Identifying the Firm-Specific Cost Pass-Through Rate

Orley Ashenfelter, David Ashmore, Jonathan B. Baker & Signe-Mary McKernan[1]

January 1998

I. Introduction

A merger that permits the combined company to reduce the marginal cost of producing a product creates an incentive for it to lower price. Accordingly, the rate at which cost changes are passed through to prices (along with an estimate of the magnitude of cost reductions that would result from merger) matters to the evaluation of the likely competitive effects of an acquisition.

In this paper, we describe our empirical methodology for estimating the cost pass-through rate facing an individual firm, and for distinguishing that rate from the rate at which a firm passes through cost changes common to all firms in an industry. In essence, we regress the price a firm charges on both its costs and the costs of another firm in the industry. Including the second cost variable allows us to estimate the impact of costs on prices while holding constant that part of cost variation due to industry-wide cost shocks.

We apply this methodology to determine the firm-specific pass-through rate for Staples, an office superstore chain, and find that this firm historically passed-through firm-specific cost changes at a rate of 15% (*i.e.* it lowered price on average by 0.15% in response to a 1% decrease

---

[1] The authors are, respectively, Professor of Economics, Princeton University; Partner, Ashenfelter & Ashmore; Director of the Bureau of Economics, Federal Trade Commission; and Economist, Federal Trade Commission. Ashenfelter testified about the results presented in this paper on behalf of the FTC in the Staples/Office Depot merger litigation. The views expressed are not necessarily those of the Federal Trade Commission or any individual Commissioner. The authors are indebted to Charles Thomas.

in marginal cost).[2] This result was relied upon by the court in deciding to enjoin preliminarily the proposed merger of Staples and Office Depot.[3]

Our primary empirical concern is distinguishing the firm-specific pass-through rate from the industry-wide pass-through rate. The firm-specific rate relates a change in the price Staples charges for a product to a change in the marginal cost of that product, holding constant the marginal cost of rival sellers of office supplies. The industry-wide rate relates a change in Staples' price to a change in its marginal cost, given that the identical marginal cost change is experienced by firms competing with Staples. This distinction is important in merger analysis, because merger-specific efficiencies[4] typically lead to firm-specific cost savings.[5]

The existing empirical literature on pass-through rates does not make the distinction between the effects of firm-level and industry-wide shocks on price. The exchange rate pass-through literature examines the response of local currency import prices to variation in the

---

[2] We follow the convention in the literature of expressing pass-through rates in percentage terms, regardless of the functional form in which they are estimated, such as levels (dP/dC) or logs (d lnP/d lnC).

[3] *Federal Trade Commission v. Staples, Inc.*, 970 F. Supp. 1066, 1090 (D.D.C. 1997)(Hogan, J.). Judge Hogan did not accept the claim of the merging firms that two-thirds of cost reductions were historically passed-through to consumers.

[4] In evaluating the competitive effect of mergers, the federal antitrust enforcement agencies consider only those efficiencies likely to be accomplished with the proposed merger and unlikely to be accomplished otherwise. These are termed merger-specific efficiencies. See generally Department of Justice and Federal Trade Commission, Horizontal Merger Guidelines §4 (1997).

[5] We do not consider here whether the merger, by lessening competition, would alter the firm-specific pass-through rate. However, the FTC staff, in an analysis not presented in court, found that the estimated firm-specific pass-through rate did not vary much with the number and identity of the superstore competition facing Staples' stores.

exchange rate between exporting and importing countries.[6] A shock to an exchange rate could be industry-wide if all sellers are located in the exporting country, firm-specific if there is only one seller in the exporting country but other sellers located elsewhere, or somewhere in between industry-wide and firm-specific if there are multiple suppliers both in the exporting country and outside.[7] In general, however, this literature appears to interpret estimated pass-through rates under the assumption that exchange rate variation is generally close to industry-wide.[8] The tax pass-through literature, which examines the impact of excise tax changes on prices, is also concerned with an industry-wide pass-through question.[9]

II. Economics of Cost Pass-Through

Our formal analysis of the economics of cost pass-through begins with a partial equilibrium model of the determination of the price and quantity for an individual firm, which, in anticipation of the empirical work, we term Staples. We adopt the following notation, and represent vectors in bold.

