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Responses to Referee Report on

"BRIDGING THE GAP BETWEEN HORIZONTAL AND VERTICAL MERGER SIMULATION"

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The referee's comments are greatly appreciated. Responses will follow the referee's order of comment. The referee's topics are in bold lettering and underlined.

Referee Overview

We agree that the presentation can be simplified and made easier to read. Every effort will be made to make the paper clearer, more concise, and the analysis more transparent. The referee recommends fixing the narratives opacity. We agree that the material presented is dense with equations, but there is nothing obscure or impenetrable about the paper. All equations of both the foreclosure model (Algorithm V-1) and the raising rivals cost model (Algorithm V-2) were present in complete detail. In fact, complete derivations were contained in the paper. We note, however, that without any impact on algorithms or empirical results, Proposition 2 requires a clearer statement. We re-state Proposition 2 more completely.

Proposition 2. Suppose that both R_0 and R_1 are well-behaved concave functions, and suppose that R_i, $i = 2,3,\ldots,N$, is a well behaved concave function. Suppose that MVPD1-PN0 maximizes $E\Pi_{MVPD1-PN0}$ with respect to prices and that provider i of programming network content maximizes Π_i^{POST} with respect to $P_{Ad,i}$ and $P_{retrans,i}$, then the post-merger first-order conditions for programing network content are

$$\begin{bmatrix} \dfrac{\partial R_0}{\partial P_{retrans,0}} + \dfrac{\partial R_1}{\partial P_{retrans,0}} \\ \dfrac{\partial R_0}{\partial P_{retrans,1}} + \dfrac{\partial R_1}{\partial P_{retrans,1}} \\ \dfrac{\partial R_2}{\partial P_{retrans,2}} \\ \vdots \\ \dfrac{\partial R_N}{\partial P_{retrans,N}} \end{bmatrix} = 0.$$

We also correct obvious typos in the proof of Lemma 1. The term $\dfrac{\partial P_{Sub,f}}{\partial q_f}\dfrac{\partial q_f}{\partial P_{Sub,f}}$ should read $\dfrac{P_{Sub,f}}{q_f}\dfrac{\partial q_f}{\partial P_{Sub,f}}$. In addition, the term $\dfrac{\partial P_{Sub,1}}{\partial q_f}\dfrac{\partial q_f}{\partial P_{Sub,1}}$ should read $\dfrac{P_{Sub,1}}{q_f}\dfrac{\partial q_f}{\partial P_{Sub,1}}$. Correction of these typos do not change or alter any results.

The referee asserts that the model's structure appeared to depart from intuition in important ways, and there was an insufficient amount of discussion of the implications of these departures. It is difficult to respond to this criticism in that the intuition of the referee is not explained. The intuition behind the model, however, arose from Schumpeterian Economics, Bertrand Price Competition, PCAIDS, and "field" examinations of real world competitive interactions between MVPDs when programming network content was withheld or "blacked-out."

Foreclosure

There are two principal structures in the model that were added to PCAIDS to facilitate the simulation of a vertical merger and the withholding of a differentiated input (programming network content) from rivals that produced differentiated products or services downstream. First, PCAIDS simulates horizontal mergers, but by recognizing that a vertically integrated MVPD could introduce a new product or service that targeted subscribers of a rival MVPD at the time the programming network content was withheld, the horizontal capability of PCAIDS was exploited. The post-vertical-merger MVPD introduced a new product, and the demand for the new product was a random variable. The demand was a function of a binary random variable that took a value of 1 when the downstream rival was eliminated from the market or took the value of zero otherwise. Because MVPDs had differentiated products and their programming network contents were not the same, a prior distribution was assigned to the random variable. The intuition for this random variable and the prior probability of eliminating a rival from the market was informed by Schumpeter (1942) and his concept of creative destruction. In addition, the intuition behind the new product by the post-vertical-merger firm came from the review of actual and historical instances in which programming network content was withheld from an MVPD and rivals of that MVPD introduced new services to gain customers from the "Blacked-out" MVPD.

