Pass-Through Rates and the Price Effects of Mergers

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Abstract

We investigate the relationship in Bertrand oligopoly between the price effects of mergers absent synergies and the rates at which merger synergies are passed through to consumers in the form of lower prices. We find that the demand conditions that cause a merger to result in large price increases absent synergies also cause the pass-through rate to be high. The low estimated pass-through rate and the relatively large predicted merger effect, thus, likely were inconsistent in an important US merger case.

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1 Introduction

In static Bertrand oligopoly, we investigate the link between price increases from mergers absent synergies and the pass through to consumers of marginal cost changes associated with merger synergies. Our investigation is motivated by US court decisions, and enforcement policies in other jurisdictions, holding that synergies are relevant to the legality of a merger only to the extent that they are passed on to consumers in the form of lower prices. In the Staples–Office Depot merger case, for example, the court cited low estimated pass-through rates as an important reason that the claimed efficiencies did not outweigh the anticompetitive effects of the merger.

We apply the term "merger effects" to the prices increases from a merger and model them as the difference between the non-cooperative equilibrium in which the merged products are priced independently, and the non-cooperative equilibrium in which they are priced jointly. In our terminology, "net" merger effects include impacts of synergies on prices, while "gross" merger effects do not. Differences between net and gross merger effects are the "pass-through effects" of merger synergies. They are modelled as the difference between the post-merger equilibrium without synergies and the post-merger equilibrium with them.

We derive expressions for the net and gross merger effects by applying the first step in Newton's method at the pre-merger prices. This provides an estimator of merger effects using only information potentially available in the observed pre-merger equilibrium. Examination of this estimator indicates that gross merger effects and pass-through effects are closely related. Both are determined largely by the degree of profit (demand) concavity. In particular, holding first derivatives (e.g., demand elasticities) constant, second derivatives (i.e., demand concavity) determine both gross merger effects and pass-through.

In the context of two major US merger cases, we demonstrate the practical importance of the association of high pass-through rates with large merger effects. The proposed WorldCom-Sprint merger illustrates that both pass-through and gross merger effects vary greatly with differing assumptions about the form of demand. The proposed Staples–Office Depot merger illustrates that price increase predictions and pass through predictions each offer a check on the other. We find a likely inconsistency in the estimates made the experts testifying for the Federal Trade Commission.

2 Merger Effects with Assumed Demand Forms

2.1 Merger Effects in Bertrand Industries

Consumers demand quantities given by the vector $\mathbf{q} = \{q_i\}$ as a function of the price vector $\mathbf{p} = \{p_i\}$, $i = 1, \ldots, n$. Product i is supplied at cost c_i which is a function of just q_i. Profit from this product is

$$\pi_i = p_i q_i - c_i. \tag{1}$$

These n products are the merging products and all competing products with prices that react to changes in the prices of the merging products.

If each product is controlled by a different firm, maximizing the profit from just its product, the n first-order conditions for a Nash equilibrium are

$$0 = \frac{\partial \pi_i}{\partial p_i} = q_i + (p_i - mc_i)\frac{\partial q_i}{\partial p_i}, \tag{2}$$

where

$$mc_i = \frac{dc_i}{dq_i} \tag{3}$$

is the marginal cost of product i. We do not assume that marginal costs are constant, although this is often done in applied work. The effect of p_j on q_i, with other prices held constant, is usually expressed in terms of elasticities:

$$\epsilon_{ij} = \frac{p_j}{q_i}\frac{\partial q_i}{\partial p_j}. \tag{4}$$

The first-order conditions imply the familiar relation between price-cost margins and own-price demand elasticities:

$$\frac{p_i - mc_i}{p_i} = -\frac{1}{\epsilon_{ii}}. \tag{5}$$

When several products are controlled by the same firm, the demand interactions among its jointly owned products are internalized. If a single firm controls products 1 and 2, its first-order conditions are

$$0 = \frac{\partial(\pi_1 + \pi_2)}{\partial p_1} = q_1 + (p_1 - mc_1)\frac{\partial q_1}{\partial p_1} + (p_2 - mc_2)\frac{\partial q_2}{\partial p_1} \tag{6}$$

and

$$0 = \frac{\partial(\pi_1 + \pi_2)}{\partial p_2} = q_2 + (p_1 - mc_1)\frac{\partial q_1}{\partial p_2} + (p_2 - mc_2)\frac{\partial q_2}{\partial p_2}. \tag{7}$$

These conditions lead to different equilibrium pricing than equation 2. In terms of the US Horizontal Merger Guidelines (1992), the difference between these two equilibria is the "unilateral" effect of the merger between sellers of products 1 and 2 in Bertrand oligopoly.