---

[6] Surveys of this literature appear in Goldberg & Knetter (1997) and Menon (1996).

[7] Another possibility is that an exchange rate shock differentially affects export suppliers within an industry because suppliers use imported inputs in varying degrees.

[8] Estimated United States pass-through rates of 60% to 70% (typically based on estimating log-linear pricing equations) appear to be the most common.

[9] Contributions include Barzel (1976), Johnson (1978), Sumner (1981), Sumner & Ward (1981), Sullivan (1985), Harris (1987) and Sung, Hu & Keeler (1994). The majority of these studies report pass-through rates slightly in excess of 100% (usually based on estimating linear pricing equations). Much of the tax pass-through literature is concerned with the significance for estimated pass-through rates of unobservable variation in product quality, an issue not important in our application.

P^S = Staples' price

Q^i = quantity for firm i

X = exogenous variables affecting demand

C = industry-wide components of marginal cost

$\mathbf{C}^i$ = firm-specific components of marginal cost, for all firms i

K^i / $C + C^i$ = marginal cost for firm i

The inverse demand function facing Staples is specified as equation (1).

(1) $P^S = P(Q^S, \mathbf{Q}^i, \mathbf{X})$, for i … S

Equation (2) sets forth the best-response function for each rival firm i. We allow for the possibility of different reactions to variation in the firm-specific and industry-wide components of marginal cost, and treat the cost components as independent of output.

(2) $Q^i = Q^i(\mathbf{Q}^j, \mathbf{X}, C, C^i)$, for i … S, j … i

The system of equations (2) is solved for the set of reduced form best-response functions (3).

(3) $Q^i = Q^i(Q^S, \mathbf{X}, C, C^i, \mathbf{C}^j)$, for i … S; j … i, S

The inverse residual demand function (4) facing Staples is derived by substituting the functions (3) into the inverse demand function (1).[10]

(4) $P^S = R(Q^S, \mathbf{X}, C, \mathbf{C}^i)$, for i … S

Staples' choice of its decision variable (output) is defined by the joint solution of equation (4), the residual demand function, and equation (5), the first order condition equating the firm's marginal revenue and marginal cost. In the notation, R_i represents the derivative of R

[10] The residual demand function faced by Staples, equation (4), is not necessarily the residual demand function that would be estimated by an outside observer. See Baker & Bresnahan (1988).

with respect to its ith argument and R_{ij} represents the derivative of R_i with respect to its jth argument.[11] We assume that $R_1 < 0$ and $R_{11} \$ 0$.

(5) $Q^S R_1 + R = K^S$

Our later empirical work focuses on the way changes in the components of marginal cost affect equilibrium price and quantity. Accordingly, we rewrite the first order condition (5) as follows:

(6) $Q^S R_1 + R = C + C^S$

We derive the rate at which Staples passes-through firm-specific and industry-wide cost shocks by differentiating equations (4) and (6) with respect to P^S, Q^S, C, and C^S.[12]

(7) $dP^S = R_1 dQ^S + R_3 dC$

(8) $[2R_1 + Q^S R_{11}]dQ^S + [Q^S R_{13} + R_3] dC = dC + dC^S$

We solve the system (7) and (8) for firm-specific and industry-wide pass-through rates, which are set forth in equations (9) and (10), respectively.

(9) $dP^S/dC^S = 1/(2 + f)$, where $f = Q^S R_{11}/R_1 \# 0$

(10) $dP^S/dC = [dP^S/dC^S][1 + R_3(1+f) - Q^S R_{13}]$

The expression f is interpreted as the elasticity of the *slope* of residual demand.[13]

We first interpret equation (9), the expression for the firm-specific pass-through rate (dP^S/dC^S). This rate reflects how Staples changes price in response to a cost change not

---

[11] The transformation of equation (5) into the following equivalent form demonstrates that the first order condition can be interpreted as equating the Lerner Index of markup over marginal cost with the absolute value of the elasticity of inverse residual demand: $(P^S - K^S)/P^S = -Q^S R_1/R$.