The second principal structure behind foreclosure was recognition that the percentage change in unit cost of a firm, θ_j, in PCAIDs would also impact the ability to foreclose a downstream rival. How do MVPDs pay for programming network content? Generally, programming network content may be considered a quasi-public good. There is a high fixed cost in creating the programming network content, but marginal cost is zero. If suppliers charged a flat fee for programming network content, the payment would appear as a fixed cost to the MVPD. Payment of a flat fee for programming network content would not vary by subscriber and, therefore, not affect marginal cost of a MVPD. There are other pricing or payment arrangements that suppliers of content may create. The supplier of programming network content may charge a MVPD a fee per subscriber. The models of the paper assumed this pricing structure for programming network content. Thus, when the post-vertical-merger MVPD withheld programming network content from a downstream rival, that rival had an altered MVPD service. The affected downstream rival had four options with respect to replacing the lost program: (i) it could present a MVPD service schedule with less program network content – provide fewer cable channels. In this case, the percentage change in unit cost of the downstream rival would decline, and in PCAIDs the efficiency parameter θ_j for that rival would be less than zero, $\theta_j < 0$. (ii) The rival that experienced the withheld programming network content could replace the withheld content with more expensive programming network content. If the replacement content were more expensive than the withheld content, then $\theta_j > 0.$ (iii) The rival that experienced the withheld programming network content could replace the withheld content with less expensive programming network content. If the replacement content were less expensive than the withheld content, then $\theta_j < 0.$ (iv) if the rival that experienced the withheld programming network content could replace the withheld content with programming network content that was equivalent in cost to the withheld programming network content, then the percentage change in unit cost was zero, $\theta_j = 0.$ (Please note that if programming network content were always a fixed payment of fixed cost to a MVPD, $\theta_j = 0.$)

In the empirical application of foreclosure model and Algorithm V-1, it was assumed that a rival which experienced the withholding of programing network content would not permit its video service to contain fewer channels or less content. It was also assumed that the cost of the replacement programming network content would be the same as the cost of the withheld programming network content. The implication of these assumptions was that the percentage change in unit cost was zero, $\theta_j = 0.$ (Alternatively, under a flat payment for programming network content, the post-vertical-merger firm's withholding of content had no effect on marginal cost of a rival.)

Another possible concern of the referee regarding providing intuition is that there is no discussion of elimination of double marginalization in the foreclosure model, where programming network content is withheld by post-vertical- merger MVPD and where that firm introduced a new product that targeted at rivals' subscribers. Assuming programming network content had been sold for a per subscriber fee, the post-vertical-merger MVPD, $MVPD1-PNO,$ would eliminate the per subscriber fee for itself, and this action would result in a lower efficiency parameter $\theta_{MVPD1-PNO} < 0.$ However, in the empirical examples, it was assumed that the fee per subscriber on the downstream partner was maintained, $\theta_{MVPD1-PNO} = 0,$ and that these "double margins" would go to finance quality improvements of the downstream partner's cable services. Quality improvements could take the form of more and better content or improved technology in the cable network. This was intuition drawn from the work of Schumpeter (1942).

Given the assumption of random demand for the new post-vertical-merger product, expected shares and elasticities of expected demand were derived. (Lemmas 1 through 4 show the relationship between elasticities of expected demand and actual elasticities of demand.) The MVPDs were assumed to maximize expected profit and were assumed to be risk neutral. Intuitively, the results flow from Bertrand first-order conditions and application of PCAIDS using Algorithm V-1.

The referee's intuition may include concerns about the use of Algorithm V-1. This algorithm was developed as an alternative to the solution algorithm in PCAIDS which resided in Microsoft EXCEL and relied on EXCEL's nonlinear solution routine. That routine solved for ratios of post-merger prices to pre-merger prices. Because in this model both pre-merger and post-merger solution variables were vectors of margins, Algorithm V-1 was developed. More importantly, the algorithm provided a means of solving the empirical problem associated with the introduction of the new post-vertical-merger product. The Excel based PCAIDS could not calculate post-merger to pre-merger price ratios because the denominator or pre-merger price for the new product or service did not exist. Algorithm V-1 of the paper is a Newton-Raphson method for solving nonlinear equations. Algorithm V-1 produces reliable and accurate results.

