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Critical Loss Analysis in Market Definition and Merger Control

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Non-technical summary

The last couple of years have seen an increasing interest in critical loss analysis, both, in academia and in practice. This development is documented by various research papers, high-level exchanges between antitrust experts as well as an increasing number of case decisions – in the United States as well as in Europe – which make use of some form of critical loss analysis.

Generally, critical loss analysis is considered as one empirical method to investigate the closeness of competitive interaction triggered by supply-side and demand-side substitution. The critical sales loss is the decrease in sales resulting from a particular price increase that is just large enough so that a hypothetical monopolist or a merged entity, respectively, would not impose a price increase of at least that amount. If the actual loss following such a price increase is found to be less than the critical loss, the price increase would pay; otherwise it would not.

In this context, it is the aim of this article to describe the general method of critical loss analysis, to assess important properties of the concept, to show how critical loss analysis has to differ between market definition exercises and the evaluation of the competitive effects of horizontal mergers and to discuss applications of critical loss analysis in recent cases.

As a general result it can be said that an application of critical loss analysis in practice is often not as straightforward as the presentation of the general theoretical concept might suggest. In fact, the method has to be applied with great care in order to receive meaningful results. On the one hand, it is shown that the critical loss might be sensitive to changes in the calculation method as well as the underlying demand and cost functions. On the other hand, the success of a critical loss analysis critically depends on the accuracy of the estimation of the actual loss. As indicated by both high-level theoretical exchanges (sketched partly in Section D.) and the review of two recent antitrust cases (sketched in Section E.), this often turns out to be the key challenge in a critical loss analysis.

Das Wichtigste in Kürze

In den vergangenen Jahren hat die Bedeutung von sogenannten Critical Loss Analysen in der Wettbewerbspolitik deutlich zugenommen – dies gilt sowohl für das wissenschaftliche als auch für das praktische Umfeld. Diese Entwicklung lässt sich beispielsweise ablesen an der Veröffentlichung verschiedener Arbeitspapiere, Diskussionen zwischen Wettbewerbsexperten sowie einer ansteigenden Anzahl an Fallentscheiden – sowohl in den Vereinigten Staaten als auch in Europa – die auf die Durchführung einer Critical Loss Analyse explizit Bezug nehmen.

Grundsätzlich ist die sogenannte Critical Loss Analyse eine empirische Methode zur Untersuchung der Intensität (angebots- und nachfrageseitiger) wettbewerblicher Interaktion. Unter dem Critical Loss wird dabei diejenige Reduktion der abgesetzten Menge in der Folge einer Preiserhöhung verstanden, die gerade groß genug ist, um diese Preiserhöhung für einen hypothetischen Monopolisten oder die fusionierenden Parteien unprofitabel werden zu lassen. Wenn nun der Actual Loss kleiner als der Critical Loss ist, so würde sich ein Preisanstieg lohnen, andernfalls würde er sich nicht lohnen.

Vor diesem Hintergrund ist es das Ziel dieses Beitrags, die generelle Methode der Critical Loss Analyse zu beschreiben, wichtige charakteristische Elemente des Konzepts zu identifizieren, Unterschiede in der Anwendung des Konzepts bei der Marktabgrenzung und der wettbewerbspolitischen Einschätzung der unilateralen Effekte von horizontalen Unternehmenszusammenschlüssen zu verdeutlichen sowie einige praktische Anwendungen des Konzepts in Wettbewerbsfällen zu diskutieren.

Als zentrales Ergebnis kann festgehalten werden, dass eine Anwendung der Critical Loss Analyse keinesfalls so einfach ist wie das überschaubare theoretische Konstrukt vermuten lassen mag. Tatsächlich sollte das Konzept nur mit großer Vorsicht angewandt werden um aussagekräftige Ergebnisse zu gewährleisten. Auf der einen Seite wurde in diesem Zusammenhang gezeigt, dass die Höhe des Critical Loss sowohl von der Berechnungsmethode als auch von den Ausprägungen der jeweiligen Nachfrage- und Kostenfunktionen abhängt. Auf der anderen Seite wurde verdeutlicht, dass der Erfolg einer Critical Loss Analyse steht und fällt mit der Genauigkeit der Abschätzung des sogenannten Actual Loss. Theoretische Diskussionen zwischen Wettbewerbsexperten (skizziert in Abschnitt D.) sowie die Betrachtung zweier praktischer Wettbewerbsfälle (skizziert in Abschnitt E.) zeigen, dass darin oftmals die zentrale Herausforderung in der Anwendung einer Critical Loss Analyse besteht.

CRITICAL LOSS ANALYSIS IN MARKET DEFINITION AND MERGER CONTROL

KAI HÜSCHELRATH*

Abstract The last couple of years have seen an increasing interest in critical loss analysis, both, in academia and in practice. This development is documented by various research papers, high-level exchanges between antitrust experts as well as an increasing number of case decisions which make use of some form of critical loss analysis. In this context, it is the aim of this article to describe the general method of critical loss analysis, to assess important properties of the concept, to show how critical loss analysis has to differ between market definition exercises and the evaluation of the competitive effects of horizontal mergers and to discuss applications of critical loss analysis in recent cases. The results suggest that the application of critical loss analysis in practice is often not as straightforward as the rather simple theoretical concept might suggest. In fact, the method has to be applied with great care in order to receive meaningful results.

Keywords Antitrust, competition policy, market power, market definition, merger control, unilateral effects

JEL Class L40, L41, L50, K21

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A. INTRODUCTION

The question of which factors constrain a firm from raising its price is at the heart of antitrust policy. In almost every market definition exercise or horizontal merger investigation, this question has to be answered in order to come to meaningful conclusions on the relevant market or the competitive effects of a proposed merger.

The size of the reduction in demand following a price increase – and therefore the key constraint which might hinder firms to raise their price – is determined by two factors: supply-side substitution and demand-side substitution. On the supply side, competitor firms which offer (or could offer) products which are (or would be) considered as substitutes constrain the behaviour of a firm. On the demand side, reactions by customers to price increases limit the market power of a firm as consumers might reduce their demand (lost sales per customer) or even decide not to consume the product at all (lost customers) in response to an increase in price.

In this context, critical loss analysis is considered as one empirical method to investigate the closeness of competitive interaction triggered by supply-side and demand-side substitution. Generally, the critical sales loss is the decrease in sales resulting from a particular price increase that is just large enough so that a hypothetical monopolist or a merged entity, respectively, would not impose a price increase of at least that amount. If the actual loss following such a price increase is found to be less than the critical loss, the price increase would pay; otherwise it would not.

The most common applications of critical loss analysis are the definition of relevant market and the assessment of unilateral effects in horizontal merger investigations. With respect to market definition, critical loss analysis helps to answer the question raised by the 'small but significant non-transitory increase in price' (SSNIP) test. With respect to horizontal mergers, critical loss analysis can help to assess the question whether and to what extent the merged entity can use its increased market power to increase prices post-merger.

Against this background, it is the aim of this article to describe the general method of critical loss analysis (Section B.), to assess important properties of the concept (Section C.), to show how critical loss analysis has to differ between market definition exercises and the evaluation of the competitive effects of horizontal mergers (Section D.), to discuss applications of critical loss analysis in recent cases (Section E.), and, finally, to come to some general conclusions for its meaningful application in antitrust analysis (Section F.).

B. DEFINITION AND ECONOMIC FOUNDATIONS

In general, an increase in price has two opposing effects on profits. First, it increases the margin and thereby has a positive effect on the change in profits. However, second, it typically leads to a reduction in demand thereby reducing the number of sales for which the higher margin can be realised causing a negative effect on the change in profits. Overall, a price increase is profitable as long as the former effect tops the latter effect.[1]

In this context, the critical sales loss is defined as the decrease in sales resulting from a particular price increase that is just large enough so that a hypothetical monopolist or a

1 Technically, the effect of a reduction of demand on production costs would need to be taken into account as well.

merged entity, respectively, would not impose a price increase of at least that amount.[2] If the actual loss following such a price increase is found to be less than the critical loss, the price increase would pay; otherwise it would not. This basic characterisation of the method already indicates that critical loss analysis has to be conducted in three steps: The derivation of the critical loss (first step), the estimation of the actual loss (second step), and the comparison of the critical loss with the actual loss (third step). All three steps are described in the following.

