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Malcolm B. Coate & Joseph J. Simons

Federal Trade Commission & Paul,Weiss

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Malcolm B. Coate & Joseph J. Simons[1]

I. INTRODUCTION

Critical Loss Analysis has been a standard method of implementation for the market definition algorithm of the Department of Justice ("DOJ") and Federal Trade Commission ("FTC") Horizontal Merger Guidelines ("Guidelines").[2] A few years ago, it was recognized as one of the major developments of the modern Merger Guidelines era.[3] At the same time, however, there has been a lively debate about the pros and cons of the standard Critical Loss Analysis ("CLA") methodology. An alternative methodology has been proposed by the current chief economists at both the FTC and the DOJ.[4] With the recent announcement by the agencies of their intent to amend the Guidelines, this debate takes on some urgency.

A few years after the issuance of the 1982 Merger Guidelines, CLA was introduced as an empirical structure to define relevant markets, as well as a method to aid in the full competitive effects analysis.[5] Recently, however, various commentators have suggested problems with CLA ranging from fairly minor issues[6] to claims that the approach is not consistent with basic economic theory.[7] Not surprisingly, there is considerable confusion in the antitrust community regarding the appropriate use of CLA and its potential alternatives. This article attempts to bring some clarity to this situation.

There are multiple sources for this confusion. We identify four. Once these sources of confusion are understood, the only real area of disagreement relates how to measure the

[1] Malcolm B. Coate is an economist at the Federal Trade Commission and Joseph J. Simons is a Partner in Paul, Weiss, Rifkind, Wharton & Garrison LLP and Director of the Bureau of Competition at the Federal Trade Commission from June 2001 to August 2003. The authors would like to thank Jeffrey Fischer, Mark Williams, Aidan Synnott, Jonathan Lave, Barry Harris, David Scheffman, Dennis Carlton, and an anonymous referee for helpful comments. The analyses and conclusions set forth in this paper are those of the authors and do not necessarily represent the views of the Federal Trade Commission, any individual Commissioner, or any Commission Bureau.

[2] Department of Justice and Federal Trade Commission Horizontal Merger Guidelines (Issued April 1992/Revised April 1997) at § 1. For an overview on the Guidelines market definition test, *see* Gregory J. Werden, *The 1982 Merger Guidelines and the Ascent of the Hypothetical Monopolist Paradigm*, 71 ANTITRUST L. J. 253 (2003).

[3] David Scheffman, Malcolm Coate, & Louis Silvia, *Twenty Years of Merger Guidelines Enforcement at the FTC: An Economic Perspective*, 71 ANTITRUST L. J. 277, 285 (2003).

[4] Joseph Farrell & Carl Shapiro, *Improving Critical Loss*, ANTITRUST SOURCE, Feb. 2008, http://www.abanet.org/antitrust/at-source/08/02/Feb08-Farrell-Shapiro.pdf.

[5] Barry C. Harris & Joseph J. Simons, *Focusing Market Definition: How Much Substitution is Enough*, 12 RES. L. & ECON. 207 (1989). This model has been generalized for increasing marginal cost conditions in Malcolm B. Coate & Mark Williams, *Generalized Critical Loss for Market Definition*, 22 RES. L. & ECON. 41 (2007). Moreover, background on the critical loss debate can be found in Malcolm B. Coate & Mark Williams, *A Critical Commentary on the Critical Comments on Critical Loss*, 53 ANTITRUST BULL. 987 (2008). This paper builds on the Harris and Simons' observation that a general critical loss methodology can also be used for the overall competitive effects analysis.

[6] Michael G. Baumann & Paul E Godek, *Reconciling the Opposing Views of Critical Elasticity*, GCP MAGAZINE September 2009 (2) for the basic presentation and Michael G. Baumann & Paul E Godek, *Could and Would Understood: Critical Elasticities and the Merger Guidelines,* 40 ANTITRUST BULL. 885 (1995) for details on the elasticities.

[7] Daniel O'Brien & Abraham Wickelgren, *A Critical Analysis of Critical Loss Analysis*, 71 ANTITRUST L. J. 161 (2003).

demand responses to a Guidelines' hypothetical price increase when defining relevant markets. CLA, applied properly, turns out not to be the issue.

The first source of confusion involves some ambiguity over what the Critical Loss is and the appropriate way to do a Critical Loss Analysis. Critical Loss is merely an estimate of the amount of sales volume a hypothetical monopolist must lose to make a hypothetical small but significant and non-transitory price increase ("SSNIP") unprofitable. It is the first step in Critical Loss Analysis and is based on margin data and nothing else. It does not assume any type of demand curve or economic model. Other than the fact that it involves an estimation of the margin, it is pure arithmetic—algebra to be precise.[8] Critical Loss Analysis includes a further step, which is to estimate whether the predicted actual loss in volume from the hypothetical price increase (the Actual Loss) will exceed the Critical Loss and thus require expansion of the candidate market under the Merger Guidelines test. This further step does, of course, involve some serious economic analysis, and turns out to be the source of the real conflict. While economists can advance other methodologies, Critical Loss Analysis is a simple break-even concept used to define relevant markets.[9]

Second, the scope of the SSNIP is another source of confusion. The common application of the Merger Guidelines test for market definition hypothesizes an across-the-board SSNIP for all products in the candidate market. Various proposals have been made to use: (1) a price increase on only one of the products in the market (single-firm SSNIP) or (2) different price increases for different products in the market, which we term a variable SSNIP.[10] Obviously, calculating Critical Loss for different price increases would require different formulas, and this could easily generate different market definitions. It is important to make sure that the SSNIPs being compared are of the same type when trying to compare the results of two Critical Loss Analyses. And given the very serious disagreement over the appropriateness of using any type of single-firm or variable SSNIP in market definition, their widespread use is problematic. We discuss problems with the use of single-firm and variable SSNIP concepts in market definition in the Appendix.

