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ABSTRACT

Quantifying the Coordinated Effects of Partial Horizontal Acquisitions*

The growth of private-equity investment strategies in which firms often hold partial ownership interests in competing firms has led competition agencies to take an increased interest in assessing the competitive effects of partial horizontal acquisitions. We propose a methodology to evaluate the coordinated effects of such acquisitions in differentiated products industries. The acquisitions may be direct and indirect, and may or not correspond to control. The methodology, that nests full mergers, evaluates the impact on the range of discount factors for which coordination can be sustained. We provide an empirical application to several acquisitions in the wet shaving industry.

JEL Classification: C54, D12, L13, L41 and L66
Keywords: antitrust, coordinated effects, demand estimation, differentiated products, oligopoly and partial acquisitions

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1 Introduction

The recent phenomenal growth of private-equity investment strategies in which firms often hold partial ownership interests in competing firms has led competition agencies to take an increased interest in assessing the competitive effects of partial horizontal acquisitions.[1] For example, in 2007, the European Commission assessed and rejected a request by Aer Lingus to order Ryanair to divest its 29.4% shareholding in the Irish flag carrier. Also in 2007, the UK Competition Commission assessed the BskyB's acquisition of a 17.9% shareholding in ITV (with no board representation) and found that would substantially lessen competition in the UK TV market. More recently, in 2008, the European Commission assessed and approved subject to conditions, the acquisition by News Corporation of an approximately 25% shareholding in Premiere.

Partial ownership interests raise antitrust concerns about unilateral effects and coordinated effects. The assessment of the former has been recently studied by Brito *et al.* (2013a, hereafter BRV) who provide an empirical structural methodology that follows a number of central aspects of Reynolds and Snapp (1986), Bresnahan and Salop (1986), Flath (1992), O'Brien and Salop (2000), Dietzenbacher, Smid and Volkerink (2000) and Brito *et al.* (2013b). This article focuses on the assessment of the latter.

The coordinated effects of partial acquisitions flow from the repeated interaction among firms in the market, an interaction that provides a structure in which a coordinated (agreement) outcome may be supported, not by explicit negotiation, but as a (tacit) non-cooperative equilibrium, under the credible threat that defections (or deviations) from this coordinated arrangement would trigger retaliation (or punishment) by rivals. In analyzing the coordinated effects of partial ownership arrangements, competition agencies need to evaluate whether a proposed acquisition changes the manner in which firms in the market interact, increasing the strength, extent or likelihood of coordinated conduct.

We propose an empirical structural methodology to evaluate quantitatively the coordinated effects of *actual* and *hypothetical* partial horizontal acquisitions in a differentiated products setting. The proposed methodology relates to two strands of the literature. The first strand of literature examines the theoretical impact of partial competitor ownership on the likelihood of a tacit coordinated agreement. In one of the earliest contributions, Reynolds and Snapp

[1] A key issue in the explanation of private equity growth over the past few years is the fact that private equity investment has been a crucial source of financing for many entrepreneurial ventures (Lerner *et al.*,2012).

(1986) argue that, in markets where entry is difficult, partial financial interests and small joint ventures can facilitate coordination among rivals by reducing the incentive of any single target firm to deviate from the coordinated arrangement because the increased deviation profit is shared with the acquiring firm(s). Malueg (1992) formally examines this argument in the context of an infinitely repeated Cournot homogeneous-product symmetric duopoly model in which each firm' single shareholder holds an identical partial financial interest in the rival. He studies the likelihood of coordination assuming that firms adopt the most basic enforcement mechanism in the repeated game such that, should any single firm in any past period deviate from the coordinated arrangement, reverts permanently to the static Cournot-Nash equilibrium. The analysis extends the literature by showing that partial financial interests have in fact *two* conflicting effects on the likelihood of a tacit coordinated agreement. On the one hand, as argued by Reynolds and Snapp (1986), partial financial interests can facilitate coordination by *reducing* the incentive of target firms to deviate from the coordinated arrangement because the increased deviation profit is shared with the acquiring firm(s). On the other hand, partial financial interests can hinder coordination by *increasing* the incentive of all firms to deviate because such links soften market competition and induce, in case of defection from the agreement, a reversion to a more profitable Cournot-Nash equilibrium. Following the dynamic oligopoly theoretical literature, he measures the likelihood of a tacit coordinated agreement in terms of the set of discount factors (used to calculate the present discounted value of firm's profits in the repeated model) for which coordination can be sustained and finds that the net result of the two effects is, in general, ambiguous and depends critically on the shape of the demand function, that can alter both quantitatively and qualitatively the impact of such partial interests on the above mentioned set of discount factors.

Gilo *et al.* (2006) extend Malueg (1992)'s analysis to the context of an infinitely repeated *Bertrand* homogeneous-product symmetric *n-firm* oligopoly model in which *both* firms and shareholders may hold a complex, *not necessarily identical*, partial financial interests in rivals, and follow grim-trigger strategies that, should any single firm in any past period deviate from the coordinated arrangement, reverts permanently to the static Bertrand-Nash equilibrium. In this framework, the static Nash equilibrium is not impacted by partial acquisitions, which allows the authors to focus the impact analysis on the first (positive) effect identified in Malueg (1992): that partial financial interests *can* facilitate collusion by reducing the incentive of target firms to deviate from the coordinated arrangement (because the increased deviation profit is shared). They show that partial financial interests *do* facilitate coordination if and only if a set of conditions is satisfied cumulatively. If either one of those conditions fails, the likelihood of a coordinated agreement is not affected. Gilo *et al.* (2009) relax the symmetry assumption in Gilo *et al.* (2006) and generalize the set of conditions that must be satisfied cumulatively in order for partial financial interests to facilitate coordination.[2]

The second strand of literature relates to the quantitative evaluation of the impact of mergers on coordinated effects. In contrast to the parallel unilateral effects literature, there is no consensus yet on how to measure the magnitude of coordinated effects, with the literature suggesting two basic approaches. Kovacic *et al.* (2007, 2009)'s approach suggests evaluating how a merger affects the firms' *incentives* for post-merger coordinated behavior and the *stability* of such behavior. They quantify the former by the raw incremental profits from coordination (the difference between competitive and coordination profits) and the latter by the raw incremental profits from deviations (the difference between deviation and coordination profits). The proposed procedure involves selecting a model of competition, fitting and/or calibrating it to the relevant features of the pre-merger market, and finally, using the fitted and/or calibrated model to compute the profitability of coordination and of deviating from that agreement. The approach assumes that the probability of coordination increases with the incremental profits from coordination and decreases with the incremental profits from deviations. The authors apply this procedure to several acquisitions by Hospital Corporation of America in the Chattanooga, Tennessee area using a model of differentiated products price competition, allowing for the possibility of post-merger quality improvements among the merging firms, differential costs and capacity constraints.

Davis (2006) and Sabatini (2006), working initially independently and then jointly in Davis and Sabatini (2011), extend Kovacic *et al.* (2007, 2009)'s procedure suggesting (correctly to the best of our knowledge) that the impact of a merger on the likelihood of a tacit coordinated agreement can only be properly captured by incorporating the raw static incremental profits in a dynamic oligopoly model. The proposed procedure is closely related to that used

[2] Gilo *et al.* (2006) show that an increase in the partial financial interest of firm r in a rival s do facilitate coordination "if and only if (*i*) each firm in the industry holds a stake in at least one rival, (*ii*) the maverick firm in the industry (the firm with the strongest incentive to deviate from a collusive agreement) has a direct or an indirect stake in firm r, and (*iii*) firm s is not the industry maverick." Following Flath (1992) the maverick has an indirect stake in firm r if it holds a direct stake in firm t and, in turn, firm t holds a direct stake in firm r. Gilo *et al.* (2009) show that an increase in the partial financial interest of firm r in a rival s do facilitate colusion "if and only if (*i*) the maverick firm in the industry has a direct or an indirect stake in firm r, and (*ii*) firm s is not the industry maverick."

to simulate the unilateral price effects of mergers in differentiated product markets. It involves estimating the demand system and using the pre-merger data, jointly with an appropriate assumption about the nature of pre-merger prices, to infer marginal costs, which are then used to simulate firms' profits under the different elements of a coordination model: maintain the coordinated arrangement, unilaterally defect from the coordinated arrangement, and punish the defections of a rival. They consider two baseline models of coordination: *joint profit maximization* that assumes coordinating firms attempt to maximize their joint profits, and *Nash bargaining* that assumes coordinating firms attempt to implement the Nash bargaining solution. Either model incorporates the standard *incentive compatibility constraints* that result from coordination strategies sustained in grim-trigger strategies, although the authors discuss two additional types of constraints: *external stability constraints* that emerge from the presence of fringe firms and/or imports and *agreement and monitoring constraints* that derive from the need to simplify complex environments by using simple and observable (monitorable) cooperative agreements. The authors provide several alternatives to quantify the coordinated effects of a merger. If the discount factors of the firms in the industry are known (inferred from internal documents or estimated from a rate of return model following the financial economics literature), the effects can be evaluated directly by examining how the merger impacts the incorporated constraints. Alternatively, and closely paralleling the dynamic oligopoly theoretical literature, the impact of a merger on the likelihood of coordination can be evaluated by examining how it affects the critical discount factors that sustain that agreement. Davis and Huse (2010) provide the first application of this proposed methodology to the merger between Hewlett Packard and Compaq in the network server market, accounting for multi-market contact, the presence of a competitive fringe and of an antitrust authority, and show that, *ceteris paribus*, the incentives to collude often fall as a result of a merger.

We specify a methodology that attempts to link these two strands of the literature. We assume a setting similar to Friedman (1971) where oligopolistic firms interact repeatedly, by playing an infinite sequence of ordinary static games over time and across markets (Bernheim and Whinston, 1990) and follow the most basic enforcement mechanism, grim-trigger strategies, to sustain a coordinated arrangement. Each ordinary static game is modelled in the lines of BRV, accounting for asymmetric multi- and differentiated-product firms (Rothschild, 1999; Vasconcelos, 2005; Kuhn, 2004), and distinguishing two distinct partial ownership rights: financial interest and corporate control (O'Brien and Salop, 2000; Brito *et al.*, 2013b). *Financial interest* refers to the right to receive the stream of profits generated by the firm from its operations and investments, while *corporate control* refers to the right to make the decisions that affect the firm. We need to identify and distinguish the two rights because partial horizontal acquisitions that do not result in effective control raise antitrust concerns distinct from partial acquisitions involving effective control. When a firm acquires a partial financial interest in a rival, it acquires a share of its profits. In the lines of Malueg (1992), such acquisition impacts the likelihood of coordinated conduct by reducing both the deviation profit of the *acquired* firm and the incentive of the *acquiring* firm to compete aggressively, which softens equilibrium Nash punishments. On the other hand, when a firm acquires corporate control in a rival, it acquires the ability to influence the competitive conduct of the target firm. Such influence may impact the likelihood of coordination by facilitating the process of reaching an agreement and by inducing the *acquired* firm to compete less aggressively against the *acquiring* firm, which again softens equilibrium Nash punishments.

We use a procedure similar to Davis (2006) and Davis and Huse (2010) to simulate firms' counterfactual static profits under the different elements of the coordination model (agreement, defection and punishment), which are then incorporated in the repeated game to identify the minimal threshold for the discount factor that sustains coordination. The procedure can be used to examine the impact of partial acquisitions involving only financial interests, corporate control or both. Furthermore, it can deal with direct and indirect partial ownership interests and nests full mergers (100% financial and control acquisitions) as a special case. This structural approach to partial acquisitions has not been, to our knowledge, examined in any other academic study and it may be a preferable method for competition policy issues to the current indirect methods focused on measures of market concentration and on informal analysis of the features of the market conducive to coordinated interaction.

We also provide an empirical application of the methodology to several acquisitions in the wet shaving industry. On December 20, 1989, the Gillette Company, which had been the market leader for years and accounted for 50% of all razor blade units sales, contracted to acquire the wet shaving businesses of Wilkinson Sword in the United States (among other operations) to Eemland Management Services BV (Wilkinson Sword's parent company) for $72 million. It also acquired a 22.9 percent of the nonvoting equity shares of Eemland for about $14 million. On January 10, 1990, the Department of Justice instituted a civil proceeding against Gillette.

The complaint alleged that the effect of the acquisition by Gillette may have been substantially to lessen competition in the sale of wet shaving razor blades in the United States. Shortly after the case was filed, Gillette voluntarily rescinded the acquisition of Eemland's wet shaving razor blade business in the United States, but went through with the acquisition of 22.9% *nonvoting* equity interest in Eemland. The Department of Justice approved the acquisition after being assured that this stake would be passive. On March, 22, 1993, the Warner-Lambert Company acquired Wilkinson Sword (full merger) for $142 million to Eemland, that had put the razor blade company up for sale the year before. These two acquisitions (one involving a partial interest and another a full merger), and two additional hypothetical ones, are evaluated below.

This article is organized as follows: Section 2 presents the empirical structural methodology used to evaluate the coordinated effects of partial acquisitions, Section 3 provides the above mentioned empirical application and Section 4 concludes.

2 Empirical Structural Methodology

This section introduces the empirical structural methodology. We study the implications of partial horizontal acquisitions on coordinated effects that flow from the repeated interaction among firms in the market. The methodology involves six steps similar to Davis (2006) and Davis and Huse (2010). Step 0 consists of estimating consumer demand and assessing the degree of substitutability between the competing products. Step 1 models each oligopolistic ordinary static game in the lines of BRV, accounting for differentiated products industries and asymmetric multi-product firms (Rothschild, 1999; Vasconcelos, 2005; Kuhn, 2004) and distinguishing partial ownership interests that may or may not correspond to control (O'Brien and Salop, 2000; Brito *et al.,* 2013b). Step 2 uses an equilibrium behavior assumption for each ordinary static game *jointly* with demand side estimates (from step 0) to recover (unobserved) marginal costs. Step 3 models the oligopolistic supergame in a setting similar to Friedman (1971) where firms in the industry play an infinite sequence of ordinary games over time, providing a formal structure in which a coordinated outcome may be supported as a non-cooperative equilibrium, under the credible threat that defections from this tacit (non-cooperative) coordinated arrangement would trigger retaliation by rivals.

In analyzing the coordinated effects of partial ownership arrangements, competition agencies need to evaluate whether a proposed acquisition changes the manner in which firms in the market interact, increasing the strength, extent or likelihood of coordinated conduct. Steps 4-5 address the likelihood of coordinated conduct pre-partial acquisition and step 6 the likelihood post-partial acquisition. Step 4 uses the marginal costs recovered in step 2 jointly with the demand side estimates from step 0 to simulate firms' static profits in the pre-partial acquisition industry under the different elements of the coordination model: maintain the coordinated arrangement, unilaterally defect from the coordinated arrangement, and punish the defections of a rival. Step 5 uses those static profits to quantify the likelihood of a coordinated arrangement by identifying the minimal threshold for the discount factor that sustains it in the supergame. Finally, step 6 repeats steps 4 and 5 for different ownership structures of the industry to quantify the coordinated effects of actual and hypothetical partial acquisitions.

We now move on to describe steps 1-6 in more detail. We defer the description of step 0 to the next section when we introduce the consumer demand model, a random coefficients multinomial logit demand function, in the context of our empirical application.

Step 1: Model the Oligopolistic Ordinary Static Game

We introduce here the firm's objective function and the assumptions of the ordinary static game in a setting similar to O'Brien and Salop (2000), Brito *et al.* (2013b) and BRV.

The Setup

There are a finite F number of firms, indexed by f, each of which produces, in each period t, some subset, Γ_{fmt}, of the J_{mt} alternative products available in market $m \in \Upsilon \equiv \{1, \ldots, M\}$. There are also K shareholders, indexed by k, who can own shares in more than one firm. Let $\Theta \equiv \{1, \ldots, K\}$ denote the set of shareholders, which can include not just owners that are external to the industry, but also owners from the subset $\Im \equiv \{1, \ldots, F\}$ of firms within the industry that can engage in rival *cross-shareholding*.

The implications of partial acquisitions on competition depends critically on two separate and distinct elements: financial interest and corporate control. Financial interest refers to the right of the (partial) owner to receive a stake of the stream of profits generated by the firm from its operations and investments, while corporate control refers to the right of the (partial) owner to make the decisions that affect the firm. Firms sometimes have quite complex corporate financial and governance structures that distinguishes the two rights in voting and non-voting (preferred) stock, with the latter giving the holder a share of the profits but no right to vote for the Board or participate in other decisions. Without loss of generality, we assume this type of structure and consider each firm f's total stock is composed of voting stock and non-voting stock.