The referee's intuition might also rest on the fact that PCAIDS was designed to solely simulate horizontal mergers, but, in this post-vertical-merger world, there were no products from a horizontal merger that were associated with a standard application of PCAIDS (i.e., there were no conventional post-merger Bertrand first-order conditions for a horizontal merger that would give rise to elasticities traditionally found in PCAIDS.) The empirical examples in the paper may have also contributed to our differences in intuition. In fact, the Comcast-Adelphia-Time Warner Merger applications contained both horizontal and vertical aspects. Because we were solely interested in vertical merger simulation, we abstracted away from all horizontal issues in Comcast-Adelphia-Time Warner to illustrate the foreclosure model and application of Algorithm V-1. Moreover, given the geographic and product market definitions of the Federal Communications Commission, there were virtually no horizontal merger related concerns. This was because the relevant geographic and product markets collapsed into the service area of a cable company, and cable services areas of applicants did not overlap. Therefore, like the Commission, we focused the vertical aspects of the merger.

The foreclosure structure of the paper and Algorithm V-1 can, however, simulate a combination of one or several simultaneous horizontal mergers that occur at the same time as one or several vertical-mergers with possible foreclosure action and introduction of a new product targeting subscribers of rivals. For example, the SBC-AT&T Merger Application occurred at the same time as the Verizon-MCI Merger Application. These two simultaneous mergers had both horizontal-merger and vertical-merger aspects. In well-defined geographic and product markets, it is obvious how our model could incorporate the horizontal aspects of those mergers, while the vertical-merger aspects and possible foreclosure actions could be simulated by introducing a new targeted product with random demand and adjusting efficiency parameters (percentage changes in unit costs) to reflect rivals actions to foreclosure in a post-horizontal-vertical-merger. Algorithm V-1 would be used to simulate the results.

The Model of Raising Rivals Cost

The model for raising rival's cost and the application of Algorithm V-2 is very intuitive. The Nash two-party bargaining solution was added to the post-merger end of PCAIDS by means of an efficiency parameter θ_j for the $j-th$ MVPD which is the percentage change in unit cost. Bargaining was over profits from specific programming network content in a previous year. The previous year was selected for simplicity. The vertically integrated MPVD extracts half the profits from a downstream rival MVPD. Thus, the downstream rival paid half its previous period's profit to the upstream vertically integrated rival, and this payment was a cost to this downstream rival. The intuition of the referee maybe suggesting that bargaining over pervious period's profits ignores probable profits in the post-merger environment. Informed by the referee's criticism, a simple approach for capturing future profits in the post-merger environment would be to permit the negotiating parties to agree on a prior distribution of a multiple, $\gamma > 0,$ of pre-merger profit. Given this random variable and assuming risk neutrality, expected post-merger profit would be the product of the previous year's profit and the expected value of $\gamma.$ If a uniform prior distribution is assumed, pre-merger documents, market data, and financial data may suggest the appropriate range for the uniform random variable. Once expected profit is determined a standard Nash bargaining solution can be applied and Algorithmn V-2 applied. Another intuitive issue is that, if withholding the differentiated input is not an issue, why is raising rivals costs? The Comcast-Adelphia-Time Warner Merger analysis conducted by the Commission suggested that Regional Sports Networks ("RSN") were near essential network programming content and the downstream competitor would pay.

In the context of the raising rivals cost and Algorithm V-2, we treated the issue of double marginalization analogously to the treatment in the foreclosure model. In the empirical examples, it was assumed that the fee per subscriber on the downstream partner was maintained, $\theta_{MVPD1-PNO} = 0,$ and that these "double margins" would go to quality improvements of the downstream partner's cable services.