Third, there is confusion over the role of Critical Loss when diversion ratios are introduced into the analysis. In effect, calculating a critical diversion ratio, as Farrell and Shapiro propose,[11] is merely a variant of calculating a Critical Loss. Rather than ask how much volume the hypothetical monopolist must lose to make the price increase unprofitable, the critical diversion approach asks how much volume must be kept by the firms in the market to make the price increase profitable. This is effectively identical to estimating Actual Loss under the Farrell & Shapiro structure.[12] Whether looked at from the point of view of loss or diversion,

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[8] Adriaan Ten Kate & Gunnar Niels, *The Concept of Critical Loss for a Group of Differentiated Products*, J. COMPETITION L. & ECON. (2009) at 4, available: doi:10.1093/joclec/nhp015. This is not to say that determining the margin is a trivial exercise.

[9] We will leave it to others to discuss what the Guidelines meant by the term "likely would impose" in relationship to a SSNIP. Our position is clear: For roughly 20 years, merger analysts have applied the standard CLA to define markets with a break-even analysis.

[10] Oystein Daljord, Lars Sorgard, & Oyvind Thomasseen, *The SSNIP Test and Market Definition with the Aggregate Diversion Ratio: A Reply to Katz and Shapiro*, 4 J. COMPETITION L. & ECON. 263 (2008) and Janusz Ordover & Robert D. Willig, *Economics and the 1992 Merger Guidelines: A Brief Survey*, 8 REV. INDUS. ORG 139 (1993).

[11] Farrell & Shapiro, *supra* note 4 at 5.

[12] Breakeven diversion defines the percentage of the sales lost by incumbent firms in response to a SSNIP that must be recovered by (diverted to) incumbent firms such that the SSNIP will breakeven with respect to profits earned

the question is essentially the same. In the literature, the diversion analysis may look different, because it is frequently discussed with assumptions regarding demand estimates baked into the calculation. We see no reason to explore this issue in greater depth.

Fourth, and most importantly, the disagreement is very real and highly significant with respect to how to compute the likely demand response to the SSNIP (the Actual Loss). Katz and Shapiro and, more recently, Farrell and Shapiro, propose an approach (the "FKS approach") based on the general applicability of: (1) the Lerner Condition, and (2) a specific method for aggregating the results from the firm level to the market level.[13] Given these two assumptions, they advocate a theoretic approach that emphasizes "premerger margins" to derive (rather than measure directly through empirical analysis) the predicted demand response to a price increase by a hypothetical monopolist under the Merger Guidelines test for market definition. Farrell and Shapiro suggest that empirical analysis of demand could rebut this theoretic "evidence," but one is left with the impression that they would impose a high burden of proof in this regard such that the theoretic evidence would almost always prevail.

As we explain below, the FKS approach has serious drawbacks, and this is the focus of our paper.[14] First, the methodology is designed to almost guarantee narrow markets, even in low-to-moderate margin industries. Courts are unlikely to get comfortable with this result, because it appears to shift the burden of proof on market definition away from the plaintiff.[15] Second, the FKS approach models firm level outcomes, while market definition under the Merger Guidelines and Critical Loss methodology focuses on market level outcomes. Thus, the FKS approach must aggregate firm effects together to obtain a market effect, but it does so through the use of restrictive assumptions that may lack empirical basis.[16] Without these

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by the incumbent firms. Mathematically, (1-D) S/M = S/(S+M) where, D is the break-even diversion, S/M is the elasticity of demand defined as the ratio of the SSNIP (S) to the Margin (M) via the Lerner index and S/(S+M) is the critical loss for a linear demand curve. Re-arranging terms shows (1-D) = M/(M+S) and then D = S/(M+S), so in percentage terms, the break-even diversion equals the breakeven critical loss for a linear demand curve.

[13] Michael Katz & Carl Shapiro, *Critical Loss Let's Tell the Whole Story*, 17 ANTITRUST L.J. 49 (2003) and Farrell & Shapiro, *supra* note 4. For a round of response-rejoinder, *see* David T. Scheffman & Joseph J. Simons, *The State of Critical Loss Analysis: Let's Make Sure We Understand the Whole Story*, ANTITRUST SOURCE, Nov. 2003, http://www.abanet.org/antitrust/at-source/03/11/scheffman.pdf , Michael L. Katz & Carl Shapiro, *Further Thoughts on Critical Loss Analysis*, ANTITRUST SOURCE, Mar. 2004, http://www.abanet.org/antitrust/at-source/04/03/katzshapiro.pdf ; and Daniel P. O'Brien & Abraham L. Wickelgren, *The State of Critical Loss Analysis: Reply*, ANTITRUST SOURCE. Mar. 2004, http://www.abanet.org/antitrust/at-source/04/03/obrienwickel.pdf.