The financial interest of shareholder k in firm f is represented by $\tau_{kf} \geq 0$ which denotes the shareholder's holdings of total stock in the firm, regardless of whether it be voting or non-voting stock. The degree of corporate control of shareholder k over the decision making of firm f is a function of $v_{kf} \geq 0$ which denotes the shareholder's holdings of voting stock in firm f. The larger the holdings of voting stock in a firm, the greater the degree of control over the decision making will typically be. However the relationship may not necessarily be linear. For example, a shareholder holding 49 percent of voting stock in a firm may have no control over the decision making of the firm if one other shareholder has 51 percent. In contrast, a shareholder holding 10 percent of voting stock in a firm may have effective control over the decision making of the firm if each of the remaining shareholders holds a very small amount of voting stock. As a consequence, we denote the degree of corporate control of shareholder k in firm f by $\gamma_{kf} \geq 0$, a measure of shareholder k's degree of control over the decision making of firm f that does not necessarily correspond to v_{kf}.[3]

Firm's Operating Profit

As it will become apparent in step 3, the supergame describes the playing of an infinitely repeated oligopolistic game with discounting by the above described F firms. Following Friedman (1971), in each market and period, each firm has a set of strategies which is a compact, convex subset of an Euclidean space of finite dimension. Let x_{fmt} denote the strategy chosen from that set by firm f in market m and period t, and let $\mathbf{x}_t = (\mathbf{x}_{1t}, \ldots, \mathbf{x}_{mt}, \ldots, \mathbf{x}_{Mt})'$ denote the corresponding vector of strategies, one for each market, with $\mathbf{x}_{mt} = (x_{1mt}, \ldots, x_{fmt}, \ldots, x_{Fmt})$.

The profits generated by a multi-market and multi-product firm f from its operations, in each period t, are defined over the set of different markets and the subset Γ_{fmt} of products

[3] Financial and corporate control interests may also depend on time period t. We do not make this dependence explicit to avoid having to introduce an additional subscript.

produced by the firm, and can be denoted by a real valued function of the chosen strategies of all firms:

$$\pi_{ft}(\mathbf{x}_t) = \sum_{m \in \Upsilon} \sum_{j \in \Gamma_{fmt}} (p_{jmt} - mc_{jmt}) \Lambda_{mt} s_{jmt}(\mathbf{p}_{mt}) - C_{fmt}, \tag{1}$$

where $s_{jmt}(\mathbf{p}_{mt})$ is the market share of product j in market m and period t, which is (by definition of market) a function of the vector $\mathbf{p}_{mt}$ of prices of the J_{mt} products available, mc_{jmt} is the (assumed constant) marginal cost of product j in market m and period t, Λ_{mt} is the size of market m in period t, and C_{fmt} is the fixed cost of production of firm f in market m and period t.

Firm's Aggregate Profit

In an industry characterized by rival cross-shareholding, the aggregate profits of firm f include not just the stream of profits generated by the firm from its operations, but also a share in its rivals' aggregate profits due to its ownership stake in these firms. We make the following assumption regarding the distribution of those profits among shareholders:

Assumption 1 *Each firm's aggregate profit is distributed among shareholders proportionally to the total stock owned, regardless of whether it be voting stock or preferred stock.*

Under Assumption 1, in each period t, firm f receives a profit stream from its ownership stake in firm g that corresponds to the percentage τ_{fg} of firm g's total stock owned. The aggregate profit of firm f can, therefore, be written as:

$$\Pi_{ft} = \pi_{ft}(\mathbf{x}_t) + \sum_{g \in \Im / f} \tau_{fg} \Pi_{gt},$$

where the first term denotes the operating profit and the second term denotes the returns of equity holding by firm f in any of the other firms.[4] This set of F equations implicitly defines the aggregate profit for each firm in each period.

Let $\mathbf{D}^*$ denote the $F \times F$ cross-shareholding matrix with zero diagonal elements, $\tau_{ff} = 0$, and off diagonal elements $\tau_{fg} \geq 0$ (if $f \neq g$) representing the percentage held by firm f on firm

[4]The set $\Im / f$ denotes the set $\Im$ not including firm f.

g's total stock. In vector notation, the aggregate profit equation becomes:

$$\mathbf{\Pi}_t = \boldsymbol{\pi}_t(\mathbf{x}_t) + \mathbf{D}^*\mathbf{\Pi}_t,$$

where $\mathbf{\Pi}_t$ and $\boldsymbol{\pi}_t(\mathbf{x}_t)$ are $F \times 1$ vectors of aggregate and operating profits in period t, respectively.

In order to solve for those profits explicitly, we make the following assumption regarding the shareholder structure of the firms in the market:

Assumption 2 *The rank of* $(\mathbf{I} - \mathbf{D}^*)$ *equals the number of firms in the market.*

Under Assumption 2, matrix $(\mathbf{I} - \mathbf{D}^*)$ is invertible, which implies it is possible to solve for the aggregate profit equation:

$$\mathbf{\Pi}_t(\mathbf{x}_t; \mathbf{D}^*) = (\mathbf{I} - \mathbf{D}^*)^{-\mathbf{1}} \boldsymbol{\pi}_t(\mathbf{x}_t), \tag{2}$$

where $\mathbf{I}$ denotes the identity matrix.

Manager's Objective Function

In a standard oligopoly model with no partial ownership interests, barring any market imperfections that preclude efficient contracting between the shareholders and the manager, the former will typically agree, and give the appropriate incentives, that the manager should maximize profits. However, as O'Brien and Salop (2000) argue:

> When multiple owners have partial ownership interests, (...) they may not agree on the best course of action for the firm. For example, an owner of firm f who also has a large financial interest in rival firm g typically wants firm f to pursue a less aggressive strategy than the strategy desired by an owner with no financial interest in firm g. In this situation, where the owners have conflicting views on the best strategy to pursue, the question arises as to how the objective of the manager is determined. Ultimately, the answer turns on the corporate-control structure of the firm, which determines each shareholder's influence over decision-making within the firm. (page 609)

We make the following assumption regarding the objective of the manager of the firm:

Assumption 3 *The manager of the firm maximizes a weighted sum of the shareholder's returns.*

The formulation implied by Assumption 3 constitutes a parsimonious way to model shareholder influence since it includes a wide variety of plausible assumptions about the amount of influence each owner has over the manager of the firm. Under this formulation, a higher weight on the return of a particular owner is associated with a greater degree of influence by that owner over the manager. Different control scenarios then correspond to different sets of control weights for the different owners. Under Assumption 3, the objective function of the manager of firm f in period t can therefore be written as follows:

$$\varpi_{ft} = \sum_{k \in \Theta} \gamma_{kf} R_{kt}, \tag{3}$$

where γ_{kf} measures (as described above) the degree of control of shareholder k over the manager of firm f, and R_{kt} is the return of shareholder k in period t.

In a setting where each firm's aggregate profit is, under Assumption 1, distributed among shareholders proportionally to the total stock owned and each shareholder can have ownership stakes in more than one firm, the return of shareholder $k \in \Theta$ in each period can be written as:

$$R_{kt} = \begin{cases} \sum_{g \in \Im} \tau_{kg} \Pi_{gt} \left(\mathbf{x}_t; \mathbf{D}^* \right) & \text{if } k \notin \Im \\ \varpi_{kt} & \text{if } k \in \Im \end{cases}. \tag{4}$$

Combining equations (3) and (4), the objective function of the manager of firm f in period t becomes:

$$\varpi_{ft} = \sum_{k \in \Im / f} \gamma_{kf} \varpi_{kt} + \sum_{\substack{k \in \Theta \\ k \notin \Im}} \gamma_{kf} \sum_{g \in \Im} \tau_{kg} \Pi_{gt} \left(\mathbf{x}_t; \mathbf{D}^* \right),$$

where the first term involves the return of rival firms within the industry ($k \in \Im / f$) that engage in cross-shareholding and the second term involves shareholders that are external to the industry ($k \notin \Im$). This set of F equations implicitly defines the objective function for each firm in each period of the supergame.

Let $\mathbf{C}^*$ denote the $F \times F$ cross-shareholding matrix with zero diagonal elements, $\gamma_{ff} = 0$, and off diagonal elements $\gamma_{fg} \geq 0$ (if $f \neq g$) representing the measure of firm f's degree of control over the manager of firm g. Let also $\mathbf{C}$ and $\mathbf{D}$ denote the $(K-F)\times F$ control interest and finance interest shareholding matrices with typical element γ_{kf} and τ_{kf}, respectively.[5] In vector notation, the objective function equation becomes:

$$\boldsymbol{\varpi}_t = \mathbf{C}^{*\prime}\boldsymbol{\varpi}_t + \mathbf{C}'\mathbf{D}\boldsymbol{\Pi}_t\left(\mathbf{x}_t;\mathbf{D}^*\right),$$

where $\boldsymbol{\varpi}_t\left(\mathbf{x}_t\right)$ denotes the $F\times 1$ vector of objective functions for period t. In order to solve for those functions explicitly, we make the following assumption regarding the shareholder control structure of the firms in the market:

Assumption 4 *The rank of* $\left(\mathbf{I}-\mathbf{C}^{*\prime}\right)$ *equals the number of firms in the market.*

Under Assumption 4, matrix $\left(\mathbf{I}-\mathbf{C}^{*\prime}\right)$ is invertible, which implies it is possible to solve for the objective function equation as follows:

$$\begin{aligned}
\boldsymbol{\varpi}_t\left(\mathbf{x}_t;\mathbf{L}\right) &= \left(\mathbf{I}-\mathbf{C}^{*\prime}\right)^{-\mathbf{1}}\mathbf{C}'\mathbf{D}\boldsymbol{\Pi}_t\left(\mathbf{x}_t;\mathbf{D}^*\right) \\
&= \left(\mathbf{I}-\mathbf{C}^{*\prime}\right)^{-\mathbf{1}}\mathbf{C}'\mathbf{D}\left(\mathbf{I}-\mathbf{D}^*\right)^{-1}\boldsymbol{\pi}_t\left(\mathbf{x}_t\right) \\
&= \mathbf{L}\boldsymbol{\pi}_t\left(\mathbf{x}_t\right),
\end{aligned} \tag{5}$$

where $\mathbf{I}$ denotes the identity matrix and the second equality is obtained by simple substitution of the aggregate profit equation (2). The last equality rewrites the objective function vector in terms of the $F\times F$ matrix $\mathbf{L}=\left(\mathbf{I}-\mathbf{C}^{*\prime}\right)^{-\mathbf{1}}\mathbf{C}'\mathbf{D}\left(\mathbf{I}-\mathbf{D}^*\right)^{-\mathbf{1}}$ with typical element l_{fg}, for any $f,g\in\Im$.

Step 2: Recovering (Unobserved) Marginal Costs

Competitive Setting and Equilibrium Prices

Having described the objective function of the manager of the firm, we now address the competitive setting. For expositional purposes, reorder and decompose the strategy vector as $\mathbf{x}_t=\left(\mathbf{x}_{ft},\mathbf{x}_{-ft}\right)'$ where $\mathbf{x}_{ft}=\left(\mathbf{x}_{f1t},\ldots,\mathbf{x}_{fmt},\ldots,\mathbf{x}_{fMt}\right)'$ and $\mathbf{x}_{-ft}$ denotes the parallel strategy vector with the choices of all firms except firm f.

[5] Note that both $\mathbf{C}$ and $\mathbf{D}$ matrices are defined only in terms of the set of shareholders external to the industry, since the interests of the set of shareholders $\Im$ of firms within the industry that can engage in rival cross-shareholding are taken into account in matrices $\mathbf{C}^*$ and $\mathbf{D}^*$.

Assumption 5 *Firms compete in prices. Furthermore, a pure-strategy Bertrand-Nash equilibrium exists, and the prices that support it are strictly positive.*

Assumption 5 is illustrative. The proposed methodology is not constrained to this assumption and remains valid under alternative strategy choices by firms (for example, Nash-Cournot behavior or capacity-choice behavior). Furthermore, the assumption can be tested in the lines of the empirical literature that attempts to evaluate the observed conduct of firms. Recent examples that attempt to test if observed equilibrium prices are consistent with Nash equilibrium pricing include Nevo (2001), Slade (2004), Salvo (2010) and Molnar *et al.* (2013).

Under assumption 5, firms choose prices and therefore $\mathbf{x}_t \equiv \mathbf{p}_t = (\mathbf{p}_{ft}, \mathbf{p}_{-ft})$. $\mathbf{p}_{ft}$ denotes the strategy vector of prices controlled by firm f, i.e., the prices of the subset Γ_{fmt} of products produced by the firm in all $m \in \Upsilon$ and $\mathbf{p}_{-ft}$ denotes the strategy vector with the price choices of the subset Γ_{-fmt} of products produced by all firms except firm f in all $m \in \Upsilon$. Allon *et al.* (2010) established the conditions under which a Nash equilibrium, in fact a unique equilibrium, exists for the general multi-product price competition model with random coefficients multinomial logit demand functions (see Theorem 6.1 therein). Following the objective function equation (5) and under Assumption 5, in each period t, the manager of firm f solves:

$$\begin{aligned}
\max_{\mathbf{p}_{ft}} \varpi_{ft}(\mathbf{p}_{ft}, \mathbf{p}_{-ft}; \mathbf{L}) &= \sum_{g \in \Im} l_{fg} \pi_{gt}(\mathbf{p}_{ft}, \mathbf{p}_{-ft}) \\
&= \sum_{g \in \Im} l_{fg} \left\{ \sum_{m \in \Upsilon} \sum_{j \in \Gamma_{gmt}} (p_{jmt} - mc_{jmt}) \Lambda_{mt} s_{jmt}(\mathbf{p}_{fmt}, \mathbf{p}_{-fmt}) - C_{gmt} \right\},
\end{aligned}$$

where the second equality makes use of equation (1).

The first-order conditions yield that the price p_{jmt} of any product $j \in \Gamma_{fmt}$ in each market m and time period t must satisfy the following:

$$l_{ff} s_{jmt}(\mathbf{p}^{ne}_{fmt}, \mathbf{p}^{ne}_{-fmt}) + \sum_{g \in \Im} l_{fg} \sum_{r \in \Gamma_{gmt}} (p^{ne}_{rmt} - mc_{rmt}) \frac{\partial s_{rmt}\left(\mathbf{p}^{ne}_{fmt}, \mathbf{p}^{ne}_{-fmt}\right)}{\partial p_{jmt}} = 0, \tag{6}$$

where the strategy combination $\mathbf{p}^{ne}_t$ is a Bertrand-Nash equilibrium in prices that for all $\mathbf{p}_{ft}$ and for all f satisfies $\varpi_{ft}\left(\mathbf{p}^{ne}_{ft}, \mathbf{p}^{ne}_{-ft}\right) \geq \varpi_{ft}\left(\mathbf{p}_{ft}, \mathbf{p}^{ne}_{-ft}\right)$. We can re-write this set of J_{mt} equations in vector notation by defining a $J_{mt} \times J_{mt}$ matrix $\mathbf{\Omega}_{mt}$ with the jr element given by

$\Omega_{mt,rj} = -l_{fg}\partial s_{rmt}\left(\mathbf{p}_{mt}^{ne}\right)/\partial p_{jmt}$ for $r \in \Gamma_{gmt}$, $j \in \Gamma_{fmt}$:

$$\mathbf{G}\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne}\right) - \mathbf{\Omega}_{mt}\left(\mathbf{p}_{mt}^{ne}\right)\left(\mathbf{p}_{mt}^{ne} - \mathbf{mc}_{mt}\right) = 0,$$

where $\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne}\right)$ and $\mathbf{mc}_{mt}$ are $J_{mt} \times 1$ vectors of shares and marginal cost in market m and period t, respectively, and $\mathbf{G}$ denotes a $J_{mt} \times J_{mt}$ diagonal matrix with diagonal elements $g_{jj} = l_{ff}$ for $j \in \Gamma_{fmt}$.

