Understanding UPP

Roy J. Epstein and Daniel L. Rubinfeld[*]
Published Version, B.E. Journal of Theoretical Economics:
Policies and Perspectives, Volume 10, Issue 1, 2010

Introduction

The standard economic theory of differentiated products mergers predicts that the post-merger firm faces two general incentives to change prices unilaterally. One incentive is to increase price. This follows because sales that previously would have been lost to the merger partner are now retained by the combined firm. At the same time, the merger may result in efficiencies that reduce marginal costs. Efficiencies create an incentive to reduce prices because the post-merger firm benefits from increased sales at lower prices. An important goal of any empirical merger analysis is to assess the net effect of these off-setting forces to determine whether the merger in fact poses a significant risk of unilateral price increases.

Joseph Farrell and Carl Shapiro have put forward for discussion the concept of Upward Pricing Pressure ("UPP") as a simplified methodology to help address the question of unilateral effects.[1] It is well known that the more consumers view the products sold by the merger partners as good substitutes, the greater the incentive for the post-merger firm to raise prices. UPP uses the standard assumptions of Bertrand competition with differentiated goods to analyze whether on net a merger is likely to result in price increases. This analysis simultaneously takes into account the expected diversion of sales to the non-merger firms as well as the merger-specific efficiencies. For example, given pre-merger margins and an assumed post-merger reduction in marginal costs, the method indicates an upper limit on the diversion ratio that is needed to avoid price increases. Alternatively, given the margins and the diversion ratio, the method indicates the minimum level of efficiencies needed to avoid unilateral price increases.[2]

A "red flag" indicator of a price increase from this analysis can be overcome by a variety of additional information. For example, there may be evidence for likely repositioning or entry, or there may be factual support for a different

---

[*] Roy Epstein is an economic consultant, Cambridge, MA and Adjunct Professor of Finance, Boston College. Daniel Rubinfeld is Robert L. Bridges Professor of Law and Professor of Economics, University of California, Berkeley and Visiting Professor of Law, NYU Law School.

[1] Joseph Farrell and Carl Shapiro, "Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition," *B.E. Journal of Theoretical Economics*, forthcoming.

[2] See their equation (a4).

characterization of the economic model that was used to generate the UPP calculations (e.g., greater efficiencies or different diversion ratios or cross-price elasticities). It may also be possible to show that the underlying Bertrand model of price formation does not apply to the firms in question.

Farrell and Shapiro make a number of important points. First, in mergers involving differentiated products, it is sensible to employ methodologies such as UPP that do not require a market definition. Instead, one can ask directly whether prices are likely to increase. Second, it is valuable to have a workable screening device, which among other things, sets up presumptions for the further analysis of a merger. If the basic UPP diagnostic test or one of its variants suggests higher prices, the burden of defending the merger will shift towards the parties. If the UPP screen does not suggest higher prices, the burden will rest with the competition authority to prove that there is nevertheless a substantial likelihood of higher prices.

Farrell and Shapiro also compare UPP to the analysis of competitive effects that is available through the methodology of merger simulation. They suggest that the UPP methodology is likely to be less demanding in terms of data and demand-specification requirements. However, merger simulation models vary considerably in their requirements and their manageability. We believe, therefore, that Farrell and Shapiro's claim that the UPP approach avoids some of the requirements of at least the more basic forms of merger simulation analysis is overstated.

In particular, Farrell and Shapiro suggest that an "attentive judge" will be more likely to accept the logic of UPP in the event a merger is litigated compared to merger simulation. But since UPP relies on the identical analytical assumptions as conventional merger simulation, we do not see this as a compelling argument. The shortcut offered by UPP is a potential reduction in data requirements, not a change in the underlying economic model.

In this note we show explicitly that UPP in fact is a special case of merger simulation. The main innovation in UPP is framing the analysis in terms of diversion ratios, while merger simulation models are conventionally calibrated using own and cross-price elasticities. But this is often more a matter of form rather than substance because diversion ratios and elasticities measure essentially the same thing. In general, for the basic question of whether a merger will increase prices, UPP and merger simulation will yield the same conclusions when the models are calibrated consistently. It is important to understand this close relationship to assess the relative strengths of the two approaches.