1. First Step – Derivation of the critical loss

In the first step of a critical loss analysis, the critical loss must be derived. Based on the general definition given in the preceding paragraph, the standard critical loss can be derived formally as follows:[3]

Before the price increase the profits are given by

$$\pi_0 = (P_0 - c)Q_0 . \tag{1}$$

After the price increase the profits are given by

$$\pi_1 = (P_1 - c)Q_1 . \tag{2}$$

If $\Delta P = P_1 - P_0$ and $\Delta Q = Q_1 - Q_0$ is defined, the profits after the price increase can be expressed as follows

$$\pi_1 = (\Delta P + P_0 - c)(\Delta Q + Q_0). \tag{3}$$

To calculate the critical loss, the question has to be answered by how much the price can increase without realising a lower profit level:

$$\Delta\pi = \pi_1 - \pi_0 = 0 \;\Rightarrow\; \pi_1 = \pi_0 . \tag{4}$$

Inserting (1) and (3) into (4) leads to

$$(P_0 - c)Q_0 = (\Delta P + P_0 - c)(\Delta Q + Q_0). \tag{5}$$

Rearranging (5) leads to

$$\frac{\Delta Q}{Q_0} = \frac{-\Delta P}{\Delta P + P_0 - c}. \tag{6}$$

Adding $((1/P_0)/(1/P_0))$ on the right side of (6) leads to the following expression

$$\frac{\Delta Q}{Q_0} = \frac{-\Delta P/P_0}{\Delta P/P_0 + ((P_0 - c)/P_0)}. \tag{7}$$

If $\Delta P/P_0 = X$ and $((P_0 - c)/P_0) = M$ is defined, the critical loss formula is given by

$$-\frac{\Delta Q}{Q_0} = \text{critical loss} = \frac{X}{X + M}. \tag{8}$$

2 An alternative definition is the following: "The Critical Loss is the level of lost sales at which the group of producers is indifferent between raising the price and not raising the price i.e. where it has a negligible impact of profits"; C Veljanovski, "Quantitative Economic Techniques in EC Merger Control", Case Associates Working Paper (2004), 12.

3 A similar derivation of the standard critical loss formula can be found in D O'Brien and A Wickelgren, "A Critical Analysis of Critical Loss Analysis", FTC Working Paper (2003), 9-10.

Equation (8) basically says that the critical percentage loss of units sold is determined by the percentage change in price divided by the sum of the percentage change in price and the (gross) margin.

For given values of X and M it is straightforward to formally derive the critical loss. If the margin is, for example, given by M = 10% and the percentage change in price is assumed to be X = 5%, the critical loss is 0.33 or 33%:

$$CL = \frac{X}{X+M} = \frac{0,05}{0.05+0.10} = 0.3\overline{3}. \tag{9}$$

This calculation can be replicated for various combinations of values for M and X. Figure 1 plots the critical losses of such a matrix for price changes of 5% to 30% against margins of 10% to 80%.

Fig. 1. Critical losses for different margins and price changes

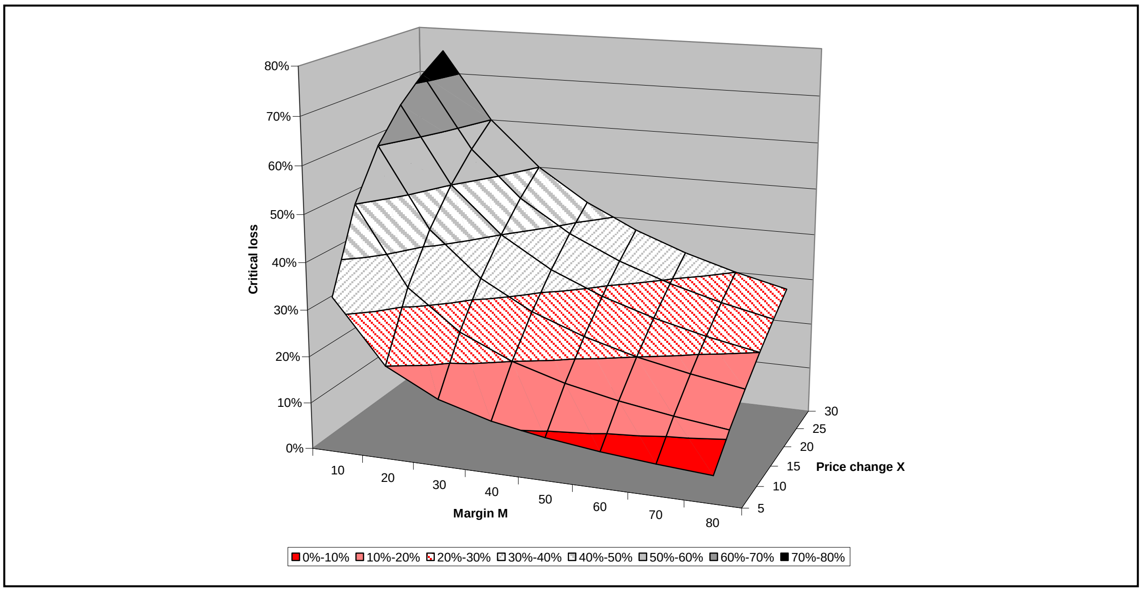

Figure 1 basically shows that the critical loss increases with the price change X and decreases with the margin M. For example, while a margin of 80% at a price change of 5% would lead to a critical loss of 5.88%, a margin of only 40% would increase the critical loss to 11.11%. Furthermore, while a price change of 5% at a margin of 40% would result in a critical loss of 11.11%, a price change of 10% at a margin of 40% would lead to a critical loss of 20%. This general result is also intuitively comprehensible: With high margins, the loss of a few customers will already have a significant impact on profitability while with low margins, more customers need to be lost in order to impose the same impact on profitability.

Although the derivation of the critical loss is arithmetically a straightforward exercise, in practice, the accuracy of the calculation depends to a great extent on the quality of the used data. In this respect, Froeb[4] urges that the critical loss should not be derived by simply using whatever the involved parties in a certain antitrust case call their margins. In order to receive meaningful results, disaggregated revenue and cost data needs to be collected in order to compute the margins suitable for critical loss

4 See L Froeb, "Regression Analysis & Market Delineation", Presentation at the ABA Spring Meeting (2008).

analysis. In particular, as argued by Gaynor et al.[5], the use of accounting data to calculate margins allows for discretion in the classification of fixed versus variable costs, since the analyst must use his own judgment in making the distinction between fixed and variable costs. "Specifically, there exists an incentive [for companies] to classify a large portion of their costs as fixed. As a larger portion of costs are classified as fixed, this forces measured variable costs to be low and thus results in the determination of a high contribution margin."

Additionally, it might not always be straightforward to derive a market price (or an aggregated form of industry output, respectively) that can enter the critical loss analysis right away. Even in relatively homogeneous markets, different package sizes, rebates or distribution channels etc. might complicate such an undertaking. This problem is aggravated when products become increasingly differentiated. As long as differentiation is not a key market characteristic, it might be acceptable to combine products together for a critical loss analysis; however, such a simplification would not be acceptable in markets in which product differentiation is too extensive to allow a meaningful aggregation of outputs.[6] In such cases, standard critical loss analysis is unlikely to result in reliable results (see Section D. below for recent research in this respect).

2. Second Step - Estimation of the actual loss

The derivation of a critical loss as such specifies how much substitution must occur as a consequence of a price increase in order to make that price rise unprofitable. In a second step, information must be collected to investigate to what extent such a demand- and supply-side substitution would actually take place in the case at hand. Such a 'real' or 'actual' loss can be defined as the percentage loss in unit sales predicted to result from a hypothetical price increase.

There are several ways to deduct information on the size of the actual loss. Harkrider[7], for example, generally differentiates between information about customer reactions to historical price changes, econometric evidence, customer interviews and affidavits as well as surveys. Customer interviews may, for example, provide information about specific customers or customer groups who would (or would not) switch to a substitute in case of a certain price increase. However, as reminded by Coate and Fischer[8], simply claiming that some customers are unwilling to switch is insufficient evidence as it does not show that other customers will not respond to a price increase (and therefore probably make the price increase unprofitable).

Although customer interviews as well as the other forms of qualitative evidence might help to answer the question of how many customers would switch in response to a hypothetical price increase, critical loss analysis typically aims at quantifying critical and actual losses with disaggregated sales and costs data and makes use of the available qualitative evidence for reality checks of the obtained results.[9]

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5 M Gaynor, S Kleiner and W Vogt, "A Structural Approach to Market Definition: An Application to the Hospital Industry", Carnegie Mellon University Working Paper (2006).

6 See MB Coate and JH Fischer, "A Practical Guide to the Hypothetical Monopolist Test for Market Definition" (2008) 4 *Journal of Competition Law & Economics* 1041.

7 See J Harkrider, "Operationalizing the Hypothetical Monopolist Test", Axinn, Veltrop & Harkrider LLP Working Paper (2004).

8 Coate and Fischer, *supra* n 6, 1042.

9 In this respect, it is important to remark that both demand- and supply-side substitution should be taken into account in the calculation of the actual loss. However, most methods proposed above focus on demand-side substitution raising the question whether supply-side aspects are systematically disregarded in standard critical loss analysis. This might have to do with the fact that the SSNIP test in

An obvious starting point of attempts to actually quantify the actual loss is to estimate the own-price elasticity of demand ε_{own}. Starting from its general definition for a given product – ε_{own}= (% change in quantity demanded / % change in price) – a simple rearrangement of the equation delivers a first expression for the derivation of the actual loss (for a linear demand curve): Actual loss = % change in price * ε_{own}. An application of the equation is straightforward. For example, in case of a 5% price increase and an estimated elasticity of 1, the actual loss would be 5%. Generally, the equation shows that the higher the price elasticity of demand, the higher is the actual loss in the event of the assumed price rise and vice versa.

