Int. J. of the Economics of Business,
Vol. 13, No. 2, July 2006, pp. 217–228

An Econometric-Driven Merger Simulation: Considerations and Application

T. RANDOLPH BEARD, GEORGE S. FORD and RICHARD P. SABA

ABSTRACT *In this paper, we offer a hybrid approach to merger simulation in which we allow rather extensive pre-testing to suggest the 'correct', or most desirable, form for the underlying demand curves. Our application is the merger between the large mobile telephone companies Cingular and AT&T Wireless in 2004. While a somewhat novel approach, our findings are not radical in any way, so the econometric determination of demand forms does not appear to produce novel conclusion per se. That said, allowing the data to inform the researcher about the appropriate form of demand seems a worthwhile effort for merger simulations, data permitting.*

Key Words: Merger simulation; Demand models; Telecommunications.

JEL Classifications: D40, L10, L66.

1. Introduction

Much research in merger simulation analysis has been aimed at introducing, and rendering tractable, increasingly complex theoretical oligopoly models which allow for greater flexibility in calibration, particularly with regard to cross elasticities of demand. This trend is understandable, since it is now widely recognized that the predictions, if one might call them that, of merger simulation are usually extremely sensitive to the assumed forms of the underlying market demand curves (see Peters, 2001, for example, for some actual evidence from the airline industry, in addition to some rather heartening findings with respect to other assumptions). Models such as those based on logit-type product demands do impose sets of often difficult to evaluate restrictions on elasticities.

In this paper we offer a type of hybrid approach, in which we allow rather extensive pre-testing to suggest the 'correct', or most desirable, form for the

T. Randolph Beard, Department of Economics, Auburn University, Alabama 36849, USA; tel: 334-844-2918; e-mail: rbeard@auburn.business.edu. George S. Ford, corresponding author, Chief Economist, Phoenix Center for Advanced Legal & Economic Public Policy Studies, Washington, DC 20015, USA; e-mail: george.ford@phoenix-center.org. Richard P. Saba, Department of Economics, Auburn University, Alabama 36849, USA; tel: 334-844-2922; e-mail: sabaric@auburn.edu

1357-1516 Print/1466-1829 Online/06/020217–12

DOI: 10.1080/13571510600784466

underlying demand curves, and then use these results to calculate elasticity inputs for a relatively conventional Bertrand differentiated products oligopoly merger simulation. Following to some extent the spirit of the Daubert discipline suggested for such simulations by Werden *et al.* (2004), we find that our results generally appear to conform to independent estimates of current quantities, such as incremental costs, in a manner suggesting that the simulation is not obviously invalid. Interestingly, the econometric testing used here suggests a relatively simple form for the demand elasticities (i.e., that they depend on own-prices only), so the resulting simulations are mathematically simple. So long as one accepts that the results of such an analysis should be taken, not as some sort of prediction of the total effects of the proposed merger, but rather as estimates of the size of the unilateral (price internalization or 'cannibalization') effects, then our approach may be useful in those cases in which data availability allows for reasonable econometric implementation.

Our basic approach exploits a small panel of price and sales data to estimate a set of demand curves, one for each firm, using market shares as the dependent variable, a restriction that is necessitated by the industry under study, but which implies an invariance property in consumer demands. Candidate demand functions consist of log-log, log-linear, and linear forms, which undergo statistical evaluation. The resulting choice is then used for Bertrand differentiated product merger analysis. Our particular application is the Cingular-AT&T merger.

Our results are not inconsistent with other findings in similar studies; generally, the price effects of mergers, modeled solely as price internalization phenomena, are not terribly large for the industry (even if large for the merging firms). If one takes the results of simulations as solely estimating these internal effects (rather than total effects), this cannot be taken as a shortcoming. In any event, our findings are not radical, so the econometric determination of demand forms does not appear to produce novel conclusions per se.