2.2 Predicting Gross Merger Effects

To predict the gross merger effects from differentiated products mergers, economists commonly assume a particular functional form for demand and estimate demand elasticities. Marginal costs are recovered from the first-order conditions at the pre-merger equilibrium (e.g., equation 5), and the gross merger effects are computed by solving the post-merger first-order conditions (e.g., equations 6 and 7), assuming the same or a different functional form for demand as that used to estimate the demand elasticities. The foregoing process, termed "merger simulation," is described by Werden and Froeb (1996) and Crooke et al. (1999). Nevo (2000), Hausman et al. (1994), Hausman and Leonard (1997), and Werden (2000) apply the technique to particular mergers.

The simplest form of merger simulation employs a constant-elasticity approximation to an unknown demand curve (e.g., Shapiro, 1996). Using an estimate of the elasticity matrix at the pre-merger equilibrium, it is straightforward to compute post-merger prices. The constant-elasticity specification makes it unnecessary to have any information about non-merging products, as their prices do not change in response to the merger. However, if demand becomes more elastic as price increases, Crooke et al. (1999) show this approach can dramatically over-estimate merger effects.

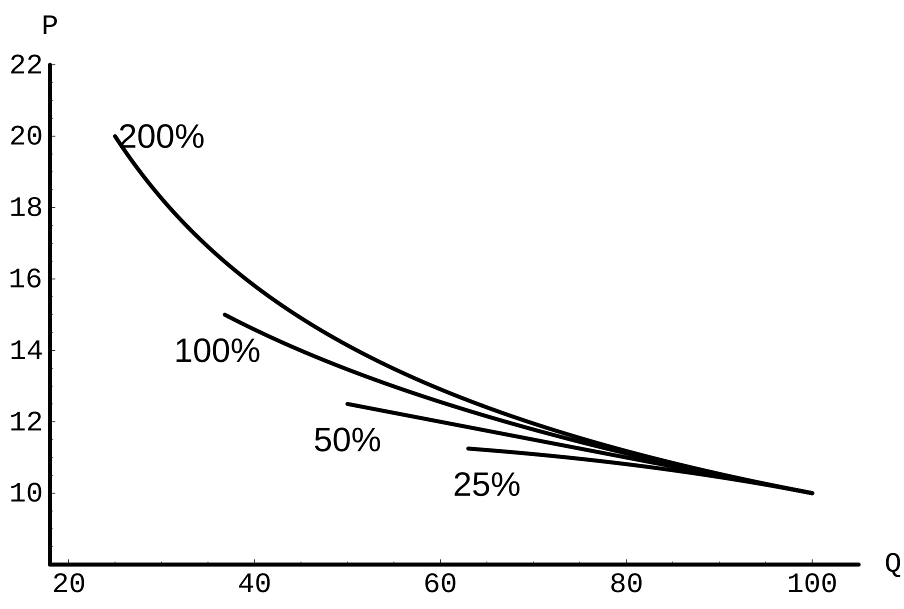

Figure 1: Four Constant-Pass-Through-Rate Demand Curves Plotted between the Competitive and Monopoly Prices

Figure 1 illustrates why an erroneous assumption as to the functional form of demand can lead to a very large prediction error. It plots four demand curves for a single-product industry, all defined by the functions

$$q(p) = \begin{cases} (a - bp)^{\theta/(1-\theta)} & \theta < 1 \\ a\exp(-bp) & \theta = 1 \\ (a + bp)^{\theta/(1-\theta)} & \theta > 1. \end{cases}$$

These demand curves exhibit a constant pass-through rate, $\theta = \partial p/\partial \Delta mc$, where Δmc is change in marginal cost resulting from merger synergies. By construction, the four demand curves share the same price, quantity, and elasticity (-2) at a single point, which we make the competitive equilibrium by assuming a constant marginal cost equal to that price. Figure 1 plots these demand curves between the common competitive equilibrium the four different monopoly equilibria. The differing concavities of the four demand curves result in substantially different monopoly prices. The top demand curve, associated with a 200% pass-through rate, yields a price–marginal cost margin at the monopoly price nearly ten times the margin with the bottom demand curve, associated with a 25% pass-through rate. To foreshadow the main result of the paper, demand concavity associated with higher monopoly prices is also associated with higher pass-through rates.

2.3 Newton's Method for Computing Post-Merger Equilibrium

To compute equilibrium in industries with various ownership structures, we imagine that the pricing of each product is controlled by a single agent that may share in the profits of other products. This heuristic allows us to characterize different kinds of equilibria, including a pre-merger equilibrium in which all prices are set independently, and a post-merger equilibrium in which the merged firm maximizes the sum of profits on its jointly owned products.