Although the own-price elasticity certainly is a key factor in the estimation of the actual loss, it misses an important other driver by ignoring the cross-price elasticities of demand:[10] A price increase for a product A not only causes the unit sales of product A to fall by the amount of the price increase times the own elasticity of demand, but also causes the unit sales of a product B to rise by the amount of the price increase times the cross elasticity of demand. Assuming symmetric products A and B, an X % increase in the price of product A causes the unit sales of product A to fall by $X*E_{own}$ % and the unit sales of product B to rise by $X*E_{cross}$ %. Combining these effects, a price increase of X % for both products A and B causes a reduction in the unit sales of $X*(E_{own} - E_{cross})$ % for both products. Therefore, the actual loss in percentage terms experienced by a hypothetical monopolist from an X % price increase is given by: Actual Loss = $X*(E_{own} - E_{cross})$.

In practice, elasticities are best estimated by observing the impact of price changes on unit sales. However, such exercises typically not only require the availability of detailed price, cost and sales data, but also sufficient time to undertake the analysis. As a consequence, approximation methods are frequently used. One possible method is to make use of the well-known theoretical relationship that shows that the Lerner index $L = ((p - c)/p) = M$ is equal to the inverse of the firm's demand elasticity $1/\varepsilon_D^i$.[11] This relationship directly allows the derivation of the firm's price elasticity of demand by estimating the price-cost margin M.[12] Although this method looks like a simple and also practical instrument to estimate the demand elasticity, it unfortunately has several well documented general theoretical and practical drawbacks.[13]

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the US mainly focuses on demand-side substitution. However, the respective guidelines in the EU basically demand the inclusion of supply-side substitution at market definition level (and not only later in the case as part of an analysis of the competitive effects generally and the role of market entry barriers in particular). See also K Hüschelrath, *Competition Policy Analysis – An Integrated Approach* (Heidelberg, Springer, 2009), 165.

10 Following O'Brien and Wickelgren, *supra* n 3, 3-4, cross-price elasticities must be included in the estimation of the actual loss independent of the exact aim of critical loss analysis (market definition or merger control): "In the 'hypothetical monopolist test' outlined in the Merger Guidelines for defining markets, the hypothetical monopolist always controls multiple products. The question of whether a price increase would be profitable *cannot* be answered without accounting for the cross elasticities among the products under the monopolist's control. Similarly, since a merger alters the set of products under a firm's control, the analyst *must* account for cross elasticities when assessing the profitability of a post-merger price increase."

11 This relationship can be derived by simply rearranging a basic result of monopoly theory which shows that a firm with market power maximises profit when $p\left(1 - 1/\varepsilon_D^i\right) = c$.

12 See generally M Motta, *Competition Policy – Theory and Practice* (Cambridge University Press, 2004), 124.

13 From a theoretical perspective, George Hay expresses the concern that focusing on the Lerner index could easily lead to a general condemnation of firms with a high Lerner index value irrespective of the fact that they might have 'deserved' their high margins by offering superior products and not by

Interestingly, a current economic debate centres on the question whether accounting margins and the Lerner relationship should be used to estimate the actual loss.[14] While some commentators argue that the introduction of such simple models of market behaviour is long overdue in critical loss analysis, others are of the opinion that the Lerner equation oversimplifies real world pricing behaviour and will not offer guidance in market definition.[15] Those commentators find it superior to instead draw inferences about elasticity from qualitative evidence such as consumer surveys and industry expert opinions.

Without wanting to enter into a detailed discussion, more sophisticated tools to estimate the price elasticity of demand for differentiated product markets are available. One possibility is to construct a full demand system for all interrelated products. As the available data typically does not allow the estimation of all own- and cross-price elasticities, econometric theory keeps ready several models to tackle this 'dimensionality problem' by way of introducing specific assumptions and restrictions. While a Logit approach factually assumes that elasticities are proportional to market shares, the almost ideal demand system (AIDS) involves a model in which products are 'nested' together in order to allow an estimation of the cross-price elasticities within these groups.[16] A further technique often applied in practice is an estimation of the elasticity of the residual demand function.[17] The residual demand function is the demand function a single firm faces once the supply responses of all other firms are taken into account.

3. Third Step - Comparison of critical loss with actual loss

After deriving the critical sales loss and estimating the actual sales loss, both have to be compared in a third step. Is the actual loss in the market smaller than the critical loss, the increase in price would be profitable, otherwise it would not. It is obvious that the reliability of the conclusions drawn in the third step critically depend on the accuracy of

abusing their market power. See G Hay, "Market Power in Antitrust" (1991) 60 *Antitrust Law Journal* 814. Furthermore, an often-reported, related problem of the Lerner index refers to its reliance on perfect competition as the competitive benchmark. This assumption is typically critical in industries where 'substantial' fixed costs are incurred (for activities such as research and development in, for instance, pharmaceutical and software industries) and therefore 'substantial' price-cost margins are by no means a general indicator of market power but might simply be required to cover the substantial amounts of fixed costs. See K Elzinga, "Unmasking Monopoly: Four Types of Economic Evidence" in R Larner and J Meehan (eds), *Economics and Antitrust Policy (*New York, Quorum, 1989), 27. In order to make the Lerner index a meaningful measure in such environments, an appropriate alternative competitive benchmark would need to be fixed in the first place to allow a differentiation between 'margins realised to cover fixed costs' and 'margins realised due to the abuse of market power'.

14 See J Schmidt, "Critical Loss Analysis: A Merger Lawyer's View", Presentation at the Fall Forum of ABA Section of Antitrust Law (2007).

15 Baker argues that price-cost margins commonly provide limited information about the magnitude of the likely buyer response to an increase in price and therefore should not be used to draw conclusions about the demand elasticity. See J Baker, "Market Definition: An Analytical Overview", American University Working Paper (2006), 35.

16 See generally American Bar Association, *Econometrics: Legal, Practical and Technical Issues* (Chicago, ABA Publishing, 2006) for an in-depth characterisation of the econometric techniques and D Rubinfeld, "Market Definition with Differentiated Products: The Post-Nabisco Cereal Merger" (2000) 68 *Antitrust Law Journal* 163-185, for a practical application of the AIDS model to the breakfast cereal industry on the occasion of the Post-Nabisco cereal merger in the United States.

17 See generally J Baker and T Bresnahan, "Estimating the Residual Demand Curve Facing a Single Firm" (1988) 6 *International Journal of Industrial Organization* 283-300; Motta, *supra* n 12, 124-134.

the analysis in the first two steps. The implications of the comparisons for market definition and merger control are investigated in more detail in Section D. below.

C. IMPORTANT PROPERTIES OF CRITICAL LOSS ANALYSIS

Although the basic concept of critical loss analysis is straightforward, some caution in its application in antitrust cases is appropriate. As it will be shown in the following, the critical loss for a certain margin/price-change combination can be sensitive to changes in the calculation method as well as the underlying demand function. Additionally, an understanding of the underlying cost structure needs to be developed to receive meaningful results out of a critical loss analysis.

1. Calculation method

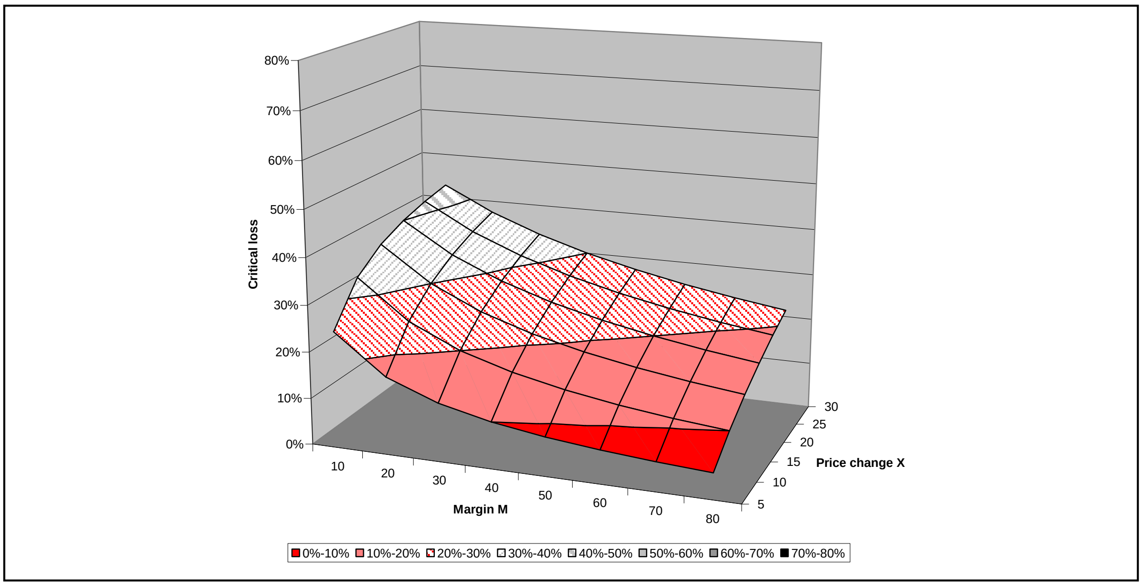
The standard critical loss is derived by answering the question whether a hypothetical monopolist *could* raise its price by a certain percentage value above the initial price P_0 without realising a lower profit level than in the initial situation. It was shown above that under such a *could-approach*, the critical loss can be calculated to CL=(X/(X+M)). However, such an approach does not answer the question whether the new price P_1 is the profit-maximising price for the monopolist or whether he has an incentive to either further raise or alternatively to lower the price in order to maximize its profit.