Overview of UPP

To explain UPP as simply as possible, we assume that the proposed merger involves only two products. Prior to the merger, each firm sets a price that maximizes its profits. Consider two scenarios. First, assume a post-merger price increase for product 1, all else equal. This will reduce profits for product 1 (because those profits were already maximized pre-merger), but it will increase profits for product 2 because some sales of product 1 are diverted to product 2. UPP analyzes this effect in terms of a "diversion ratio." The profit-maximizing post-merger price increase for product 1 would be larger, the greater the diversion ratio, which indicates the volume of sales that would be recaptured by product 2.

Second, assume that the merger yields efficiencies that reduce the marginal cost of product 1. This would increase the profit on each unit of product 1, all else equal. The post-merger firm would increase its profits by reducing the price of product 1 in order to generate additional sales. The profit-maximizing post-merger price decrease for product 1 would be larger the greater the number of sales that would be generated.

A merger with efficiencies therefore creates both an incentive to increase price and an incentive to decrease price. The comparative strengths of these effects depend on the underlying profit margins for each product, the diversion of demand from product 1 to product 2, and the magnitude of the efficiencies. In essence, UPP requires these three separate pieces of information. If the price increase effect exceeds the price decrease effect, the merger is said to exhibit UPP and signals a need for further analysis.

The UPP methodology takes the pre-merger structure of demand as a given and assumes that prices in the industry are determined by a Bertrand equilibrium. In particular, the UPP framework does not take allow for possible entry of new competitors when postulating a post-merger price increase. Nor does it allow for possible product repositioning by existing competitors in response to higher post-merger prices. These dynamic factors, which could significantly constrain the pricing decisions of the merged firm, are outside the scope of the formal UPP analysis.

Merger Simulation

Merger simulation has been used for over a decade to address variants of essentially the same question: what level of efficiencies would eliminate unilateral price effects?[3] It is not surprising, therefore, that many of the issues and debates that center on merger simulation apply equally to UPP.[4]

In this section, we show that UPP offers an alternative way to generate approximations to the parameters used in a merger simulation model. We also show that there is a potential bias associated with the UPP approximation, as also acknowledged by Farrell and Shapiro.

---

[3] See, e.g., Epstein and Rubinfeld (2002), p. 903: "PCAIDS can also be used to provide estimates of the efficiencies that would fully offset the predicted price effects."

[4] Farrell and Shapiro offer a brief discussion of the relationship between UPP and merger simulation in Section 5 of their paper.

To see how UPP relates to merger simulation in the presence of efficiencies we consider a merger involving only two products. Like UPP analysis, merger simulation in its most basic form uses three types of information. First is the own price elasticity of demand for product 1, which measures how the quantity demanded for product 1 changes as its price changes.[5] Second is cross-price elasticity of demand, which measures the change in demand for product 2 as a result of the change in the price of product 1.[6] Third is the magnitude of the efficiencies. Merger simulation also assumes that industry prices are determined as a Bertrand equilibrium.

Merger simulation uses this information to estimate post-merger price changes. One standard use of merger simulation is to estimate post-merger prices when there are merger-specific efficiencies. Another use is to determine the level of efficiencies that would be required for the model to yield a prediction of unchanged post-merger prices.

The conclusions from a UPP analysis therefore essentially coincide with merger simulation. A merger that exhibits UPP will also result in a prediction of higher post-merger prices in a merger simulation. A merger that does not exhibit UPP will result in a prediction of unchanged or even lower prices in a merger simulation. What drives the analysis in each case is balancing the potential reduction in competition between the two merging firms against the merger-specific efficiencies that allow each firm to produce at lower cost.

The Role of Customer Switching in UPP and Merger Simulation

The extent of consumer "switching" from one of the goods in the merger to the others in response to a post-merger price increase is fundamental to both UPP and merger simulation. While UPP uses the concept of a "diversion ratio" for this analysis, merger simulation uses cross-price elasticity. These alternatives are closely related.

The diversion ratio can be understood as follows. A hypothetical post-merger price increase for product 1 would reduce the demand for good 1 by some number of units. In addition, a fraction of the former product 1 purchasers would turn to product 2 as their now preferred alternative. The incremental product 2 unit sales divided by the "lost" product 1 units is the diversion ratio. For example, a post-merger price increase that reduced demand for product 1 by 100 units but increased demand for product 2 by 30 units would indicate a diversion ratio of 30 percent.

