81	9.51	4.70	9.48
(5) East	3.78	4.87	1.83	6.14
(6) South	8.34	9.49	5.24	5.91
(7) Central	3.96	3.49	2.86	3.09
(8) Southwest	2.40	1.98	1.68	2.29
National average	4.53	6.15	2.47	4.83

†Gross rent is calculated by $\Pi_i^C = \sum_{t=1}^{12} (\hat{p}_{it}^C - c_{it}) \cdot q_{it}$.

‡Net rent is calculated by $\Pi_i^C = \sum_{t=1}^{12} (\hat{p}_{it}^C - c_{it}) \cdot q_{it} - F_i$.

FIGURE 1: TIMELINE OF COMPUTEC'S QUARTERLY SALES CYCLE

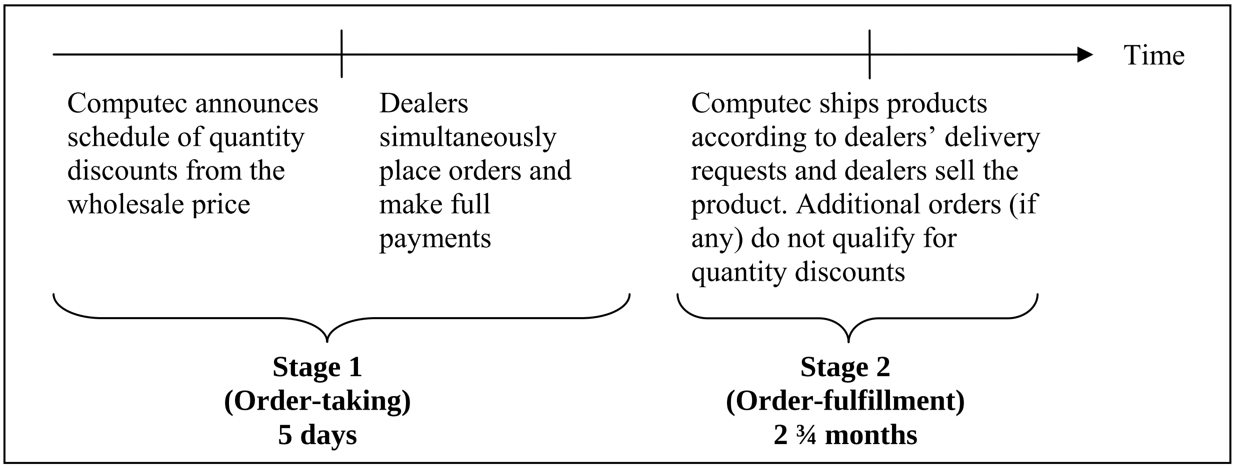


FIGURE 2: SEQUENCE OF MOVES

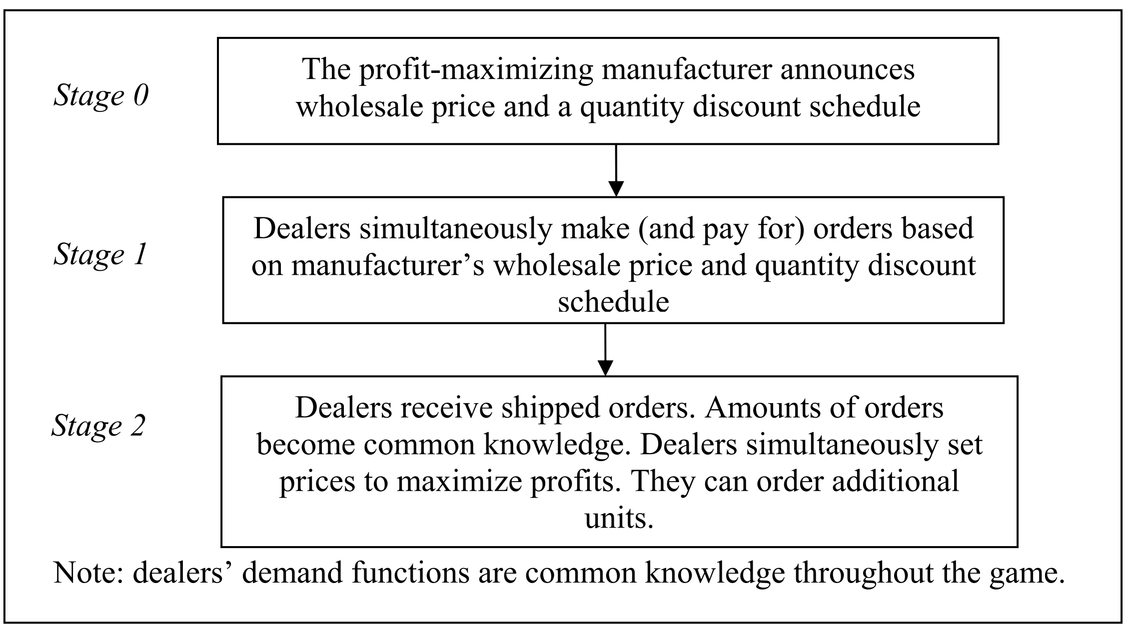