To make this notion precise, we construct the "ownership-structure matrix," $\mathbf{W} = \{w_{ij}\}$, with w_{ij} indicating the share of profits from product j received by agent i setting the price of product i. Agent i thus maximizes

$$\Omega_i = \sum_j w_{ij} \pi_j. \tag{8}$$

The pre-merger ownership structure, for example, may have $\mathbf{W}$ equal to the identity matrix, while a post-merger ownership structure may have $\mathbf{W}$ equal to the identity matrix except for two off-diagonal entries. Both structures are represented by the matrix

$$\mathbf{W} = \begin{pmatrix} 1 & r & 0 \\ r & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}. \tag{9}$$

Setting $r = 0$ reflects the pre-merger structure, while setting $r = 1$ reflects the post-merger structure. The formulation of the model in terms of the $\mathbf{W}$ matrix also can be used to incorporate partial ownership before or after a merger, as analyzed by O'Brien and Salop (2000).

In this general formulation, the n first-order conditions are

$$0 = \frac{\partial \Omega_i}{\partial p_i} = \sum_j w_{ij} \frac{\partial \pi_j}{\partial p_i} = w_{ii} q_i + \sum_j w_{ij} (p_j - mc_j) \frac{\partial q_j}{\partial p_i}. \tag{10}$$

These first-order conditions apply both pre- and post-merger, using the relevant pre- and post-merger values for the w_{ij} and mc_j.

To develop an expression for the net merger effect, we review how one uses Newton's method to find a Nash equilibrium satisfying these first-order conditions. Let $z_i = \partial \Omega_i / \partial p_i$, and let $\mathbf{z} = \{z_i\}$ be the vector of these derivatives expressed as functions of $\mathbf{p}$. To solve for simultaneous zeros of $\mathbf{z}$, we take an initial estimate $\mathbf{p}^{(0)}$ and successively refine the estimate by the

$\mathbf{p}^{(1)}$, $\mathbf{p}^{(2)}$, $\mathbf{p}^{(3)}, \ldots$, generated by the rule

$$\mathbf{p}^{(k+1)} = \mathbf{p}^{(k)} - \mathbf{A}^{-1}\mathbf{z}^{(k)}, \tag{11}$$

where $\mathbf{z}^{(k)} = \mathbf{z}(\mathbf{p}^{(k)})$ is the value of $\mathbf{z}$ at the latest approximation, and $\mathbf{A} = \{a_{ij}\}$,

$$a_{ij} = \frac{\partial z_i}{\partial p_j} = w_{ii}\frac{\partial q_i}{\partial p_j} + w_{ij}\frac{\partial q_j}{\partial p_i} + \sum_k w_{ik}(p_k - mc_k)\frac{\partial^2 q_k}{\partial p_j \partial p_i}, \tag{12}$$

is also evaluated at $\mathbf{p}^{(k)}$. The $\mathbf{A}$ matrix, which indicates the slopes of the derivatives of the profit functions, also may be written

$$\mathbf{A} = \frac{\partial \mathbf{z}}{\partial \mathbf{p}}. \tag{13}$$

For notational simplicity, we suppress the fact that $\mathbf{A}$ is a function of prices and is affected by merger through both $\mathbf{W}$ and the marginal costs.

Newton's method takes a first-order approximation to $\mathbf{z}$ at $\mathbf{p}^{(k)}$,

$$\mathbf{z} \approx \mathbf{z}^{(k)} + \frac{\partial \mathbf{z}}{\partial \mathbf{p}}\left(\mathbf{p} - \mathbf{p}^{(k)}\right), \tag{14}$$

and finds the value of $\mathbf{p}$ that sets this approximation equal to zero. To apply Newton's method, it is necessary to specify an initial solution $\mathbf{p}^{(0)}$, and the natural choice in merger analysis is the pre-merger equilibrium. Taking $\mathbf{z}^{(0)}$ to be the first-order conditions evaluated with the post-merger ownership matrix at the pre-merger equilibrium prices, the first step in applying Newton's method is

$$\mathbf{p}^{(1)} = \mathbf{p}^{(0)} - \mathbf{A}^{-1}\mathbf{z}^{(0)}. \tag{15}$$

Solving equation 15 requires evaluation of the second derivatives of $\mathbf{q}$, as they appear in $\mathbf{A}$. These second derivatives determine the sharpness of the peaks in the merged firm's profit function or, put another way, how much a small deviation from optimal pricing reduces profits.