[12] We do not differentiate with respect to C^i (for i … S) because we are not concerned with the firm's price response to cost shocks specific to rival firms.

[13] More precisely, 1/f is the elasticity of the slope of inverse residual demand.

experienced by any rival. The second order condition guarantees that the firm-specific pass-through rate is non-negative.[14] Thus, Staples will raise price when its firm-individuated costs rise and lower price when its firm-individuated costs decline.

The shape of the demand curve affects the pass-through rate. If the firm's residual demand is linear ($R_{11} = f = 0$), then the firm-specific pass-through rate equals ½. Such a firm is a monopolist of its residual demand function, and a monopolist facing linear demand and constant marginal cost passes through half of any cost increase to consumers. The firm-specific pass- through rate varies from the benchmark of ½ with the curvature of the residual demand function, as is evident from the presence in equation (9) of a parameter (f) related to the second derivative of demand. This occurs because the curvature is related to the way the demand elasticity changes with price.[15] Firms exercising market power have an incentive to take advantage of more inelastic industry demand by raising price. If residual demand grows elastic when price rises less rapidly than it would were residual demand linear, then the firm may respond to a small cost increase by raising price by more than half the cost increase.

The pass-through rate also may vary with the extent of competition. In the limiting case

---

[14] The second order condition guaranteeing that the solution to equation (6) maximizes profits requires that $2R_1 + Q^S R_{11} < 0$. This implies that $(2 + f) > 0$, essentially restricting the slope of the residual demand function not to grow more horizontal too rapidly as output increases.

[15] Bulow & Pfleiderer (1983) and Stiglitz (1988) show that a monopolist facing a linear demand curve will pass through 50% of cost changes while pass through rates can be higher or lower depending on the shape of the demand curve. The relationship between the pass-through rate and the elasticity of the slope of demand has been highlighted by Bishop (1968), Seade (1985) and Goldberg & Knetter (1997). The theoretical literature on pass-through rates also considers an issue we do not treat: the relationship between the pass-through rate and the slope of marginal cost. *E.g.* Bishop (1968); Stiglitz (1988); and Goldberg & Knetter (1997).

of perfect competition, under which the residual demand function Staples faces becomes horizontal (R_1 6 0), the firm-specific pass-through rate goes to zero.[16] This result is derived by totally differentiating equation (4) under the assumption that residual demand does not vary with firm output, yielding:

(7') $dP^S = R_3\, dC$

In this limiting case, price varies only with industry-wide shocks to marginal cost, not with variation in firm-specific costs.[17]

The industry-wide pass-through rate (dP^S/dC) defines the way Staples alters its price in response to a cost increase common to it and its rivals (such as the incidence of an industry-wide tax). In general, we expect this rate to be positive, and indeed to exceed the firm-specific pass through rate, on the view that the industry's response to a common cost shock is likely to be more like that of a monopolist than a competitor.[18] Under the technical assumptions of the model, the industry-wide pass through rate will be positive if $1 + R_3(1+f) - Q^S R_{13} > 0$, and the industry rate will exceed the firm-specific rate if $1 + R_3(1+f) - Q^S R_{13} > 1$. These conditions will be satisfied in one benchmark case: when the Staples residual demand function is approximately linear ($R_{11} = R_{13} = 0$) and an industry cost increase raises the residual demand

---

16 This result is illustrated in Yde & Vita (1996).

17 We cannot infer the slope of residual demand or the extent of competition from an estimate of the firm-specific pass-through rate, however. As equation (9) makes clear, the firm-specific pass-through rate in general also depends upon the curvature of residual demand. See also Bulow & Pfleiderer (1983).