Other things equal, a higher diversion ratio will be associated with a greater

---

[5] The own-elasticity and the profit margin are closely related, given the "Rule of Thumb for Pricing." See, for example, Robert Pindyck and Daniel Rubinfeld, *Microeconomics*, 7th Edition, Chapter 10.

[6] As we will show, the cross-price elasticity is closely related to the diversion ratio.

increase in the price of product 1, since more sales that would have been lost pre-merger are now captured through the acquisition of product 2. Further, UPP takes account of the fact that the incentive to increase the price of product 1 will be stronger, the higher the profit margin for product 2, because the diverted sales would result in higher profits for the merged firm.

A UPP analysis can be expressed as a specific formula that depends on the underlying demand and profitability parameters. Following Farrell and Shapiro's notation, let D_{12} represent the diversion ratio from product 1 to product 2 (associated with an increase in the price of product 1). Also, let $\mu_2 = (P_2 – C_2)$ be the profit margin on the second product, where C_2 is the marginal cost of producing product 2. Let C^*_1 be the marginal cost of product 1 after the merger. This cost will be lower than C_1 if the merger provides efficiencies.

Farrell and Shapiro present a "rule of thumb" criterion that a merger exhibits UPP if

$$C_1 - C^*_1 < D_{12}(P_2 - C_2) \quad (1)$$

This expression can be evaluated using the pre-merger data on costs and prices, an assumption about how efficiencies affect the post-merger marginal cost, and an estimate of the diversion ratio.[7] The intuition is that UPP arises if the diversion to product 2 outweighs the efficiency for product 1.

Instead of a diversion ratio, substitutability in merger simulation is generally framed in terms of cross-price elasticity. Cross-price elasticity measures the percentage change in the quantity demanded of product 2 when the price of product 1 is increased, instead of the change in the number of units. But the two approaches measure virtually the same thing. If we let *Q* represent quantity and *P* price, then the cross-price elasticity is given by $\varepsilon_{21} = (\partial Q_2/\partial P_1)(P_1/Q_2)$. It can be shown that the diversion ratio, D_{12} is exactly determined by the cross-price elasticity divided by the own-price elasticity (measured as an absolute value) and scaled by the ratio of the quantities.[8] Specifically,

$$\begin{aligned} D_{12} &= -(\partial Q_2/\partial P_1)/(\partial Q_1/\partial P_1) \\ &= -(\partial Q_2/\partial P_1)(P_1/Q_2)/(\partial Q_1/\partial P_1)(P_1/Q_1)(Q_1/Q_2) \\ &= -(\varepsilon_{21}/\ \varepsilon_{11})\ (Q_2/Q_1) \quad (2) \end{aligned}$$

---

[7] Assuming that the merger does not alter the marginal cost associated with product 2, this is equivalent to Equation (4) in the Farrell-Shapiro paper.

[8] This was pointed out by Werden (1996).

Hence, the diversion ratio is based on cross-price elasticity and the own-price elasticity.

The two approaches measure substitution using different scales, much like measuring temperature in Fahrenheit or Celsius. There is no essential difference between them as measures of product substitutability. It is important to stress that knowledge as to the magnitude of the diversion ratio often comes from the specification and estimation of a demand system. If there is sufficient information to simplify or to short-circuit this determination, that information will be as useful in a merger simulation analysis as it will be in an UPP analysis.

In our view, UPP has requirements that are essentially the same as the requirements of standard merger simulation when the goal is to identify "price neutral" efficiencies. In practice, the choice of method may be determined by what empirical information is available to calibrate the model. If diversion ratios are known but not cross-price elasticities, then the UPP formulation is convenient. Frequently, however, econometric analysis yields estimates of own and cross price elasticities, while diversion ratios cannot be independently observed. In this case, conventional merger simulation is more convenient.