Recovering (Unobserved) Marginal Costs

In order to use the above set of first-order conditions to simulate counterfactual prices, we require information on marginal costs that are typically unobserved. We propose to use assumption 5's equilibrium behavior jointly with demand side estimates (from step 0) to recover the pre-partial acquisition unobserved marginal costs. The procedure is as follows. The set of conditions above implicitly describes the following markup equation for each of the J_{mt} products in market m and period t:

$$\left(\mathbf{p}_{mt}^{ne} - \mathbf{mc}_{mt}\right) = \mathbf{\Omega}_{mt}\left(\mathbf{p}_{mt}^{ne}\right)^{-1}\mathbf{G}\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne}\right),$$

from which the corresponding marginal costs can be derived:

$$\mathbf{mc}_{mt} = \mathbf{p}_{mt}^{ne} - \mathbf{\Omega}_{mt}\left(\mathbf{p}_{mt}^{ne}\right)^{-1}\mathbf{G}\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne}\right).$$

This procedure assumes constant marginal costs. However, it can easily be extended to deal with non-constant marginal costs. In this case, the set of J_t first-order conditions differ slightly from the above and the marginal costs can be recovered by estimating a marginal cost function using, for example, a method of moments approach.

Let $\widehat{\partial s}_{rmt}\left(\mathbf{p}_{mt}^{ne,pre}\right)/\partial p_{jmt}$ denote the own- and cross-price effects for any two products r and j estimated in step 0 and evaluated at the subset $\mathbf{p}_{mt}^{ne,pre}$ of the pre-partial acquisition *observed* Bertrand-Nash equilibrium prices vector, $\mathbf{p}_{t}^{ne,pre}$. Let also $\widehat{\mathbf{\Omega}}_{mt}^{ne,pre}$ denote the current ownership structure matrix with the jr element given by $\widehat{\Omega}_{mt,rj}^{ne,pre} = -l_{fg}^{pre}\widehat{\partial s}_{rmt}\left(\mathbf{p}_{mt}^{ne,pre}\right)/\partial p_{jmt}$ for $r \in \Gamma_{gmt}$ and $j \in \Gamma_{fmt}$, and $\mathbf{G}^{ne,pre}$ denote the matrix with diagonal elements $g_{jj} = l_{ff}^{pre}$ for $j \in \Gamma_{fmt}$, where l_{fg}^{pre} represents the typical element of matrix $\mathbf{L}^{pre} = \left(\mathbf{I} - \mathbf{C}^{*pre\prime}\right)^{-1}\mathbf{C}^{pre\prime}\mathbf{D}^{pre}\left(\mathbf{I} - \mathbf{D}^{*pre}\right)^{-1}$, both computed under the pre-partial acquisition (corporate control and financial interest) shareholder's weights. Using the demand estimates from step 0 and the current ownership structure, we can recover market m's subset vector of marginal costs by:

$$\widehat{\mathbf{mc}}_{mt}^{pre} = \mathbf{p}_{mt}^{ne,pre} - \widehat{\mathbf{\Omega}}_{mt}^{ne,pre}\left(\mathbf{p}_{mt}^{ne,pre}\right)^{-1}\mathbf{G}^{ne,pre}\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne,pre}\right), \tag{7}$$

where $\widehat{\mathbf{mc}}_{mt}^{pre} = \left(\widehat{\mathbf{mc}}_{1mt}^{pre}, \ldots, \widehat{\mathbf{mc}}_{fmt}^{pre}, \ldots, \widehat{\mathbf{mc}}_{Fmt}^{pre}\right)'$.

The empirical structural methodology just described to recover the marginal costs (and we will see below to simulate counterfactuals) relies on the ability to consistently estimate the own- and cross-price effects required for every jr element of matrix Ω_{mt}: $\Omega_{mt,rj} = -l_{fg}\partial s_{rmt}\left(\mathbf{p}_{mt}\right)/\partial p_{jmt}$ in step 0. We defer an analysis of this aspect of the procedure to the next section when we introduce the consumer demand model in the context of our empirical application.

Step 3: Model the Oligopolistic Supergame

We introduce here the oligopolistic supergame in a setting similar to Friedman (1971) where firms in the industry interact repeatedly and play an infinite sequence of oligopolistic ordinary games over time with discounting. Although this unlimited interaction assumption among firms may seem unrealistic, it is fully mathematically equivalent to assuming that each firm is uncertain about being in the market (the game may end with some probability) the period after.

In this "infinite" sequence of oligopolistic ordinary games over time, let $\mathbf{p}_\infty = \{\mathbf{p}_0, \mathbf{p}_1, \ldots, \mathbf{p}_t, \ldots\}$ denote a path of play, where as detailed before $\mathbf{p}_t$ denotes the vector of strategies in period t. Given $\mathbf{p}_\infty$, the present discounted value of the future stream of *aggregate* profits of firm f is given by:

$$V_f\left(\mathbf{p}_\infty\right) \equiv \sum_{t=0}^{\infty}\delta_f^t\Pi_{ft}\left(\mathbf{p}_t;\mathbf{D}^*\right) = \sum_{t=0}^{\infty}\delta_f^t\Pi_{ft}\left(\mathbf{p}_{ft},\mathbf{p}_{-ft};\mathbf{D}^*\right),$$

where $\delta_f \in (0,1)$ denotes the discount factor of firm f that represents its rate of time preference, i.e., the weight that the firm places in future profits. If we assume risk-free firms that can freely borrow at the market interest rate r, the discount factor will be common to the firms and equal to $\delta_1 = \ldots = \delta_f = \delta = 1/(1+r)$. Because imperfect information in the capital market can cause firms to have different costs of capital and, therefore, different discount rates of time preference, we follow Harrington (1989) and allow for firm-specific discount factors.

The repeated choice of the ordinary static game's Bertrand-Nash prices is a sub-game perfect equilibrium in prices of the supergame: $\mathbf{p}_{\infty}^{ne} = \{\mathbf{p}_0^{ne}, \mathbf{p}_1^{ne}, \ldots, \mathbf{p}_t^{ne}, \ldots\}$. However, it is well known that there may exist more profitable strategies (Luce and Raiffa, 1957; Friedman, 1971). When choosing strategy $\mathbf{p}_{ft}$, each firm f knows and therefore can condition upon the strategies of every other firm in all previous periods. Friedman (1971) suggests that the repeated interaction among firms in the industry provides a formal structure in which *grim-trigger* strategies may support a collusive outcome as a non-cooperative equilibrium.

Assumption 6 *Each firm f adopts the following grim-trigger strategy σ_f^g in the supergame:*

$$
\begin{aligned}
\mathbf{p}_{f1} &= \mathbf{p}_{f1}^{c} \\
\mathbf{p}_{ft} &= \mathbf{p}_{ft}^{c} \text{ if } \mathbf{p}_{gl} = \mathbf{p}_{gl}^{c}, \quad \forall g \in \Im,\ l = 1, \ldots, t-1;\ t = 2, 3, \ldots, \\
\mathbf{p}_{ft} &= \mathbf{p}_{ft}^{ne} \text{ otherwise}
\end{aligned}
$$

where $\mathbf{p}_{f1}^{c}$ and $\mathbf{p}_{ft}^{c}$ denote the vector of coordinated prices controlled by firm f for the ordinary static game in period 1 and t, respectively, and (as before) $\mathbf{p}_{ft}^{ne}$ denotes firm f's vector of Bertrand-Nash prices for the ordinary static game t.

In this type of strategy, each firm chooses to set coordinated prices in period 1 and trust each other to continue to do so indefinitely. In face of this coordinated conduct, individual firms may be tempted to increase static profit for a period or so by deviating from the arrangement. However, should any single firm in any past period choose something different (let $\mathbf{p}_{ft}^{d}$ denote the vector of defection, or deviation, prices controlled by firm f in ordinary static game t), trust vanishes and each firm reverts *permanently* to a position in which no firm has any short-term temptation to deviate: the Bertrand-Nash equilibrium in prices.

The supergame grim strategy vector $\sigma^g = \left(\sigma_1^g,\ \ldots,\ \sigma_f^g,\ \ldots,\ \sigma_F^g\right)$ may support a coordinated outcome as a non-cooperative equilibrium under the credible threat that defections from this coordinated arrangement would trigger retaliation by rivals. In particular, σ is a non-cooperative equilibrium if the following no-deviation conditions (or incentive compatibility constraints) are satisfied:

$$
\sum_{r=0}^{\infty} \delta_f^r \Pi_{fr}\left(\mathbf{p}_{fr}^{c}, \mathbf{p}_{-fr}^{c}; \mathbf{D}^*\right) > \Pi_{ft}\left(\mathbf{p}_{ft}^{d}, \mathbf{p}_{-ft}^{c}; \mathbf{D}^*\right) + \sum_{r=1}^{\infty} \delta_f^r \Pi_{fr}\left(\mathbf{p}_{fr}^{ne}, \mathbf{p}_{-fr}^{ne}; \mathbf{D}^*\right), \quad f \in \Im.
$$

We acknowledge that the Nash reversion that characterizes the grim-trigger strategies established in Assumption 6, while subgame perfect, is not in general optimal. Abreu (1986, 1988) discusses more sophisticated forms of retaliation, *optimal punishments*, that support the *maximal* degree of coordination for arbitrary values of the discount factor. These optimal punishments have a stick-and-carrot structure that, for example, may include temporary price wars: should any single firm in any past period deviate from the coordinated arrangement, each firm reverts to a war state in which firms set below Bertrand-Nash price levels for some period of time (stick) before reverting, if no firm deviates from the war state arrangement, to the coordinated arrangement again (carrot). Although the extension of the methodology to Abreu (1986, 1988)'s optimal punishments is a very interesting potential area for future research, in this article, we focus on developing an empirical methodology to quantify coordinated effects for the grim-trigger strategies' benchmark. First, because this type of strategies has the advantage of requiring simple calculations and also of being easily understood by market participants. Second, because as pointed out by Harrington (1991):

> It is quite natural to think of a punishment strategy as being an industry norm with respect to firm conduct (...). Furthermore, once a norm is in place, firms may be hesitant to change it (...). Thus, even though the norm might not be the best in some sense (for example, it might not be a most severe punishment strategy), firms might choose to maintain it if it seems to work. In light of this interpretation of a punishment strategy, it seems plausible that the grim trigger strategy would be a commonly used norm. (page 1089)

Step 4: Pre-Partial Acquisition Counterfactual Static Prices and Profits

In order to evaluate the pre-partial acquisition sustainability of a coordinated outcome as a tacit non-cooperative equilibrium, we have to be able to empirically compute each firm's aggregate profit under three alternative individual behavior strategies: maintain the coordinated arrangement, unilaterally defect from that arrangement, and punish the defections of a rival.

Under the grim-trigger strategies established in Assumption 6, defections from the coordinated arrangement would trigger a Nash reversion punishment by rivals forever after, a position in which no firm has any short-term temptation to deviate. Furthermore, following Assumption 5, the industry pre-partial acquisition is characterized by Bertand-Nash competition. As a consequence, the vector of pre-partial acquisition Bertrand-Nash prices and aggregate profits are directly observable and no counterfactual simulation is required. The same is not true, however, for the remaining two elements (coordination and defection) of the no-deviation conditions, requiring empirically counterfactual computation of each firm's aggregate profit. In this article, we consider the benchmark case of full tacit coordination, that encompasses all firms in the market. We defer an analysis of other coordination agreements to future research. In particular, the extension of the methodology to not all-inclusive coordination agreements in the lines of Davis and Huse (2010) and Bos and Harrington (2010) seem a very interesting area of future research.

Assumption 7 *Tacit coordination involves all firms in the market. The managers of tacitly coordinating firms maximize the* <u>*joint*</u> *weighted sum of the shareholder's returns.*

Step 4 uses the marginal costs recovered in step 2 jointly with the demand side estimates from step 0 to simulate the static payoffs for the firms in the pre-partial acquisition industry under the two mentioned alternative individual behavior strategies. The details are given in Appendix *A*.

Step 5: Likelihood of Coordinated Conduct

Step 5 uses the static profits computed in step 4 to quantify the likelihood of a tacit coordinated arrangement by identifying the minimal threshold for the discount factor that sustains coordination in the supergame. We perform this quantification for the following useful benchmark:

Assumption 8 *For any given ownership structure, the future operating profit of a firm is time-independent.*

Under Assumption 8, the aggregated profit function $\Pi_f(\mathbf{p}; \mathbf{D}^*) = \Pi_{ft}(\mathbf{p}_t; \mathbf{D}^*)$ for any $f \in \Im$ and for any $t = 0, 1, 2, \ldots$. Although this assumption constitutes a benchmark that rules out tacit coordination settings with, for example, future demand growth, future demand fluctuations (deterministic or not) and future innovative activity, the proposed methodology is not constrained to this assumption and remains valid under alternative settings. In this benchmark, the no-deviation conditions that ensure that the supergame grim strategy vector σ^g supports a coordinated outcome as a tacit non-cooperative equilibrium can be written as follows:

$$\frac{\Pi_f\left(\widehat{\mathbf{p}}^{c,pre};\mathbf{D}^*\right)}{1-\delta_f} > \Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pre};\mathbf{D}^*\right) + \delta_f \frac{\Pi_f\left(\mathbf{p}^{ne,pre};\mathbf{D}^*\right)}{1-\delta_f}$$

or

$$\Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pre};\mathbf{D}^*\right) - \Pi_f\left(\widehat{\mathbf{p}}^{c,pre};\mathbf{D}^*\right) < \frac{\delta_f}{1-\delta_f}\left[\Pi_f\left(\widehat{\mathbf{p}}^{c,pre};\mathbf{D}^*\right) - \Pi_f\left(\mathbf{p}^{ne,pre};\mathbf{D}^*\right)\right], \quad f \in \Im,$$

which can be evaluated using the static profits computed in step 4.

This inequality makes clear the supergame grim strategy vector σ^g supports equilibrium coordinated conduct if, for every $f \in \Im$, the one-shot net gain from deviating from the coordinated agreement (the left term of the above inequality) is more than compensated by the present discounted value of the long run benefit from maintaining coordination in all succeeding periods (the right term of the above inequality).

An alternative interpretation, paralleling the dynamic oligopoly theoretical literature, can be derived by rewriting the no-deviation conditions in terms of the discount factor:

$$\delta_f > \delta_f^{crt,pre} = \frac{\Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pre};\mathbf{D}^*\right) - \Pi_f\left(\widehat{\mathbf{p}}^{c,pre};\mathbf{D}^*\right)}{\Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pre};\mathbf{D}^*\right) - \Pi_f\left(\mathbf{p}^{ne,pre};\mathbf{D}^*\right)}, \quad f \in \Im,$$

that shows the supergame grim strategy vector σ^g supports equilibrium coordinated conduct if the discount factor exceeds a critical threshold $\delta_f^{crt,pre}$ for every $f \in \Im$. In order for equilibrium coordinated conduct to be sustained in the industry as a whole, firms need to be sufficiently patient in the sense that the weight each firm places in future profits exceeds the maximum of all critical thresholds:

$$\delta^{crt*,pre} = \max\left\{\delta_1^{crt,pte}, \delta_2^{crt,pre}, \ldots, \delta_F^{crt,pre}\right\},$$

which constitutes our proposed quantitative measure of the likelihood of a tacit coordinated arrangement in the pre-partial acquisition ownership structure.

Step 6: Partial Acquisition Impact on the Likelihood of Coordinated Conduct

In analyzing the coordinated effects of partial ownership arrangements, competition agencies need to evaluate whether a proposed acquisition changes the manner in which firms in the market interact, increasing the likelihood of coordinated conduct. Our methodology proposes to assess this by quantifying the impact of the acquisition on the critical threshold of the discount factor. The procedure is as follows. First, we empirically compute each firm's post-acquisition aggregate profit under the three discussed alternative individual behavior strategies: agreement, defection and punishment. We do so by repeating step 4 for the new post-acquisition ownership structure.

Assuming the partial-acquisition does not alter the competitive setting among firms nor the vector of marginal costs ($\widehat{\mathbf{mc}}_t^{pst} = \widehat{\mathbf{mc}}_t^{pre}$), the vector of post-partial acquisition's predicted (counterfactual) coordinated prices, $\widehat{\mathbf{p}}_t^{c,pst}$ do not depend, under Assumption 7, on the actual ownership structure.[6] As a consequence, the vector of pre- and post-coordinated prices coincide, $\widehat{\mathbf{p}}_t^{c,pst} = \widehat{\mathbf{p}}_t^{c,pre}$, which implies that pre- and post-acquisition aggregate coordinated profits also coincide: $\Pi_{ft}\left(\widehat{\mathbf{p}}_t^{c,pst}; \mathbf{D}^*\right) = \Pi_{ft}\left(\widehat{\mathbf{p}}_t^{c,pre}; \mathbf{D}^*\right)$ for every $f \in \Im$ and time period t. The same is not true, however, for the remaining two elements (defection and punishment) of the no-deviation conditions, which still do require empirically counterfactual computation. The details are given in Appendix A.