18 The FTC's principal economic expert in the *Staples* litigation, Dr. Frederick Warren-Boulton, took this view. He based his conclusion in part on a theoretical model he developed in which Cournot oligopolists passed through a greater fraction of industry-wide cost shocks than firm-specific cost shocks.

function facing Staples ($R_3 > 0$).[19] More generally, without restricting the curvature of the residual demand function, the conditions for the industry pass-through rate to be positive and in excess of the corresponding firm-specific pass-through rate are most likely to hold when the main effect of an industry-wide cost rise is non-strategic (reducing industry supply without markedly altering the way firms interact). If so, then it is plausible that an industry cost shock would lead the residual demand function facing Staples to rise ($R_3 > 0$) without altering its slope (R_{13} small).[20]

III. Estimating Cost Pass-Through

As is evident from their derivation, the pass-through rates dP^S/dC^S and dP^S/dC are derivatives of the reduced form price equation (11), which we seek to estimate.

(11) $P^S = f(C^S, \mathbf{X}, C, C^i)$, for i … S

We specify a functional form (12) linear in logarithms (using lower case values of the variables to reflect logs).[21] In order to highlight the econometric issues, we suppress the vector of exogenous demand shift variables **X**. The error term e is assumed to be independently and

---

[19] This assumption is consistent with the experience of the brewing industry: Baker & Bresnahan (1988) found empirically that common cost increases raised the residual demand facing three brewers. Note that R_3 mixes structural parameters of demand with conduct terms, as is evident from the following relationship derived from equations (1) and (2):
$R_3 = 3_{i \ldots s}\, dP^S/dQ^i \;\, dQ^i/dK^i$.

[20] This interpretation also presumes restrictions on the elasticity of the slope of residual demand such that (1+f) > 0.

[21] We might prefer a functional form that is second-order flexible, such as a translog model, given the importance of the curvature of the demand function to the pass-through rate. But in our application, we have insufficient data to estimate with precision many more parameters of the demand function, so do not use such a functional form here.

identically distributed and uncorrelated with the regressors.

(12) $p^S = ß_0 + ß_1 c^S + ß_2 c +$ $\mathbf{?^i c^i}$ $+ e$, for $i \ldots S$

We also assume that the industry-wide and firm-specific marginal cost components are independent, and that the firm-specific components are uncorrelated across firms:[22]

(13) $cov(c^i, c) = cov(c^i, c^j) = 0$, for $i \ldots j$

We do not observe the cost components; instead we observe measures of marginal cost by firm, k^S and k^D. We treat the components as additive in logs:

(14) $k^i = c + c^i$, where $i = S, D$

Although the assumption that the cost components are additive in levels is equally plausible, equation (14) may nevertheless be a reasonable local approximation.

Our primary goal is to estimate $ß_1$, the pass through rate for Staples-specific cost shocks.[23] With the model expressed in logs, this parameter would have an elasticity interpretation: a 1 percent increase (reduction) in Staples-specific costs will be associated with a $ß_1$ percent increase (reduction) in Staples' price. We will sometimes refer to $ß_1$ alternatively as the price elasticity with respect to Staples' costs.

Our strategy for estimating $ß_1$ is to extract the Staples-specific cost component from k^S, by including in the equation costs for a rival firm (k^D), Office Depot, as a measure of the industry-wide cost component. This strategy exploits the assumed independence of firm-specific

---

[22] These assumptions are plausible for office supply retailing, our application. For example, if the cost of plastic for pens increased, the wholesale costs of pens might rise for all firms independent of firm-specific components such as the negotiating skills of individual managers in bargaining with suppliers.

[23] One advantage of our procedure is that we can recover the parameter $ß_1$ without independently estimating the multiple demand and conduct parameters of which it is composed.

and industry-wide cost shocks. Accordingly, we rewrite equation (12) using equation (14):

(15) $p^S = ß_0 + ß_1 k^S + (ß_2 - ß_1) k^D + (ß_1 - ß_2 + ?^D) c^D + \mathbf{?^i c^i} + e, \quad i… S,D$

Equation (15) explains Staples' price in terms of two observable variables, Staples' and Office Depot's marginal costs, and several unobservable variables, the Office Depot-specific cost component and other firm-specific cost components. The main econometric issue we treat is whether and to what extent the omission of the unobservable variable for Office Depot-specific costs (c^D) would bias coefficient estimates.[24] As will be seen, it is straightforward to estimate $ß_1$ consistently in a regression model involving only observable right hand variables.