Consequently, an alternative way to calculate a critical loss is the so-called *would-approach*. Under such an approach, the question is asked whether a hypothetical monopolist *would* raise price a certain percentage above the initial price (because it is the profit-maximising price increase). As shown by Baumann and Godek[18], such an approach requires, first, the calculation of the profit maximising price and second, a comparison of that price to the initial price. If a linear demand function is assumed, it can be shown that the critical loss under a would-approach is given by CL=(X/(2X+M)).[19] Figure 2 plots the critical losses (would-approach) for price changes of 5% to 30% against margins of 10% to 80%.

[18] M Baumann and P Godek, "Could and Would Understood: Critical Elasticities and the Merger Guidelines" (1995) 40 *Antitrust Bulletin* 894-899.

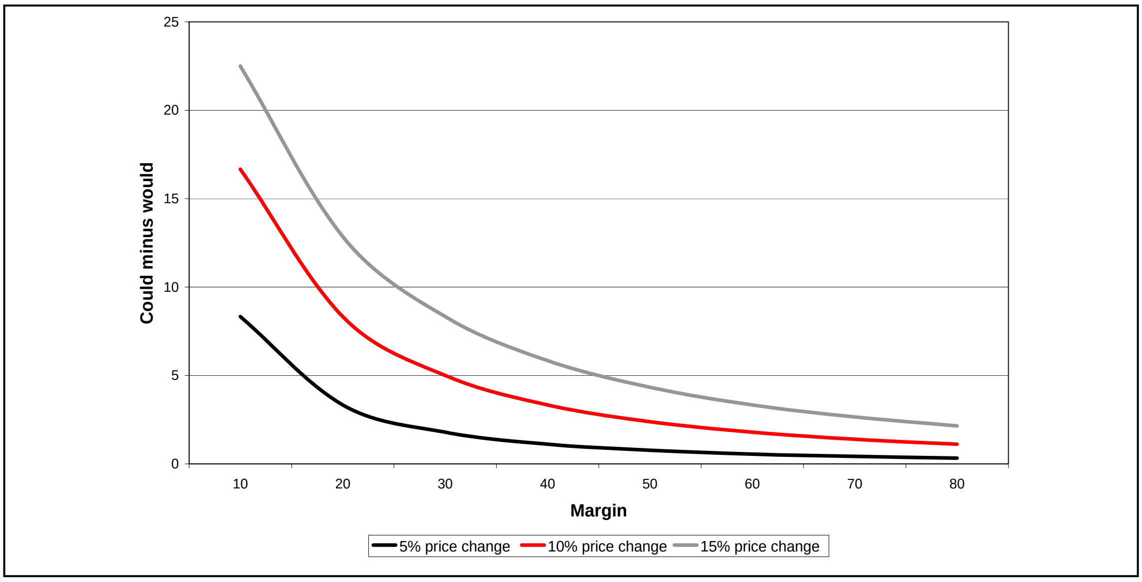
[19] For the proof, see G Werden, "Demand Elasticities in Antitrust Analysis" (1998) 66 *Antitrust Law Journal* 410-414.

Fig. 2. Critical losses (would-approach, linear demand function) for different margins and price changes



Comparing Figures 1 (could-approach) and 2 (would-approach) show that although the shapes of both planes are similar, the plane levels differ considerably. The could-approach systematically leads to higher critical loss values than the would-approach. The implications of this finding are further clarified by Figure 3 below which plots the differences in percentage points between the could-approach and the would-approach[20] for variable margins and the three most commonly used price increases: 5%, 10% and 15%.

Fig. 3. Critical loss difference between could- and would-approach (linear demand function)



20 The basic idea of plotting the difference between could- and would-approach is taken from Baumann and Godek, *supra* n 18, 891. However, in their article, Baumann and Godek make use of critical elasticities instead of critical losses. Generally, it is easily possible to derive critical demand elasticities instead of critical losses. For example, the corresponding ‘critical demand elasticity’ equation to the ‘critical loss’ Equation (8) can be calculated to (1/(M+X)). See generally Werden, *supra* n 19.

Figure 3 shows, first, that the could-approach leads to systematically larger critical loss values than the would-approach. Second, it shows that the difference between could- and would-approach is largest for small margins and is reduced with growing margins. Third, Figure 3 clarifies that the difference between could- and would-approach is increasing with growing percentage price increases.

Summing up the analysis in this section it can be said that the choice of the calculation method matters most in investigations in which either industries with relatively low margins and/or the effects of relatively large price increases are investigated.

2. Underlying demand function

A further attribute of the critical loss is that it can react sensitively to changes in the underlying demand function. In Section B., it was shown that for a linear demand function, the critical loss is given by CL=(X/(X+M)). The preceding section showed that this is in fact only true if the break-even method is chosen to calculate the critical loss. The profit-maximisation approach would instead lead to a smaller critical loss given by CL=(X/(2X+M)).

Besides linear demand functions, several other functional forms of demand are frequently used in antitrust economics. For example, the critical losses for iso-elastic demand functions can be substantially different from the critical losses derived for linear demand functions. Table 1 shows the critical loss formulas for linear and iso-elastic demand functions under the two different approaches 'would' and 'could'.[21]

Table 1. Critical loss formulas with respect to chosen approach and demand function

Approach / *Demand function*	Profit-maximisation (would-approach)	Break-even (could-approach)
Linear	$CL = \frac{X}{2X+M}$	$CL = \frac{X}{X+M}$
Iso-elastic	$CL = 1-(1+X)^{\frac{-1-X}{M+X}}$	$CL = \frac{X}{X+M}$

As shown in Table 1, the critical loss formulas derived by applying the could-approach are identical for linear and iso-elastic demand functions.[22] However, the would-approach leads to different critical loss formulas for the two types of demand

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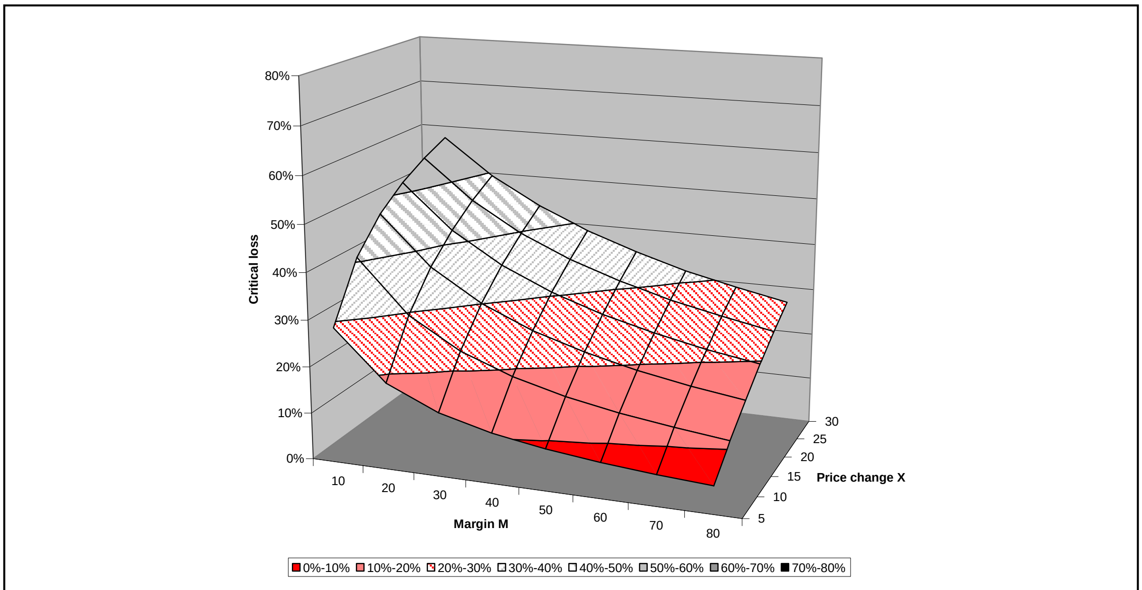
21 For the proofs, see Werden, *supra* n 19, 410-414.