FIGURE 3: DEALER i's PRICING DECISION IN STAGE 2

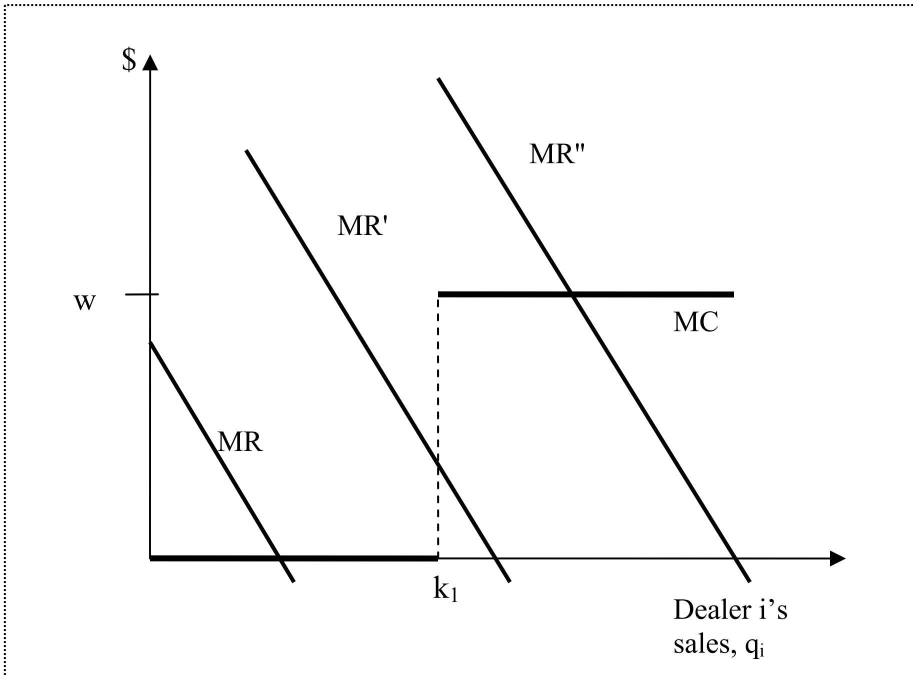


FIGURE 4: PRICE REACTION CURVES

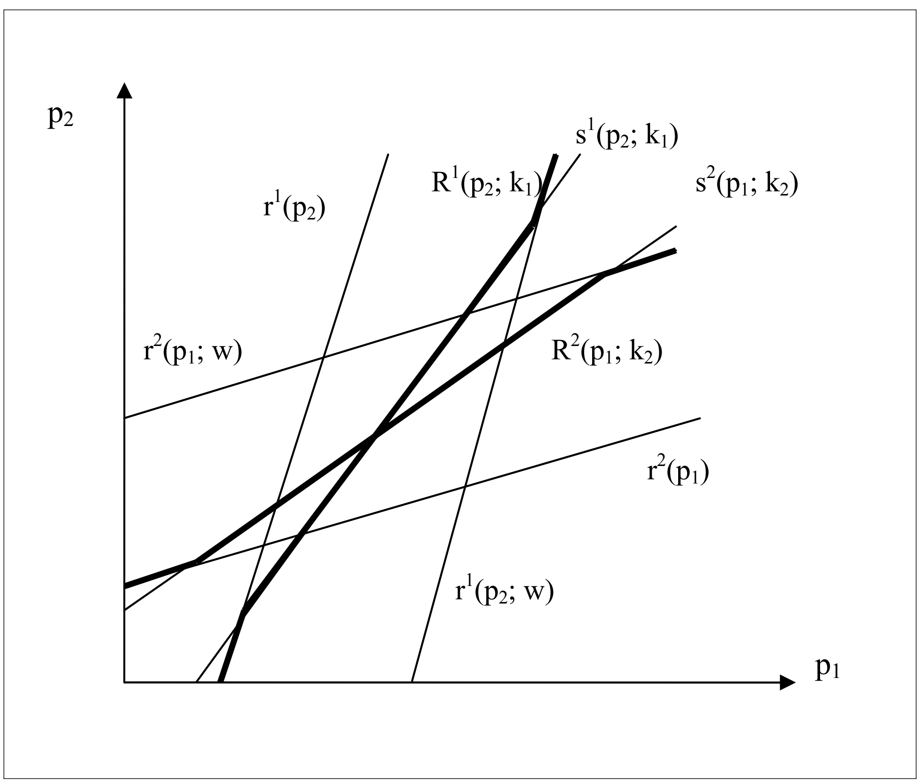


FIGURE 5: BERTRAND AND COURNOT PRICES

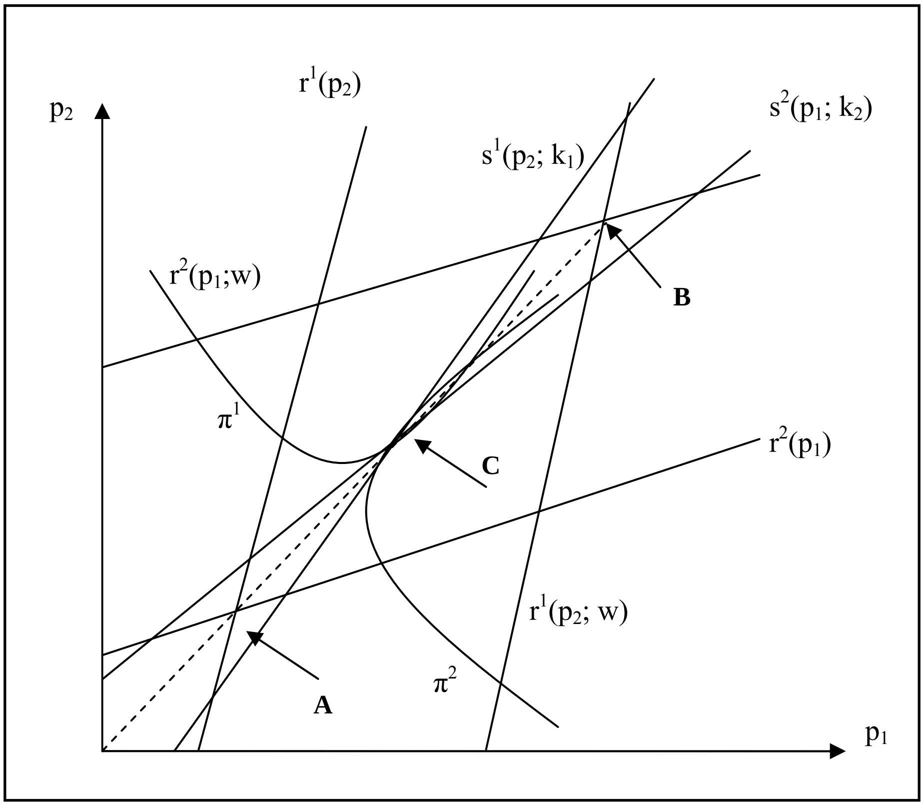
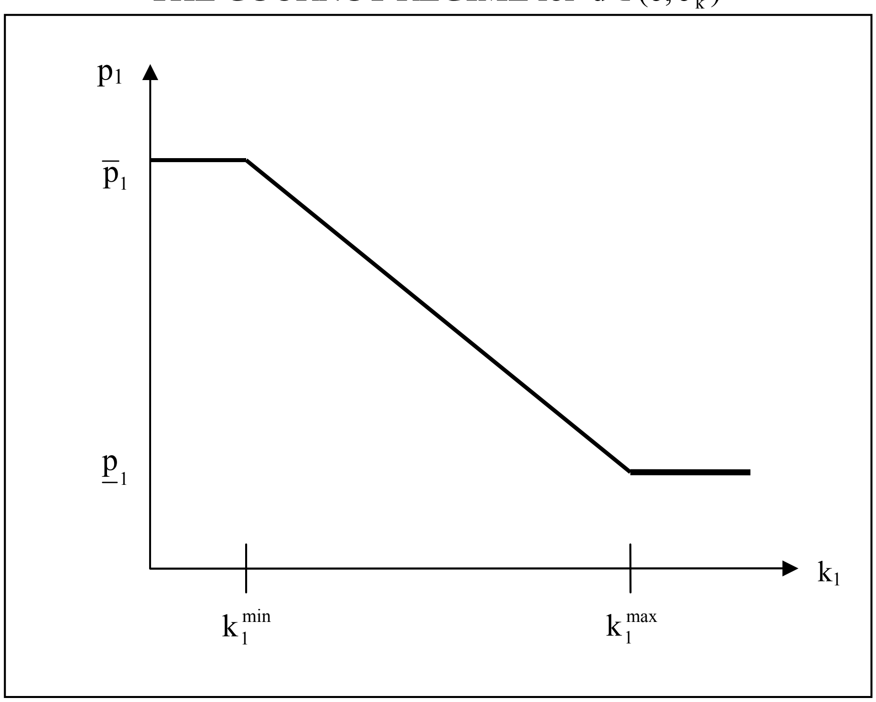