The models we estimate are specified in equations (16) and (17).[25]

(16) $p^S = a_0 + a_1 k^S + ?$

(17) $p^S = b_0 + b_1 k^S + b_2 k^D + ?$

Equation (16) relates Staples' price to Staples' costs but not to two variables present in (15): Office Depot's costs and the unobservable component of Office Depot's costs. This is not our preferred model for identifying the pass-through rate on firm-specific cost shocks because the coefficient on k^S in (16) will be a biased estimator of the true coefficient in (15). The bias arises because k^S is correlated with the industry-wide component of the omitted variable k^D (though not with the firm-specific component), as indicated in equation (18). The notation E represents

---

[24] Because the other unobservable firm-specific cost-components are uncorrelated with the observable variables, their omission does not bias regression coefficient estimates.

[25] Equations (16) and (17) implicitly recognize that office superstores adjust prices in response to cost shocks rapidly. In other industries, firms may have reasons to smooth their responses to cost shocks. For example, price adjustments may be costly and the firms may believe that most cost shocks are temporary. Under such circumstances, we might have considered estimating the model on lower frequency data (*e.g.* quarterly rather than monthly) or incorporating lagged costs in the estimating equations.

the expectations operator.

(18) $E\ a_1 = ß_1 + (ß_2 - ß_1)[cov(k^S, k^D)/var(k^S)] + (ß_1 - ß_2 + ?^D)[cov(k^S, c^D)/var(k^S)]$

$+ 3\ ?^i [cov(k^S,c^i)/var(k^S)]$ for i … S,D

$= ß_1 + (ß_2 - ß_1)?^S$, where $?^S = var(c)/[var(c) + var(c^S)]$ 0 $[0,1]$

$= (1-?^S)\ ß_1 + ?^S\ ß_2$

The expected value of the parameter a_1 is a weighted average of $ß_1$ and $ß_2$, with more weight placed on $ß_2$ as more of the variation in Staples' costs comes from the industry-wide component (*i.e.* as $?^S$ rises). Accordingly, if the industry-wide cost pass-through rate exceeds the firm-specific rate (*i.e.* if $ß_2 > ß_1$), as is plausible, then a_1 will be biased upward as an estimator of the firm-specific rate (*i.e.* then $E\ a_1$ \$ $ß_1$). In discussing our results below, we refer to a_1 as an overall average estimate of the effect of changes in Staples' costs on Staples' prices (that is, averaging the effects of firm-specific and industry-wide cost shocks on price).

We instead use equation (17) to estimate the Staples-specific cost pass-through rate because the coefficient on k^S in equation (17) is an unbiased estimator of the true coefficient in equation (15):

(19) $E\ b_1 = ß_1$.

The omitted variables c^D and c^i do not introduce bias here because they are uncorrelated with k^S; this is implied by equations (13) and (14).[26]

The coefficients in equation (17) also generate a biased estimate of the industry pass-through rate, $ß_2$. In particular:

---

[26] Although measurement error in one independent variable can bias the regression coefficients on other independent variables, that does not occur here because we have assumed that the error in measuring industry-wide costs is uncorrelated with Staples' costs.

(20) E b_2 = $(ß_2 - ß_1)?^D + ?^D (1 - ?^D)$, where $?^D$ = var(c)/[var (c) + var(c^D)]0 [0,1].

The parameter $?^D$ reflects the effect on Staples' price of a change in the firm-specific component of *Office Depot*'s costs. To the extent this is small, as may be plausible, equation (20) implies that b_2 is a downward-biased estimator of the difference between the rate at which Staples passes through industry-wide and firm-specific cost shocks, and thus that the sum of b_1 and b_2 is a downward-biased estimator of the industry pass through rate, $ß_2$.[27] However, it is evident from equation (20) that regardless of the magnitude of $?^D$, the expected value of b_2 approaches the expression $(ß_2 - ß_1)$ in the limit as most of the variation in Office Depot's costs comes from the industry-wide component. Under such circumstances, the sum of b_1 and b_2 converges to an unbiased estimator of the pass through rate for industry-wide cost shocks, $ß_2$.