[14] In a companion paper, Coate and Simons discuss a number of situations in which the price-based model of product differentiation is not applicable. In effect, the conclusions of the two papers are the same; the theorists' approach to Critical Loss Analysis represents a special case generalization of the standard technique. *See* Malcolm B. Coate & Joseph J. Simons, *Critical Loss: Modeling and Application Issues*. (2009). Available at http://ssrn.com/abstract=1520069 .

[15] In Swedish Match, the FKS approach was rejected by the court, but the views of the competitors and distributors, along with the internal documents, were considered sufficient to support a narrow market of loose-leaf smokeless tobacco. Here, the court felt the loose-leaf business would not lose more than the critical level of sales in response to an across the boards SSNIP. *See*, FTC v. Swedish Match 131 F. Supp 2d 151 (D.D.C. 2000). Broader markets were sustained in the face of close head-to-head competition from the merger partner in Gillette and Russell Stover. *See*, U. S. v. Gillette 828 F. Supp. 78 (D.D.C. 1993) and Pennsylvania v. Russell Stover Candies, 1993-1 Trade Cas. 70,224 (E.D. Pa. 1993).

[16] Although almost standard procedure for game theoretic economists, this type of analysis substitutes deductive logic for empirical evidence. Under the Daubert standard, experts are limited to fact-based analysis. *See*, Malcolm B. Coate & Jeffrey H. Fischer, *Daubert, Science and Modern Game Theory: Implications for Merger Analysis*, 2009, forthcoming in SUP. CT. ECON. REV. Draft available at http://ssrn.com/abstract=1268386.

restrictive assumptions, almost any result can obtain, depending on the facts.[17] Third, use of the Lerner Condition to measure elasticities depends critically on the accurate measurement of marginal cost. This may prove impossible, thus precluding the FKS approach. Even if a point estimate of marginal cost is available, it would be a mistake to conclude that marginal cost equals the estimate of incremental cost needed for a Critical Loss Analysis. We conclude that any form of Critical Loss Analysis requires factual evidence.

II. THE LERNER INDEX, AND DIVERSIONS, VIRTUALLY GUARANTEE NARROW MARKETS

The Lerner Index exploits the basics of profit maximization to link the firm's own elasticity of demand with the relevant marginal cost condition facing the firm at the optimal level of output. Assuming applicability of the Lerner Index, the economic theorists recognize that if you know marginal cost, you know the own elasticity, and visa-versa. This proposition (coupled with the concept of diversion) underpins the theorists' criticism of the standard application of CLA.

It is well known in economics, however, that virtually all unilateral effects models utilizing the Lerner Condition produce price increases for any horizontal merger. That is, every horizontal merger is predicted to raise price, which of course has no empirical support and would face serious Daubert issues if used in court.[18] Because the FKS approach uses the same underlying assumption (i.e. the Lerner Condition), it produces narrow markets even for low-margin industries. Thus, even though there are serious issues with the use of the Lerner Condition, we continue our discussion assuming its validity.

To understand the basic impact of the Farrell-Katz-Shapiro analysis, it is helpful to reconstruct the basic math to see how the methodology exploits the optimization relationship that underlies the standard Lerner Index to highlight how even small amounts of diversion to products within the purported market are sufficient to turn broader markets into narrow ones. Table 1 presents the aggregate Critical Loss calculations associated with evaluating the profitability of a standard SSNIP in a differentiated product market.

The first column lists the margin, which is allowed to range from a high of ninety percent (.90) to a low of ten percent (.10). Column 2 is the linear demand, break-even Critical Loss for a 5 percent SSNIP corresponding to the margins in Column 1.[19] The next column simply converts Critical Loss into Critical Elasticity by dividing the Critical Loss by the five percent SSNIP.

Assuming the Lerner Condition applies, Column 4 computes the demand elasticity for the hypothetical monopolist (i.e. the candidate market demand elasticity) as the inverse of the margin. Although this demand elasticity estimate based on the Lerner Condition is technically defined for an individual firm, it can also be used as the maximum demand elasticity facing a

[17] The Lerner analysis, coupled with the firm-level diversions implicit in the aggregate diversion analysis, implies every horizontal merger generates price increases, and absent special circumstances or offsetting reductions in marginal cost, could be prima facie illegal. There is simply no empirical support for this modeling structure, and its predictions must be considered unconfirmed.

[18] Coate & Fischer, *supra* note 16.

[19] For the calculation with differentiated products, *see*, Ten Kate & Niels, *supra* note 8 at equation 3.

larger group of firms (i.e. the maximum market demand elasticity).[20] This maximum market demand elasticity is then used to estimate the predicted maximum Actual Loss associated with an across-the-board five percent price increase assuming a linear demand curve, which appears in column 5.