2. The Cingular and AT&T Wireless Merger

On 17 February 2004, formal terms were announced for the merger of the second and third largest mobile telecommunications carriers in the United States – Cingular and AT&T-Wireless.[1] The combined market share of the two firms equaled about 40%, which is about ten percentage-points higher than the then largest mobile carrier Verizon Wireless (with about a 30% market share).[2]

There was considerable debate over the consequences of the proposed merger for end-user prices. An expert hired by Cingular and AT&T-Wireless (unsurpringly) argued the merger 'will not harm [but] will strengthen competition by creating a more efficient and effective competitor (Gilbert, 2004: 2–3)'. Alternately, a study by the Consumer Federation of America ('CFA') asserted the merger 'is anticompetitive from every angle' and that '[w]ireless competition will be dramatically reduced by the merger (Cooper, 2004)'. Financial analysts predicted consolidation in the wireless industry would be 'beneficial in terms of reduction of price competition and churn' and would 'slow [ ] the relentless pace of price competition', but also recognized the 'potential for a return to scale in sales, advertising and distribution'.[3] As with any merger, there are fears of market power and hopes of efficiencies, with the overall consumer benefit of the merger requiring an assessment of the merger's potential consequences (Williamson, 1968).[4]

In this paper, we evaluate the Cingular-AT&T Wireless merger by conducting an econometrically-based merger simulation. We consider price effects with and without merger synergies.

The results of the simulation analysis are as follows. First, absent merger efficiencies, the equilibrium prices of the merging firms increase by about 11%. Given the chosen functional form of the demand curves used in the simulation, the prices of the merging parties' rivals do not change, so the predicted industry effects are very conservative. Even so, the industry average price rises 4%. Even with the predicted reductions in cost from the merger, the merging firms' prices rise by no less than 10%. However, using financial data from the wireless industry to produce econometric estimates of merger efficiencies, we actually find that post-merger prices could fall considerably.

In the next section, we describe in detail our merger simulations. First, we present the econometric model used to estimate the demand elasticities. These elasticities play a key role in the merger simulation. Second, we present the results of the merger simulation on wireless prices assuming no change in the marginal cost of the merging firms. Third, we compute the price effects of the merger assuming the merger results in efficiencies. Two measures of merger efficiencies are employed, one based on the estimates of the merging firms and a second based on our own analysis of financial data. Conclusions are provided in the final section.

3. The Merger Simulation

The predicted price responses from merger simulations depend heavily on a number of key assumptions, including the form of competition, the shape of demand and cost curves, and the firm-specific demand elasticities (own- and cross-price) and marginal costs. Any predicted price effects from a merger are conditional on the very specific set of assumptions used for the simulation. Our particular set of assumptions is as follows. First, we adopt a product differentiated price-competition model (i.e., Bertrand). Thus, our focus is solely on unilateral price effects; ignoring the intensity of price competition and the potential for collusion, both of which have been historically the primary concerns of antitrust analysis. Second, the demand curves are semi-log, a decision based on the econometric analysis used to estimate the own- and cross-price elasticities of demand. Third, the own- and cross-price elasticities of demand are based on our own econometric analysis. Fourth, marginal costs are assumed constant and are derived from the relevant markup rules based on first-order conditions for profit maximization, using the demand elasticities from our econometric analysis. Other relevant assumptions and inputs are presented in those sections in which they are used.

Estimates of Demand Elasticities

Our econometric analysis begins with the general model specification

$$g\left(\frac{q_i}{Q}\right) = f\left(\alpha_0 + \alpha_1 p_i + \alpha_2 \sum_{j=1}^{r} \frac{s_i}{s_j} p_j + \alpha_3 POPS + \alpha_4 DTM\right) + \varepsilon_i \quad (1)$$

where Q is total industry quantity (so q/Q is market share), s_i is a quality index for firm i (and j), $POPS$ is a measure of the total population served by firm i's network, *DTM* is dummy variable for the wireless firm T-Mobile, the α are the estimated parameters, and ε is the econometric disturbance.[5] The functions *f* and *g* are suitably selected transformations of the variables. Market share rather than quantity is employed because of the rapid growth of wireless subscription over the sample period.[6] The cross-price effects are weighted by a quality index, thus making the size of the cross-price depend on the relative quality between firm *i* and each of its rivals.[7] Coefficients α_1 and α_2, respectively, are used to compute the own-price and cross-price elasticities of demand. The exact computation for the elasticity will depend on the specific functional form of functions *f* and *g*.[8]