Again, the referee may have expected to see horizontal merger related first-order conditions in the raising rivals' cost' aspect of our work. The expectation would arise from our use of PCAIDS and our selected application. We were, however, singularly focused on a vertical merger and raising rivals cost. Indeed, a horizontal merger in combination with a vertical merger can be assessed in our raising rivals cost model which is based on PCAIDS. Bertrand post-horizontal-merger first-order conditions and percentage increases in unit costs of rivals, as a result of Nash Bargaining over expected profits, can be simply processed in Algorithm V-2. In fact, Algorithm V-2 is also a Newton-Raphson algorithm for solving a system of non-linear equations, where the variables are margins.

The empirical application of raising rivals cost model ignores horizontal aspects of the Comcast-Adelphia-Time Warner Merger. Again, given the geographic and product market definitions of the Federal Communications Commission, there were virtually no horizontal merger related concerns. This was because the relevant geographic and product markets collapsed into the service area of a cable company, and cable services areas of applicants did not overlap. Therefore, like the Commission, our focus was on the vertical aspects of the merger.

Methodological Comparisons

The referee requested comparisons of empirical results from the Comcast-Adelphia-Time Warner Merger analysis by the FCC and the methodologies of this paper. Such direct comparisons are not possible. There are several reasons for this reply. First, the methods and models of the paper and the analysis by Commission's Staff were incommensurable. The literature review of the paper explained the fundamental problems of Commission Staff's Methodology. Second, in Appendix D of the Commission's Order, percentage increases in prices of regional sports networks, by DMA, were presented. Regional Sports Networks were differentiated inputs to rivals' systems – satellite providers' systems and, therefore, the Commission Staff results were percentage changes in input prices. Setting aside the incommensurable methodologies, the analyses from the foreclosure model and Algorithm V-1 may be examined. Such examination reveals that percentage changes of end users or consumer prices were estimated under the foreclosure model and Algorithm V-1. Third, in order to convert the Commission Staff's estimates of percentage changes in input prices into percentage changes in output prices, additional and unavailable data would be required, e.g. the share that expenditures on RSNs make of the unit cost of a rival, the pre-merger prices rivals paid for RSNs, and elasticity data. Finally, the finding, that Commission Staff's Model underestimated price increases to end users, is an inoffensive way of saying that the Commission Staff failed to estimate the percentage increases in end user/consumer prices. In merger review, consumer welfare is based on consumer surplus and changes in consumers' prices. Estimates of percentage increases in prices of RSNs were insufficient for traditional welfare analysis.

Referee Suggestions

First Suggestion of the Referee

The referee made five suggestions, and we address each. First, the referee suggested that the readability of the paper be improved. The referee's comment about presentation and style of writing are taken into consideration.

Second Suggestion of the Referee

In Moresi and Salop (2013) indices of vertical gross upward pricing pressure were developed. The vGUPPIs were derived "to score the incentives for input price foreclosure and downstream unilateral price increase in vertical mergers,"[1] i.e., a vGUPPI indicates a likely price effect. The indices were based on profit optimization by both upstream and downstream firms. A highly specific constant returns-to-scale production function was assumed for downstream firms. Bertrand Competition was assumed and a perfect Bayesian equilibrium was considered. Pre-merger first-order conditions were derived. Then, post-vertical-merger first order conditions were derived. Solutions for independent variables from first-order conditions were not found. Focusings on a specific index, vGUPPIu was derived, under specific assumptions, from pre-merger first-order conditions and post-vertical-merger first order conditions. Other vGUPPIs were also derived. In summary, vGUPPIs indicate pricing pressure.

Our work differs from the work of Moresi and Salop. In their work specific prices were not derived nor were percentage changes in prices derived. The vGUPPI methodology was not a general form of vertical merger simulation. In our foreclosure

[11] Moresi and Salop (2013), **79 Antitrust Law Journal N0.** 1: 211.

model, we assumed a Bayesian prior distribution which was the same for all players. Bertrand competition was assumed and, in the post-vertical- merger environment, a new product, was introduced that was targeted at customers of rivals. Profit maximization was the behavior of all players. Solutions to independent variables, which were margins, for both pre-merger and post-merger first-order conditions were found. Given assumptions about efficiency parameters and solutions for margins, percentage changes in prices were determined. Moreover, our work can easily accommodate responses of rivals to foreclosure as discussed above, e.g., rivals could find replacement programming network content at some selected price or other responses. The direction of a rival's efficiency parameter would capture that choice. Data from merger documents and interviews with players could inform such parameters. Indeed, in a vertical merger review, our work could serve as additional economic analysis along with vGUPPI analysis.