22 This characteristic might explain why the could-approach is favoured in practical applications of critical loss analysis. However, following Baumann and Godek, *supra* n 18, 891, "[t]he would-elasticity generates a given percentage price increase, where price is determined by profit maximization. For the sake of theoretical integrity, it would seem better to know what the hypothetical monopolist would do, not what it could do without reducing profits below the initial level." Furthermore, as added by Langenfeld and Li, if the break-even critical loss is applied for various price increases it is thinkable that the results will show that two or even more price increases are profitable and therefore a profit-maximizing critical loss analysis would have to solve the question which price increase is the most profitable. See J Langenfeld and W Li, "Critical Loss Analysis in Evaluating Mergers" (2001) 46 *Antitrust Bulletin* 334-337. If critical loss analysis is applied in a merger control context, however, the analyst might be interested most in the optimal price increase post-merger in order to come to a conclusion whether the merger has anticompetitive potential.

functions. While for the linear case, the critical loss is given by CL=(X/(2X+M)), it can be shown that for an iso-elastic demand function, the critical loss is given by $CL = 1-(1+X)^{\frac{-1-X}{M+X}}$. Figure 4 below plots the critical losses (would-approach) for an iso-elastic demand function and price changes of 5% to 30% against margins of 10% to 80%.

Fig. 4. Critical losses (would-approach, iso-elastic demand function) for different margins and price changes



Comparing Figures 2 and 4 (would-approach) show that the shapes of the planes are still similar, however, that the plane levels again differ considerably. The would-approach with an iso-elastic demand function systematically leads to higher critical loss values than the would-approach with a linear demand function. Furthermore, a graph comparable to Figure 3 above which plots the differences in percentage points between the could- and would-approach with an iso-elastic demand function for variable margins and the three most commonly used price increases (5%, 10% and 15%) would show that the sensitivity of the critical loss (in low M regions) between could- and would-approach is considerably smaller for iso-elastic demand curves than for linear demand curves.

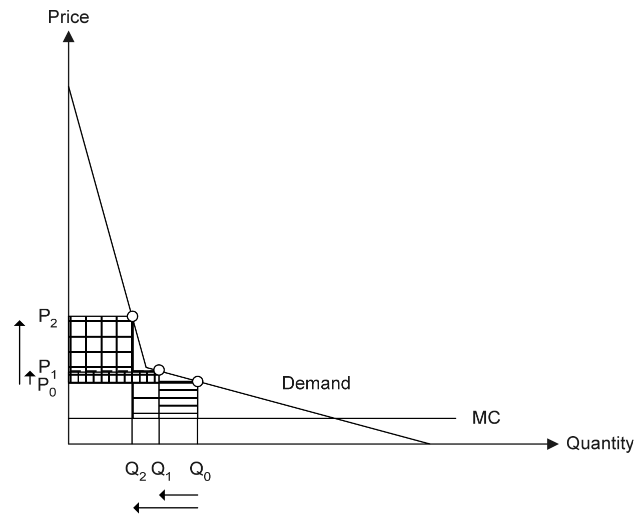
Generally, the analysis in this section so far has shown that the choice of the calculation method as well as the underlying demand function matter most in cases of relatively small margins. This would allow the conclusion that – if the observation of Katz and Shapiro[23] is correct that observed (gross) margins are often in the 50 % range or even larger (at least in industries with large fixed costs and/or highly differentiated products) – these properties of critical loss analysis should not have a huge influence on the results of a critical loss analysis.

In addition to the choice between linear and iso-elastic demand functions, critical loss analysis might generally be challenged by discontinuous demand functions. For example, single kinked demand curves can be observed if a product has two distinct uses one in which demand his relatively elastic and one in which the demand is relatively inelastic. Such a kinked demand curve can have the unpleasant characteristic

23 See M Katz and C Shapiro, "Critical Loss: Let's Tell the Whole Story" (2003) *Antitrust Magazine* 50.

that small price increases might not be profitable, however, larger price increases might very well be profitable.[24] A stylised example is shown in Figure 5.

Fig. 5. Kinked demand curve and price changes



As shown in Figure 5, in case of a kinked demand curve a price increase from P_0 to P_1 would not be profitable (indicated by a comparison of the sizes of the two respective rectangles representing the 'higher margin' and the 'lost margin' profit effects), however, a larger price increase from P_0 to P_2 would lead to an increase in profits. Generally, the latter situation occurs as soon as the hypothetical monopolist or the merged entity would find it profitable to sacrifice all sales to customers with elastic demand in order to be able to exploit customers with inelastic demand. In such cases, applying standard critical loss analysis might lead to misleading results (i.e. they underestimate the incentives to increase price and therefore lead to broader markets than they actually are). However, the problem can be avoided by explicitly modelling the hypothetical monopolist or merged entity as facing demand from multiple sources with differing elasticities.[25] Generally, it can be concluded that it is advisable to conduct critical loss analysis for various price increases to check for possible anomalies.

3. Underlying cost function

In addition to the calculation method and the functional form of demand, a third area of potential concern in critical loss analysis is the underlying cost function. As shown above, the standard critical loss formula technically needs to estimate marginal costs in order to be able to derive the margin that enters the calculation. However, as marginal costs are hardly observable in practice, a first typical approximation is to replace marginal costs by average variable cost. Depending on the respective firm characteristics, this approximation might already lead to an underestimation of the critical loss as long as the marginal cost curve lies above the average variable cost (AVC) curve in the relevant area of output. Furthermore, as already described in Section B. above, it might not be straightforward in practice to come up with a good estimate of

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24 For the proof, see Langenfeld and Li, *supra* n 22, 334-337.

25 See G Werden, "Beyond Critical Loss: Tailoring Applications of the Hypothetical Monopolist Paradigm", EAG Working Paper 02-9 (2002), 6.

average variable costs either due to, for instance, possible problems to differentiate between variable and fixed costs.

Additionally, another potentially critical assumption of standard critical loss analysis is that the marginal cost curve (or the average variable cost curve, respectively) is flat, i.e. the marginal costs are identical for both relevant levels of output (Q_0 and Q_1). Already the critical loss pioneers Harris and Simons[26] were aware of this potentially critical assumption; however, saw no suitable alternative given their key aim of practicability and the anticipated difficulties in getting a reasonable estimate of marginal or average variable cost at the new output level. Nevertheless, in case it is possible to estimate the respective cost function, critical loss analysis could take account of the effect of changing AVC by adjusting the standard critical loss formula (could-approach, linear demand) to the following expression:

$$CL = \frac{XP_0 + AVC_0 - AVC_1}{P_0 + XP_0 - AVC1} \tag{10}$$

Equation (10) shows that the critical loss estimate now also depends on the average variable costs in the pre- and post-price increase state. In case of AVC_0=AVC_1, rearranging equation (10) leads to the standard critical loss formula derived in Section B. above.

Acknowledging the potential importance of the underlying cost function for critical loss calculations, Coate and Williams aim at deriving a generalized critical loss formula incorporating a more generalized cost structure. In particular, they are looking for an appropriate way to convert between accounting measures of average costs and actual marginal costs. In a first step, they define the general critical loss in a homogeneous market with a linear marginal cost function (with a positive slope) and the assumption that pre-merger prices equate to marginal cost at the competitive level of output. The results show that the critical loss now depends on the assumed price increase and the elasticity of marginal costs. However, given the observation that the formula results in several cases in which the required loss would push the linear marginal cost function below zero, Coate and Willams continue their search for a more sophisticated cost model. "Such a model would allow marginal cost to equal average variable cost for a range of output values but then increase linearly so the standard market equilibrium could be generated."[27] Revisions of the initially obtained formula with respect to the average marginal cost function and several manipulations lead to the following final critical loss formula in the generalized form

$$CL = \frac{2\varepsilon_{MC}^{0}X + AVCM^2}{2\varepsilon_{MC}^{0}(AVCM + X)} \tag{11}$$

with ε_{MC}^{0} representing the elasticity of marginal costs and AVCM standing for the average variable contribution margin (P_0-AVC)/P_0. For a given price increase X, a data matrix of critical losses could be constructed for any combination of average variable contribution margin and marginal cost elasticity. Taking these results of Coate and Williams into account, it can be concluded that the standard critical loss formula derived above is only likely to offer reasonable results if short run marginal costs play little role

26 B Harris and J Simons, "Focusing Market Definition: How Much Substitution is Necessary?" (1989) 12 *Research in Law and Economics* 212-215.

27 M Coate and M Williams, "Generalized Critical Loss for Market Definition", Potomac Working Paper 05-01 (2005), 13. However, as discussed by Werden, *supra* n 25, it is also thinkable that either marginal costs differ across units of capacity (i.e. there are kinks in the marginal cost curve) or that fixed costs are avoidable by shutting down capacity (i.e. there are kinks in the total cost curve). In both cases, standard critical loss analysis is unlikely to offer reasonable results.

in driving competition in the respective market (if, for instance, the market faces tight capacity constraints or the evidence suggest that market participants consider long run issues when setting prices).

Summing up the whole paragraph, it was shown that an understanding of the most suitable calculation method as well as the underlying demand and cost functions needs to be developed in order to derive meaningful and reasonable results from an application of critical loss analysis in a certain antitrust case.[28]

D. KEY APPLICATIONS OF CRITICAL LOSS ANALYSIS

Critical loss analysis has two major areas of application in antitrust policy: Market definition and horizontal merger control. The particularities of both areas will be assessed in the following two paragraphs.