The latter case — in which most of the variation in firm costs comes from the industry-wide component, so our estimator of the pass-through rate for industry-wide cost shocks is unbiased — will be important in our empirical work. We can identify this situation using the simple correlation between k^S and k^D, derived from equations (13) and (14), which we denote ?:

(24) ? = $[cov(k^S, k^D)/var(k^S)]^{½} [cov(k^S, k^D)/var(k^D)]^{½} = [?^S?^D]^{1/2}$

Because the variance ratios are bounded ($?^i$ 0 [0,1] for i = S,D), the square of the correlation ? provides a lower bound estimator for the variance ratio $?^D$. Thus, if ? is near one, it is reasonable to report the sum of b_1 and b_2 as an estimator of the pass through rate for industry-wide cost shocks.

---

[27] If $?^D$. 0, the downward bias has an errors in variables interpretation: it arises because equation (17) omits the unobservable variable c^D which appears in equation (15), and thus because Office Depot costs are a noisy proxy for industry-wide costs.

IV. Data

The data used to estimate price equations (16) and (17) comes from two samples, one provided by Staples and one by Office Depot, of average monthly price and variable cost data on products sold during the years 1995 and 1996. From these two samples we matched 30 identical products that were sold in both Staples and Office Depot stores during 1995 and 1996 and for which we had cost data from both companies. These monthly data cover almost all (approximately 500) Staples stores and are at the stock-keeping unit (SKU)[28] level. The 30 SKUs comprised: 17 pens, 7 paper items, 5 toner cartridges, and 1 computer diskette.[29] These items are largely what Staples terms "price-sensitive" SKUs.[30]

We include store, SKU, and time fixed effect dummy variables in our regressions in order to control for price variation due to differences across stores, products, and months. Equations (16) and (17) are rewritten below to reflect these additional variables and the level of the data used in the analysis. For store *j*, SKU *l*, at time *t*, the reduced form price equations estimated are

(16') $p^S_{jlt} = a_o + a_1 k^S_{jlt} + \mathbf{X}_{jt}\mathbf{a}_2 + \mu_{1j} + \mu_{2l} + \mu_{3t} + ?_{jlt}$

(17') $p^S_{jlt} = b_o + b_1 k^S_{jlt} + b_2 k^D_{lt} + \mathbf{X}_{jt}\mathbf{b}_3 + \mu_{1j} + \mu_{2l} + \mu_{3t} + ?_{jlt}$.

---

[28] Stock-keeping units are the finely specified product definitions chosen by a firm for internal inventory management uses. For example, a firm might use different stock keeping units for red ink and blue ink models of a particular brand and style of pens, and different SKUs for the medium and fine-point models.

[29] We also estimated our model on a second sample of SKUs matched by the defendants' expert. (The defendants' expert had gone through a similar exercise, for another purpose, of matching those Staples and Office Depot SKUs for which cost data were available.) The pass-through rate estimates based on our sample and the defendants' sample were nearly identical.

[30] In general, price sensitive items are highly visible items that are comparison-shopped and frequently purchased.

The variables included are log Staples price (p^S_{jlt}), log Staples cost (k^S_{jlt}) and log average Office Depot cost (k^D_{lt}) (for corresponding SKU in the same month averaged over all Office Depot stores), fixed effect dummies for store (μ_{1j}), SKU (μ_{2l}), and time (μ_{3t}), and in some models, competitor variables ($\boldsymbol{X}_{jt}$). The competitor variables control for the number of Staples, Office Depot, OfficeMax, Wal-Mart, Sam's Club, Computer City, Best Buy, Office 1 Superstore, Costco, BJ's, CompUSA, Kmart, and Target stores in the metropolitan statistical area (MSA). The cost variables were accounting estimates of average variable cost (essentially, cost of goods sold) supplied by the merging firms; we treat these as estimates of marginal cost. We cannot present descriptive statistics, such as the mean and standard deviation of the variables in our sample, as they are not in the public domain. The regression results are discussed below.