Although we assume the partial-acquisition does not alter the competitive setting among firms, the proposed methodology is not constrained to having the same assumption of firm behavior before and after the partial acquisition. If the partial-acquisition does alter the competitive setting among firms, the methodology idea remains valid, the only difference being that the post-partial acquisition equilibrium price vector must solve the corresponding (new) set of first-order conditions.[7]

Having computed all the post-partial acquisition elements of the no-deviation conditions, we can investigate the impact on the minimal threshold for the discount factor that enables the

[6] In order to understand why, note that the set of first-order conditions in equation (8) does not depend on $\mathbf{L}$. The reason being that each firm internalizes the effects of price changes on the operating profits of all firms in the industry.

[7] In such cases, the methodology requires the computation not only of the defection and punishment elements of the no-deviation conditions, but also of the coordinated element, all according to the new behavioral setting. This will also be required, even in the absence of changes in the behavioral setting, if the partial acquisition incorporates eventual cost efficiencies that impact the marginal costs.

supergame grim strategy vector σ^g to support a coordinated outcome as a tacit non-cooperative equilibrium. In order to do so, we first compute the post-partial acquisition critical threshold $\delta_f^{crt,pst}$ for every $f \in \Im$ as follows:

$$\delta_f > \delta_f^{crt,pst} = \frac{\Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pst}; \mathbf{D}^*\right) - \Pi_f\left(\widehat{\mathbf{p}}^{c,pst}; \mathbf{D}^*\right)}{\Pi_f\left(\widehat{\mathbf{p}}^{d\{f\},pst}; \mathbf{D}^*\right) - \Pi_f\left(\widehat{\mathbf{p}}^{ne,pst}; \mathbf{D}^*\right)},$$

and then examine the maximum of all critical thresholds:

$$\delta^{crt*,pst} = \max\left\{\delta_1^{crt,pst}, \delta_2^{crt,pst}, \ldots, \delta_F^{crt,pst}\right\},$$

where $\widehat{\mathbf{p}}^{ne,pst}$, $\widehat{\mathbf{p}}^{c,pst}$ and $\widehat{\mathbf{p}}^{d\{f\},pst}$ denote the vector of post-partial acquisition's predicted (counterfactual) Bertrand-Nash, coordinated and firm$f$'s deviation prices, respectively.

Having described the supply side of the model and the empirical structural methodology that can be used to quantify the likelihood of a tacit coordinated arrangement that would result from several partial acquisition counterfactuals, we move on to address the empirical illustration.

3 Empirical Application

In this section, we present an illustration of the structural methodology used to evaluate the coordinated effects of partial acquisitions. We apply our framework to several acquisitions in the wet shaving industry. On December 20, 1989, the Gillette Company, contracted to acquire the wet shaving businesses of Wilkinson Sword trademark outside of the 12-nation European Community (which included the United States operations) to Eemland Management Services BV (Wilkinson Sword's parent company) for \$72 million. It also acquired a 22.9 percent of the nonvoting equity shares of Eemland for about \$14 million. Gillette said that its reason for participating in Eemland was solely its wish to acquire various Wilkinson Sword trade marks and wet-shaving activities in certain countries outside the 12-nation European Community.

At the time, consumers in the United States annually purchased over \$700 million of wet shaving razor blades at the retail level. Five firms supplied all but a nominal amount of these blades: Gillette Company, BIC Corporation, Warner-Lambert Company, Wilkinson Sword Inc., and American Safety Razor Company.

On January 10, 1990, the Department of Justice instituted a civil proceeding against Gillette. The complaint alleged that the effect of the acquisition by Gillette may have been substantially to lessen competition in the sale of wet shaving razor blades in the United States. Shortly after the case was filed, Gillette voluntarily rescinded the acquisition of Eemland's wet shaving razor blade business in the United States. Gillette said it decided to settle the case to avoid the time and expense of a lengthy trial. However, Gillette still went through with the acquisition of 22.9% nonvoting equity interest in Eemland and of all worldwide assets and businesses of Wilkinson Sword trademark from Eemland, apart from the United States and the European Community. Because Eemland kept the Wilkinson Sword's United States wet shaving razor blades business, Gillette had became one of the largest, if not the largest, shareholder in a competitor. The Department of Justice (1990) allowed the acquisition after being assured that this stake would be passive.[8] However, even when the acquiring firm cannot influence the conduct of the target firm, the partial acquisition may still raise antitrust concerns about unilateral and coordinated effects. BRV empirically examine the unilateral effects of this stake. We examine the latter by quantifying the coordinated effects impact of the operation.

On March, 22, 1993, the Warner-Lambert Company acquired Wilkinson Sword for $142 million to Eemland, that had put the razor blade company up for sale the year before. The sale was prompted after the European Commission, the executive arm of the European Community, in November ordered the Gillette Company to sell its stake in Eemland because of antitrust concerns. A full merger constitutes the extreme case of a partial acquisition, which is nested in our empirical structural methodology. As an illustration we also examine this question and quantify the corresponding coordinated effects.

These two acquisitions, and two additional hypothetical ones, are evaluated below. In this analysis, we make the following assumption regarding the measure of shareholder k's degree of control over the manager of the firm:

Assumption 9 *The control weight each owner has over the manager of the firm equals the corresponding voting shares, i.e.,* $\gamma_{kf} = v_{kf}$.

[8] "Gillette and Eemland shall not agree or communicate an effort to persuade the other to agree, directly or indirectly, regarding present or future prices or other terms or conditions of sale, volume of shipments, future production schedules, marketing plans, sales forecasts, or sales or proposed sales to specific customers (...)." (Department of Justice, 1990).

The article proceeds by describing the data and performing some preliminary analysis. We then move on to describe the demand model, the estimation procedure and discuss the identifying assumptions. Finally, we present the demand estimation results that we use to compute the implied marginal costs and then simulate the coordinated effects of the different acquisitions.

Data Description and Preliminary Analysis

We use scanner data collected from July 1994 to June 1996 from the Dominick's Finer Foods (DFF) chain in the Chicago metropolitan area. The dataset covers 29 different product categories at the store level. It includes weekly sales, prices and retail profit margins for each universal product code (UPC) and store of the chain. We supplemented the data with ZIP code (*i*) demographic information obtained from the Decennial Census 2000, and (*ii*) industry structure obtained from the Business Patterns 1998 databases.

In order to investigate the implications of Gillette 22.9% nonvoting equity interest acquisition in Eemland and Warner-Lambert merger with Wilkinson Sword, we focus on the grooming category. In particular, we focus on disposable razor products to avoid the complications that the tied-goods nature of demand poses for modeling in other razor products.

The sample covers 6 brands in 81 stores (across 7 counties in the Chicago metropolitan area) for 104 weeks. Gillette is the dominant brand with an average share of 59.5% of the total number of razors sold in each market (which we define as a store) and time period (defined as a week) combination. DFF private label is the second biggest-selling brand with an average share of 20.6%, followed by Shick (14.0%) and BIC (5.6%). Personna and Wilkinson Sword have very residual average market shares.

We define a product on the basis of two attributes: gender segment (men or women) and brand so that, for example, Schick Slim Twin and Schick Slim Twin Women are classified as distinct products. Women products account for an average share of 17.3% of the total number of razors sold in every market and time period. The choice set available to consumers is relatively limited. Although the sample covers 30 products, DFF stores carry only an average of 13.2 different products in each store/week combination. In contrast with the substantial brand concentration, at the product level there is slightly more fragmentation. Gillette Good News is the market leader with an average share of 14.2% of the weekly total number of razors sold in each store.

Each product is typically offered in several package sizes, with the top four sizes accounting for an average share of more than 99% of the weekly total number of razors sold in each store: 10 razors packages (41.5%), 5 razors packages (41.4%), 12 razors packages (11.3%) and 15 razors packages (5.2%). A product-package size combination defines an UPC. The sample covers 56 UPCs and DFF stores carry an average of 17.3 different UPCs in each store/week combination. Table 1 details the volume market shares for the top-6 brands, products and package sizes. Appendix B describes the dataset in more detail and the different price discrimination features of the price variable that must be incorporated into the structural model and justify the quarterly aggregation of the original data.

Step 0: Model Consumer Demand

The supply-side of our empirical structural methodology outlined in the previous section relies on the ability to consistently estimate own- and cross-price effects in step 0. Here, we introduce the consumer's utility function and the assumptions of the demand side of the model. We model consumer demand using the multinomial random-coefficients Logit model in the lines of McFadden and Train (2000), where consumers are assumed to purchase at most one unit of one of the products available in the market. We consider a differentiated products setting similar to Berry *et al.* (1995, hereafter BLP). The estimation approach allows for consumer heterogeneity and controls for price endogeneity.

The Setup

In each market $m \in \Upsilon \equiv \{1, \ldots, M\}$ (here defined as a store) and time period t (here defined as a quarter), there are I_{mt} consumers, indexed by i, each of which chooses among J_{mt} UPC alternatives. Let $j = 1, \ldots, J_{mt}$ index the inside UPC alternatives to the consumer in market m and period t. The no purchase choice (outside alternative) is indexed by $j = 0$.

Consumer Flow Utility

The consumer flow utility is expressed in terms of the indirect utility from each of the available alternatives. We begin by specifying the indirect utility from choosing an inside alternative.

The utility derived by consumer i from purchasing UPC j in market m and period t is assumed to be of the form:

$$\begin{aligned} u_{ijmt} &= \bar{u}_{ijmt}\left(p_{jmt}, q_j, x_{jmt}, w_m, \xi_{jmt}\right) + \varepsilon_{ijmt} \\ &= \alpha_i p_{jmt} + \varphi\left(q_j\right) + \beta_i x_{jmt} + \tau_i w_m + \xi_{jmt} + \varepsilon_{ijmt}, \end{aligned}$$

where p_{jmt} denotes the price of UPC j in market m and period t, q_j denotes the number of disposable razors included (package size) in UPC j, x_{jmt} denotes a K_x-dimensional vector of observed characteristics of UPC j in market m and period t (observed by the consumer and the econometrician), w_{mt} denotes a K_w-dimensional vector of observed characteristics of the competitive environment of each market m (and potentially period t) to account for variations in the shopping alternatives that consumers have for making their purchases, and ξ_{jmt} denotes the mean utility derived from the unobserved characteristics of UPC j in market m and period t (observed by the consumer, but unobserved by the econometrician), which may be potentially correlated with price. Finally, ε_{ijmt} is a random shock to consumer choice. α_i denotes consumer i's price sensitivity. β_i denotes the parameters representing consumer i's preference for the observed characteristics included in the vector x_{jmt}, and τ_i denotes consumer i's valuation of shopping alternatives.

Disposable razor products come in several package sizes and prices are typically nonlinear in size. $\varphi\left(q_j\right)$ denotes the component of the utility function associated to package size. We assume non-linear functional forms for $\varphi\left(q_j\right)$. Following McManus (2007), a linear specification for both price and package size would be inappropriate. If the marginal utility from increasing size is constant, given that price schedules are typically concave in size, then (if the random shock is omitted from the model) all consumers with sufficiently high valuation to purchase a small size would prefer a larger size to the small one.

The estimation approach allows for general parameter heterogeneity. In particular, we allow for observed and unobserved heterogeneity in price sensitivity, α_i:

$$\alpha_i = \alpha + \eta d_i + \gamma v_i,$$

where d_i is a vector of demographic variables and v_i is a vector of random-variables drawn from a normalized multivariate normal distribution that allows for unobserved heterogeneity. η is a vector of parameters that represent how price sensitivity varies with demographics, while γ is a scaling vector. We allow for price sensitivity to depend on the *age* of the consumer, as well as on her *household size* and annual *household income*. For the remaining parameters, we have $\beta_i = \beta$ and $\tau_i = \tau$.

We now move on to specify the indirect utility from not purchasing. The utility derived by consumer i from this outside option in market m and period t is assumed to be of the form:

$$\begin{aligned} u_{i0mt} &= \bar{u}_{i0mt}\left(\xi_{0mt}\right) + \varepsilon_{i0mt} \\ &= \xi_{0mt} + \eta_0 d_i + \gamma_0 v_i + \varepsilon_{i0mt}, \end{aligned}$$

where ξ_{0mt} denotes the mean utility derived from not purchasing in market m/period t combination and ε_{i0mt} is a random shock to consumer choice. Because utility is ordinal, the preference relation is invariant to positive monotonic transformations. As a consequence, the model parameters are identifiable up to a scalar, which implies that a normalization is required. The standard practice is to normalize the mean utility of the outside option, ξ_{0mt}, to zero.

Having described the indirect utility from the different alternatives available to the consumer, we now address her maximization problem: consumers are assumed to purchase one unit of the alternative that yields the highest utility. Because consumers are heterogeneous (d_i, v_i, ε_{imt}), the set of consumers that choose UPC j in market m and period t is given by:

$$A_{jmt} = \left\{\left(d_i, v_i, \varepsilon_{imt}\right) | u_{ijmt} \geq u_{ilmt} \forall l = 0, 1, \ldots, J_{mt}\right\},$$

where $\varepsilon_{im} = (\varepsilon_{i0mt}, \ldots, \varepsilon_{iJ_{mt}mt})$. If we assume a zero probability of ties, the aggregate market share of UPC j in market m and period t is just the integral over the mass of consumers in region A_{jmt}:

$$s_{jmt} = \int_{A_{jmt}} dP^*\left(d, v, \varepsilon_t\right) = \int_{A_{jmt}} dP^*_d\left(d\right) dP^*_v\left(v\right) dP^*_\varepsilon\left(\varepsilon_t\right),$$

where $P^*\left(d, v, \varepsilon_t\right)$ denotes the population distribution function of the consumer types $\left(d_i,\ v_i,\ \varepsilon_{imt}\right)$. We assume d, v and ε_t to be independent. The last equality is just a consequence of this assumption. Having computed the aggregate market shares, the aggregate demand of UPC j in market m and period t is given by $q_{jmt} = \Lambda_{mt} s_{jmt}$, where Λ_{mt} denotes the size of market m in period t.

Estimation Procedure

Having described the consumer demand model, we address the estimation procedure. We estimate the parameters of the demand model assuming the empirical distribution of demographics for $P_d^*(d)$, independent normal distributions for $P_v^*(v)$ and a Type I extreme value distribution for $P_\varepsilon^*(\varepsilon_t)$. The latter assumption allows us to integrate the ε's analytically which implies that the unobserved characteristics, ξ, constitute the only source of sampling error. This gives an explicit structural interpretation to the error term and, thereby, circumvents the critique provided by Brown and Walker (1989) related to the addition of ad-hoc errors and their induced correlations. After integrating the ε's, the aggregate market share of UPC j in market m and period t is given by:

$$s_{jmt} = \int_{A_{jmt}} \left[\frac{\exp(\bar{u}_{ijmt})}{\sum_{k=0}^{J_{mt}} \exp(\bar{u}_{ijmt})} \right] dP_d^*(d)\, dP_v^*(v).$$

We estimated the parameters of the model by following the algorithm used by BLP and Nevo (2000). The general estimation procedure involves searching for the parameters that equate *observed* and *predicted* aggregated market shares at the market/period level.

Price Endogeneity and Identification

The pricing decision of firms takes into account *all* characteristics of a UPC. This introduces correlation between prices and UPC characteristics and, in particular, between prices and the *unobserved* UPC characteristics (that constitute the structural error term of the demand model). As a consequence, instrumental variable techniques are required for consistent estimation. Controlling for the (market- and time period-invariant) mean unobserved UPC characteristics and for UPC-invariant market/time period deviations from that mean by using fixed effects decreases the requirements on the instruments, since the correlation between prices and those specific unobserved UPC characteristics is fully accounted for and does not require an instrument. In order to understand why this is the case, note that we can model $\xi_{jmt} = \xi_j + \xi_{mt} + \Delta\xi_{jmt}$ and capture ξ_j and ξ_{mt} by UPC and market/time period fixed effects, where ξ_j denotes the (market- and time period-invariant) mean valuation for the unobserved characteristics of UPC j and ξ_{mt} denotes the UPC-invariant market and time period deviations from that mean. However, it does not completely eliminate the need for instrumental variable techniques since UPC-specific market/period deviations from that mean $\Delta\xi_{jmt}$ are still expected to be correlated with prices.