1. Market definition

Defining markets is not about studying real phenomena but rather must be understood as an instrument to reduce the complexity of market interaction. In the words of Geroski[29], "[m]arket definitions are a way of intellectually organising the way we think about the economic activity we observe, and are not inherent in the nature of things". Although there may be measurable relationships between a lot of different products (reflected in non-zero cross-price elasticities), identifying the relevant market is about identifying the most 'substantial' and 'relevant' of these relationships. In particular, market definition serves as a pre-requisite for identifying "… those actual competitors of the undertakings involved that are capable of constraining their behaviour and preventing them from behaving independently of an effective competitive pressure".[30]

Under the assumption that economic power exercised by firms is typically transformed into elevated prices, the key for the derivation of antitrust markets lies in getting an understanding of what factors constrain the pricing behaviour of firms. From a firm perspective, a price rise is profitable as long as the increased price charged on the new lower quantity Q_1 is greater than the lost margin on the decrease in quantity ΔQ:

$$\frac{\Delta P}{P_0} Q_1 > \frac{P_0 - C_0}{P_0} \Delta Q \ . \tag{12}$$

It follows that the decrease in quantity caused by a price increase is the basic constraint a firm faces. If the actual decrease in quantity is large following a small increase in

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28 Horwitz identifies further situations in which the standard critical loss formula needs to be changed. One occurs where there is a by-product created by the production of the product in the candidate market from which revenues are derived. Another occurs if the reduction in the supply of the product in the candidate market allows an increase in the production of other products. A third example involves licensing fees where there are 'feedback' effects possible because of the existence of licensing agreements which may attenuate the lost profits due to the lost sales caused by the hypothesised higher price. Another challenge of critical loss analysis is the possibility of price discrimination. Although standard critical loss analysis can basically be applied in such an environment, it needs to take account for 'diversions' between price discrimination categories. See RB Horwitz, "The Use of Critical Loss in and Beyond Merger Analysis" (2002) 2 *Clayton Act Newsletter* 6.

29 P Geroski, "Thinking Creatively about Markets" (1998) 16 *International Journal of Industrial Organization* 678.

30 European Commission, Notice on the Definition of the Relevant Market for the Purposes of Community Competition Law, OJ C 372 [1997].

price, it is likely that the ‘lost margin’ effect overcompensates the ‘higher margin’ effect and – as a consequence – the respective price increase would be unprofitable.

The consequential follow-up question which needs to be investigated is what factors determine the decrease in quantity following a price increase? On the demand side, customers switching to alternative goods and customers looking for the same good in new geographic areas might lead to the unprofitability of a certain price rise. On the supply side, rivals starting to produce a substitute and rival firms looking for new geographic areas to sell their products in the event of a price rise constrain the price-setting behaviour of the firm (by providing switching alternatives to consumers).

Based on this initial characterisation of the basic competitive constraints – supply and demand substitutability – the *small but significant non-transitory increase in price test* (the *SSNIP test*) has become the standard technique to identify the relevant antitrust market. The SSNIP test starts with a small candidate market containing one or a narrow set of products and asks whether a hypothetical monopolist controlling the product(s) in this hypothesised market could raise prices profitably and permanently (i.e., at least twelve months) by a significant amount (i.e., usually 5-10%). If the answer is Yes, the (set of) product(s) in the candidate market represent a well-defined market, because the constraints by other products on the price-setting behaviour of the hypothetical monopolist are too weak to make the price increase unprofitable. If, however, the hypothetical monopolist in the candidate market cannot raise the price (profitably and permanently) by, for example, 5%, this speaks for an effective constraint of its behaviour by the considered next-best substitute, and it should therefore belong to the same relevant antitrust market. This procedure of adding potential substitutes (downward sorted by assumed substitution potential) has to be continued until a product is added which does not hinder the hypothetical monopolist to raise its price permanently and profitably by 5%. This product remains in the candidate market and the relevant market is constituted. Consequently, following this methodology of the SSNIP test, the relevant antitrust market is defined as the smallest collection of products with which a hypothetical monopolist could extract and maintain some degree of market power (here 5% above the competitive price).[31]

It is often argued that standard critical loss analysis can directly be used to answer the question of the SSNIP test: If a hypothetical monopolist would not be able to profitably increase price because the actual loss would be larger than the critical loss, this implies that the relevant market should be wider than the goods in the candidate market. Subsequently, the next closest substitute needs to be included in the candidate market until the price increase would be profitable and the market therefore is defined.

Although critical loss analysis was in fact developed to assist in the definition of the relevant market and certainly can be very helpful in this regard, economic research and actual applications in antitrust cases have shown that its implementation is not always as straightforward as suggested by the short description provided in the preceding paragraph. This has partly to do with the fact that the implementation of the SSNIP test itself faces several challenges which are carried forward to the critical loss method as implementation vehicle of the SSNIP test. Although it cannot be the aim here to cover all of these challenges, a few key arguments are described a little further in the following.

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31 It should at least be mentioned here that the SSNIP test and critical loss analysis can be used for the definition of the geographical market as well. See especially N Strand, “A Simple Critical Loss Test for the Geographical Market” (2006) 2 *Journal of Competition Law & Economics* 697–707.

First, as demonstrated by Filistrucchi[32] and others, the exact SSNIP question slightly differs between the EU Guidelines on the Assessment of Horizontal Mergers and the US DOJ Merger Guidelines. According to the former, the SSNIP test is implemented by first simulating *a given price increase* above the current competitive level by a hypothetical monopolist which owns just one product and, as long as that leads to estimated losses in profits, progressively increasing the number of products owned by the monopolist. However, according to the US guidelines, the SSNIP test is implemented by first simulating *the optimal price increase* above the current competitive level by a profit maximizing hypothetical monopolist and, as long as that is at least a small but significant non transitory increase, progressively increasing the number of products under control of the hypothetical monopolist. As shown in Section B. above, both approaches can differ especially in cases of relatively low margins.

Second, in both merger guidelines, the question remains open (on all but the first step) whether one should raise just the price of the first product taken into consideration or should raise the prices of all products owned by the hypothetical monopolist at each step in the procedure of enlarging the candidate market. Oxera[33] has put more thought into this question and argues that the aim of the SSNIP test is to find the smallest market worth monopolising and therefore the SSNIP test should be applied iteratively by adding further substitutes, however, the price increase should be imposed on the first product only. Daljord, Sørgard and Thomassen[34] also address this issue and remark that standard critical loss analysis typically assumes that the products are symmetric in price and cost, and only focuses on a uniform SSNIP imposed on all products in the candidate market. As in practice, however, a hypothetical monopolist might well want to raise some prices more than others, they argue that in cases in which evidence suggests that such asymmetries might play a role, critical loss analysis has to either adapt to these changes or should be replaced by other methods to define the relevant market. [35]

Third, the role of cross-price elasticities in critical loss analysis for market definition purposes seems to be disputed.[36] Generally, the assumption of a hypothetical monopolist suggests that all non-zero cross-price elasticities are already taken into account and that the answer to the SSNIP question solely relies on the own-price elasticity of demand. However, as already mentioned in Section B. above, at least some scholars argue that cross-price elasticities have to play a key role in the estimation of the actual loss in both,

32 See L Filistrucchi, "A SSNIP Test for Two-sided Markets: The Case of Media", Tilburg University Working Paper (2008), 4-9.

33 See generally Oxera, "The SSNIP test: Some Common Misconceptions", Competing Ideas Bulletin (2005).

34 Ø Daljord, L Sørgard and Ø Thomassen, "The SSNIP Test and Market Definition with the Aggregate Diversion Ratio: A Reply to Katz and Shapiro", forthcoming Journal of Competition Law & Economics.

35 See also J Farrell and C Shapiro, "Improving Critical Loss Analysis" (2008) *Antitrust Source* 2.

36 In a recent paper, Daljord clarifies this difference between both approaches by differentiating between an Actual Loss from an All-Price Increase and a Stand-Alone Critical Loss Test. In case of a linear demand function, the stand-alone actual loss for both products can be calculated by the formula mentioned above including the relevant cross-price elasticity or diversion ratio, respectively: Actual loss = $X^*(E_{own} - E_{cross})$. If both products satisfy the stand-alone critical loss tests, it can immediately be concluded that the price increase is profitable, and conversely, if both products fail the stand-alone critical loss test that the price increase is definitely not profitable. However, if one product satisfies the stand-alone test, while the other fails, the results of the two tests must be weighted in order to come to a conclusion. See Ø Daljord, "An Exact Arithmetic SSNIP Test for Asymmetric Products", forthcoming Journal of Competition Law & Economics.

market definition and merger control.[37] Again Oxera[38] tries to clarify the issue by arguing that the SSNIP test asks whether a certain price increase for a certain product (constituting the initial candidate market) is profitable. The answer depends on any sales that the hypothetical monopolist loses as a result of a price increase and not only on the sales he loses to the next closest substitute.[39]