FIGURE 6: RELATIONSHIP BETWEEN DEALER PRICE AND PREORDER IN THE COURNOT REGIME for $d \in (\delta, \delta_k)$



Endnotes

[1] To preserve confidentiality, we use the pseudonym Computec to refer to the manufacturer who provided the context and data used in this paper.

[2] Most of these authors confine attention to pure strategies and some (e.g. Friedman, p. 608 and footnote 13, 1988) regard mixing in a pricing game as implausible. These authors conclude, therefore, that there is typically no subgame-perfect equilibrium (in pure strategies) in games with inflexible capacity constraints.

[3] Padmanabhan and P'ng (2004) agree but show that with sufficient difference between low and high demand in the case of uncertainty, the policy does have an impact.

[4] That is, we assume that each firm must satisfy the demand induced by the price profile. Provided preorders can be augmented, this is always possible (although not always profit-maximizing).

[5] We assume that the manufacturer does not entertain orders so large that the wholesale price net of the discount drops to zero. Moreover, we assume that d is small enough to assure positive equilibrium prices. In fact the upper bound for d is implicitly defined in the equilibrium Cournot price (See Appendix A).

[6] See Kolay, Shaffer, and Ordover (2004) for a model that involves single-tier all-unit discounts.

[7] To avoid clutter, we have suppressed the dependence of the four thresholds $(\overline{p}_1, \underline{p}_1, k_1^{max}, k_1^{min})$ on k_2. In each case, however, $k_2 = k_2^C(d)$.

[8] In showing that a preorder pair does *not* form a second equilibrium, it suffices to show that a *local* deviation by one dealer (dealer 1) is strictly profitable. In assessing its profitability, we implicitly assume that the other dealer continues, after observing his rival's marginal first-stage deviation, to sell all of his own preorder in the second stage. This assumption is valid since the marginal deviation of dealer 1 will have only an infinitesimal effect on dealer 2's marginal revenue if he sells his entire preorder and so his perturbed marginal revenue, evaluated at the same point, will continue to lie in the open interval (0,w).

[9] Like previous studies (e.g., Sudhir 2001), we lack data on the full set of marketing expenses; hence we assume that the marketing expenses of the competing brands are absorbed by dealer- specific, time-invariant characteristics. Nevertheless, the inclusion of the marketing expenses by the focal brand (Computec) in our specifications improves our estimation by significantly reducing the (own) price endogeneity problem (e.g., Chintagunta 2002; Lal and Narasimhan 1996).

[10] If dealers were using percentage margins, then Equation (6) would have been specified in a log-log or semi-log form to enable one to difference away the unobserved margin terms (see below).

[11] China Statistics Press (2004, 2005), Provincial Statistical Yearbooks.

[12] Caution should be exercised in interpreting these profits. We had no information on other dealer expenses (e.g., electricity, office operating costs) which according to Computec's management are very low.

[13] *Ex post* rent is the expected stream of profits *after* the dealers commence marketing the product and can be different from the *ex ante* rent which is the expected profit *before* they choose to market the product. For example, in a two-part tariff where the manufacturer extracts *all* the profits through a fixed fee, the *ex ante* rent is the amount of fixed fee and *ex post* rent is zero.

[14] See www.digiticalchina.com.hk and www.ecs.com.sg. Accessed on December 5, 2007. ECS Singapore is a major shareholder of PCI China. The companies use the accounting term "operating margin" or "operating profit" in their financial statements.