The sixth column presents the ratio of the Critical Loss to predicted Actual Loss. This fraction defines the percentage of the hypothetical monopolist's predicted Actual Loss that must be lost to products outside the candidate market (i.e., not diverted among products within the candidate market) for the relevant SSNIP to be break-even. For example, if the margin is 60 percent, the hypothetical monopolist must lose more than 92.31 percent of its foregone sales to entities outside the proposed market for the narrow market to be rejected.[21]

Table 1 – Critical Loss vs. Predicted Actual Loss (for a five percent SSNIP)

Margin	Critical Loss (%)	Implicit elasticity	Est. Elasticity	Predicted Loss (%)	Critical/Predicted
0.9000	5.2632	1.0526	1.1111	5.5556	.9474
0.8000	5.8824	1.1765	1.2500	6.2500	.9412
0.7000	6.6667	1.3333	1.4286	7.1429	.9333
0.6000	7.6923	1.5385	1.6667	8.3333	.9231
0.5000	9.0909	1.8182	2.0000	10.0000	.9091
0.4000	11.1111	2.2222	2.5000	12.5000	.8889
0.3000	14.2857	2.8571	3.3333	16.6667	.8572
0.2000	20.0000	4.0000	5.0000	25.0000	.8000
0.1000	33.3333	6.6667	10.0000	50.0000	.6667

Farrell and Shapiro parameterize the sales diverted to other firms in the proposed market by the Aggregate Diversion Ratio, which they denote as "A." The sixth column in Table 1 is equal to 1-A. Whether expressed as A or 1-A, the basic point Farrell and Shapiro try to make is that when margins are moderate to high, only a very small share of the lost sales must

[20] The market elasticity must equal or exceed (be less elastic than) the firm-level elasticity, because a firm's departing customers may switch to other products in the market, while industry customers searching for alternative products must switch to suppliers outside the market. Obviously, the concept also requires the analyst to be able to define a composite good to aggregate the differentiated products together.

[21] This calculation matches the results in O'Brien & Wickelgren's Table 1 for a five percent SSNIP (the 7.69 percent recovery by firms within the market is the same as a 92.31 percent loss to firms outside the market, O'Brien & Wickelgren, *supra* note 7, at 174). Because the Lerner index assumes profit maximization, the predicted Loss from a pure Lerner Index model must be more than the Critical Loss.

be diverted to other firms in (or a very large share of the lost sales must diverted to other firms outside) the candidate to confirm (reject) a candidate market.

Farrell and Shapiro summarize their result as follows:

> **Proposition 1**: If each firm owns a single product and prices to maximize its profits and if demand is linear in price for small price changes starting from the premerger price, then a symmetric group of products forms a market under break-even analysis if:
>
> A≥ S/ (M+S) (where S is the SSNIP and M the margin.)[22]

According to Farrell and Shapiro, Proposition 1 means that the standard Merger Guidelines implementation of the SSNIP will generally lead to narrow markets for high-margin industries. Essentially, the diversion must be larger than the Critical Loss, which ranges from 5 percent to 33 percent (for margins ranging from 10 to 90 percent) for a 5 percent SSNIP.[23] Looking at these diversion numbers (5-33 percent), one might think superficially that they are very low thresholds that would generally result in narrow markets even in low-margin industries.

This proposition, however, only results in narrow markets if there will be sufficient diversion in the face of an across-the-board price increase by ***all of the firms in the market***. But why would customers divert volume among firms that are raising prices jointly, as opposed to diverting volume to firms that are not raising price? For example, if Mercedes, BMW, and Audi all raise prices simultaneously by the same amount, why would we expect any Mercedes customers to switch to BMW or Audi? We think that generally the Mercedes customers would not but, at a minimum, it is an empirical issue. If the answer is that we do not expect such switching, then the Farrell & Shapiro approach (with a linear demand curve) would result in expanding the candidate market for across the board SSNIPs because A would be very close to zero and thus, will be less than S/(M+S) in their Proposition 1. This result is the opposite of the one they seek to draw.

III. AGGREGATION NEEDS TO BE MODELED

The theorists attempt to deal with this problem using the following structure. Rather than start with an across the board SSNIP, they hypothesize a series of sequential price increases for the firms in the market. That is, they impose, firm by firm, the single-firm price increase, compute the firm-specific diversions, and then aggregate.[24] Following Farrell & Shapiro's example, let BMW raise its price by the SSNIP, while the other prices remained constant; then let Mercedes raise its price rise by the SSNIP, but let BMW's price remain at the higher level, while the prices of the other rivals remain fixed. The process repeats itself for Audi, as it sees the prices of all its competitors at the high level, and imposes its own SSNIP. As each price increases, some output would divert around, moving first to competitors with lower

[22] Farrell & Shapiro, *supra* note 4 at 5. Technically, the break-even concept of the hypothetical monopolist means the firms in the market simply impose the SSNIP even if a lower price increase would be more profitable.

[23] Replace the linear with a "constant elasticity" demand curve, and the critical diversion falls to a range from .3 to 10.5 percent. O'Brien & Wickelgren, *supra* note 7, at 175.

[24] In the Katz & Shapiro paper (*supra* note 13, at 54), a sequential aggregation scheme is suggested, but the reader is cautioned, at footnote 31, that aggregation could cause the "aggregate diversion ratio" facing one firm to fall when the prices of the other firms in the market are increased. We are aware of no attempt to parameterize this effect.

prices and then possibly back to the original firm now selling at the high price or possibly out of the market entirely as the customers are unable to find any supplier in the candidate market holding the competitive price.

Using the linear demand structure, however, Farrell and Shapiro find that the diversion to other firms in the market caused by a single firm raising price is the same as when all firms in the market raise price at the same time. Thus, given their construct, Farrell and Shapiro predict the substantial diversion among firms in a market will not be lost to entities outside the market when all of those firms impose an across the board SSNIP. What Farrell and Shapiro appear to assume is that the product differentiation in the market leads to a relatively inelastic demand for the specific products in the hypothetical market, such that consumers are willing to pay the higher prices to retain access to the unique characteristics of the in-market products. When just one firm raises price, customers divert to close rivals, but when the across-the-boards SSNIP is imposed, customers remain with an in-market supplier. Obviously, this could happen, but it is an empirical question.