From a theoretical perspective, the SSNIP test is based on a given demand system that in theory covers all goods and services in an economy and in which the demand for a certain product depends on its own-price elasticity, the own price, the prices of all other products and the disposable income of consumers. In such a demand system the sensitivity of the demand for each product can be measured by the respective elasticities. As soon as all these elasticities have been measured, the answer to the SSNIP solely depends on the own-price elasticity of the initial product. Only if it is found that the price increase is not profitable, the cross-elasticities are helpful in guiding which is the next closest substitute and should enter the candidate market next.[40]

Fourth, given the discussion about the role of cross-price elasticities, the broader question of how to estimate the actual loss in a market definition exercise needs to be addressed. As already mentioned in Section B. above, some scholars propose to start from the simple relationship $AL=X^*\varepsilon_{own}$ with X representing the percentage increase in price and combine it with the Lerner condition which directly leads to the following expression: AL=X/M.[41] If it is now assumed that the hypothetical monopolist imposes a uniform SSNIP on all of the products in the candidate market, it will recapture a fraction Z of the sales lost by any one product when its price is raised because these lost sales will be diverted to products owned by the hypothetical monopolist. As a consequence, the actual loss of a price increase by the hypothetical monopolist is given by $AL=(1-Z)^*X^*\varepsilon=(1-Z)^*X/M$. Therefore, it can be concluded that the products in the candidate market form the relevant market if and only if this expression is less than the critical loss given by X/(X+M). This inequality can be simplified to $Z\geq X/(M+X)$ basically saying that as long as the so-called aggregate diversion ratio Z is larger than the critical loss, the actual loss is less than the critical loss and thus a hypothetical monopolist would find a SSNIP profitable.[42]

Fifth, in direct connection to this approach to estimate the actual loss, a frequently mentioned methodological problem of critical loss analysis in market definition exercises is its potential for misuse. Starting from the SSNIP question, the standard critical loss formula suggests that if the margin is large, critical loss will be small. As a

37 See especially footnote 10 above.

38 See generally Oxera, *supra* n 33.

39 This point is also raised by Katz and Shapiro, *supra* n 23, 51: "A central question for market definition is how price-induced changes in the quantity demanded would affect the profits of the *hypothetical monopolist*. This is different from asking how a price increase would affect the profits earned by one of multiple competitors. One must go from evidence about the demand elasticity faced by a single competitor for one of its products to drawing inferences about the elasticity faced by a hypothetical monopolist controlling all of the products in the candidate market. In general, the elasticity of demand facing the hypothetical monopolist is less than that facing a single firm because the monopolist does not lose sales competing with itself."

40 See generally Oxera, *supra* n 33.

41 See Katz and Shapiro, *supra* n 23 and Farrell and Shapiro, *supra* n 35.

42 As shown by Daljord, Sørgard and Thomassen, *supra* n 34, the result of Katz and Shapiro is based on the standard critical loss expression for the case in which all prices are increased although Katz and Shapiro intend to focus on the case in which only one price is increased. If the latter approach is build into their model, it can be shown that if and only if the aggregate diversion ratio is larger than the *actual* loss, then the hypothetical monopolist would find a SSNIP profitable.

consequence, defendants might try to argue that – given the large margin – a price increase cannot be profitable and the candidate market therefore needs to be broadened. There are at least two reasons why such a story is necessarily incomplete. First, as shown in the preceding paragraph, high margins not only indicate a small critical loss but also a small actual loss and therefore very well allow the possibility that a price increase is profitable although the critical loss is small.[43] Second, high margins can be an indication of high market power due to price-insensitive customers. In other words, it is possible that firms have already raised price to the point where demand starts to become more responsive to price (i.e. they already charge monopoly prices) and the market should therefore be defined narrowly. However, if the market is broadened anyway, critical loss analysis might be confronted with the phenomenon of the 'Cellophane Fallacy'[44] which challenges market definition exercises since the 1950s.[45] In fact, as shown by Danger and Frech III[46], the critical loss is indeed highly sensitive to the degree of market power at the starting point of the analyis. More pre-existing market power leads to smaller critical loss estimates, thus potentially broader market than they actually are.

Sixth, a last area of potential technical and methodological concern in the application of critical loss analysis is the presence of so-called two-sided markets or platform businesses.[47] In such markets, a platform has to deal with (at least) two different

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43 According to Katz and Shapiro, *supra* n 23, 52, there are basically three possible explanations for large observed gross margins with claims that unit sales would be sensitive to a price increase imposed by the hypothetical monopolist. First, defendants could argue that the Lerner condition fails to provide information about the demand faced by the hypothetical monopolist because the firms in the candidate market are coordinating their prices rather than setting their prices independently. Second, defendants might argue that there is a 'kink' in the underlying demand curve, so that consumers would be very sensitive to price *increases* even though they are not sensitive to price *decreases*. Third, defendants might claim that there is a "kink" in the underlying cost curve, so that the marginal cost associated with additional output is much higher than the marginal cost associated with the last units actually produced.

44 As described by the so-called cellophane fallacy, the SSNIP test is in danger of leading to too broad markets when it is applied in markets where market power is already exercised. The reason is simply that a firm with market power is expected to have raised prices already to the point where no further price increases are profitable (i.e., to the point where demand is elastic). Consequently, conducting the SSNIP test at prevailing prices would likely lead to the inclusion of products in the candidate market which would not have been part of it if the analysis had started at the competitive price level. Therefore, an application of the SSNIP test needs to identify the appropriate benchmark price against which to apply the hypothetical price increase. Historically, the cellophane fallacy is much older than the SSNIP test. It was first reported in a landmark antitrust case, *United States vs. E.I. du Pont de Nemours & Co.* (351 US 377 [1956]), in which the Court erroneously concluded that the only producer of cellophane, Du Pont, did not have market power because it measured the demand elasticity at the monopoly level and not at the competitive level. In fact, other products were only considered as substitutes by the customers because of the elevated prices of cellophane charged by Du Pont. In order to avoid the Cellophane Fallacy, several merger guidelines suggest that the prevailing market price should be replaced by a competitive price in the SSNIP or critical loss test, respectively, if there are indications that the prevailing price does not appear to be the competitive price. See International Competition Network, "ICN Report on Merger Guidelines" (2004), 9-11.

45 See H Hovenkamp, "Analyzing Horizontal Mergers: Unilateral Effects in Product-Differentiated Markets", University of Iowa Working Paper (2009), 10.

46 KL Danger and HE Frech III, „Critical Thinking about „Critical Loss" in Antitrust" (2001) 46 *Antitrust Bulletin* 339-355.

47 Generally speaking, a two-sided market can be characterised by a platform which has to serve two separate customer groups (located on two separate market sides) in order to be successful. The specific feature of such markets is that the utility a customer on the one side of the market realises depends on the number of customers on the other side, and vice versa (so-called 'indirect' or 'cross-

customer groups whose demands are interrelated and which must therefore both be taken into account in order to maximise profits. Given the existence of such 'cross-group' or 'indirect' network effects, an analysis of the profit effect of a price increase for a product on side A of the platform cannot solely concentrate on the typical 'higher margin' / 'lost margin' trade-off on side A, but also has to consider that a reduction in demand on side A of the platform leads to a reduction in the demand and price on side B of the platform. Additionally, this reduction on side B has a feedback effect on side A of the platform which reduces demand on this side accompanied by price decreases. Given this key effect, it becomes immediately clear that the standard SSNIP test needs to be extended to both sides of the market in order to take account of the interdependency of demand and to avoid errors in market definition.[48]

For critical loss analysis, the existence of indirect network effects already feeds the intuition that the standard critical loss formulas derived in Section B. above need to be extended by the lost revenues from the complementary platform side and the feedback effects between both sides. Otherwise the negative profit effects of a price increase would likely be understated and the market would be defined too narrowly. Furthermore, with respect to the calculation of the actual loss it is, first, equally important to include the strength of the indirect network externalities into the equation. Second, it is important to remark that simple applications of, for instance, the Lerner index on one side of the market (as described in Section B. above) to estimate demand elasticity for the entire actual loss of the platform is equally error-prone and tends to lead to broader markets than they actually are. However, as shown by Evans and Noel[49], it is possible to extend the simple version of the actual loss equation for an application in two-sided markets by basically including cross-side elasticities into the equation.

2. Merger control

In addition to market definition, critical loss analysis can also be applied in horizontal merger control to investigate the unilateral price effects of proposed mergers. In such a context, the relevant question is not whether a hypothetical monopolist would find it profitable to increase price by a certain percentage but rather whether the merging firms would be able to do so post-merger. If a comparison of actual loss and critical loss shows that the former exceeds the latter, the merged entity would not find such a price increase profitable; otherwise it would find it profitable. The result derived from such a critical loss analysis can then be used as one piece of evidence to answer the general question whether the merger is likely to cause significant anticompetitive effects or not.

group' network effects). A straightforward example for such a market is a heterosexual dating club, which has to attract both men and women to operate profitably. Another example is the credit card industry, in which the respective card-issuing firms need to attract both customers who own the card as well as shops who actually accept the card as a form of payment. Given the specifics of two-sided markets, a maximization of profits requests from the respective managing platform to consider not only the demands on both sides of the platform but also the interrelationships between these demands. The balancing of demands on both sides of the platform is typically implemented by imposing not only a price level but also a price structure which helps to take account of the different economic characteristics (such as demand elasticities etc.) on both sides and therefore their relative importance for the overall success of the platform. See, for instance, DS Evans, "Two-sided Market Definition", Working Paper (2008); DS Evans and MD Noel, "The Analysis of Mergers that Involve Multisided Platform Businesses" (2008) 4 *Journal of Competition Law & Economics* 663–695; DS Evans, "The Antitrust Economics of Two-Sided Markets", University of Chicago Working Paper (2002); L Filistrucchi, *supra* n 32, 4-9.