The Relationship between UPP and Merger Simulation

To see the formal relationship between UPP and merger simulation, we begin with a review of the mathematics of merger simulation when the merger involves two single product firms that are Bertrand competitors. Pre-merger, each firm is presumed to maximize its profit; the necessary (first-order) conditions for profit maximization in the differentiated product Bertrand equilibrium are:

$$\varepsilon_{11} = 1/\mu_1 \tag{3a}$$

$$\varepsilon_{22} = 1/\mu_2 \tag{3b}$$

Let s_i represent the shares of revenue generated by each of the two products. Then, the post-merger first-order conditions are:[9]

$$\varepsilon_{11}s_1\mu_1 + \varepsilon_{21}s_2\mu_2 = -s_1 \tag{4a}$$

$$\varepsilon_{12}s_1\mu_1 + \varepsilon_{22}s_2\mu_2 = -s_2 \tag{4b}$$

Note that these expressions are quite general; in particular they do not depend on the specific functional form assumptions for the demand system.

To evaluate the post-merger price changes implied in this framework, denote the equilibrium post-merger values with a superscript *. Suppose the merger

[9] The details are spelled out in Epstein and Rubinfeld (2002).

leaves prices unchanged. Then, there will be no change in the various price elasticities and no change in revenue shares, although margins will change due to the efficiencies that reduce marginal cost. When equilibrium post-merger prices are unchanged, it follows from (4a) and (4b) that the efficiencies generated by the merger satisfy[10]:

$$C_1 - C_1^* = \frac{\varepsilon_{21}\dfrac{s_2}{s_1} - \dfrac{\varepsilon_{12}\varepsilon_{21}}{\varepsilon_{11}}}{\varepsilon_{11}\varepsilon_{22}\left(1 - \dfrac{\varepsilon_{12}\varepsilon_{21}}{\varepsilon_{11}\varepsilon_{22}}\right)} P_1 \qquad (5)$$

One can also interpret (5) as indicating the magnitude of the efficiencies necessary for the merger simulation to yield a "price neutral" result. The pre-merger shares, elasticities, prices, and costs in principle are observable data. One can then solve to find the threshold C^*_1 that satisfies (5). If the expected efficiencies are relatively small, so that the post-merger marginal cost is greater than this threshold, then the merger would be expected to result in higher prices. In other words, the merger would exhibit UPP. But larger efficiencies could imply marginal costs equal to or lower than the threshold, which would eliminate price concerns from the merger.

Equation (5) can also be rewritten in terms of diversion ratios. To do so, we substitute equation (2) into (5). The corresponding efficiency equation for unchanged prices is as follows:

$$C_1 - C_1^* = \frac{D_{12}(P_2 - C_2) + D_{12}D_{21}(P_1 - C_1)}{\left(1 - D_{12}D_{21}\right)} \qquad (6)$$

We can now compare the required efficiency gain that follows from a complete merger simulation analysis to the proposed first-order approximation proposed by the UPP measure. The basic corresponding UPP rule would be:

$$C_1 - C_1^* = D_{12}(P_2 - C_2) \qquad (7)$$

A comparison of (6) and (7) shows that the UPP rule of thumb corresponds to a special case of the complete merger simulation analysis, the special case in which $D_{21} = 0$. Farrell and Shapiro are aware of this and offer a more complex test that accounts for this feedback in Section 2.D of their paper.

In our view, the most basic UPP diagnostic is not likely to be preferable in

---

[10] The solution is reached by treating (4a) and (4b) as two equations in the two unknowns μ^*_1 and μ^*_2.

most situations because it implies only "one way" substitution from product 1 to product 2. In essence, the UPP rule of thumb ignores the "feedback" in the model that links a change in the price of product 2 to a change in the price of product 1 to determine the post-merger equilibrium. As Farrell and Shapiro point out, once feedback is taken into account, somewhat larger efficiencies are required to make the likely merger price neutral.

What is the effect of using the UPP rule of thumb rather than the more complete merger simulation analysis? Subtracting the right-hand side of the merger simulation ("MS") representation (6) from the right-hand side of the UPP representation (7), we find that the algebraic sign of the result must be negative. The implication is that UPP will be biased downward in the sense that it will require less in the way of efficiencies than would be appropriate from a merger simulation perspective. The magnitude of the bias depends fundamentally on the magnitude of the product of the two diversion rations, $D_{12}D_{21}$. Indeed, the bias is likely to be largest in just those cases in which a merger is most likely to generate substantial unilateral effects. We therefore believe it is most appropriate to conduct the analysis in terms of equation (5), or its equivalent re-statement equation (6).