Rather than impose *a priori* a particular functional form on the regression, we select the functional form with the 'best' statistical properties. Candidate transformations considered here include the widely used linear and logarithmic transformations (e.g., lin-lin, log-lin, and log-log). Research shows that the functional form of the demand curve for the simulation is an important determinant of the size of the simulated price effects. We believe that allowing the data to inform us to the most suitable functional form is an improvement over simply assuming a functional form that may have desirable properties for simulation (e.g., the frequently used logit demand functional form which allows simulations to be performed with very little information). Five statistical criteria help select the best functional form. First, we compare the fit of the models using a measure of R-squared that is comparable across alternate specifications of the dependent variable (Studenmund, 1992: 227–9). Second, following Godfrey, *et al.* (1988), we employ RESET. RESET is a general test of specification error and is a powerful test for incorrect functional form (Gujarati, 1995: 464–6.). Third, we test the model for heteroskedasticity using White's Test (Gujarati, 1995: 379–380). Fourth, we use Jarque-Bera test to evaluate the normality of the disturbance term (Gujarati, 1995: 143–4). Finally, we appeal to the Davidson-McKinnon J-Test to evaluate which, if any, of the specific functional forms is most desirable (Gujarati, 1995: 490–3).

Table 1 summarizes the results of the model selection tests. Overall, the tests indicate that the Log-Lin (or semi-log) specification is best. The R-squared values are all high and too similar to indicate a preference for a particular model. Only the Log-Lin functional form passes the RESET test (with a null hypothesis of 'no specification error') at the 10% significance level, so a clear preference for the Log-Lin specification is indicated by RESET. Both the Lin-Lin and Log-Lin models have homoskedastic disturbances, but the Log-Log form is heteroskedastic. All three functional forms render normally distributed disturbances, so all are suitable on normality grounds.[9] The Davidson-MacKinnon J-Test also shows a clear preference for the Log-Lin functional form, since neither of the t-statistics for the augmented regressions is statistically significant for the Log-Lin form. The Log-Lin form is preferred to either the Lin-Lin (probability 0.0185) or Log-Log (probability 0.1033) models. Based on this battery of tests, we believe the Log-Lin or semi-log specification is best and, consequently, we use the results from the semi-log models to compute own- and cross-price elasticities. We also base all calculations in the merger simulation on the semi-log demand curve.

Exhibit 1 summarizes the estimated parameters from the semi-log specification. The model exhibits good statistical significance and overall fit. As mentioned, the disturbance is normal and homoskedastic and the model passes RESET. Given the small sample size (24 observations), we also evaluated statistical significance using a bootstrap procedure (MacKinnon, 2002). Given the large

Table 1. Functional form selection criteria

Model	*Quasi R^2*	*RESET Probability*	*White*	*J-Bera Test*
Lin-Lin	0.880	0.105	0.508	0.922
Log-Lin	**0.888**	**0.235**	**0.140**	**0.825**
Log-Log	0.892	0.050	0.050	0.825

Davidson-McKinnon J-Test (t-stat probability)

Base Model ↓	Lin-Lin	Log-Lin	Log-Log
Lin-Lin	…	0.0185	0.0152
Log-Lin	**0.2596**	**…**	**0.3009**
Log-Log	0.9848	0.1033	…

t-statistics on the price coefficients (both exceeding 4.00 in absolute value), we did not expect the non-parametric approach to render different conclusions on statistical significance and we were correct. The bootstrapped critical values were about 2.2, so both price coefficients are statistically different from zero regardless of the method used. We also bootstrapped the RESET F-statistic, and our conclusions were unchanged.

The own-price and cross-price elasticities are derived from the results of the econometric model summarized in Table 2, with the own-price elasticities of demand being $-0.042p_i$ and the cross-price elasticities being $0.01p_j$ where p_j is the quality-adjusted price for firm j (each firm has five cross-price elasticities, one for each of its five rivals). The firm-specific elasticities are a function of own-price alone, but the overall demand curve is related (in a statistically significant way) to the prices of rivals (the services are substitutes, as expected).