We now provide an informal discussion of identification. We have already noted that because utility is ordinal, the preference relation is invariant to positive monotonic transformations. As a consequence, the model parameters are identifiable up to a scalar, which implies that a normalization is required. Without loss of generality, we normalize the mean utility of the outside option, ξ_{0mt}, to zero. Given this restriction, the identification of the remaining parameters is standard given a large enough sample. The fixed effects ξ_j and ξ_{mt} are identified from variation in market shares across the different UPC and markets/time periods, respectively. The taste parameters β and the parameters in $\varphi(q_j)$ are identified from variations in the observed UPC characteristics and package sizes. The mean value of the price coefficient, α, is identified from variation in prices. The competition environment coefficients, τ, are identified from variation in the number of grocery stores, convenience stores and pharmacies across ZIP codes. The parameters in vector η are identified from variation in demographics across ZIP codes and, finally, the parameters in vector γ are identified from variation in market shares due to unobserved factors.[9]

Because of price endogeneity, it will be appropriate to use instruments rather than the variation in the actual prices to empirically identify the model's parameters. We follow Davis and Huse (2010) in using three types of instruments for the price of UPC j in market m and period t. First, we use the median price of UPC j in quarter t across stores in other counties, in the lines of Hausman *et al.* (1994, hereafter HLZ). Second, we use the number of other own firm UPCs and the number of rival firms UPCs that are offered in that market and time period, as well as the sum of package sizes of other own firm UPCs and the sum of package sizes of rival firms UPCs that are offered in that store/quarter combination, in the lines of BLP. Third, we use the latter BLP-type instruments within the same gender segment, in the lines of Bresnahan *et al.* (1997, hereafter BST): the number of other same segment and firm UPCs and the number of same segment rival firms UPCs that are offered in that market and time period, as well as the sum of package sizes of other same segment and firm UPCs and the sum of package sizes of same segment rival firms UPCs that are offered in that store/quarter combination.

In order for an instrument to be valid, it needs to be simultaneously (1) correlated with the endogenous variable price p_{jmt} and (2) uncorrelated with the unobserved UPC character-

[9]Note that η_0 and γ_0 are not identified separately from an intercept in $\bar{u}_{ijmt}$ that varies with consumer characteristics.

istics variations $\Delta\xi_{jmt}$. The validity of the former condition can be tested by regressing the endogenous variable on the full set of instruments: the instruments excluded from the demand equation plus all the exogenous explanatory variables in the demand equations (the F-test of the joint significance of the excluded instruments constitutes a statistic commonly used for such test). The validity of the latter condition is more difficult to test and, although, if the demand equations are over-identified (the number of excluded instruments exceeds the number of included endogenous variables), the overidentifying restrictions may be tested via the J statistic of Hansen (1982), there are limits to the extent to which the uncorrelation condition in itself can be tested in an entirely convincingly way.

Consumer Demand Estimation Results

Table 2 presents the demand estimation results, with the different columns reporting distinct specifications that vary on both the covariates included, the estimation procedure and the type of price instruments. Specification (1) reports the results of an ordinary least squares standard multinomial Logit model regression. This first specification includes price, demographic and competition variables as covariates. Furthermore, we consider a quadratic functional form for $\varphi(q_j)$ and introduce heterogeneity by interacting price with observable demographic characteristics. The coefficients on these different covariates are all of the expected sign but mostly statistically insignificant. The price coefficient is one example of the latter, suggesting that the average consumer is price insensitive. The interactions with household size and consumer age are also statistically insignificant suggesting that these observed demographics do not explain price sensitiveness. The interaction with household income is, however, highly significant indicating that households with higher income are less price sensitive. The coefficients on package size suggest that consumers value package size at a statistically significant decreasing rate. Finally, the coefficients on demographic and competition covariates are statistically insignificant. This indicates that the utility of purchasing (and not purchasing) is not explained by the observed demographics nor impacted by the number of nearby grocery, convenience stores and pharmacies.

The structural error term of specification (1) includes the full ξ_{jmt} since the specification does not include any control of the unobserved characteristics. In specification (2), we include

UPC fixed effects in order to fully control for ξ_j.[10] This increases the absolute value of the price coefficient, which suggests that prices may be positively correlated with the mean valuation of the unobserved UPC characteristics, which will underestimate consumer price sensitivity if not accounted for. We interpret the effects on the price coefficient as evidence that controlling for ξ_j matters. The price coefficient suggests that the average consumer is in fact price sensitive. The interactions with household size and consumer age remain statistically insignificant indicating that these observed demographics do not explain price sensitiveness. The interaction with household income remains, however, highly significant suggesting that households with higher income are less price sensitive. While most demographic covariates remain statistically insignificant, the coefficient on age becomes statistically significant indicating that the utility of purchasing lowers with age. Finally, the coefficients on the competition covariates seem to suggest that the utility of not purchasing is higher with more nearby pharmacies in the area, while the number of nearby grocery and convenience stores remain not to have a statistically significant impact.

Specification (2) controls for UPC fixed effects that capture the mean valuation of the unobserved UPC. However, it does not fully control for ξ_{jmt}. The error term includes UPC-invariant and UPC-specific market/time period deviations from that mean: ξ_{mt} and $\Delta\xi_{jmt}$, respectively, both of which, as argued above, are taken into account in the pricing decision of firms, introducing correlation with the price covariate. Specifications (3), (5) and (7) report the results of a generalized method of moments standard multinomial Logit model regression that replicate specification (2) using each of the types of instruments described above to account for the correlation between prices and unobserved characteristics: ξ_{mt} and $\Delta\xi_{jm}$. The effect on the price coefficient seems sensitive to the choice of instruments. Although the first stage F-test of the joint significance of the excluded instruments are statistically significant for all types of instruments, the tests of over-identification are rejected, suggesting that the identifying assumptions are not valid.

In order to reduce the requirements on the instruments, we estimate specifications (4), (6) and (8) that include store- and quarter-fixed effects that control for ξ_{mt}, UPC-invariant market and time period deviations from the valuation means. ξ_{mt} may be a function of unobserved demographics, and if those unobserved demographics are correlated with prices, ξ_{mt} will be

[10] Moreover, this captures flexible non-linearities in $\varphi(q_j)$.

correlated with prices. The inclusion of these fixed effects increases the absolute value of the price coefficient, which suggests that prices may be positively correlated with ξ_{mt}, which will underestimate consumer price sensitivity if not accounted for. We interpret the effects on the price coefficient as evidence that controlling for ξ_{mt} matters. The first stage F-test of the joint significance of the excluded instruments are, again, statistically significant for all types of instruments. Controlling for the unobserved demographics via ξ_{mt} eliminates the omitted-variable bias and improves the over-identification test statistic. In the case of the BLP type instruments, the improvement is such that the instruments are no longer rejected, suggesting that the BLP identifying assumption is valid. We explored the sensitivity of our results to the inclusion of market/time period fixed effects and all the main coefficients were found to be robust. In order to avoid increasing unnecessarily the dimensionality of our problem, we controlled for ξ_{mt} using store- and quarter-fixed effects.

Finally, specification (9) reports the results for the full multinomial random-coefficients Logit model with BLP type instruments. The results suggest that the average consumer is price sensitive. The interaction with household income is, once again, statistically significant confirming that households with higher income are less price sensitive. The remaining interactions with household size and consumer age are statistically insignificant indicating that these observed demographics do not explain price sensitiveness. The standard deviations coefficients are also statistically insignificant, which suggests that most of the heterogeneity is due to demographics.

Table 3 reports a sample of the estimated median (across the 643 store-quarter combinations) own- and cross-price elasticities computed according to the estimates from specification (9) in Table 2. The average (across the 56 UPCs) of the median of the estimates of the own-price elasticity is -8.9. While such elasticities may seem relatively high, when one takes into account the fact that there is a large number of UPCs typically produced by large multiproduct firms, the elasticities seem quite reasonable. If we were to look at own-price elasticities across products or brands, considering the cross-price elasticities of all the other UPCs that the company owns, the magnitudes would be lower. The average of the median of the estimates of the cross-price elasticity is 0.1. By a similar argument as above, while such elasticities may seem relatively low, if we were to look at cross-price elasticities across products or brands, the magnitudes would be higher.

Recovered Marginal Costs

We now move on to predict and recover the marginal costs. The procedure makes use of equation (7) that relies on the Bertrand-Nash behaviour described in Assumption 5, on the current ownership structure established in matrix $\mathbf{L}^{pre}$, and on the ability to consistently estimate the own- and cross-price effects required to compute the elements of matrix $\Omega_{mt}^{ne,pre}$.

The vectors $\mathbf{p}_{mt}^{ne,pre}$ and $\mathbf{s}_{mt}\left(\mathbf{p}_{mt}^{ne,pre}\right)$ are observed in the data. The own- and cross-price effects required to compute the elements of matrix $\widehat{\Omega}_{mt}^{ne,pre}$ are estimated within the demand model (Table 3 provides a sample of the estimated price-elasticities). Matrix $\mathbf{L}^{pre}$ is computed, under Assumptions 1-4 and 9, using each firm's distribution of total and voting stock. Table 4 presents this distribution for the ownership structure of the different firms from March 22, 1993 onwards according to 1994's Schedule 14A (proxy statement) information reported by each firm.

In the context of our illustrative application, the recovered marginal costs, $\widehat{mc}_{jmt}^{pre}$, include any incremental cost required for the manufacturer firm to produce, distribute and make available one additional pack of disposable razors to the final consumer. In the lines of Nevo (2001) and consistently with a wide variety of models of manufacturer-retailer interaction, this cost can be expressed as follows:

$$\widehat{mc}_{jmt}^{pre} = \widehat{mc}_{jmt}^{pre,man} + \widehat{mc}_{jmt}^{pre,ret} + \widehat{margin}_{jmt}^{pre,ret},$$

where $\widehat{mc}_{jmt}^{pre,man}$ denotes the pre-partial acquisition manufacturer's marginal cost of producing the additional pack of product j in time period t and transporting it from the plant to the retailer store (market) m, $\widehat{mc}_{jmt}^{pre,ret}$ denotes the pre-partial acquisition retailer's marginal cost of getting the additional pack to the store shelves and selling it, and finally, $\widehat{margin}_{jmt}^{pre,ret}$ denotes the pre-partial acquisition retailer markup over the acquisition cost.

The first two columns of Table 5 present price and recovered marginal costs for a sample of UPCs. Given that those variables vary by UPC, market and time period, we present the median for each selected UPC across the 643 store-quarter combinations. The median price and recovered marginal cost is \$3.02 and \$2.59, respectively. The third column of Table 5 presents the recovered marginal costs as a percentage of price, with the median marginal cost to sale price ratio being 85.8%.

In order to evaluate the reasonability of our results, we decompose the recovered (predicted) marginal cost using the gross retail margin (to capture $\widehat{margin}_{jmt}^{pre,ret}$), a variable not used in the demand side estimation for exactly this purpose. This decomposition is presented, with the obvious exception of private labels, in columns four and five of Table 5. The median markup, excluding private labels, corresponds to 36.6% of price, yielding that the manufacturer's marginal cost of producing the additional pack, transporting it from the plant to the retailer store, getting it to the store shelves and finally selling it correspond to the remaining 51.6% of price. We now address the decomposition of this markup between manufacturer and retailer. According to the Department of Commerce's Annual Retail Trade Survey, which provides national estimates of (among others) total annual sales and total operating expenses for retail businesses located in the United States, grocery stores's marginal cost of getting the additional pack to the shelves and selling it account for around 4.2% of price.[11] This includes costs (some of which can be argued not to be marginal costs) with temporary labour, packaging materials, containers and other materials, electricity, transportation, shipping and warehousing services, and advertising and promotional services. This implies an average manufacturer's marginal cost of producing an additional pack and transporting it from the plant to the retailer store of 47.4% of price. We compare this marginal cost estimate with the accounting estimates supported by 1994's Annual Report of the two biggest-selling brands (excluding private labels). Gillette and Warner-Lambert's production and distribution costs account for 62.7% (blades & razors business segment) and 72.0% (consumer health care industry segment) of the corresponding manufacturer price, respectively. If we were to use the ratio between the sale price and the manufacturer price (DFF's average acquisition cost computed using the gross retail margin) to re-scale the percentages in terms of the sale price, we would conclude that Gillette and Warner-Lambert's production and distribution costs account for 40.3% and 44.8% of the sale price, a value reasonably close to our results. This conclusion is reinforced by the fact that disposable razor products typically sell at a lower margin than the remaining razor products, making the accounting estimates above a conservative one.

[11] We use data for detailed operating expenses as a percentage of sales referent to 2009 as a crude measure. We argue that this ratio may have had a similar path to the annual gross margin as a percentage of sales, that data shows to have been relatively stable ratio from 1993-2010.

Pre-Partial Acquisition Analysis

After recovering the vector of pre-partial acquisition (implied) marginal costs, $\widehat{\mathbf{mc}}_{mt}^{pre}$, we address the issue of evaluating the sustainability of a coordinated outcome as a tacit non-cooperative equilibrium in that industry setting. In a typical competition policy issue, we would begin to do so by computing the vector of prices under the two discussed alternative individual behavior strategies: coordination and defection, since under grim-trigger strategies, established in Assumption 6, the vector of pre-partial acquisition punishment (Bertrand-Nash reversion) prices are directly observable and no counterfactual simulation is required. It is possible, however, to adjust the methodology to fit the specificities of the data used in the demand estimation (step 0). This is the case of our empirical illustration. The shareholder structure of Wilkinson Sword in the pre-partial acquisition setting is independent of the remaining firms in the industry. This mimics the industry ownership structure before December 20, 1989. Because our dataset ranges from July 1994 to June 1996, we are required to compute the counterfactual pre-partial acquisition vector of prices under *all* three alternative individual behavior strategies: coordination, defection and punishment. We already discussed the procedure to simulate collusion and defection prices. The details to derive the pre-partial acquisition Bertrand-Nash equilibrium price vector are given in Appendix *A*.

Table 6 reports the pre-partial acquisition median simulated prices under the three alternative individual behavior strategies for a sample of UPCs across all markets (DFF stores). The results suggest that if firms were able to coordinate successfully, median prices would increase 3.92% compared with the ones arising in a Bertrand-Nash competitive setting. This price increase is relatively larger for smaller firms, indicating that those tend to benefit more from the full internalization induced by coordination. The defection prices simulations suggest that the incentive to defect is non-negligible: each deviant firm undercuts coordinated prices considerably, to a level close to that of the Bertrand-Nash equilibrium.

After simulating the counterfactual vector of prices under all three alternative individual behavior strategies (coordination, defection and punishment), we use it as input to examine the pre-partial acquisition's market shares, static (annual) operating profit and, particularly, the static (annual) aggregated profit of each firm. Table 7 presents the aggregated profit's gain from deviating and loss from punishment for each firm $f \in \Im$: $\Pi_f\left(\mathbf{p}^{d\{f\},pre}; \mathbf{D}^*\right) - \Pi_f\left(\mathbf{p}^{c,pre}; \mathbf{D}^*\right)$ and $\Pi_f\left(\mathbf{p}^{c,pre}; \mathbf{D}^*\right) - \Pi_f\left(\mathbf{p}^{ne,pre}; \mathbf{D}^*\right)$, respectively. The results were computed as follows for each alternative individual behavior strategy. The first step consisted in computing, for each firm, the operating profits for each market (store) m, which we then aggregated across all markets. The second step consisted in extrapolating the results for the US economy as a whole. In order to do so, we computed, for each firm, the average operating profit across the different markets and multiplied the result by the US economy yearly potential market. The third step consisted of using equation (2) to compute the aggregated profit of each firm. Finally, we used the aggregated profit computed under each three alternative individual behavior strategies, to derive the gain from deviating and the loss from punishment.

The results are consistent with the theoretical literature on the impact of firm asymmetry on the likelihood of coordination: Compte *et al.* (2002), Vasconcelos (2005) and Kuhn (2004). First, that in the absence of biding capacity constraints, smaller firms tend to be *maverick firms*, i.e., smaller firms tend to have the greatest incentive to deviate, (e.g., American Safety Razor and Wilkinson Sword) since they tend to be the ones that benefit the most from disrupting a coordinating agreement (18% and 15% of the static coordinated aggregated profits, respectively). Second, that larger firms (e.g., Gillette) will have a lower incentive to punish since they tend to be the ones that suffer the greatest loss in punishing (5% of the static coordinated aggregated profit).