We suggest that this modeling structure often obscures the reality faced by customers in responding to a series of price increases (or the analogous simultaneous market-wide SSNIP). Firm level Diversion, A, is estimated based on the assumption that only the price of the firm's own product changes.[25] All other prices remain the same. However, in the sequential analysis discussed above, all prices eventually change. For example, take the situation faced by the customers of BMW that choose to divert to Mercedes and Audi to obtain a substitute product at a lower relative price. At the end of the sequential analysis, these customers find all the prices are higher. In effect, they have three choices: return to their original supplier; remain with their alternative supplier; or leave the narrow market. Farrell and Shapiro exclude this last alternative by their choice of mathematical structure. Customers are simply denied the option of switching to Japanese luxury cars when the prices of all German luxury cars increase together. This limitation may have significant effects.[26]

To account for all three potential customer responses, we suggest that an Aggregate Retention Rate (R) is needed to define the percentage of the sales "initially" diverted from each firm to its rivals within the market in response to a single-firm SSNIP that is retained by firms within the market when all the rivals raise price by the SSNIP. The modeling assumptions imposed by Farrell and Shapiro are equivalent to setting $R = 1$ and thus all sales initially lost to an in-market competitor by any entity in response to the first stage SSNIP analysis end up as retained by the firms within the proposed market. An alternative structure would set $R = 0$ and assume that the marginal customers would switch to out-of-market suppliers when all the firms in the market raise price by the SSNIP.

[25] Farrell and Shapiro report "that A is calculated on the assumption that the price of one product changes and the other prices do not." Farrell & Shapiro, *supra* note 4 at 6.

[26] While Farrell and Shapiro explicitly assume linearity to obtain their result, all they really need is a first-order Taylor's series expansion for the relevant demand system. Exclude the higher-order derivatives and their result obtains. However, real world systems of demand equations can not always be accurately linearized and, thus, empirical evidence suggesting substantial switching in a high margin market is easy to reconcile with optimization models of economics. All that is needed is a set of second (and higher order) derivative effects to "offset" part (or even all) of the first order Farrell & Shapiro diversion result. In effect, the "diverted" customer, seeing the prices for all differentiated products rise by a SSNIP, may find some alternative outside the market.

More complicated modeling structures could impose any value on R between 0 and 1, but the fact remains that the modeling structure would assume the value of the key parameter.[27] Theoretical Lerner Index analysis, parameterized with market data for linear equations, cannot conclusively define the predicted Actual Loss, because the value of the Retention Rate parameter is an empirical question. Natural experiments could generate an implicit estimate of the retention parameter by combining Lerner analysis with a direct measure of the predicted Actual Loss for the proposed market to back out the Retention Rate. However, the predicted Actual Loss is sufficient to complete the Critical Loss arithmetic; thus making the estimation of the more complex modeling structure redundant.

IV. AN EXAMPLE OF DIVERSION ANALYSIS WITH A RETENTION PARAMETER

We use a simple example to illustrate the market-narrowing potential of the FKS approach. Assume that there are nine equally-sized firms each selling a separate differentiated product, along with one composite actor representing the other alternatives, such that volume diverts equally among them (eight firms and outside choice) for any firm-specific unilateral price increase. Each firm takes one-ninth (11.1 percent) of the volume lost by the firm raising price by the five percent SSNIP.[28]

To demonstrate the impact of the differences among the market definition concepts, we first model the analysis with a very low margin of 10 percent and assume that half of the sales diverted to competitors return to the firm raising price if the rival that obtained diverted sales also raises price, and that the other half are diverted to firms outside the proposed market (*i.e.*, the Retention Rate is 50 percent).

Going back to Table 1 momentarily, recall that it shows the Critical Loss for a ten percent margin is 33 percent. Thus, if the modeling exercise shows an actual loss above 33 percent, the collection of firms does not comprise a relevant market. Likewise, Table 1 estimates the Actual Loss under the Lerner Index model as 50 percent. Under the Farrell & Shapiro analysis, this implies (as per Proposition 1) that a narrow market survives if 33 percent (or more) of this 50 percent loss in sales is diverted to firms within the market boundaries. Our more complex analysis requires a more detailed review of these "diverted sales" to be sure that they are retained by a firm within the market in response to the market-wide SSNIP. Overall, we show that market definition turns on the interaction of the Diversion Ratio and the Retention Rate.

Table 2 illustrates these calculations. The first column shows the number of firms in the candidate market. The second column computes the Aggregate Diversion Ratio to other firms inside the candidate market, and the assumed Retention Rate is provided in the third column.

[27] The concept of a retention rate could be illustrated for a class of relatively homogeneous goods. First select M firms producing homogeneous goods for inclusion in a hypothetical market and N firms producing the same good for exclusion. When a single-firm SSNIP is imposed, some of the customers of the affected firm switch to the M-1 firms within the market and others to the N firms outside the market. For a market-wide SSNIP, virtually all customers of the M firms will switch to the N firms outside the market. Thus, while a firm-specific aggregate diversion index can be calculated, the Retention Rate is almost 0, leading to the conclusion little market-wide diversion will occur. If all M+N firms are included in the market, the firm-level diversion rate will be large. The Retention Rate will probably be substantial, because all the M+N firms are now in the market. Still, some of the diverted sales will leave the market in response to an across the boards SSNIP. The exact level of retention depends on the overall elasticity of demand and the firm-level diversion.