Marginal costs follow from these estimated elasticities, based on the first-order condition:

$$1+\eta_i\left(\frac{p_i-c_i}{p_i}\right)=0. \tag{2}$$

Armed with the prices, market shares, demand elasticities, and marginal costs, we have what is needed for the merger simulation. The semi-log demand

Table 2. Elasticities, prices, and implied marginal costs

	Own-Price Demand Elasticity (η_i)	Pre-Merger Price	Marginal Cost	Price-Cost Margin
Verizon	–1.92	45.19	21.65	0.52
Cingular	–2.09	49.33	25.73	0.48
AT&T Wireless	–2.52	59.37	35.81	0.40
Sprint	–2.57	60.52	36.97	0.40
T-Mobile	–1.82	42.97	19.36	0.55
Nextel	–2.71	63.99	40.37	0.37

specification is passed through to the merger simulation, so the relevant first-order conditions reflect this demand model. The following sections describe additional specifics of the merger simulation.

Simulation of Wireless Prices, No Efficiencies

In our first simulation, AT&T Wireless and Cingular merge, but maintain unique customers bases and separate prices.[10] Incremental costs are assumed to be unchanged following the merger. Because of the semi-log demand specification – where elasticities are a function of prices only, not quantities – the optimal prices of Verizon, Sprint, T-Mobile, and Nextel do not change following the merger. This feature of the simulation makes the industry-wide price increases from the merger very conservative since only the merging firms' prices change (the price change is purely unilateral).

In the simulation, following the merger AT&T Wireless and Cingular take into account the cross-price elasticities of demand between them, so post-merger prices for AT&T Wireless and Cingular solve

$$\max \pi^M = \pi^A + \pi^C \tag{3}$$

where π^M represents profit from wireless/mobile services, π^A is profit from AT&T Wireless and π^C is profit from Cingular wireless. The simulation focuses on the joint profit maximization by Cingular and AT&T Wireless, so the computed price increases from this simulation are from the unilateral exercise of market power.

The equation(s) to solve for post-merger prices are

$$D_i(\cdot)\big(1-(p_i-c_i)(-0.0424)\big)+D_j(\cdot)(p_j-c_j)(0.0098)(s_i/s_j)=0 \tag{4}$$

where D_i $(\cdot)$ = k_i $\exp(Z_i)$ is demand for firm i and k_i is the calibration factor that makes D_i exactly equal the observed pre-merger market share and Z_i is the value of the regression equation with inputs for firm i.[11] These equations are solved simultaneously for the merging firms (using Maple mathematics software).

Table 3 summarizes the pre- and post-merger prices computed using the simulation. The simulated price increases are large, with Cingular's price rising 11.3% and AT&T Wireless' price rising by 15.4% because of the merger. Using calibrated predicted market shares and the post-merger price vector, a price index for wireless service rises from $52.11 to $54.96 (4%) due to the merger induced market share and price changes.[12] Recall that the increase in the wireless industry price index comes solely from the price increases by the merging firms – the prices of the rival firms are unchanged (due to the demand model).

Simulation of Wireless Prices, With Predicted Merger Efficiencies

In the previous simulation, we assumed that marginal costs were unchanged by the merger. By allowing marginal cost to decline for the post-merger firms, we can compute the expected price increase from the merger accounting for merger efficiencies. Based on the testimony filed on behalf of the Cingular and AT&T

Table 3. Simulated price increases

	Pre-Merger Price	Post-Merger Price	% Price Increase
Cingular	$49.33	$54.90	11.3%
AT&T Wireless	$59.37	$68.50	15.4%
Industry Avg.	$52.11	$54.18	4.0%

Wireless, we assume a 1.4% reduction in marginal cost and re-compute the post merger prices.[13] Table 4 summarizes these additional results.

Assuming a 1.4% marginal cost reduction resulting from the merger, the post-merger prices of Cingular and AT&T Wireless still rise by more than 10%. Cingular's price rises by 10.7% and AT&T Wireless' price rises by 14.2%. The wireless industry price index rises by 3.8%.