Model Calibration

The largest challenge in both UPP analysis and merger simulation is to arrive at reasonable values for the necessary parameters for practical implementations of the approaches. We stress that the accuracy and reliability of the UPP diagnostic depends crucially on the accuracy of the diversion ratio. It is important not to understate the difficulty of getting this information. A plausible assumption in many instances is that diversion is proportional to current market shares.[11] When that assumption fails to hold the UPP diagnostic is likely to generate misleading results. If the two merging products are closer substitutes than allowed by the proportionality assumption, the diversion will be underestimated, leading to an underestimate of the likely price effects. The converse will be the case if the two products in fact are relatively poor substitutes.

Merger simulation provides a more general framework for measuring and calibrating the extent of substitution that drives the assumed Bertrand post-merger equilibrium. For example, one might specify and estimate a basic logit or a nested logit model. Our merger simulation methodology, PCAIDS, when used with nests, also provides a relatively parsimonious but flexible model to calibrate elasticities that are not constrained by the proportionality assumption.[12]

Alternatively, with a large dataset it may be possible to estimate a full demand

---

[11] Shapiro makes this assumption in a previous insightful speech (Shapiro (1995)).

[12] See Epstein and Rubinfeld (2004).

model that yields direct estimates of each relevant price elasticity and cross-price elasticity. Finally, as Farrell and Shapiro suggest, there may be situations in which it is possible to measure diversion ratios directly, in which case it would be easiest to use equation (6). The key consideration is to identify the most reliable empirical basis for the analysis, regardless of whether it is framed in terms of elasticities or diversion ratios.

Concluding Comments

Farrell and Shapiro suggest that the UPP measure and the associated presumption will simplify unilateral effects merger analyses in part by avoiding the necessity of formally defining relevant markets, and in part by avoiding the problem of selecting the functional form for and the associated curvature of the demand functions for the products. We find the full UPP approach as expressed in equation (6) compelling. It is compelling, however, primarily because it offers many of the advantages that are offered by a basic merger simulation analysis.

Conceptually, UPP is a special case of merger simulation. Both UPP and the more general merger simulation approach rely on the computation of a post-merger Bertrand equilibrium with differentiated products and merger-specific efficiencies. UPP asks whether in this framework there would be a price increase, without attempting to quantify the magnitude. Merger simulation goes one step further and estimates the magnitude of a price increase. But the two techniques, when consistently calibrated, yield the same qualitative conclusion. When one method signals a price increase, the other will, as well.

The practical challenge in unilateral effects analysis is calibrating the various model alternatives. Depending on the available data, there are advantages to UPP, calibrated simulation models such as PCAIDS, and full econometric demand models. The availability of modern software for merger analysis means that practical computation of the post-merger equilibrium is about as easy (or difficult) regardless of the approach used.

In terms of interpretation, it is not surprising that UPP and merger simulation share many of the same issues. In some cases, the Bertrand assumption may be open to challenge. Moreover, neither UPP analysis nor merger simulation is well suited to account for entry or product repositioning as additional competitive constraints. However, both approaches provide valuable and workable diagnostic and analytical tools for evaluating the likely unilateral effects of mergers.

References

Epstein, Roy J. and Daniel L. Rubinfeld (2002), “Merger Simulation: A Simplified Approach with New Applications,”, *Antitrust Law Journal,* Volume 69, No. 3, December, 883-91.

Epstein, Roy J. and Daniel L. Rubinfeld (2004), “Merger Simulation with Brand-

Level Margin Data: Extending PCAIDS with Nests", *Advances in Economic Analysis & Policy*: Vol. 4: No. 1, Article 2, Berkeley Electronic Press, March.

Farrell, Joseph and Carl Shapiro (forthcoming), "Antitrust Evaluation of Horizontal Mergers: An Economic Alternative to Market Definition," *B.E. Journal of Theoretical Economics.*

Shapiro, Carl (1995), "Mergers with Differentiated Products," Antitrust Division, Department of Justice.

Werden, Gregory (1996), "A Robust Test for Consumer Welfare Enhancing Mergers Among Sellers of Differentiated Products," 44 *Journal of Industrial Economics*, 409–413.