Equation 15 is a closed-form predictor of the net merger effects using only information potentially available at the observed pre-merger equilibrium. If nothing is known about the functional form of demand function, equation 15 offers the best possible predictor of merger effects. If the post-merger first-order conditions are evaluated at the pre-merger marginal costs, i.e., $\mathbf{z}^{(0)}|_{\mathbf{mc}^{pre}}$, equation 15 yields the gross merger effect:

$$\Delta\mathbf{p}_{gme} = -\mathbf{A}^{-1}\left(\mathbf{z}^{(0)}|_{\mathbf{mc}^{pre}}\right). \tag{16}$$

If the post-merger first-order conditions are evaluated at the marginal costs resulting from merger synergies, i.e., $\mathbf{z}^{(0)}|_{\mathbf{mc}^{post}}$, equation 15 yields the net merger effect:

$$\Delta\mathbf{p}_{nme} = -\mathbf{A}^{-1}\left(\mathbf{z}^{(0)}|_{\mathbf{mc}^{post}}\right) \equiv \mathbf{g}(\lambda). \tag{17}$$

In both cases, $\mathbf{A}$ is evaluated at pre-merger prices and the same marginal costs as the first-order conditions.

The net merger effects predictor can be used to compute confidence intervals. For example, if equation 17 is parameterized by a vector of estimable parameters λ, and $\hat{\lambda}$ is an estimator of λ with a limiting normal distribution $\sqrt{n}(\hat{\lambda} - \lambda) \xrightarrow{D} N(\mathbf{0}, \Sigma)$ then $\sqrt{n}(\mathbf{g}(\hat{\lambda}) - \mathbf{g}(\lambda)) \xrightarrow{D} N(\mathbf{0}, (\nabla\mathbf{g})\Sigma(\nabla\mathbf{g})')$, provided that $\mathbf{g}$ is continuously differentiable at λ. Such analytic expressions are useful for identifying factors that make confidence intervals large and may suggest estimation strategies to reduce sampling variance. The λ vector may include Δmc_i as well as demand parameters, reflecting the uncertainty of synergy estimates.

If profits are a quadratic function of prices, e.g., demand is linear and marginal costs are constant, Newton's method converges to the post-merger equilibrium in one step, so our one-step approximation gives the exact solution. For other demand functions, the approximation could be refined by applying Newton's method iteratively, but that would require information about the profit functions at prices away from the observed equilibrium. In merger simulation, the source of such "information" always has been an arbitrary assumption about the form of demand. Without making such an assumption, equation 17 offers the best possible approximation.

An arbitrary assumption about the form of demand can be avoided if that form can be determined empirically, along with the elasticities at the pre-merger equilibrium. The available data (commonly two years of scanner data), however, normally are insufficiently informative: The range of price variation is rather limited, and the relationship between prices and quantities is noisy. Without better data than normally is available, distinguishing among even large differences in pass-through rates is apt to be infeasible. Consider the problem of empirically distinguishing among the four demand curves in Figure 1. If prices were observed only between 10 and 12, these four demand curves would be empirically indistinguishable unless the data fit extraordinarily well.

3 Pass-Through Rates and Gross Merger Effects

3.1 Pass-Through Rates

We now consider how equilibrium pricing is affected by changes in costs, as examined in the context of monopoly by Bulow and Pleiderer (1983) and in the context of differentiated products oligopoly by Anderson, De Palma, and Kreider (2001). We assume the effect of merger synergies on marginal cost is invariant to output, but we do not assume that marginal cost itself is invariant to output. In particular, merger synergies are assumed to shift the marginal cost functions for the merged firm's products by $\Delta\mathbf{mc} = \{\Delta mc_i\}$, with Δmc_i independent of q_i, so each post-merger cost function equals that pre-merger plus $q_i \Delta mc_i$.

We assume the equilibrium prices are continuous and differentiable functions of $\Delta \mathbf{mc}$. Let

$$\frac{\partial \mathbf{p}}{\partial \Delta \mathbf{mc}} = \left\{ \frac{\partial p_i}{\partial \Delta mc_j} \right\} \tag{18}$$

be the matrix of rates at which marginal cost changes affect equilibrium prices, with the diagonal entries being the rates at which firms pass-through changes in their own marginal costs. Using the implicit function theorem and differentiating the first-order conditions for post-merger equilibrium (equation 10), it is straightforward to compute the rate at which changes in marginal cost are passed through to prices. The pass-through-rate matrix is

$$\frac{\partial \mathbf{p}}{\partial \Delta \mathbf{mc}} = -\left(\frac{\partial \mathbf{z}}{\partial \mathbf{p}}\right)^{-1} \left(\frac{\partial \mathbf{z}}{\partial \Delta \mathbf{mc}}\right) = -\mathbf{A}^{-1}\mathbf{B}, \tag{19}$$

where $\mathbf{B} = \{b_{ij}\}$ and

$$b_{ij} = \frac{\partial z_i}{\partial \Delta mc_j} = -w_{ij}\frac{\partial q_j}{\partial p_i}. \tag{20}$$