Combining the gain from deviating and the loss from punishment's results, we derive the critical threshold for the discount factor that satisfies the no-deviation condition of each firm, presented in the last column of Table 7. The critical threshold that supports a coordinated outcome as a tacit non-cooperative equilibrium is given by the maximum of those critical thresholds. The results suggest that the binding incentive compatibility constraint is the one regarding American Safety Razor: 0.888. In order to assess the coordinated effects of partial ownership arrangements, we propose to evaluate whether a proposed acquisitions changes that critical threshold.

Post-Partial Acquisition Analysis

We now assess the effect of several (actual and hypothetical) partial acquisitions on the likelihood of a collusive outcome. In particular, we investigate the impact of the following acquisitions:

1. (counterfactual): The Gillette Company acquires a 100% voting equity interest in Wilkin-

son Sword. This constitutes an hypothetical ownership structure and it is presented to illustrate the counterfactual market outcomes if Gillette did not voluntarily rescinded the acquisition of Eemland's wet shaving razor blade business in the United States.

2. (counterfactual): The Gillette Company acquires a 22.9% nonvoting equity interest in Wilkinson Sword. This mimics the industry ownership structure from December 20, 1989 to March 22, 1993.

3. (counterfactual): The Gillette Company acquires a 22.9% voting equity interest in Wilkinson Sword. This constitutes an hypothetical ownership structure and it is presented here to illustrate the differential impact of acquiring a voting and nonvoting equity interest.

4. (1994 actual situation): Warner-Lambert Company acquires a 100% voting equity interest in Wilkinson Sword. This constitutes a full merger and mimics the industry ownership structure from March 22, 1993 onwards.

We begin the analysis by computing the vector of prices under the two discussed post-partial acquisition alternative individual behavior strategies: defection and punishment, given that assuming the partial-acquisition does not alter the competitive setting among firms nor the vector of marginal costs, coordinated prices do not depend, following Assumption 7, on the actual ownership structure.[12]

Table 8 reports the median simulated percentage variation in punishment (Bertrand-Nash) and defection prices relative to the pre-acquisition case for a sample of UPCs across all DFF stores. Case 1's counterfactual, presented in column two, examines the impact (when compared with the baseline, pre–acquisition, case) of the 100% voting equity interest acquisition in Wilkinson Sword initially proposed by Gillette, against which the Department of Justice (DoJ) instituted a civil proceeding. The complaint alleged that the effect of the acquisition by Gillette may have been substantially to lessen competition in the sale of wet shaving razor blades in the United States and shortly after the case was filed, Gillette voluntarily rescinded the acquisition of Eemland's wet shaving razor blade business in the United States. The simulated Bertrand-Nash (punishment) price increases are, however, low: 9.3% and 7.2% for WS Colors and WS

[12] Case 4 constitutes an exception. It only requires the computation of the vector of each firm's defection prices since, under grim-trigger strategies, established in Assumption 6, the vector of punishment (Bertrand-Nash reversion) prices are directly observable (because our dataset ranges from July 1994 to June 1996) and no counterfactual simulation is required.

Ultra Glide, respectively. The defection price increases, as inferred by the pre-partial acquisition analysis, mirror the punishment ones: 9.9% and 7.7%, respectively, since each deviant firm undercuts coordinated prices to a level close to that of the Bertrand-Nash equilibrium.

Case 2's counterfactual, presented in column three, examines the impact (when compared with the baseline case) of the 22.9% nonvoting equity interest acquisition in Wilkinson Sword by Gillette. The DoJ allowed this acquisition after being assured that this stake would be passive. However, even when the acquiring firm cannot influence the conduct of the target firm, the partial acquisition of a financial interest in a rival may still reduce the incentive of the acquiring firm to compete aggressively because it shares in the losses thereby inflicted on that rival. We examine this question. The results confirm the reasonability of the DoJ decision. The simulated variation in Bertrand-Nash prices is extremely low: smaller than 0.001% for both WS Colors and WS Ultra Glide, a variation, once again, mirrored by the simulations for the defection prices.

Case 3's counterfactual, presented in column four, examines the impact (when compared with the baseline case) of a 22.9% voting equity interest acquisition in Wilkinson Sword by the Gillette Company. When a firm acquires a voting interest in a rival, it acquires the ability to influence the competitive conduct of the target firm. Such influence can lessen competition because it may be used to induce the rival to compete less aggressively against the acquiring firm. We expect the impact of, in addition to a financial interest, acquiring a voting interest to lessen competition to a greater extent when compared with the sole acquisition of a financial interest. The Bertrand-Nash (punishment) price increases confirm this expectation: 2.7% and 2.1% for WS Colors and WS Ultra Glide, respectively. The variation in defection prices is simulated to undergo, as before, a similar path.

Finally, case 4's counterfactual, presented in the last column, examines the impact (when compared with the baseline case) of a 100% voting equity interest acquisition in Wilkinson Sword by the Warner-Lambert Company. The acquisition was prompted after the European Commission ordered the Gillette Company to sell its stake in Eemland because of antitrust concerns. The concern was focused particularly on Europe where Wilkinson Sword was a stronger player than in the US. Consistently with traditional merger analysis, a merger between firms selling differentiated products may diminish competition by enabling the merged firm to profit by unilaterally raising price. The simulated Bertrand-Nash (punishment) price increases are however relatively low: 1.6% and 1.3% for WS Colors and WS Ultra Glide, respectively. Interestingly, the quantitative impact of a full merger with a smaller player (the Warner-Lambert Company) on WS's prices is relatively similar to a 22.9% partial voting acquisition by a larger player (the Gillette Company). The defection price increases, once again, mirror the punishment ones.

After simulating the counterfactual vector of punishment and defection prices, we use them (jointly with the vector of coordinated prices computed in the pre-partial acquisition industry setting) as an input to examine the corresponding static (annual) operating profit and aggregated profit of each firm. Table 9, Panels A and B present the post-acquisition median simulated percentage variation in aggregated profit's gain from deviating and loss from punishment for each firm $f \in \Im$. The results suggest that (partial or full) acquisitions tend to decrease both the per-period benefit of maintaining the coordinated agreement (panel B) and the one-shot net gain from deviating from such an arrangement (panel A). The combination of these two impacts yields a decrease in the discount factor's critical threshold of acquiring firms, while an increase in the critical discount factors corresponding to the remaining firms. The critical threshold that supports a collusive outcome as a tacit non-cooperative equilibrium is given by the maximum of those critical thresholds. The results suggest that, in the counterfactuals under analysis, this critical threshold (referent to American Safety Razor) increases slightly, indicating that tacit coordination in the post-(partial or full) acquisition industry is less likely to be sustained. This result is consistent with Davis and Huse (2010)'s findings that, *ceteris paribus*, the incentives to collude often fall as a result of an acquisition.

4 Conclusions

This article considers an empirical structural methodology to examine quantitatively the coordinated effects of partial acquisitions involving pure financial interests and/or effective corporate control on the range of discount factors for which coordination can be sustained. The proposed methodology can deal with differentiated products industries, with both direct and indirect partial ownership interests and nests full mergers (100% financial and control acquisitions) as a special case.

We assume a setting where oligopolistic firms interact repeatedly, by playing an infinite sequence of ordinary games over time and across markets. We model the oligopolistic ordinary static game taking into account asymmetric multi- and differentiated-product firms and partial ownership interests that may or may not correspond to control. We propose a procedure to simulate firms' counterfactual static profits under alternative individual behavior (maintain the coordinated arrangement, unilaterally defect from the coordinated arrangement, and punish the defections of a rival), which are then incorporated in the repeated game to identify the minimal threshold for the discount factor that sustains collusion. This structural approach to partial acquisitions may be a preferable method for competition policy issues to the current indirect methods focused on measures of market concentration and on informal analysis of the features of the market conducive to coordinated interaction.

We also provide an empirical application of the methodology to several acquisitions in the wet shaving industry. A DoJ challenged's proposed full acquisition of Wilkinson Sword by Gillette in 1989, voluntarily rescinded due to antitrust concerns in favor of a (not-challenged) partial acquisition of 22.9% nonvoting equity interest in 1990, and finally the full merger between Warner-Lambert and Wilkinson Sword in 1993, prompted after the European Commission ordered Gillette Company to sell its stake in Wilkinson Sword. The results seem to confirm the DoJ challenge of the initial proposal in the sense it would have induced a steeper increase in the likelihood of coordinated conduct than the 22.9% passive final participation. The results seem also to confirm Gillette version in saying that its reason for participating in Wilkinson Sword was non-financial in the sense that the estimated incremental impact of the acquisition for Gillette profits seems relatively low. And finally, the results seem also to suggest that the Warner-Lambert and Wilkinson Sword merger prompted for antitrust concerns, was, in fact, detrimental in the sense it increased, although only slightly, the strength of coordinated conduct.

This article leaves many issues yet to be explored. Extensions of this methodology to Abreu (1986, 1988)'s optimal punishments, to not all-inclusive coordination agreements and to partial vertical acquisitions constitute very interesting potential areas for future research.

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Appendix A

Pre-Partial Acquisition Counterfactual Static Prices and Profits

Coordination

We begin by addressing the coordination setting and characterizing the vector of coordinated prices $\mathbf{p}_t^c = \left(\mathbf{p}_{ft}^c, \mathbf{p}_{-ft}^c\right)$. Following the objective function equation (5) and under Assumption 7, the managers of tacitly coordinating firms solve:

$$\begin{aligned}
\max_{\mathbf{p}_t} \sum_{f \in \Im} \varpi_{ft}\left(\mathbf{p}_{ft}, \mathbf{p}_{-ft}; \mathbf{L}\right) &= \sum_{f \in \Im} \sum_{g \in \Im} l_{fg}^c \pi_{gt}\left(\mathbf{p}_{ft}, \mathbf{p}_{-ft}\right) \\
&\equiv \sum_{f \in \Im} \sum_{m \in \Upsilon} \sum_{j \in \Gamma_{fmt}} \left(p_{jmt} - mc_{jmt}\right) \Lambda_{mt} s_{jmt}\left(\mathbf{p}_{fmt}, \mathbf{p}_{-fmt}\right) - C_{fmt},
\end{aligned}$$

where the second equivalence makes use of the fact that because firms act collectively, the typical element of matrix $\mathbf{L}^c$ is given by $l_{fg}^c = 1$, for any $f, g \in \Im$. The reason being that, under full tacit coordination, each firm internalizes the effects of price changes on the operating profits of <u>all</u> firms in the industry.

The first-order conditions yield that the price p_{jmt} of any product j in each market m and period t must satisfy the following:

$$s_{jmt}\left(\mathbf{p}_{fmt}^c, \mathbf{p}_{-fmt}^c\right) + \sum_{g \in \Im} \sum_{r \in \Gamma_{gmt}} \left(p_{rmt}^c - mc_{rmt}\right) \frac{\partial s_{rmt}\left(\mathbf{p}_{fmt}^c, \mathbf{p}_{-fmt}^c\right)}{\partial p_{jmt}} = 0. \tag{8}$$

We can make use of the above set of first-order conditions to solve for each market m's subset of the predicted (counterfactual) pre-partial acquisition price vector under tacit coordination, $\widehat{\mathbf{p}}_t^{c,pre}$. The procedure uses step 0's demand estimates to evaluate the own- and cross-price effects for any two products r and j, the marginal costs recovered in step 2, and the $J_{mt} \times J_{mt}$ tacit collusion ownership structure matrix as follows:[13]

$$\widehat{\mathbf{s}}_{mt}\left(\widehat{\mathbf{p}}_{mt}^{c,pre}\right) - \widehat{\boldsymbol{\Omega}}_{mt}^{c,pre}\left(\widehat{\mathbf{p}}_{mt}^{c,pre}\right)\left(\widehat{\mathbf{p}}_{mt}^{c,pre} - \widehat{\mathbf{mc}}_{mt}^{pre}\right) = 0,$$

[13] Note that $\widehat{\Omega}_{mt}^{c,pre}$ does not necessarily imply that price effects are invariant to the ownership structure in the industry, since they may vary with price. This note is valid for all counterfactual prices simulated in the methodology.

where $\widehat{\boldsymbol{\Omega}}_{mt}^{c,pre}$ denotes the matrix with jr element given by $\widehat{\Omega}_{mt,rj}^{c,pre} = -\widehat{\partial s}_{rmt}\left(\widehat{\mathbf{p}}_{mt}^{c,pre}\right)/\partial p_{jmt}$.

After solving for $\widehat{\mathbf{p}}_{t}^{c,pre}$, we can then use it as input, given that the model is structural, to examine the market shares, the operating profit and, particularly, the static aggregated profit of each firm $f \in \Im$: $\Pi_{ft}\left(\widehat{\mathbf{p}}_{t}^{c,pre}; \mathbf{D}^{*}\right)$, a structural element of the above no-deviation conditions.

Defection

In face of a coordinated agreement, individual firms may be tempted to increase static profit for a period or so by deviating from the arrangement. We now address the individual defection incentive of any given firm $f \in \Im$ and characterize the corresponding prices $\mathbf{p}_{t}^{d\{f\}} = \left(\mathbf{p}_{ft}^{d}, \mathbf{p}_{-ft}^{c}\right)$. Following Bernheim and Whinston (1990), given that in any multimarket coordination equilibrium, firms know that deviations will be punished in all markets (Abreu, 1988), if a firm decides to deviate, it will do so in every market. As a result, the defection manager of firm f solves:

$$\begin{aligned}
\max_{\mathbf{p}_{ft}} \varpi_{ft}\left(\mathbf{p}_{ft}, \mathbf{p}_{-ft}^{c}; \mathbf{L}\right) &= \sum_{g\in\Im} l_{fg}\pi_{gt}\left(\mathbf{p}_{ft}, \mathbf{p}_{-ft}^{c}\right) \\
&= \sum_{g\in\Im} l_{fg}\left\{\sum_{m\in\Upsilon}\sum_{j\in\Gamma_{gmt}}\left(p_{jmt} - mc_{jmt}\right)\Lambda_{mt}s_{jmt}\left(\mathbf{p}_{fmt}, \mathbf{p}_{-fmt}^{c}\right) - C_{gmt}\right\}.
\end{aligned}$$

The first-order conditions yield that the price p_{jmt} of any product $j \in \Gamma_{fmt}$ in each market m and period t must satisfy the following:

$$l_{ff}s_{jmt}\left(\mathbf{p}_{fmt}^{d}, \mathbf{p}_{-fmt}^{c}\right) + \sum_{g\in\Im} l_{fg}\sum_{r\in\Gamma_{gmt}}\left(p_{rmt}^{d} - mc_{rmt}\right)\frac{\partial s_{rmt}\left(\mathbf{p}_{fmt}^{d}, \mathbf{p}_{-fmt}^{c}\right)}{\partial p_{jmt}} = 0. \tag{9}$$

Let J_{fmt} denote the number of products $j \in \Gamma_{fmt}$ produced by firm f in period t and market m. We can make use of the above J_{fmt} set of conditions to solve for each market m' subset of the pre-partial acquisition predicted (counterfactual) price vector under deviation by firm f, $\widehat{\mathbf{p}}_{t}^{d\{f\},pre} = \left(\widehat{\mathbf{p}}_{ft}^{d,pre}, \widehat{\mathbf{p}}_{-ft}^{c,pre}\right)$. As before, the procedure uses step 0's demand estimates, step 2's recovered marginal costs and the $J_{fmt} \times J_{mt}$ structure matrix as follows:

$$\mathbf{G}^{d\{f\},pre}\widehat{\mathbf{s}}_{mt}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pre}\right) - \widehat{\boldsymbol{\Omega}}_{mt}^{d\{f\},pre}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pre}\right)\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pre} - \widehat{\mathbf{mc}}_{mt}^{pre}\right) = 0,$$

where $\boldsymbol{\Omega}_{t}^{d\{f\},pre}$ denotes a matrix with jr element given by $\widehat{\Omega}_{mt,rj}^{d\{f\},pre} = -l_{fg}^{pre}\widehat{\partial s}_{rmt}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pre}\right)/\partial p_{jmt}$

and $\mathbf{G}^{d\{f\},pre}$ denotes the matrix with diagonal elements $g_{jj} = l_{ff}^{pre}$ for $j \in \Gamma_{fmt}$, with l_{fg}^{pre} representing the typical element of matrix $\mathbf{L}^{pre}= \left(\mathbf{I} - \mathbf{C}^{*pre\prime}\right)^{-1} \mathbf{C}^{pre\prime}\mathbf{D}^{pre} \left(\mathbf{I} - \mathbf{D}^{*pre}\right)^{-1}$ computed under the pre-partial acquisition (corporate control and financial interest) shareholder's weights.