There is good reason to expect larger efficiencies than those derived from filed testimony. While not mentioned in merger filings, a review of the financial forms of the wireless companies reveals a strong relationship between market share and operating costs. Figure 1 illustrates the average per-line operating cost (AOC) of wireless carriers as a function of market share.[14]

What this financial data tells us about marginal cost is not certain, but there is obviously a sizeable relationship between AOC and firm size, and this relationship may tell us something about marginal cost. Table 5 summarizes the predicted price effects of the merger for various levels of efficiency.

From Table 5, we see that an efficiency gain of about 25% is required for an industry-average price decline. This efficiency effect is sizeable, but may be plausible. Fitting a line to this data, we have:

$$\ln(AOC) = 5.513 - 2.408MS + \varepsilon \quad (5)$$

where ε is a disturbance term. Figure 1 includes an illustration of the estimated regression line. The coefficients of equation (5) are highly statistically significant and the R^2 of the regression is 0.49.[15] Figure 1 also reveals some observations possibly qualifying as outliers, all of which are attributable to Sprint. Including dummy variable accounts for Sprint, the coefficient on market share falls to −1.93, the t-statistics for all coefficients remain highly significant, and the R^2 of the regression increases to 0.90.[16]

The estimates from equation (5) offer an econometric estimate of average cost reductions from the merger (based on the firm's scale), which may proxy to some extent the size of the reduction in marginal cost. From the regression estimates in equation (5), the predicted cost reduction from the merger is 38%.[17] This reduction is, obviously, a sizeable cost reduction, but only about 65% of this reduction in marginal cost leaves prices unchanged. While some may feel the reduction is

Table 4. Simulated unilateral price increases (1.4% marginal cost reduction)

	Pre-Merger Price	Post-Merger Price	% Price Increase
Cingular	$49.33	$54.60	10.7%
AT&T Wireless	$59.37	$67.80	14.2%
Industry Avg.	$52.11	$54.09	3.8%

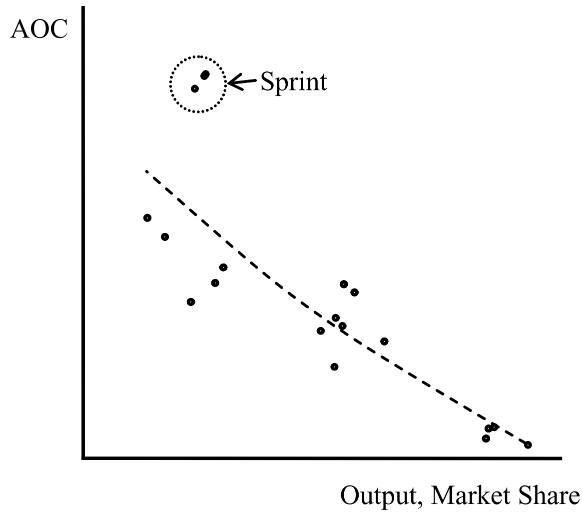

Figure 1. Average operating cost curve.

unrealistic, the predicted savings comes from actual cost data from the industry. From Figure 1, it is difficult to deny that size in terms of market share (or output) is not an important determinant of operating cost in the wireless industry.

Obviously, the size of the assumed merger efficiencies is a key driver of the simulation. Since we use financial data to formulate the demand side of the simulation, it perhaps makes sense to use the same data to construct efficiency estimates. If we do, then the combination of these large wireless carriers leads to price reductions rather than price increases. The reliability of financial cost data as an indicator of marginal cost is debatable, but all that is required is that marginal cost be proportional to operating cost, so the level of cost is unimportant to our procedure. This proportionality requirement is comforting, but only somewhat so.