[28] The composite entity is referred to as a firm for brevity of explanation. In effect, "firms not in the market" can be read as "firms not in the market and the composite entity for outside alternatives."

The fourth column provides the volume lost directly to firms outside the candidate market, which is the estimated Actual Loss (50 percent) multiplied by the share lost to firms NOT in the candidate market (*i.e.*, not diverted to firms in the proposed market). For a two firm candidate market, the direct loss multiplies the number of firms outside the market (eight) by the 11.1 percent lost to each firm and then by the overall sales loss (50 percent) to get .4445.

In addition, because firms 1 and 2 will both raise prices in the standard SSNIP, we need to calculate what we term as the indirect loss as well. Recall that we suggest that when firm 2 also raises price, the market will lose some of the sales retained after firm 1's price increase. We assume a Retention Rate of 50 percent so that the firms in the candidate market will be able to keep one-half of what was initially diverted to firm 2 when firm 2 follows firm 1 and raises price. Thus, for the two firm candidate market, we multiply the number of other firms inside the candidate market (*i.e.*, 1) by the 11.1 percent, then by the output lost (50 percent) and finally by the Retention Rate of 50 percent to compute .0278. The sixth column shows Total Loss, which simply sums the two Loss columns and defines the predicted Actual Loss.

Table 2 – Market Definition for Standard SSNIP with Diversion and Retention

Number of Firms	Diversion Ratio	Retention Rate	Direct Loss Outside	Indirect Loss	Total Loss
2	.1111	.5	.4445	.0278	.4723
3	**.2222**	**.5**	**.3889**	**.0556**	**.4445**
4	.3333	.5	.3333	.0833	.4166
5	.4444	.5	.2778	.1111	.3889
6	.5556	.5	.2222	.1389	.3611
7	.6667	.5	.1667	.1667	.3333
8	.7778	.5	.1111	.1944	.3055

CLA simply compares the level of Critical Loss (33.3 percent from Table 1 for a margin of .1) with the predicted Actual Loss. For the Farrell & Shapiro analysis, we read the resulting Actual Loss off the direct loss outside column (because Farrell and Shapiro implicitly set the Retention Ratio to 1) and find the market will include four rivals.

When accounting for the Retention Rate (.5 in this example), the final column (total loss) is controlling. Thus, if two firms raise price by the SSNIP, these entities will each lose 47.23 percent of their sales to entities outside the proposed market, a loss well above the Critical Loss and thus this market definition fails. The market is expanded by adding rivals until seven firms are in the market, since this seven-firm market just passes the Critical Loss test when the Retention Rate is considered. Thus, the market definition under the Farrell & Shapiro approach is almost half the size of a market defined with a 50 percent retention ratio (4 firms vs. 7 firms).

It is possible to undertake the same analysis for a range of values for the margin and Retention Rate. As shown in Table 3, decreases in the retention from 100 percent (the standard FSK assumption) to 10 percent (only 10 percent of the lost sales are diverted to rivals within the market remain with firms within the market in response to an across the boards SSNIP) broaden out the market towards the homogeneous goods baseline of 9 firms.[29] Likewise, lowering the margin from .9 to .1 also broadens out the market. While using the high margin of .9 generally suggests that markets must be narrow (2 or 3 firms), 6 firms will remain in the market if the retention parameter is set a 10 percent.

Table 3 – Number of Firms in Market by Retention Rates (for a five percent SSNIP)

Margin	Retention set to 100 percent	Retention set to 50 percent	Retention set to 25 percent	Retention set to 10 percent
0.9000	2 firms	2 firms	3 firms	6 firms
0.8000	2 firms	3 firms	4 firms	7 firms
0.7000	2 firms	3 firms	4 firms	7 firms
0.6000	2 firms	3 firms	4 firms	8 firms
0.5000	2 firms	3 firms	5 firms	9+ firms
0.4000	2 firms	3 firms	5 firms	9+ firms
0.3000	3 firms	4 firms	7 firms	9+ firms
0.2000	3 firms	5 firms	9 firms	9+ firms
0.1000	4 firms	7 firms	9+ firms	9+ firms

Two points emerge from Table 3. First, the use of the FKS approach (retention rate of 100 percent) generates narrow markets (with between 2 and 4 rivals) for all possible values of the margin (as defined in column 2). Thus, instead of just narrowing the market definition for high margin markets, the FKS approach narrows markets for all values of the margin parameter. Second, generalizing the FKS approach for the Retention Rate shows that anything can happen. Markets may remain broad for low margins and low Retention Rates or narrow dramatically for large margins and high Retention Rates (closer to the FKS assumption). Market definition must be considered an empirical question. Theory may raise interesting questions

[29] For very low values of the margin and retention parameter, the level of actual diversion to rivals within the market is too small to overcome the difference between the Critical Loss and the Lerner estimate of Actual Loss (both given in Table 1) for any market structure. In this case, the dynamics of competition implicit in this particular simulation model preclude the definition of any narrow market and more than 9 rivals (9+ firms) must compete in the market. It is important to remember that our model is designed only to illustrate the need to consider the effect of an across-the-boards SSNIP when undertaking merger analysis and not focus on the simulation result that seems to show differentiated products may result in broader markets than homogeneous goods.

and suggest needed lines of analysis (*i.e.*, is the product differentiated material?), but the Actual Loss from a SSNIP remains an empirical question.