The referee cites the work of Nate Miller (Georgetown Strategy). I obtained a published copy of "Modeling the Effects of Mergers in Procurement," (October 17, 2014) by Nathan H. Miller of Georgetown University. Dr. Miller created a stochastic model of procurement that predicts the effects of mergers involving the combination of suppliers in procurement markets. The model was concerned with business-to-business transaction/procurement and intermediate prices arising from procurement. Using a scoring auction model, buyers (businesses) scored offers of prospective suppliers, and a contract was awarded to the supplier with the highest score. Dr. Miller derived general expressions for the *ex ante* expected changes in price, buyer utility, supplier profit that arose from a merger between two suppliers. When a Gumbel Distribution was used for surplus, closed-form expressions were derived and a percentage change in average price was determined. The work does, however, not address vertical intergration through merger. In addition, the work does not model the effects of a vertical merger, withholding an input, possible foreclosure, and downstream consumer prices. In our vertical merger model for foreclosure there was no bidding or scoring of input from a supplier, including the vertically integrated supplier.

As the referee suggested Dr. Miller's results may be used, for example, in the foreclosure context of our model. Maintaining product differentiation in both upstream and downstream markets, suppose that there were other intermediate inputs, excluding programming network content, to final products of MVPDs. Suppose that the other intermediate inputs involved bidding and scoring by a purchasing MVPD. Suppose that the other intermediate inputs are not associated with any vertically integrated firms. Suppose that a merger in procurement of other intermediate inputs occurs at the same time as the vertical merger. Then, under the Gumbel distribution and the Miller Model, the unit price changes resulting from the intermediate input may be used to inform the efficiency parameters θ_j, for any downstream MVPD j. Given Algorithm V-1, the downstream percentage changes in prices to consumers of video can be determined. Analogous, logic would apply to the raising rivals' cost models and Algorithm V-2.

Third Comment of Referee

The referee required greater discussion of the parameterization of the foreclosure question. In the paper there was an extensive discussion of Schumpeter's concept of competing for the market in a process of creative destruction, and the introduction of a new product nicely coincided with Schumpeter's concept, even if the product was target at customers of rivals. In addition, in the foreclosure context, there was a discussion of how raising rivals' cost can result in rivals exiting the market. As discussed above, if a rival selected replacement programing network content that was more expensive than the withheld content, the efficiency parameter for the rival would be greater than zero. A binary random variable was select to represent the success of foreclosure. When the differentiated input was withheld, the random variable took the value 1=foreclosure if rivals exited the market, 0 otherwise. In the choice of a binary random variable, we were guided by the scientific principle of simplicity – the simplest explanation. Moreover, as most economists are taught, it is the predictive power of the model that is valued. The entire discipline of economics rests on various simplifying assumptions. At this time we do not have access to the work of Yorukoglu, Crawford, Lee, and Whinston. On Professor Yorukoglu's website, their work is listed as in progress. With all due respect to the referee, there was not a substantial abstraction from MVPD industry behavior. For motivation and intuition, an example of Disney and Time Warner Cable dispute is cited. In addition, the Viacom and Dish dispute of 2004 is cited. Moreover, the prediction from the foreclosure model of the paper was akin to Perry and Goff (1985) which was previously cited. Determination of the reliability of the model's predictions requires time and data. One method for examining predictions involves repeated application of the model to vertical mergers and generation of data on outcomes from the model. Actual post-vertical-merger data on percentage changes in prices would also be required to study the difference between actual post-merger percentage changes in downstream prices and predicted percentage changes in downstream prices from the model. Such work is beyond the scope of the paper. In deed, the reliability and accuracy of predictions from any merger simulation, horizontal or vertical, is an interesting research question that goes beyond the present paper.