4. Conclusions

In this paper, we offer a hybrid approach to merger simulation in which we allow rather extensive pre-testing to suggest the 'correct', or most desirable, form for the

Table 5. Simulated unilateral price increases (various marginal cost reductions)

	Marginal Cost Reduction	Price AT&T	Price Cingular	Industry Average
Pre-Merger	…	$49.33	$59.37	$52.11
Case 1	0.0%	$54.92	$68.49	$54.18
Case 2	1.4%	$54.66	$67.81	$54.10
Case 3	5.0%	$53.99	$66.09	$53.89
Case 4	10%	$53.10	$63.74	$53.56
Case 5	20%	$51.36	$59.22	$52.74
Case 6	30%	$49.78	$54.82	$51.72

underlying demand curves. Our approach may be useful in those cases in which data availability allows for reasonable econometric implementation. Our application is the merger between the large mobile telephone companies Cingular and AT&T Wireless merger in 2004. While a somewhat novel approach, our findings are not radical in any way, so the econometric determination of demand forms does not appear to produce novel conclusion *per se*. That said, allowing the data to inform the researcher about the appropriate form of demand seems a worthwhile effort for merger simulations, data permitting.

Notes

1. Hall and Carew (2003).
2. Business Wire (2004). The 2003 market shares of the national wireless carriers (subscribers, revenues) are: Verizon Wireless (29%, 29%), Cingular (21%, 18%), AT&T Wireless (20%, 20%), Sprint (15%, 16%), T-Mobile (10%, 9%), and Nextel (6%, 9%).
3. Katz (2003) and Businessweek Europe (2004).
4. A study by the Phoenix Center for Advanced Legal and Economic Public Policy Studies reported the results from a financial event study and a simple merger simulation (Phoenix Center, 2004).[1] Over the event dates of the Cingular/AT&T merger, the Phoenix Center estimates a 12.6% cumulate stock price *increase* for the non-merging firms. Using the financial data of the non-merging firms and the methodology proposed by Warren-Boulton and Dalkir (2001), this stock price increase translated into a retail price increase of 7.9%.[1] The Phoenix Center's merger simulation was a simple, Cournot-based model of oligopolistic competition. Using industry data and the static equilibrium properties of the Cournot model, the Phoenix Center evaluated its Cournot-competition assumption and found it to be a reasonable proxy for competitive interaction in the industry. The Phoenix Center simulation was also calibrated using existing market shares and an estimate of industry price and the market elasticity of demand. Assuming no cost efficiencies resulting from the merger, the predicted industry price rose by 7.1%, reducing consumer welfare by $5.2 billion annually. With a 15% marginal cost reduction, the merger results in a 5.7% price increase and a consumer surplus loss of $4.2 billion.
5. The individual firm's Form 10-Ks and 10-Qs provide all the quantity and price data. Prices are the annual service revenues divided by end-of-year subscriber lines. This approach to computing price is somewhat problematic for T-Mobile given that its subscriber base is growing rapidly. As an alternate specification, we replaced T-Mobile's price with its reported average revenue per unit (ARPU). The computed elasticities were not much affected (the own-price coefficient increased by about 5% and the cross-price coefficient increased by 2%. Thus, we employ a consistent method for computing price for all firms by using service revenues deflated by lines. Quality data is provided by J.D. Power and Associates (2003). POPS data is provided by Rockhold (2002).
6. The wireless market has grown from 81.7 million accounts in 2000 to 122.4 million in 2003, a growth rate of almost 50%. This rate of growth is very rapid. By using market shares rather than quantities, we render the dependent variable vector stationary and avoid the significant problems of accounting for growth parametrically.
7. J.D. Power and Associates (2003). The scale of the quality index is irrelevant because the ratio is used. For this particular scale, the index has a value of 100 for AT&T. The regression results are not much affected by the inclusion of the quality adjustments, but these adjustments did allow the cross-price effects to vary by price and quality.
8. The own-price demand elasticities for various functional forms are: (a) the Lin-Lin model = $\alpha_2(p_i/q_i)$; (b) the Log-Lin model = $\alpha_2 p_i$; and (c) the Log-Log model α_2.
9. Heteroskedasticity and non-normality do not render biased coefficients, only inefficient standard errors. If statistical testing is important to the analysis, consideration of the problems is warranted.
10. It is more profitable for the firm to have two prices rather than one as long as there are variations in demand across customers. Also, there is some evidence that the merged firm intends to operate in the short term using both brands. See Morphy (2004) ('We have worked out an arrangement with AT&T Wireless (NYSE: AWE - news) and Cingular that is designed for us to fully meet our plans for serving customers with AT&T-branded wireless services …'). Obviously, if we computed a single price for the merged firm it would lie between the individual firm prices. There is discussion of eliminating overlap in the calling plans of the two carriers, but integrating the other plans (Belson and Richtel, 2004).