V. MARGINAL COST AND DIVERSION ANALYSIS

The measure of the marginal cost that defines the Lerner index represents a final and often ignored problem with the entire FKS methodology.[30] In a theoretical analysis, the relevant marginal cost is the economic cost to produce the very last unit of output. In contrast, the appropriate cost under the standard CLA is the incremental cost associated with output lost to a SSNIP, an output that could vary from a few percent to 20 percent or more of the premerger output. As a result, there is no reason to assume that the average incremental cost will be the same—or even close—to the theoretical marginal cost. Thus, the determination of the elasticity of demand from an estimate of the incremental margin may easily generate a misleading result. Unless the analyst can measure the marginal cost at the market equilibrium, the elasticity of demand cannot be accurately estimated even assuming the applicability of the Lerner Condition. And even when the theoretical marginal cost can be measured, the Critical Loss analysis will need both the theoretical and incremental marginal cost variables to complete the analysis.

Thus, a more complete Critical Loss analysis would combine the adjustment for the Retention Rate (detailed in Table 3) with two estimates of the margin (a margin driven by the generally higher value of the theoretical marginal cost needed for the Lerner calculation and a margin defined by the generally lower incremental cost associated with the output lost to the SSNIP needed for the Critical Loss calculation). Use of a low margin in the Lerner analysis generates an initial estimate of a relatively large Actual Loss (from Table 1, a 20 percent margin leads to a predicted loss of 25 percent), but the diversion/retention analysis may reduce the Actual Loss substantially. This adjusted loss is the estimate of the predicted Actual Loss that is then compared to the breakeven Critical Loss benchmark computed using the higher margin (and tabulated in the second column in Table 1). Empirically, no strong conclusions can be drawn, because the differences in the two margin estimates, the diversion rate and the retention variable all interact in the revised Critical Loss Analysis calculation. Once the market conditions associated with the Critical Loss Analysis are fully considered, it is clear that market definition must remain an empirical process.

V. CONCLUSION

Other than a call for more careful analysis, it is hard to take much away from the Farrell, Katz, and Shapiro critique. They argue that their diversion parameter A is controlling, while never really explaining the strength of their results (virtually all markets are narrow) or the special case nature of their mathematical modeling. Moreover, their entire methodology collapses if the analyst is unable to estimate the theoretical marginal cost. Once more general demand structures are considered, it becomes clear that anything can happen. Thus, in differentiated

[30] Bauman & Godek, *supra* note 6 at 3. Their analysis is comparable to Coate & Williams (*supra* note 5) but focuses on profit maximizing price increases, instead of break-even price increases.

goods markets, critical loss remains an empirical issue and empirical evidence on actual loss is required to apply a critical loss test. Theory cannot trump fact.

VI. APPENDIX —THE VARIABLE SSNIP TEST AND CRITICAL LOSS

The 1992 Merger Guidelines introduced a variable SSNIP structure for market definition in which the hypothetical monopolist was required to: (1) raise the price of a product (product line) offered by one of the merged firms by the SSNIP, and (2) ensure that this price increase, when coupled with optimal price increases for the other products in the proposed market, was more profitable than smaller potential price increases. Ordover & Willig explained how the variable SSNIP enables the definition of a relevant market when various groups of products are relatively close competitors.[31]

In the Ordover & Willig example, a frozen string bean monopolist is unable to raise price by five percent without losing too many sales to frozen carrots.[32] The frozen bean/carrot monopolist still cannot raise price by five percent without losing too many sales to frozen spinach. The analysis could continue and chain together all frozen vegetables. In effect, the standard SSNIP analysis could create a huge market and totally miss the potential for market power in market niches like string beans and carrots. The bean/carrot monopolist could behave in a less-than-competitive manner by charging the full five percent SSNIP for beans and a smaller price premium for carrots. This price increase might be profitable and thus the standard SSNIP methodology needs to be tweaked to define a relevant market in which to study this special case situation.[33] The variable SSNIP methodology provides the required algorithm.[34]

Starting with this 1992 special case generalization of the standard SSNIP, it is possible to consider the implications of the Lerner index analysis for market definition when only one price is increased by the SSNIP. The variable SSNIP modeling structure allows the prices of the other products in the market to rise by a de-minimis amount—or even by nothing at all—once one price has increased by the SSNIP and, thus, a single-firm SSNIP merits consideration. Moreover, holding the prices charged for rival products constant would rehabilitate Farrell & Shapiro's mathematical concept, because the math defines the adjustment in the single firm Critical Loss Analysis required for diversions to closely related products.[35] As Ten Kate and Niels have proved, aggregate diversion only needs to be greater than the ratio of the SSNIP to

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[31] Ordover & Willig, *supra* note 10

[32] *Id*. at 140.

[33] The reader might find a geographic market analysis more convincing. For example, in the suburbs of Washington D.C., the price of gasoline in Annandale is constrained by the price in Fairfax, Springfield, and Falls Church. These prices are constrained by pricing in communities such as Vienna, Arlington, and Burke. This chain could easily expand to cover the entire Washington D.C. area and might even chain north to Boston and south to Richmond. Abstracting from the fact that the function of cars is to drive around (and thus the consumer can buy gas whenever they are in a distant, low-priced community), a variable SSNIP market might be sustainable with a standard SSNIP for Annandale and smaller price increases in the surrounding communities of Fairfax, Springfield, and Falls Church.