Hence, the impact of the marginal cost changes on equilibrium price changes is approximated to the first order by

$$\Delta \mathbf{p}_{spt} \approx -\mathbf{A}^{-1}\mathbf{B}\Delta \mathbf{mc}, \tag{21}$$

where the subscript "spt" denotes "synergy pass through." The pass-through-rate matrix (equation 19) indicates the extent to which marginal cost savings from a merger are passed through to consumer prices *in the post-merger equilibrium* and can be thought of as a predictor of the gross benefits of a merger (under a consumer-welfare standard, which ignores profit increases).

Equation 19 is a function of both prices and the ownership structure, $\mathbf{W}$, so pass-through rates in the pre-merger equilibrium differ from those in the post-merger equilibrium. The difference between pre- and post-merger pass-through rates is most important for the cross pass-through rates of the products of the merging firms. This difference depends on the properties of particular demand systems, and almost anything is possible. Cross pass-through rates may be positive pre merger but negative post merger, and they may be substantially greater pre merger even if positive both pre and post merger.

The $\mathbf{W}$ matrix incorporated in equation 21 through $\mathbf{A}$ and $\mathbf{B}$ reflects the post-merger ownership structure, while the derivatives in equation 21 are evaluated at pre-merger prices. Like the gross and net merger effect predictors, the synergy effect predictor incorporates only information potentially available at the observed pre-merger equilibrium.

The second-order conditions for Bertrand equilibrium require that the $\mathbf{A}$ matrix be negative definite, and this imposes restrictions on the pass-through matrix, $-\mathbf{A}^{-1}\mathbf{B}$. For example, in an industry characterized by single-product firms, $-\mathbf{A}^{-1}$ is positive definite and $\mathbf{B}$ is a diagonal matrix, with $b_{ii} = -\partial q_i/\partial p_i$ along the main diagonal. This implies that own pass-through rates are positive. And in a *symmetric* industry with single-product firms, all of the b_{ii} are the same, so $\mathbf{B}$ is a scalar times the identity matrix, which implies that the pass-through matrix is positive definite.

3.2 The Relationship Between Pass-Through Rates and Merger Effects

Adding the gross merger effect of equation 16 and the synergy effect of equation 21 yields the net merger effect:

$$\Delta\mathbf{p}_{gme} + \Delta\mathbf{p}_{spt} \approx -\mathbf{A}^{-1}\left(\mathbf{z}^{(0)}|_{\mathbf{mc}^{pre}} + \mathbf{B}\Delta\mathbf{mc}\right). \tag{22}$$

Because $\mathbf{A}$ is the matrix of derivatives with respect to prices of the vector of first-order conditions for profit maximization, equation 22 clearly indicates the influence of demand second derivatives, through $\mathbf{A}$, on both the gross merger effect and the pass-through effect. The terms in the parentheses in equation 22 include only first derivatives: $\mathbf{z}^{(0)}|_{\mathbf{mc}^{pre}}$ is the vector of first-order conditions evaluated at the pre-merger marginal costs (equation 12), while $\mathbf{B}$ is the matrix of demand partial derivatives multiplied by profit ownership shares (equation 20). Holding these two terms constant, there is a one-to-one relationship between gross merger effects and pass-through rates. This relationship is manifest in Figure 1 (and in Table 2 below).

It is easy to understand why the gross merger effects and pass-through rates both depend on demand concavity. The first-order conditions characterizing equilibrium are the first derivatives of the profit functions. The extent to which equilibrium is displaced by a merger or marginal cost reduction thus depends on the derivatives of the first-order conditions, and hence on concavity of the profit function, which in this model is determined by demand concavity.

Data relating to the abandoned WorldCom-Sprint merger can be used to illustrate the relationship between merger effects and pass-through rates. Shares and estimated elasticities of demand for residential long-distance service are taken from Hausman's (2000) submission to the Federal Communications Commission in opposition to the merger. We assume a common pre-merger price of \$0.07 per minute. AT&T was the largest carrier with 63.4% of the domestic residential long-distance minutes, followed by WorldCom with 16.4% and Sprint with 5.0%. We place all other firms in the residual category, "Emerging," treating them as a single price-setting entity in the simulations below. This treatment imparts a slight upward bias to the simulated merger effects. Hausman's estimated elasticity matrix is presented in Table 1. The columns relate to prices and the rows relate to quantities, so the figure in the third column of the first row is the elasticity of AT&T's demand with respect to Sprint's price.