11. To do the simulation, the market shares of AT&T Wireless and Cingular are calibrated by being multiplied by a constant so that, at initial prices, the 'predicted' market shares of AT&T and Cingular are exactly equal to 0.175 and 0.192, respectively. This calibration does not affect the elasticities (they are as reported in Table 2). While we do not impose an adding up restriction on market shares, the simulated market shares are very close to 1.00 (ranging from 1.02 to 0.99). So, the model is well behaved in this sense. Linear models, alternately, are generally not so well behaved.
12. Industry wide price was calculated by taking the antilog of the fitted values the regression, which are calibrated to sum to one. We then compute a market share weighted average price.
13. Gilbert (2004) at ¶29 ('Cingular estimates that the efficiencies … will generate operating and capital expense savings of more than $1 billion in 2006 and more than $2 billion per year in the following years as a merged entity'). Thus, the merger is expected to reduce total costs by about $1 billion over the next two years (2005, 2006). Horizontal Merger Guidelines, US Department of Justice and the Federal Trade Commission, April 8, 1997 at sec. 3.2. In 2003, the operating can capital expenses of Cingular and AT&T Wireless summed to about $35 billion, suggesting a reduction in overall costs of about 1.4% ($1 billion/$70 billion). Of course, only reductions in marginal costs are relevant to equilibrium prices and we assume here that all components of total costs are affected by the same amount (1.4%). Also see McGaw (2004, ¶¶23–27). According to Ralph de la Vega, Chief Operating Officer of Cingular, the integration of the two carriers will probably take two years, suggesting that merger-related savings will not occur in the short term (Belson and Richtel, 2004).
14. In a static sense, market share is a measure of output, since market share can be converted to quantity by multiplying each share by industry output.
15. The regression includes 22 observations. White's Robust t-statistics for the two estimated coefficients are 55.34 and –5.93, respectively. Given the large size of the t-statistics we do not bootstrap the critical values.
16. White's Robust t-statistics for the three coefficients (adding the dummy for Sprint) are 85.23, –7.26, and 13.50.
17. Including a dummy variable for Sprint reduces the efficiency gain to about 32%.

References

Belson, K. and Richtel, M. (2004) For Cingular, becoming no. 1 also poses risks, *New York Times,* 27 September.

Businessweek Europe (2004) Cellular stocks: this year, tread with care, 1 January.

Business Wire (2004) Turbulent marketplace for telecom marked by shifting market share; Comcast holds largest provider share of customers spending, *Business Wire,* 21 April.

Cooper, M. (2004) Remonopolizing Local Telephone Markets: Is Wireless Next? Consumer Federation of America (July): http://www.consumerfed.org/localwireless.pdf.

Gilbert, R. J. (2004) Affidavit filed to the Federal Communications Commission on behalf of Cingular and AT&T Wireless, WT Docket No. 04–70, 18 March.

Godfrey, L. G. *et al.* (1988) Variable addition and lagrange multiplier tests for linear and logarithmic regression models, *Review of Economics and Statistics,* 70(3), pp. 492–503.

Gujarati, D. (1995) *Basic Econometrics* (New York: McGraw Hill).

Hall, J. and Carew, S. (2003) Cingular Wins AT&T Wireless for $41 Bln, *Reuters,* 17 February.

J.D. Power and Associates (2003) *Verizon Wireless Ranks Highest in Network Quality Performance,* 29 July.

Katz, R. (2003) Can mergers mend industry woes?, *America's Network,* 1 October.

MacKinnon, J. (2002) Bootstrap inference in econometrics, *Canadian Journal of Economics,* 35(4), pp. 615–45.