V. Empirical Results

Table 1 presents estimates of the impact of changes in costs on Staples' prices.[31] Models 1 and 2 correspond to estimates of equations (16') and (17'), respectively, but without the competitor variables. Model 1 does not separate firm-specific from industry-wide cost changes. The coefficient of 0.571 on log Staples Cost is an estimate of a_1, the price elasticity with respect to weighted average marginal cost, in equation (16'). Thus, for a 10% decrease in Staples' costs,

---

[31] We are unable to report additional coefficients or regression diagnostics, as this information was not made public during litigation. We did not formally examine the statistical properties of the error terms, though nothing in our results suggested that they had troublesome properties.

Model 1 estimates a 5.7% decrease in Staples' prices; the combined firm-specific and industry wide pass-through rate is 57%.[32]

Model 2 separates Staples' firm-specific cost changes from industry-wide cost changes by including log Office Depot cost as an explanatory variable for Staples' prices. The coefficient of 0.149 on log Staples cost in Model 2 is an estimate of b_1 , the price elasticity with respect to firm-specific costs, and measures the impact of Staples' firm-specific cost changes on Staples' prices. It implies that if Staples-specific costs fall 10%, Staples lowers prices on average by roughly 1.5%; the firm-specific pass-through rate is about 15%.

The coefficient of 0.149 on log Staples cost in Model 2 is much lower than the coefficient of 0.571 on log Staples cost in model 1, thus demonstrating that the bias in estimating firm-specific pass-through without controlling for industry-wide cost changes can be large.

Models 3 and 4, also presented in Table 1, are identical to Models 1 and 2 except for the addition of variables to control for the number of competitors in the MSA. Including competitor variables made only a trivial difference to the estimated coefficients on the cost variables. The overall pass-through and firm-specific pass-through remain 0.571 and 0.149, respectively, and stay highly significant statistically.

Models 2 and 4 also permit us to estimate the pass through rate on industry-wide cost shocks. Because the Staples and Office Depot cost variables were highly correlated in our data (? close to one), we treat the sum of the coefficients on the log Staples cost and log Office Depot cost variables as a reasonable estimator of the industry-wide pass-through rate. In both models,

[32] This estimate is close to the two-thirds suggested by the merging firms' expert in the *Staples* litigation.

the point estimate is close to 0.85, implying an 85% pass-through rate for industry-wide cost shifts.

At the preliminary injunction hearing, the merging firms argued that our empirical estimates were not a good guide for policy-making because our data were limited. They emphasized that the 30 SKUs used in the analysis were not a random sample and that we did not test whether they were representative of all of the products sold at Staples. For example, they noted that 17 of the 30 SKUs were pens, while pens make up only 2.3% of Staples' sales; that 27 of the 30 SKUs were price-sensitive items; and that excluding variants in style and color, which are likely to have a similar shelf price, there were only 20 SKUs in the sample. The defendants also pointed out that the time period covered by our study was limited to the years 1995 and 1996. In response, we pointed out three empirical reasons to trust our results. First, when we estimated our models on a second sample of matched SKUs put together by the merging firms' expert for a different purpose, we found the pass-through rates to be nearly identical to those estimated from our sample. Second, when we simulated the impact of the merger based on the models from equations (16') and (17') on this sample of 30 largely price-sensitive items we found a predicted price increase of 16-18% from the merger, as presented in Table 1. This predicted price increase is close to the 19-20% price increase derived independently of the cost pass-through study with a model estimated on a far broader, and more representative, sample of price-sensitive items.[33] Finally, we found no significant difference in the pass-through rate when we estimated the model separately on cost increases and cost decreases.

---

[33] The results of the pricing study are summarized in Appendix Table A1.

Table 1
Estimates of the Impact of Log Costs on Log Staples Prices

	Model 1	Model 2	Model 3	Model 4
Log Staples Cost	0.571 (194.20)	0.149 (37.62)	0.571 (195.15)	0.149 (37.65)
Log Office Depot Cost	-	0.696 (150.25)	-	0.697 (151.22)
Competitor Variables Included?	No	No	Yes	Yes
Simulated Impact on Staples Prices of Merging Staples and Office Depot	Not Applicable	Not Applicable	16.4%	16.6%
Simulated Impact on Staples Prices of Merging Staples, Office Depot, and OfficeMax	Not Applicable	Not Applicable	17.0%	17.6%

Notes: Based on models in which the log of Staples' price for each of 30 SKUs is regressed on fixed effects for store, month, and SKU, and on the variables indicated in the Table. Cost variables are entered as natural logarithms. Numbers in parentheses are t-statistics.