Table 1: Estimated Elasticity Matrix for Residential Long Distance Carriers

	AT&T	WorldCom	Sprint	Emerging
AT&T	−1.12	0.09	0.03	0.16
WorldCom	0.50	−1.33	0.06	0.23
Sprint	0.61	0.22	−1.81	0.30
Emerging	0.47	0.12	0.04	−1.33

Three different commonly used demand systems—linear, AIDS (without income effects), and constant elasticity—are calibrated to the same pre-merger equilibrium, i.e., the same prices, quantities, and elasticities (see Crooke et al. (1999) for calibration details). Table 2 displays the resulting merger effects as well as the marginal pass-trough rates at the post-merger equilibrium. We suppose that all of the merger synergies accrue to the Sprint product and examine the pass-through rates to the prices of all four products. These pass-through rates are not approximations; the assumption of specific demand forms makes approximation unnecessary.

Table 2: Gross Merger Effects and Pass-Through Rates for the WorldCom-Sprint Merger

Demand	Merger Effect	Pass-through Rate from Sprint Cost to			
Form	$\%\Delta p_{WC+Sp}$	AT&T	WorldCom	Sprint	Emerging
Linear	2.3	0.007	0.001	0.502	0.008
AIDS	13.8	0.046	0.032	1.807	0.052
Isoelastic	16.4	0.000	−0.343	3.838	0.000

The striking feature of Table 2 is the difference across demand systems in predicted gross merger effects and pass-through rates. With isoelastic demand, both the merger effect and Sprint's own pass-through rate (from Sprint's marginal costs to Sprint's price) are over seven times as large as they are with linear demand. Since all demand systems have the same elasticities by construction, the differences across systems are due to the different second derivatives.

4 Compensating Marginal Cost Reductions

While demand second derivatives are important determinants of both merger and pass-through effects, Werden (1996) and Stenneck and Verboven (2001) have shown that the marginal cost reductions necessary to keep prices constant depend only on first derivatives, prices, and quantities. These "compensating marginal cost reductions" can be computed by setting the term in parentheses in equation 22 to zero, and solving for $\Delta\mathbf{mc}$:

$$\Delta\mathbf{mc}_{comp} = -\mathbf{B}^{-1}\mathbf{z}^{(0)}|_{\mathbf{mc}^{pre}}. \tag{23}$$

Compensating marginal cost reductions are robust with respect to different demand forms, in that they do not depend on the concavity of demand. This is easily seen from the fact the matrix $\mathbf{B}$ and the vector $\mathbf{z}^{(0)}$ contain only first-order terms. And since prices do not change, the non-merging firms' first-order conditions remain at zero, so the elements of $\mathbf{z}^{(0)}$ corresponding to the non-merging firms are zero. The matrix $\mathbf{W}$, and thus the matrix $\mathbf{B}$, has a block-diagonal form, with the merging products forming a block. Because the inverse of $\mathbf{B}$ is also block diagonal, the compensating marginal cost reductions depend only on the elements corresponding to the merging products. Using Hausman's estimated elasticities from the WorldCom-Sprint merger, the compensating marginal cost reductions are 19% for Sprint and 13% for WorldCom, measured as a percentage of their pre-merger marginal costs.

When merger synergies exactly offset the gross merger effects, the pass-through rates can be computed by dividing the gross merger effect, $\Delta\mathbf{p}_{gme}$, by the compensating marginal cost reductions, $\Delta\mathbf{mc}_{comp}$. Thus, there is a simple relationship between compensating marginal cost reductions, gross merger effects, and merging product demand elasticities. This relationship allows a useful analysis of pass-through rates that does not depend on second derivatives of demand and hence is not dependent on its functional form.

5 Pass Through in Staples–Office Depot

As discussed by Dalkir and Warren-Boulton (2004), in 1997 the Federal Trade Commission successfully challenged the merger of Staples and Office Depot, the two largest office supply superstore chains in the US. In opposing the merger, the FTC's economic experts estimated that 85% of industry-wide marginal cost reductions had been passed through to retail prices, while only 15% of firm-specific marginal cost reductions had been passed through (Ashenfelter et al., 1998). The court relied on the latter estimate in determining that synergies generated by the merger were insufficient to prevent price increases.