Fourth Comment of Referee

The referee suggests that technical material should be simplified and presented parsimoniously. Complete mathematical derivations for models in the paper were presented. Formal mathematical derivations can be placed in a shortened appendix. Again, the derivations in the paper are clear and straight forward, but every effort will be made to make the body of the paper less mathematical and more readable.

Fifth Comment of Referee

The referee asserted that the presentation of the empirical application was confusing and that an enormous number of tables were presented. I agree that the presentation of the empirical application can be simplified. The paper is not a study of the Comcast-Adelphia-Time Warner merger. The paper is about a new methodology, and, as such, we will follow the referee's suggestion on Miller's (2014) style and empirical presentation. A single example will be presented. At this time, we will, however, explain Table l: Foreclosure: $\alpha = 0$ for Buffalo. The original material follows:

Table 1: Foreclosure: $\alpha = 0$

Buffalo

Post-Merger-Foreclosure Initial Elasticities

Elasticity	Cable	Cable Foreclose	Satellite
Cable	-3.175	8.03627	0
Cable Foreclose	1.71549	-9.49577	0
Satellite	0	0	-10.75176

Buffalo	Original	Expected	Margin	Expect Margin	Margin	%Change	Post-Foreclose
1	Share	Share	Pre-Merger	Post-Merger	Post-Merger	Price	Share
Cable	78.7%	78.7%	31.5%	68.5%	68.5%	117.5%	78.7%
Cable Foreclose	n/a	16.8%	n/a	68.5%	68.5%	n/a	16.8%
Satellite	21.3%	4.5%	11.1%	9.3%	9.3%	-1.9%	4.5%

The prior probability, that foreclosure action by the vertically integrated firm is completely successful, is $\alpha = 0$. The matrix of elasticities is the post-merger matrix of initial elasticities which is based on expected shares, introduction of the new product, and the withheld of RSNs from satellite providers in Buffalo. Contents of the columns labeled original share and expected share are obvious. The column labeled Margin Pre-Merger contains pre-merger margins which is denoted μ^{Pre} in Algorithm V-1. The Column labeled Expected Margin Post-Merger is the calculation of $\mu_1^{V\,\mathrm{Pre}}$ from Algorithm V-1. The column labeled Margin Post-Merger contains margins from the convergence of the algorithm, i.e., μ^{post} from Algorithm V-1. The reason that the values for columns Expected Margin Post-Merger and Margin Post-Merger were the same was because the efficiency parameters $\theta_j s$ were set to zero for all competitors. In the case of the vertically integrated MVPD, the reasoning for this choice was that the fee per subscriber on the downstream partner was maintained, $(\theta_{MVPD1-PNO} = 0, \theta_f = 0)$ and that these "double margins" would go to finance quality improvements of the downstream partner's cable services. Quality improvements could take the form of more and better content or improved technology in the cable network. (Profits, that are used to finance innovation, are in the Schumpeterian (1942) tradition.) For the rival of the vertically integrated cable firm, $\theta_{Satellite} = 0$. Here, it was assumed the satellite MVPD would replace withheld programming network content with alternative content at the same cost as the withheld programming network content. The column labeled % Change Price contains percentage changes in consumer prices after the merger. Because $\theta_j s$ were zero the algorithm converged rapidly. In real world applications, the assumptions about all parameters would be a result of document review, interviews, third party data, and third party interviews, but in the above applications simplifying assumptions were made. A revised presentation of the table would contain the columns: Original Market Share, % Change in Price, and Post-Merger Market Share. The revised paper would not contain revised results from other DMAs or other values for α.

The referee requested comparison of the model's results with other FCC approaches. As stated previously such a comparison is not possible due to data limitations. Again, our finding, that Commission Staff's Model underestimated price increases to end users, was an inoffensive way of saying that the Commission Staff failed to estimate the percentage increases in end user/consumer prices. Consumer welfare is based on consumer surplus and changes in consumers' prices. Estimates of percentage increases in prices of RSNs were insufficient for traditional welfare analysis and merger review.