[34] Only one possible example of this analysis has been identified in a review of FTC mergers and even this example seems better understood as an "in the alternative" market definition argument, so the situations envisioned by Ordover and Willig turn out to be extremely rare. See, Coate & Fischer, *supra* note 16 , at fnt 57.

[35] Here, the analyst relaxes the Guidelines' requirement of profit maximization by using the breakeven critical loss structure.

the margin for a single-firm SSNIP to isolate a narrow market.[36] In this theoretical SSNIP world, markets are almost always narrow, even for relatively low-margin industries. The math works, and the analyst needs only to parameterize the model.

Recycling the German car example, assume a number of potential BMW customers would likely substitute to Mercedes or Audi, given the prices of these products do not materially change in response to the SSNIP affecting the price of BMWs. Thus, predicted Actual Loss in the German luxury car market would need to be adjusted to reflect the sales retained by competitors in the narrow market. Virtually any diversion to products within the proposed market could easily reduce the predicted Actual Loss to a level below the Critical Loss and support a narrow market. Moreover, the model does not even require high margins. If the margin is only 20 percent, the Ten Kate & Niels formula shows that the narrow market would be upheld as long as 25 percent of the lost customers choose the in-market substitute products. It seems quite reasonable to expect one in four disgruntled BMW customers to pick Mercedes or Audi and thus substantiate the narrow German luxury car market.

There are problems with any variable SSNIP approach. To be most useful, the theoretical version of the variable SSNIP must serve to focus the competitive analysis in both collusion and unilateral effects situations. For collusion analysis, the flaw is obvious—only one price must materially increase to define a market. To be credible in a variable SSNIP market, the collusion story must include some type of side-payment mechanism that allows the merged firm to share its profits with competitors that basically hold prices constant. Most, if not almost all side-payment schemes require explicit collusion and thus would be very unlikely to occur after a merger. In effect, the variable SSNIP structure appears likely to preclude collusion analysis.

For unilateral effects analysis, the problems are more subtle. While a variable SSNIP would focus the analysis on a particular theory of concern, it would also artificially narrow the scope of competition within the market. These restrictions are based on the parameterization of the price model, so the exclusion of somewhat distinct rivals would not distort the estimation of a unilateral price effect.

However, modeling the price increase is not the end of the unilateral analysis. Repositioning issues are crucial and the variable SSNIP market is also used to address this problem. Firms selling somewhat similar products can be excluded from the market, because a sufficient number of the merged firm's customers purchase other products in the narrow market in response to the variable SSNIP such that the price increase is profitable. Thus, the repositioning of the firms selling somewhat similar products is never considered in the competitive effects analysis, but put off until the overall entry analyses.[37]

In theory, sophisticated entry analyses could address this point, but the exclusion of the affected firms amounts to burden shifting.[38] Moreover, the Guidelines' likelihood of entry

[36] Ten Kate & Niels, *supra* note 8 at equation 6.

[37] If the repositioning could occur within one year, with minimal expenditure on sunk costs, the excluded demand side rivals would need to be included in the market on the supply side. In this case, the variable SSNIP analysis would generate the same market as the standard SSNIP.

[38] It is well known that merger law requires the plaintiff to substantiate an anticompetitive effect stemming from a merger. By using a variable SSNIP to artificially exclude competitors from the market, the plaintiff avoids bearing its full burden.

analysis models sales opportunities available from the incumbents, while repositioning analysis could consider some of the repositioning firm's current sales as available to build an efficient scale operation. Likewise, an incumbent firm repositioning its product might be expected to capture a larger share of the market growth. By artificially excluding somewhat similar firms from the relevant market, the variable SSNIP structure generally biases the analysis in favor of finding a competitive concern.[39]

While we admire the mathematical elegance of the theoretical single-firm SSNIP implementation of the Guideline's variable SSNIP construct, the methodology suffers from a collection of disadvantages associated with firm-specific price increases. At best, these methodologies can offer only a special case customization of the standard market definition analysis. No commentator has described the use of any variable SSNIP for market definition by the FTC or the DOJ in any investigation, and we're not aware of one.[40] Markets should be defined to allow the evaluation of any competitive effects concern and, as we show, the variable SSNIP model often generates narrow markets with very limited usefulness. Thus, a variable SSNIP methodology is not likely to be relevant in the Critical Loss debate.

[39] Theorists are likely to observe that the market definition process does not aid the analysis when the unilateral effects of a merger can be estimated directly. It is important to note that market analysis plays an important role in the choice of the priced-based modeling structure. As Coate and Simons point out, competitive analysis can also proceed under the assumptions of either product homogeneity or dynamic differentiation. (Coate & Simons, *supra* note 14). Either structure may identify problems with the performance evidence used to identify a competitive concern and thus it is necessary to fully evaluate the competitive environment.

[40] One possible exception is the recent case involving the FTC and Whole Foods where the FTC's expert, Professor Murphy, arguably advocated the aggregate diversion ratio approach in conjunction with a variable SSNIP. To the extent Murphy proposed such an approach, it does not appear that the judges or the lawyers involved recognized that he was doing anything out of the ordinary. Ilene K. Gotts, Joseph J. Simons, George T. Conway, & Aidan Synnott, *Recent DC Circuit Decisions in Whole Foods Leave Standard for Future Mergers Unsettled*, 12 COMPETITION L. INTERNATIONAL 2009.