Appendix

Table A1
Simulated Impact of Two Hypothetical Mergers on Staples' Price
for Price Sensitive Office Products

Simulation:	Percent Impact on Prices	t-Statistic	Number of Observations in Simulation
Merge Staples and Office Depot in Markets with Office Depot Competition	18.7%	16.81	3,038
Merge Staples, Office Depot, and OfficeMax in Markets with Office Depot and OfficeMax Competition	19.7%	13.69	1,960

Notes: Simulations based on a model in which Staples' prices for price sensitive items are regressed on fixed effects for the store, fixed effects for the month, and variables which control for the number of Staples, Office Depot, OfficeMax, Wal-Mart, Sam's Club, Computer City, Best Buy, Office 1 Superstore, Costco, BJ's, CompUSA, Kmart, and Target stores in the MSA.

References

Baker Jonathan B. and Timothy Bresnahan, "Estimating the Residual Demand Curve Facing a Single Firm," *International Journal of Industrial Organization*, September 1988, 6(3), pp. 283-300.

Barzel, Yoram., "An Alternative Approach to the Analysis of Taxation," *Journal of Political Economy*, 1976, 84(6), pp. 1177-1197.

Bishop, Robert L., "The Effects of Specific and Ad Valorem Taxes," *Quarterly Journal of Economics*, 1968, 82, pp.198-218.

Bulow, Jeremy I. and Paul Pfleiderer, "A Note on the Effect of Cost Changes on Prices," *Journal of Political Economy*, 1983, 91(1), pp. 182-185.

Federal Trade Commission v. Staples, Inc., 970 F. Supp. 1066 (D.D.C. June 30, 1997) (Hogan, J.).

Goldberg, Pinelopi Koujianou and Michael M. Knetter, "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature*, September 1997, XXXV, pp. 1243-1272.

Harris, Jeffrey E., "The 1983 Increase in the Federal Cigarette Excise Tax," Reprinted from Tax Policy & the Economy, 1987, 1, edited by L.H. Summers, Cambridge, MA: M.I.T. Press.

Johnson, Terry R., "Additional Evidence on the Effect of Alternative Taxes on Cigarette Prices," *Journal of Political Economy*, December 1978, 86(2), pp. 325-328.

Menon, Jayant., "Exchange Rate Pass-Through," *Journal of Economic Surveys*, June 1995, 9(2), pp. 197-231.

Seade J., "Profitable Cost Increases and the Shifting of Taxation: Equilibrium Responses to Markets in Oligopoly," Warwick Economic Research Papers Number 260, April 1985, University of Warwick Coventry.

Stiglitz, Joseph E., "Who Really Pays the Tax: Tax Incidence," in Economics of the Public Sector, Chapter 17, 1988. New York, NY: W.W. Norton & Company, pp.411-436.

Sumner Daniel A., "Measurement of Monopoly Behavior: An Application to the Cigarette Industry," *Journal of Political Economy*, October 1981, 89(5), pp. 1010-1019.

Sullivan, Daniel, “Testing Hypotheses about Firm Behavior in the Cigarette Industry,” *Journal* *of Political Economy*, 1985, 93(3), pp. 586-598.

Sumner, Michael T. and Robert Ward, "Tax Changes and Cigarette Prices," *Journal of Political Economy*, 1981, 89(6), pp. 1261-1265.

Sung, Hai-Yen, The-Wei Hu, and Theodore E. Keeler, "Cigarette Taxation and Demand: An Empirical Model," *Contemporary Economic Policy*, July 1994, Vol. 12, pp. 91-100.

United States Department of Justice and Federal Trade Commission, Horizontal Merger Guidelines, Section 4, Revised 1997.

Yde, Paul L. and Michael G. Vita, "Merger Efficiencies: Reconsidering the 'Passing-On' Requirement," *Antitrust Law Journal*, 1996, 64, pp. 735-747.