As discussed by Ashenfelter et al. (2004) and Baker (1999), the FTC's economic experts also used panel data to estimate the price effect of changing the number of office superstores, assuming no synergies. Public sources report only nationwide average price increase predictions for the merger, reflecting both cities in which the merging firms were the only office supply superstores and cities in which there was a third superstore. Based the reported estimates, we assume a predicted price increase of 7.5% for the cities with just the merging firms.

The analysis of the preceding section provides a check for the consistency of the estimated firm-specific pass-through rate with the predicted price increase. Assuming the merging firms were symmetric in all relevant respects, Werden (1996) shows that the compensating marginal cost reduction relative to pre-merger price, can be computed as

$$\frac{\Delta mc}{p} = -\frac{dm}{1-d}, \tag{24}$$

where m is the price-marginal cost margin and d is the diversion ratio from one superstore to another, $d = \epsilon_{ij}/\epsilon_{ii}$. Rearranging the result at the end of the preceding section, the implied compensating marginal cost reductions are given by the gross merger effect (7.5%) divided by the firm-specific pass-through rate (15%). This yields a compensating marginal cost reduction of 50% of price for both merging firms, so equation 24 implies $d = 1/(1+2m)$.

Symmetry also implies the aggregate elasticity of demand for office superstores, ϵ, divided by the individual firm own-price elasticity, ϵ_{ii}, equals $1-d$. Since Betrand equilibrium implies $\epsilon_{ii} = -1/m$, the solution for d as a function of m implies $\epsilon = -2/(1+2m)$. To check for consistency, this relationship implied by the price-increase and pass-through rate predictions can be compared with what may have been known about margins and the aggregate elasticity of office superstore demand. We suspect that aggregate demand for office supply superstores was known to be rather elastic because there were many alternative sources for office supplies. If so, the price-increase prediction was inconsistent with the pass-through prediction, since $\epsilon < -2$ implies $m < 0$, which surely was not the case. This conclusion, however, depends on the assumption of Bertrand competition, and we do not know whether this is what the FTC had in mind.

An additional check on the internal consistency of the predictions of the FTC's economists follows from Section 3.1. This check employs the 15%

firm-specific pass-through rate estimated and the estimated industry-wide pass-through rate of 85%. In a symmetric Bertrand industry, the industry-wide pass-through rate is the sum of the elements of any row in the pass-through matrix. Assuming symmetry and that both of the estimates from Ashenfelter et al. (1998) were correct, it is simple to compute the implied off-diagonal, or cross, pass-through rates—those from the costs of one merging firm to the other merging firm's price.

In two-superstore cities, the cross pass-through rates in each row would have to be 70%, causing the pass-through matrix not to be positive definite, and causing the second-order conditions for Bertrand equilibrium not to be satisfied. Another way to see this is to translate the cross pass-through rates into slopes of best-response functions. This translation is straightforward because the cross pass-through effect is just a response to a rival's price change. The slopes of the two best-response functions are just the ratio of the cross and own pass-through rates, which is 70/15. With these slopes, the best-response functions would not cross, and equilibrium would not exist.

Finally, even if the estimated pass-through rates were correct and accurate in the Staples–Office Depot case, they may have been misleading, because the merger would have caused the pass-through rates to change. The changes in prices resulting from the merger, and the changes in ownership that the merger bring about, both affect the pass-through rates. Post-merger pass-through rates could not have been estimated directly, but could have been constructed from the parameters of the firm-level profit functions.

6 Discussion

The net price effects of mergers is the touchstone for the legality of mergers under current law in the US and many other jurisdictions, and we present a rigorous methodology for implementing that policy. We show that there is a strong relationship between the gross consumer costs imposed by a merger, i.e., the increases in consumer prices absent synergies, and the gross consumer benefits derived from the merger, i.e., the pass through to consumer prices of marginal cost reductions from merger synergies. Holding constant the first-order conditions at the pre-merger equilibrium, higher-order properties that cause larger price increases absent synergies also cause merger synergies to be passed through at higher rates.

The gross price effects and pass-through effects of mergers can be jointly estimated using the net merger predictor presented in equation 17. The second derivatives of the profit (demand) function play a vital role in determining both effects, and the estimator of the net merger effect is crucially dependent on them. As an alternative to estimating demand second derivatives, one can compute the compensating marginal cost reductions necessary to offset the merger price effects. These depend only on the first-order conditions at the pre-merger equilibrium, which in principle are observable. By comparing likely cost reductions with these compensating marginal cost reductions, it generally is possible to determine whether prices are likely to rise or fall.