Finally, after solving for $\widehat{\mathbf{p}}_t^{d\{f\},pre}$, we can then, as before, use it as input, given that the model is structural, to examine the market shares, the operating profit and, particularly, the static aggregated profit of each deviating firm $f \in \Im$: $\Pi_{ft}\left(\widehat{\mathbf{p}}_t^{d\{f\},pre}; \mathbf{D}^*\right)$, a structural element of the above no-deviation conditions.

4.0.1 Bertrand-Nash

The pre-partial acquisition Bertrand-Nash equilibrium price vector can be derived by choosing $\widehat{\mathbf{p}}_{mt}^{ne,pre}$ to satisfy the following set of J_{mt} first-order conditions for each market and time period:

$$\mathbf{G}^{ne,pre}\widehat{\mathbf{s}}_{mt}\left(\widehat{\mathbf{p}}_{mt}^{ne,pre}\right) - \widehat{\mathbf{\Omega}}_{mt}^{ne,pre}\left(\widehat{\mathbf{p}}_{mt}^{ne,pre}\right)\left(\widehat{\mathbf{p}}_{mt}^{ne,pre} - \widehat{\mathbf{mc}}_{mt}^{pre}\right) = 0,$$

where $\widehat{\mathbf{\Omega}}_{mt}^{ne,pre}$ denotes a matrix with jr element given by $\widehat{\Omega}_{mt,rj}^{ne,pre} = -l_{fg}^{pre}\widehat{\partial s}_{rmt}\left(\widehat{\mathbf{p}}_{mt}^{ne,pre}\right)/\partial p_{jmt}$ for $r \in \Gamma_{gmt}$ and $j \in \Gamma_{fmt}$, and finally $\mathbf{G}^{ne,pre}$ denotes a diagonal matrix with diagonal elements $g_{jj} = l_{ff}^{pre}$ for $j \in \Gamma_{fmt}$.

Post-Partial Acquisition Counterfactual Static Prices and Profits

Defection

Assuming the partial-acquisition does not alter the competitive setting among firms, we can make use of the set of first-order conditions in equation (9) to solve for each market m's subset of the predicted (counterfactual) post-partial acquisition price vector under deviation by any firm $f \in \Im$, $\widehat{\mathbf{p}}_t^{d\{f\},pst}$. The procedure closely parallels the one for the pre-partial acquisition structure as follows:

$$\mathbf{G}^{d\{f\},pst}\widehat{\mathbf{s}}_{mt}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pst}\right) - \widehat{\mathbf{\Omega}}_{mt}^{d\{f\},pst}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pst}\right)\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pst} - \widehat{\mathbf{mc}}_{mt}^{pst}\right) = 0,$$

where l_{fg}^{pst} denotes the typical element of matrix $\mathbf{L}^{pst}= \left(\mathbf{I} - \mathbf{C}^{*pst\prime}\right)^{-1} \mathbf{C}^{pst\prime}\mathbf{D}^{pst} \left(\mathbf{I} - \mathbf{D}^{*pst}\right)^{-1}$ computed under the post-partial acquisition (corporate control and financial interest) shareholder's weights (actual or hypothetical), $\widehat{\boldsymbol{\Omega}}_{mt}^{d\{f\},pst}$ denotes a matrix with jr element given by $\widehat{\Omega}_{mt,rj}^{d\{f\},pst} = -l_{fg}^{pst}\widehat{\partial s}_{rmt}\left(\widehat{\mathbf{p}}_{mt}^{d\{f\},pst}\right)/\partial p_{jmt}$ for $r \in \Gamma_{gmt}$ and $j \in \Gamma_{fmt}$, and finally $\mathbf{G}^{d\{f\},pst}$ denotes a diagonal matrix with diagonal elements $g_{jj} = l_{ff}^{pst}$ for $j \in \Gamma_{fmt}$. After solving for $\widehat{\mathbf{p}}_{t}^{d\{f\},pst}$, we can then use it as input to examine the market shares, the operating profit and, particularly, the static aggregated profit of each deviating firm $f \in \Im$: $\Pi_{ft}\left(\widehat{\mathbf{p}}_{t}^{d\{f\},pst};\mathbf{D}^{*}\right)$, a structural element of the post-acquisition no-deviation conditions.

Punishment

The predicted (counterfactual) post-partial acquisition Bertrand-Nash equilibrium price vector, $\widehat{\mathbf{p}}_{t}^{ne,pst}$ can be derived making use of the set of first-order conditions in equation (7). Assuming the partial-acquisition does not alter the competitive setting, the procedure uses step 0's demand estimates to evaluate the own- and cross-price effects for any two products r and j, the marginal costs recovered in step 2 and the new post-partial acquisition $J_{mt} \times J_{mt}$ ownership structure as follows:

$$\mathbf{G}^{ne,pst}\widehat{\mathbf{s}}_{mt}\left(\widehat{\mathbf{p}}_{mt}^{ne,pst}\right) - \widehat{\boldsymbol{\Omega}}_{mt}^{ne,pst}\left(\widehat{\mathbf{p}}_{mt}^{ne,pst}\right)\left(\widehat{\mathbf{p}}_{mt}^{ne,pst} - \widehat{\mathbf{mc}}_{mt}^{pst}\right) = 0,$$

where $\widehat{\boldsymbol{\Omega}}_{mt}^{ne,pst}$ denotes a matrix with jr element given by $\widehat{\Omega}_{mt,rj}^{ne,pst} = -l_{fg}^{pst}\widehat{\partial s}_{rmt}\left(\widehat{\mathbf{p}}_{mt}^{ne,pst}\right)/\partial p_{jmt}$ for $r \in \Gamma_{gmt}$ and $j \in \Gamma_{fmt}$, and finally $\mathbf{G}^{ne,pst}$ denotes a diagonal matrix with diagonal elements $g_{jj} = l_{ff}^{pst}$ for $j \in \Gamma_{fmt}$. As before, after solving for $\widehat{\mathbf{p}}_{t}^{ne,pst}$, we can then use it as input to examine the market shares, the operating profit and, particularly, the static aggregated profit of each firm $f \in \Im$: $\Pi_{ft}\left(\widehat{\mathbf{p}}_{t}^{ne,pst};\mathbf{D}^{*}\right)$, a structural element of the post-acquisition no-deviation conditions.

Appendix B

Data Preliminary Analysis

An important question is obviously whether the dataset is representative of the whole population buying disposable razor products. For purposes of Gillette 22.9% nonvoting equity interest acquisition in Eemland, the Department of Justice (1990) characterized the industry as follows:

> Gillette accounts for 50% of all razor blade units (...). The next closest competitor is BIC with 20%, followed by Warner-Lambert with 14%, Wilkinson with 3%, and American Safety Razor with less than 1% of unit sales. (page 9)

Because this industry characterization does not account for private labels, we must be cautious in a straightforward comparison with our dataset. However, it does suggest that our data is reasonably representative, although slightly overrepresenting Gillette and underrepresenting BIC and Wilkinson Sword.

We now move on to describe the dataset in more detail. Table B1, Panel A presents summary purchase statistics at the UPC level. Although there is evidence of substantial heterogeneity across stores and weeks, the median store in the sample sells 2 packages of 5 men razors per week at a price of $3.10 per package, generating 38.9% gross retail margin. This margin is computed with reference to the average acquisition cost of the items in inventory, an issue we will address in more detail below. Table B1, Panel B presents summary statistics at the store level. 17,539 households visit and purchase something in the median store per week. The potential market size in a given time period is defined in terms of the number of purchases of razor packages and assumed to be proportional to the weekly number of household visits of each store. The proportionality factor is assumed to be the percentage of households buying razor products times the probability of a purchase in any given visit. According to the IRI Builders Suite (Bronnenberg *et al.*, 2008) 28.5% of US households purchase razor blades in a year, with an average purchase cycle of 106 days. Furthermore, according to Food & Beverage Marketing (Degeratu *et al.*, 2000), US households visit regular grocery stores about 7.9 times per month on the average. This translates into a median potential market size of 181.7 package purchases per store and week, a potential market that a median of 7 grocery stores, 3 convenience stores and 5 pharmacies compete for each week. We explored the sensitivity of our results to the proportionality factor assumption and all the main conclusions were found to be robust. Finally, Table B1, Panel C presents summary demographic statistics of each store surrounding area (same ZIP code). The median consumer is 40-year-old within an household consisting of two members and an annual income of $57,457.

Having described the main data summary statistics, we now examine in more detail the price variable. Temporary price promotions are important marketing tools in the pricing strategy of many nondurable goods and disposable razors are no exception, as the high price variance and the (occasional) negative gross retail margin reported in Table B1, Panel A suggest. Prices in the sample display a classic high-low pattern: products have a *regular level* that remains constant for long periods of time with occasional temporary reductions. High-low pricing allows firms to discriminate between (*i*) informed and uninformed consumers; (*ii*) consumers with different inventory holding costs; and (*iii*) price-sensitive switchers and store-loyal consumers. While the classic high-low pattern is easy to spot, regular price levels are hard to define because they may change over time. We define a temporary price promotion in the lines of Dossche *et al.* (2010): as any sequence of prices that is below at least 95 percent of the most left and the most right adjacent prices. Table B2 characterizes DFF's temporary price promotions. Following the typical pattern of setting regular price levels that remain constant for long periods of time, the median prices set by this supermarket chain across all UPCs, stores and weeks are non-promoted. Occasional temporary reductions account for only 11.5% of all price observations and, although there is evidence of substantial heterogeneity, consist of a median 20.8% discount every 4 weeks.

In an environment characterized by temporary price discounts, it is important to examine how consumers respond to price cuts. As Hendel and Nevo (2006a) show, demand estimation based on temporary price reductions may mismeasure the long-run responsiveness to prices. This is of fundamental importance in a setting like ours that relies on the ability to consistently estimate own- and cross-price elasticities. The first two columns in Table B3 addresses this issue by comparing, per package size, the percentage of weeks that a UPC was on promotion and the percentage of razors sold during those weeks. The results suggest that consumers do respond to temporary price discounts: the percentage of quantity sold on promotion is larger than the percentage of weeks that the promoted price is available. This is consistent with the hypothesis that consumers respond to temporary price cuts by accelerating (anticipating) purchases and hold inventories for future consumption (i.e. stockpile). The main alternative explanation that consumers simply increase their consumption in response to a price reduction is less valid in the wet shaving setting. In order to avoid mismeasuring the long-run responsiveness to prices due to temporary price reductions, we aggregate the data quarterly.

Having characterized the price discrimination induced by temporary price promotions, we now address a second form of discrimination: discrimination induced by price nonlinearity in package size. Nonlinear pricing can be used by oligopolistic firms as a screening mechanism to price discriminate between types of consumers that hold private information about their tastes by nudging consumers to self-select (according to their tastes) into a given price-package size combination. Disposable razors are once again no exception. Prices in the sample display a non-linear schedule in package size, which is reported in Table B3. The last column of the table presents the quantity discount associated with the biggest-selling package sizes. In a context where not all products are sold in all package sizes and all DFF's stores, we analyzed the nonlinearity in package size in the lines of Hendel and Nevo (2006b), using a regression of the price per 5 razors on size dummy variables, controlling for temporary price promotions as well as product and store fixed effects. The quantity discount of each package size is then computed as the ratio of the coefficient on the corresponding size dummy variable to the constant. The results show that prices do exhibit quantity discounting. As a consequence, price nonlinearity constitutes a feature of the market that must be incorporated into the structural model.

Table 1
*Volume Market Shares (%)**

	Mean	Median	Std	Min	Max
Panel A: Brand Level					
1. G Gillette	59.538	61.538	14.737	0.000	95.037
2. PL Private Label	20.562	18.634	10.837	0.000	100.000
3. WL Schick	14.043	12.753	8.832	0.000	66.154
4. B BIC	5.551	0.000	14.392	0.000	93.776
5. ASR Personna	0.275	0.000	0.770	0.000	11.990
6. WS Wilkinson Sword	0.032	0.000	0.314	0.000	9.284
Panel B: Product Level					
1. G Good News	14.210	12.975	8.387	0.000	74.850
2. G Good News Plus	11.173	10.504	6.535	0.000	52.941
3. G Daisy Plus	9.553	8.467	6.767	0.000	45.455
4. WL Schick Slim Twin	8.832	7.634	6.988	0.000	56.893
5. G Good News Pivot Plus	6.959	6.094	5.313	0.000	48.980
6. G Good News Microtrac	6.891	6.061	5.552	0.000	54.545
Panel C: Package Size Level					
1. 10 Razors	41.482	41.667	13.978	0.000	97.162
2. 5 Razors	41.438	40.650	13.348	2.080	100.000
3. 12 Razors	11.328	10.480	7.384	0.000	56.376
4. 15 Razors	5.247	0.000	10.677	0.000	71.942
5. 3 Razors	0.378	0.000	0.886	0.000	12.060
6. 2 Razors	0.121	0.000	0.556	0.000	11.538

* The statistics presented are computed across the 8,346 store-week combinations. Volume market share denotes the percentage of the number of razors sold by brand, product and package size in the total number of razors sold in each market. B: BIC, G: Gillette, ASR: American Safety Razor, PL: Private Label, WL: Warner-Lambert, WS: Wilkinson Sword.

TABLE 2

*Demand Estimation Results**

	Logit OLS		Logit HLZ		Logit BLP		Logit BST		RC Logit BLP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Standard Price Parameters									
Price	-0.074	-0.837	-0.921	-1.054	-0.442	-2.442	-0.627	-2.301	-2.516
	(0.364)	(0.216)	(0.188)	(0.124)	(0.487)	(0.239)	(0.510)	(0.232)	(0.352)
Price × HH Size	-0.021	-0.053	-0.074	-0.074	-0.256	-0.187	-0.216	-0.189	
	(0.160)	(0.100)	(0.083)	(0.055)	(0.220)	(0.083)	(0.233)	(0.088)	
Price × Age	0.016	0.007	0.009	-0.016	-0.083	-0.250	-0.020	-0.135	
	(0.261)	(0.135)	(0.115)	(0.076)	(0.292)	(0.135)	(0.314)	(0.140)	
Price × HH Income	0.113	0.123	0.159	0.144	0.154	0.181	0.082	0.161	
	(0.072)	(0.043)	(0.038)	(0.021)	(0.085)	(0.036)	(0.094)	(0.041)	
Standard Product Characteristics Parameters									
Package Size	0.029								
	(0.025)								
Package Size^2	-0.005								
	(0.001)								
Standard Demographic Parameters									
HH Size	-0.213	-0.141	-0.020		0.482		0.253		
	(0.591)	(0.290)	(0.240)		(0.633)		(0.665)		
Age	-0.460	-0.620	-0.557		-0.299		-0.576		
	(0.892)	(0.355)	(0.325)		(0.829)		(0.881)		
HH Income	-0.082	-0.112	-0.171		-0.274		-0.065		
	(0.268)	(0.125)	(0.106)		(0.256)		(0.283)		

TABLE 2

Extended

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Standard Competition Parameters									
Nearby Grocery Str.	0.704	0.646	0.383		0.429		0.731		
	(0.844)	(0.571)	(0.406)		(0.493)		(0.482)		
Nearby Conven. Str.	1.403	0.733	2.017		0.886		0.151		
	(1.479)	(0.953)	(0.737)		(0.849)		(0.849)		
Nearby Pharmacies	-1.313	-1.343	-1.556		-1.452		-1.568		
	(1.359)	(0.696)	(0.635)		(0.671)		(0.661)		
Random Coefficients: Standard Deviations									
Constant									0.030
									(2.501)
Price									0.047
.									(0.330)
Random Coefficients: Demographic Interactions									
Price × HH Size									-0.189
									(0.190)
Price × Age									-0.223
									(0.222)
Price × HH Income									0.131
									(0.068)
Control Parameters	—	j–	j–	jmt	j–	jmt	j–	jmt	jmt
No. End. Var./Instr.	4/0	4/0	4/28	4/28	4/16	4/16	4/16	4/16	6/16
R^2/Hansen J Statistic	0.03	0.55	146.39	159.15	150.59	18.044^{+}	154.82	105.54	17.398^{+}

* Based on 17,745 store-quarter-UPC observations. Standard errors clustered by store-brand in parentheses. HH denotes household. Nearby Grocery Str. and Nearby Conven. Str. denote the number of nearby grocery and convenience stores, respectively. No. End. Var./Instr. denote the number of endogenous variables and the number of instruments, respectively. Specification (1) includes a constant term. j, m and t denote UPC, market (store) and time (quarter) dummy variables. + denotes that the J statistic of Hansen is statistically significant at the 5 percent level.