McGaw, S. (2004) Affidavit filed to the Federal Communications Commission filed on behalf of Cingular and AT&T Wireless, WT Docket No. 04–70, 18 March.

Morphy, E. (2004) Cingular, AT&T and AT&T wireless resolve brand issues, NewsFactor Network, 25 August.

Peters, C. T. (2001) Evaluating the performance of merger simulations: evidence from the US airline industry, DOJ Antitrust Division Economic Analysis Group Discussion Paper No. 03–1, January.

Phoenix Center (2004a) Higher prices expected from the Cingular/AT&T wireless merger, Phoenix Center Policy Bulletin No. 11, 26 May: http://www.phoenix-center.org/

Rockhold, J. (2002) 2002 who gets out alive?, *Wireless Review,* 1 December.

Studenmund, A. H. (1992) *Using Econometrics* (New York: HarperCollins).

Warren-Boulton, F. R. and Dalkir, S. (2001) Staples and office depot: an event-probability case study, *Review of Industrial Organization*, 19(4), pp. 469–81.
Werden, G. J. *et al.* (2004) A daubert discipline for merger simulation, *Antitrust Magazine*, 18(3), pp. 89–95.
Werden, J. W. *et al.* (2004) Whither merger simulation?, *The Antitrust Source*, 3(5), pp. 1–15.
Williamson, O. E. (1968) Economies as an antitrust defense: the welfare tradeoffs, *American Economic Review*, 58(5), 1372–76.

Appendix 1.

Table A1. Regression results for wireless demand equation

	Coefficients (Robust t-stat)	Mean [st. dev.]
Constant	–1.258	…
	(–1.54)	
p_i	–0.042	51.44
	(–5.98)	[8.95]
$\Sigma(s_i/s_j)p_{-i}$	0.010	257.11
	(4.84)	[19.77]
POPS	–0.004	228.5
	(–3.37)	[34.74]
DTM	–1.254	0.17
	(–6.26)	[0.38]
MS	…	0.17
		[0.08]
ln(MS)	…	–1.91
		[0.53]
R^2	0.87	
Obs.	24	

Appendix 2.

Table A2. Data used to estimate demand equations

Firm	Year	Service Revenues	Subscribers	POPS	J.D. Power Quality Index
Verizon	2003	20336	37.5	248	104.00
Cingular	2003	14223	24.0	211	101.00
AT&T Wireless	2003	15659	22.0	165	100.00
Sprint	2003	11548	15.9	244	95.00
T-Mobile	2003	6755	13.1	273	94.00
Nextel	2003	9892	12.9	230	103.00
Verizon	2002	17747	32.5	248	104.00
Cingular	2002	13922	21.9	211	101.00
AT&T Wireless	2002	14483	20.9	165	100.00
Sprint	2002	10867	14.8	244	95.00
T-Mobile	2002	4245	8.7	273	94.00
Nextel	2002	8186	10.6	230	103.00
Verizon	2001	16011	29.4	248	104.00
Cingular	2001	13229	21.6	211	101.00
AT&T Wireless	2001	12532	18.0	165	100.00
Sprint	2001	8577	13.6	244	95.00
T-Mobile	2001	2926	5.8	273	94.00
Nextel	2001	6575	8.7	230	103.00
Verizon	2000	13000	26.8	248	104.00
Cingular	2000	10424	19.7	211	101.00
AT&T Wireless	2000	9374	15.1	165	100.00
Sprint	2000	5453	9.5	244	95.00
T-Mobile	2000	1520	3.9	273	94.00
Nextel	2000	4995	6.7	230	103.00

The individual firm's Form 10-Ks and 10-Qs provide all the quantity and price data. Prices are computed as the annual service revenues divided by end-of-year subscriber lines. Quality data is provided by *J.D. Power and Associates Reports: Verizon Wireless Ranks Highest in Network Quality Performance* (July 29, 2003). POPS data is provided by J. Rockhold, *2002 Who Gets Out Alive*? WIRELESS REVIEW (December 1, 2002): http://www.findarticles.com/p/articles/mi_m0GTV/is_23_18/ai_80848046/print. The data is provided in Exhibit 2.