The foregoing is predicated on the assumption of Bertrand competition, but similar results obtain with other Nash non-cooperative equilibria. The conditions characterizing such equilibria are first derivatives of the profit functions, so the displacement of equilibrium by either merger or marginal cost reductions is determined by the concavity of the profit functions. In other models, however, profit concavity may not be controlled by the form of demand. Tschantz, Crooke, and Froeb (2000) show that the distribution of costs is critical in a first- or second-price private-values auction model.

Generalizations of the Bertrand model may affect pass through significantly. Froeb, Tschantz, and Werden (2002) show that adding a monopoly retail sector downstream of the merging Bertrand competitors may change nothing or everything, depending on the rules of the game and terms of the contracts between the retailer and the upstream competitors. One possible outcome is no pass through at all. We have not explored the impact of non-linear pricing or long-term contracts between the merging firms and ultimate consumers, but either could make it possible for fixed-cost reductions to be pass through, although they are not in Betrand competition. Merger policy in both the US and Europe gives little or no weight to fixed cost-reductions from merger synergies because they are not expected to be passed through.

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References

Anderson, S., A. de Palma, B. Kreider, 2001. Tax Incidence in Differentiated Product Oligopoly, Journal of Public Economics 81, 173–92.

Ashenfelter, O., D. Ashmore, J.B. Baker, S.-M. McKernan, 1998. Identifying the Firm-Specific Cost Pass-Through Rate, FTC Working Paper No. 217.

Ashenfelter, O., D. Ashmore, J.B. Baker, S. Gleason and D.S. Hosken, 2004. Econometric Methods in Staples, in: John Harkrider, ed., Econometrics in Antitrust (American Bar Association Antitrust Section).

Baker, J.B., 1999. Econometric Analysis in *FTC v. Staples*, Journal of Public Policy & Marketing 18, 11–21.

Bulow, J. and P. Pfleiderer, 1983. A Note on the Effect of Cost Changes on Prices, Journal of Political Economy 91, 182-85.

Crooke, P., L. Froeb, S. Tschantz, G.J. Werden, 1999. The Effects of Assumed Demand Form on Simulated Post-Merger Equilibria, Review of Industrial Organization 15, 205–17.

Dalkir, S. and F.R. Warren-Boulton, 2004. Prices, Market Definition, and the Effects of Merger: Staples–Office Depot, in: J.E. Kwoka, Jr. and L.J. White, eds., The Antitrust Revolution (Oxford, New York) 52–72.

Froeb, L., S. Tschantz, G.J. Werden, 2002. Vertical Restraints and the Effects of Upstream Horizontal Mergers, Owen Working Paper, Vanderbilt University.

Hausman, J., 2000. Declaration of Jerry Hausman, submitted to the Federal Communications Commission.

Hausman, J., G. Leonard, J.D. Zona, 1994. Competitive Analysis with Differentiated Products, Annales d'Economie et Statistique 34, 159–80.

Hausman, J. and G. Leonard, 1997. Competitive Analysis with Differentiated Products, George Mason Law Review 34, 159–80.

Nevo, A., 2000. Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry, RAND Journal of Economics 31, 395–421.

O'Brien, D. and S. Salop, 2000. Competitive Effects of Partial Ownership: Financial Interest and Corporate Control, Antitrust Law Journal 67, 559–614.

Shapiro, C., 1996. Mergers with Differentiated Products, Antitrust (Spring) 23–30.

Stennek, J. and F. Verboven, 2001. Merger Control and Enterprise Competitiveness: Empirical Analysis and Policy Recommendations, available at http://www.iui.se/wp/Wp556/IUIWp556.pdf.

Tschantz, S., P. Crooke, L. Froeb, 2000. Mergers in Sealed versus Oral Auctions, International Journal of the Economics of Business, 7, 201–212.

U.S. Department of Justice and Federal Trade Commission, 1992. Horizontal Merger Guidelines, 4 Trade Reg. Rep. (CCH) ¶13,104.

Werden, G.J., 1996. A Robust Test for Consumer Welfare Enhancing Mergers Among Sellers of Differentiated Products, Journal of Industrial Economics 44, 409–13.

Werden, G.J., 2000. Expert Report in *United States v. Interstate Bakeries and Continental Baking Co.*, International Journal of the Economics of Business 7, 139–48.

Werden, G.J. and L.M. Froeb, 1996. Simulation as an Alternative to Structural Merger Policy in Differentiated Products Industries, in: M. Coate and A. Kleit, eds., The Economics of the Antitrust Process (Kluwer, New York) 65–88.