TABLE 3

*Median Own- and Cross-Price Elasticities**

UPC	4	7	9	10	12	13	14	15	16
1. B Lady Shaver 10r	0.045	0.275	0.009	0.031	0.105	0.045	0.059	0.004	0.006
2. B Metal Shaver 5r	0.036	0.327	0.009	0.033	0.105	0.050	0.149	0.004	0.006
3. B Pastel Lady Shaver 5r	0.031	0.301	0.011	0.032	0.105	0.051	0.156	0.004	0.006
4. B Shaver 10r	-6.439	0.256	0.010	0.028	0.106	0.046	0.145	0.004	0.006
5. G Daisy Slim 5r	0.024	0.294	0.011	0.051	0.111	0.072	0.228	0.004	0.006
6. G Good News 3r	0.036	0.325	0.009	0.033	0.114	0.051	0.146	0.004	0.006
7. G Good News 10r	0.032	-12.877	0.010	0.032	0.109	0.051	0.165	0.004	0.006
8. G Good News Microtrac 5r	0.031	0.346	0.009	0.035	0.117	0.052	0.181	0.004	0.006
9. G Good News Pivot Plus 10r	0.022	0.387	-12.761	0.038	0.111	0.054	0.205	0.004	0.006
10. ASR Personna Flicker 5r	0.032	0.313	0.009	-10.221	0.113	0.053	0.187	0.004	0.006
11. PL Single Blade 5r	0.030	0.246	0.008	0.028	0.107	0.047	0.135	0.004	0.006
12. PL Twin Blade 5r	0.030	0.258	0.008	0.029	-4.538	0.047	0.140	0.004	0.006
13. WL Schick Slim Twin 5r	0.027	0.323	0.009	0.034	0.111	-7.277	0.157	0.004	0.006
14. WL Schick Slim Twin 10r	0.031	0.305	0.010	0.031	0.110	0.050	-10.901	0.004	0.006
15. WS Colors 5r	0.026	0.324	0.011	0.036	0.108	0.056	0.202	-3.650	0.007
16. WS Ultra Glide Twin 5r	0.023	0.336	0.011	0.033	0.110	0.058	0.205	0.004	-4.769

* Figures denote the median price elastiticities over the 643 store-quarter combinations. The elasticity in row i and column j represents the percentage change in market share of product i with a 1% change in price of product j. B: BIC, G: Gillette, ASR: American Safety Razor, PL: Private Label, WL: Warner-Lambert, WS: Wilkinson Sword. 3r, 5r and 10r denote package sizes of 3, 5 and 10 razors, respectively.

Table 4

*Principal Shareholders and Subsidiaries**

	Shareholders		Subsidiaries	
	Total Stock	Voting Stock	Total Stock	Voting Stock
American Safety Razor Company				
Allsop Venture Partners III, LP	12.40	12.40		
Goldman Sachs Group, LP	7.80	7.80		
Scudder Stevens and Clarck	7.00	7.00		
Equitable*	14.40	14.40		
Grantham Mayo Van Otter	5.10	5.10		
Leucadia Investors, Inc.	4.10	4.10		
Mezzanine Capital and Income Trust 2001 PLC	2.00	2.00		
BIC Corporation				
Bruno Bich	77.70	77.70		
Warner-Lambert Company				
The Capital Group, Inc.	5.16	5.16		
Wilkinson Sword, Inc.			100.00	100.00
The Gillette Company				
Berkshire Hathaway, Inc.	10.90	10.70		

* 1994's Schedule 14A (proxy statement) information. Equitable denotes the cumulative ownership of Equitable Capital Partners, LP, Equitable Deal Flow Fund, LP, Equitable Capital Partners (Retirement Fund), LP, and The Equitable Life Assurance Society of the United States.

Table 5

*Pre-Partial Acquisition Median Recovered Marginal Costs**

UPC	$price$	mc	mc	mc decomposition: $margin^r$	mc decomposition: mc^{m+r}
	($)		(as a % $price$)		
1. B Lady Shaver 10r	2.16	1.79	83.1	27.6	55.3
2. B Metal Shaver 5r	2.09	1.73	82.4	48.3	34.1
3. B Pastel Lady Shaver 5r	2.01	1.64	82.0	45.7	35.2
4. B Shaver 10r	2.39	2.00	84.1	34.5	49.6
5. G Daisy Slim 5r	1.89	1.48	77.9	4.20	68.2
6. G Good News 3r	2.19	1.71	78.6	37.9	40.9
7. G Good News 10r	4.83	4.38	90.6	35.6	54.8
8. G Good News Microtrac 5r	2.89	2.41	83.6	34.5	48.2
9. G Good News Pivot Plus 10r	4.66	4.15	89.3	36.1	55.0
10. ASR Personna Flicker 5r	3.74	3.39	90.2	61.0	28.7
11. PL Single Blade 5r	1.01	0.62	61.8	–	–
12. PL Twin Blade 5r	1.67	1.28	76.7	–	–
13. WL Schick Slim Twin 5r	2.69	2.30	85.6	35.6	49.4
14. WL Schick Slim Twin 10r	4.03	3.65	90.7	35.1	55.7
15. WS Colors 5r	1.29	0.92	71.1	61.9	9.50
16. WS Ultra Glide Twin 5r	1.69	1.32	78.8	43.8	34.1
Overall Median	3.02	2.59	85.8	–	–
Median Excluding PL	3.37	2.95	87.4	36.6	51.6

* Figures denote the median price, average acquisition cost and inferred marginal cost over the 643 store-quarter combinations. B: BIC, G: Gillette, ASR: American Safety Razor, PL: Private Label, WL: Warner-Lambert, WS: Wilkinson Sword. 3r, 5r and 10r denote package sizes of 3, 5 and 10 razors, respectively.

Table 6

*Pre-Partial Acquisition Prices**

UPC	Coordinated	Defection	Bertr-Nash
1. B Lady Shaver 10r	2.206	2.003	1.999
2. B Metal Shaver 5r	2.304	2.093	2.090
3. B Pastel Lady Shaver 5r	2.146	1.992	1.990
4. B Shaver 10r	2.503	2.391	2.390
5. G Daisy Slim 5r	2.564	2.465	2.445
6. G Good News 3r	2.093	2.004	1.990
7. G Good News 10r	4.793	4.722	4.719
8. G Good News Microtrac 5r	2.707	2.606	2.590
9. G Good News Pivot Plus 10r	4.509	4.410	4.390
10. ASR Personna Flicker 5r	4.155	3.990	3.990
11. PL Single Blade 5r	1.090	0.993	0.990
12. PL Twin Blade 5r	1.254	1.163	1.158
13. WL Schick Slim Twin 5r	2.257	2.061	2.057
14. WL Schick Slim Twin 10r	4.118	3.991	3.990
15. WS Colors 5r	1.484	1.270	1.269
16. WS Ultra Glide Twin 5r	1.887	1.670	1.669
Overall Median	2.889	–	2.780

* Figures are the median pre-partial acquisition counterfactual price level for each product over 81 stores. B: BIC, G: Gillette, ASR: American Safety Razor, PL: Private Label, WL: Warner-Lambert, WS: Wilkinson Sword. 3r, 5r and 10r denote package sizes of 3, 5 and 10 razors, respectively.

Table 7

*Pre-Partial Acquisition Non-Deviation Condition**

	Static Aggregated Profits $ (%)				Critical
Firm	gain from deviating		loss from punishment		Threshold
1. BIC	135,047	(11%)	28,039	(2%)	0.792
2. Gillette	610,600	(7%)	450,802	(5%)	0.262
3. American Safety Razor	17,630	(15%)	1,966	(2%)	0.888
4. Private Label	349,844	(8%)	152,630	(3%)	0.564
5. Warner-Lambert	173,202	(11%)	36,421	(2%)	0.790
6. Wilkinson Sword	7,168	(18%)	1,328	(3%)	0.815

* Aggregated Profit figures are in US dollars.

TABLE 8

*Post-Partial Acquisition Punishment and Defection Prices**

UPC	WS independent shareholder structure	WS acquired by G 100% voting	WS acquired by G 22.9% nonvoting	WS acquired by G 22.9% voting	WS acquired by WL 100% voting
	($ price)	(percentage change)			
Panel A: Punishment Prices					
1. B Lady Shaver 10r	1.999	0.001	†0.001	†0.001	†0.001
2. B Metal Shaver 5r	2.090	0.002	†0.001	†0.001	†0.001
3. B Pastel Lady Shaver 5r	1.990	0.001	†0.001	†0.001	†0.001
4. B Shaver 10r	2.390	0.000	0.000	0.000	0.000
5. G Daisy Slim 5r	2.445	0.038	0.008	0.009	0.001
6. G Good News 3r	1.990	0.053	0.012	0.012	0.002
7. G Good News 10r	4.719	0.000	0.000	0.000	0.000
8. G Good News Microtrac 5r	2.590	0.041	0.009	0.010	0.002
9. G Good News Pivot Plus 10r	4.390	0.027	0.006	0.006	0.001
10. ASR Personna Flicker 5r	3.990	0.000	0.000	0.000	0.000
11. PL Single Blade 5r	0.990	0.000	0.000	0.000	0.000
12. PL Twin Blade 5r	1.158	0.000	0.000	0.000	0.000
13. WL Schick Slim Twin 5r	2.057	0.002	†0.001	0.001	0.048
14. WL Schick Slim Twin 10r	3.990	0.000	0.000	0.000	0.000
15. WS Colors 5r	1.269	9.283	†0.001	2.673	1.643
16. WS Ultra Glide Twin 5r	1.669	7.247	†0.001	2.087	1.264
Overall Median	2.780	0.000	0.000	0.000	0.000

TABLE 8
Extended

UPC	WS independent shareholder structure	WS acquired by G 100% voting	WS acquired by G 22.9% nonvoting	WS acquired by G 22.9% voting	WS acquired by WL 100% voting
	($ price)	(percentage change)			
Panel B: Defection Prices					
1. B Lady Shaver 10r	2.003	0.000	0.000	0.000	0.000
2. B Metal Shaver 5r	2.093	0.000	0.000	0.000	0.000
3. B Pastel Lady Shaver 5r	1.992	0.000	0.000	0.000	0.000
4. B Shaver 10r	2.391	0.000	0.000	0.000	0.000
5. G Daisy Slim 5r	2.465	0.081	0.000	0.000	0.000
6. G Good News 3r	2.004	0.050	0.000	0.000	0.000
7. G Good News 10r	4.722	0.000	0.000	0.000	0.000
8. G Good News Microtrac 5r	2.606	0.000	0.000	0.000	0.000
9. G Good News Pivot Plus 10r	4.410	0.023	0.000	0.000	0.000
10. ASR Personna Flicker 5r	3.990	0.000	0.000	0.000	0.000
11. PL Single Blade 5r	0.993	0.000	0.000	0.000	0.000
12. PL Twin Blade 5r	1.163	0.000	0.000	0.000	0.000
13. WL Schick Slim Twin 5r	2.061	0.000	0.000	0.000	0.049
14. WL Schick Slim Twin 10r	3.991	0.000	0.000	0.000	0.000
15. WS Colors 5r	1.270	9.921	0.000	2.047	1.890
16. WS Ultra Glide Twin 5r	1.670	7.725	0.000	1.617	1.437
Overall Median	–	–	–	–	–

* Figures are the median post-acquisition percentage change for each product over 81 stores. †0.001 denotes percentage changes smaller than 0.001. B: BIC, G: Gillette, ASR: American Safety Razor, PL: Private Label, WL: Warner-Lambert, WS: Wilkinson Sword. 3r, 5r and 10r denote package sizes of 3, 5 and 10 razors, respectively.

TABLE 9

*Post-Partial Acquisition Non-Deviation Condition**

	WS independent	WS acquired by			
	shareholder	G 100%	G 22.9%	G 22.9%	WL 100%
Firm	structure	voting	nonvoting	voting	voting
Panel A: Gain from Deviating	$	(percentage change)			
1. BIC	135,047	-0.676	-0.071	-0.193	-0.159
2. Gillette	610,600	-0.361	-0.044	-0.224	-0.239
3. American Safety Razor	17,630	-0.607	-0.062	-0.170	-0.136
4. Private Label	349,844	-0.819	-0.085	-0.234	-0.197
5. Warner-Lambert	173,202	-0.730	-0.078	-0.208	2.556
6. Wilkinson Sword	7,168	–	-0.126	-0.070	–
Panel B: Loss from Punishment	$	(percentage change)			
1. BIC	28,039	-3.256	-0.342	-0.927	-0.767
2. Gillette	450,802	-0.149	-0.063	-0.181	-0.324
3. American Safety Razor	1,966	-5.443	-0.560	-1.526	-1.221
4. Private Label	152,630	-1.877	-0.194	-0.537	-0.451
5. Warner-Lambert	36,421	-3.471	-0.371	-0.991	3.347
6. Wilkinson Sword	1,328	–	-0.678	10.994	–
Panel C: Critical Threshold	dis.fact.	(value)			
1. BIC	0.792	0.798	0.793	0.794	0.794
2. Gillette	0.262	0.260	0.261	0.261	0.262
3. American Safety Razor	0.888	0.894	0.889	0.890	0.890
4. Private Label	0.564	0.568	0.564	0.565	0.565
5. Warner-Lambert	0.790	0.796	0.790	0.791	0.788
6. Wilkinson Sword	0.815	–	0.816	0.794	–

* Aggregated Profit figures are in US dollars.

Table B1

*Summary Statistics**

	Mean	Median	Std	Min	Max
Panel A: UPC Level					
Quantity (number of packages)	3.297	2.000	3.951	1.000	308.000
Price ($)	3.272	3.090	1.393	0.460	6.390
Gross Retail Margin (%)	41.108	38.890	15.889	-97.570	74.910
Package Size (number of razors)	7.377	5.000	3.052	1.000	20.000
Women Segment	0.209	0.000	0.407	0.000	1.000
Panel B: Store Level					
Number of Household Visits (000's)	17.481	17.539	4.675	1.686	30.640
Potential Market (number of packages)	181.079	181.684	48.431	17.465	317.395
Number of Grocery Stores	9.765	7.000	8.784	1.000	46.000
Number of Convenience Stores	4.296	3.000	3.404	0.000	16.000
Number of Pharmacies	5.556	5.000	3.637	0.000	14.000
Panel C: Demographic Level					
Age	41.537	40.221	19.228	10.000	79.000
Household Size	2.660	2.000	1.552	1.000	9.000
Household Income ($ 000's)	79.544	57.457	87.337	0.002	599.999

* Panel A statistics are based on 144,325 store-week-UPC observations. Gross Retail Margins denotes the margin in percent that DFF makes on the dollar for each item sold. Panel B Number of Household Visits and Potential Market statistics are based on 8,346 store-week combinations. Panel B competition statistics are based on 81 store observations. Panel C statistics are based on 2,000 simulated consumers for each of the 8,346 store-week combinations under analysis.

Table B2

*Temporary Price Promotions Characterization**

UPC Level	Mean	Median	Std	Min	Max
Promotion	0.115	0.000	0.319	0.000	1.000
Promotion Discount (%)	22.864	20.761	12.113	5.010	74.874
Duration from Last Promotion (weeks)	11.833	4.000	17.823	1.000	94.000

* Promotion statistics are based on 137,808 store-week-upc observations (since our temporary price promotion definition makes use of the first and last observation of the sequence of prices of each UPC in a given supermarket). Promotion Discount and Duration from Last Promotion statistics are conditional on a promotion and therefore are based on the corresponding 15,869 store-week-upc observations.

Table B3

*Temporary Price Promotions and Quantity Discount**

Package Size	Weeks on Promotion (%)	Quantity Sold on Promotion (%)	Quantity Discount (%)
5 Razors	11.427	19.027	–
10 Razors	11.967	23.959	29.635
12 Razors	11.755	15.489	52.555
15 Razors	6.199	7.875	61.278

* Weeks on Promotion and Quantity Sold on Promotion denote, conditional on package size, the percentage of weeks a promotion was offered and the percentage of number of packages sold on promotion, respectively. Figures are computed across all stores, weeks and UPCs. Quantity discount computed as the ratio of each dummy variable coefficient to the constant, from a regression of the price per 5 razors on size dummy variables, controlling for temporary price promotions as well as product and store fixed effects.