48 See generally Evans, "The Antitrust Economics of Two-Sided Markets", *ibid*.

49 See generally Evans and Noel, *supra* n 47.

Given this slightly different focus of critical loss analysis in a merger control context, the question how the respective standard calculations might be affected immediately suggests itself. In general, there are basically two different ways proposed in the literature. First, it is argued that the critical loss formula derived in Section B. above basically stays unchanged and the only difference in an application of critical loss analysis between market definition and merger control basically lies in the calculation of the actual loss. Second, it is argued that both the critical loss formula and the actual loss formula need to be adjusted in order to come to meaningful results in a merger context.

Focusing on the second approach first, Langenfeld and Li[50] basically argue that an intuitive reason for a need to adjust the critical loss equation is that some of the sales lost by firm A due to an increase in price would be recaptured by its merging partner – firm B – and would therefore stay in the merged company A+B. Ceteris paribus, this effect tends to water down the impact of a price increase on lost sales and therefore indicates that the critical loss in a unilateral effects assessment has to be larger than the critical loss for a market definition assessment. This effect can be investigated formally as follows:[51]

Consider that firms A and B plan to merge. When considering whether an increase in the price of firm A is profitable, the merged company will compare if

$$\left(P_0^A + \Delta p^A - MC^A\right)\left(Q_0^A - \Delta Q^A\right) + \left(P_0^B - MC^B\right)\left(Q_0^B + \Delta Q^A D_{AB}\right) \geq \left(P_0^A - MC^A\right)Q_0^A + \left(P_0^B - MC^B\right)Q_0^B \tag{13}$$

is true. D_{AB} is defined as the diversion ratio from firm A to firm B.[52] Rearranging the terms of the inequality above and defining

$$X^A = \frac{\Delta p^A}{P_0^A}, \tag{14}$$

$$M^A = \frac{P_0^A - MC^A}{P_0^A}, \tag{15}$$

$$M^B = \frac{P_0^B - MC^B}{P_0^B} \tag{16}$$

leads to the following inequality

$$\frac{X^A}{M^A + X^A - M^B \frac{P_0^B}{P_0^A} D_{AB}} \geq \frac{\Delta Q_A}{Q_0^A}. \tag{17}$$

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50 Langenfeld and Li, *supra* n 22.

51 The model approach follows Langenfeld and Li, *supra* n 22, 336.

52 The diversion ratio was introduced by Shapiro and is defined as 'the fraction of sales lost by brand A that are captured by brand B' in case the price for product A is increased by x%. Formally, the diversion ratio from A to B is the ratio of the cross-price elasticity of demand for A with respect to the price of B over the own elasticity of demand for A. To give a practical example: If we know that a certain increase in the price of butter leads to a switch of 33% of the demand to margarine, the diversion ratio is 0.33. In other words, the diversion ratio gives an indication of how close the two products are in the product space. If the diversion ratio is 1, a merger of products A and B would eliminate any kind of competition between the two products. If the diversion ratio is 0, a merger would not lead to a loss of competition. See C Shapiro, "Mergers with Differentiated Products", US Department of Justice Speech Manuscript (1995).

The left side of inequality (17) is the critical loss (could-approach[53], linear demand function) to be used in a unilateral effects analysis. A comparison with the critical loss for market definition $\frac{X^A}{M^A + X^A}$ derived in Section B. above shows that the denominator of this expression is by $M^B \frac{P_0^B}{P_0^A} D_{AB}$ smaller which leads to larger ratio as a whole. In other words, the adjusted critical loss for merger control applications is larger than the standard critical loss for market definition applications. Expression (17) further clarifies that the critical loss now also depends on the pre-merger margin of firm B, the relative price of the merging firms B and A as well as the diversion ratio between A and B. The relationship between the last two is shown in Figure 6 below for fixed $M^A = 0.6$, $M^B = 0.5$ and $X^A = 0.05$.

53 As already mentioned in footnote 22 above, in a merger control context, the would-approach should be preferred as the key interest of the analyst lies in the profit-maximising price increase post-merger.

Fig. 6. Critical loss (could-approach, linear demand function) for different relative prices and diversion ratios (ranges 0-1.0 and 0-0.8)

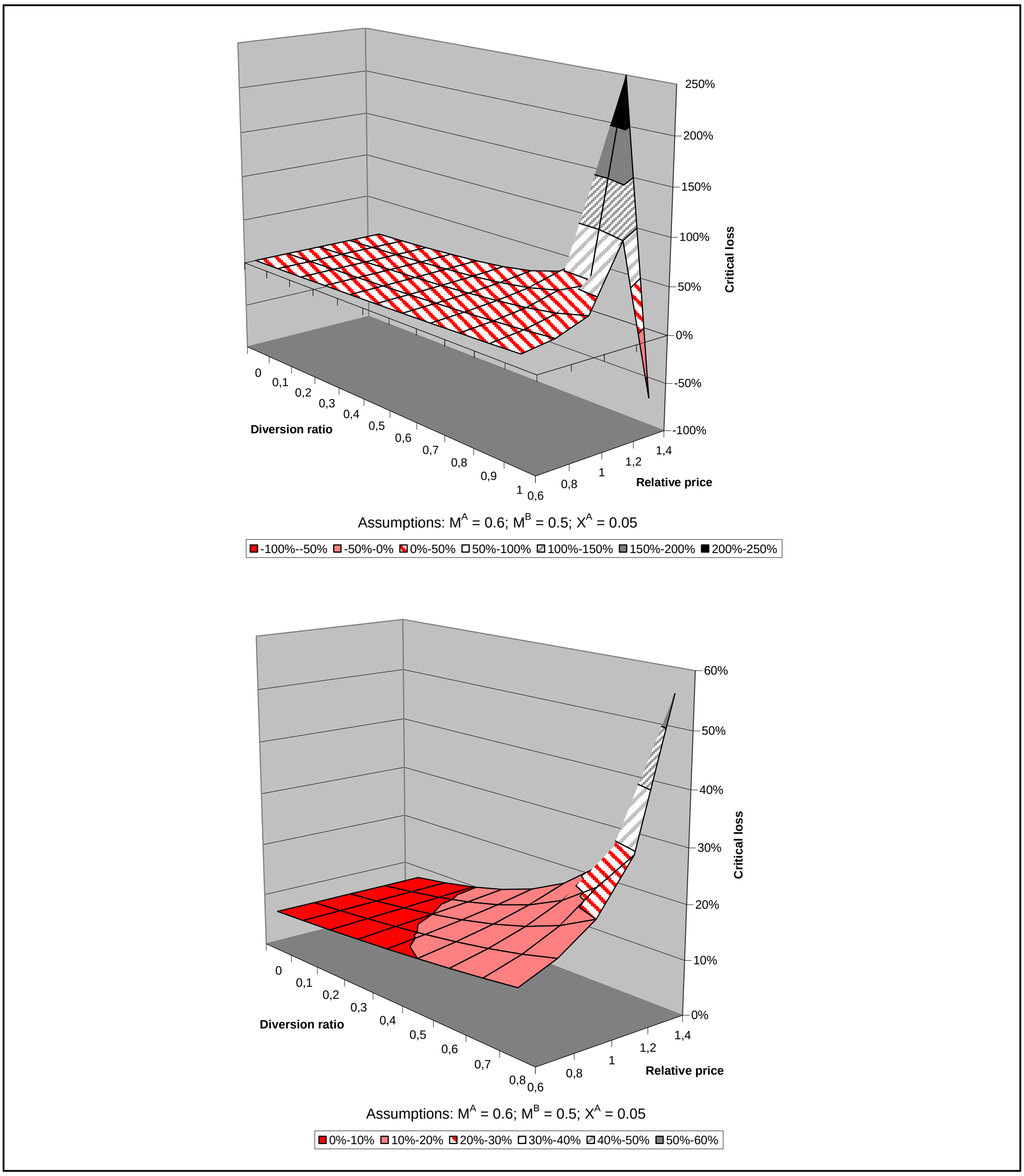

Figure 6 shows that the critical loss increases with the diversion ratio and the relative price of B to A. Both results are in line with economic intuition. The larger the diversion ratio between the two merging products, the closer are the two merging products in the product space and the larger is the fraction of the demand lost by A which is recaptured by B. Equally, the larger the relative price (B to A), the larger is the fraction of lost revenue firm A can regain by customers switching from A to B. Therefore, both effects underpin the argument that the critical loss has to be larger in a merger control exercise than in a market definition exercise. This implies that price increases which weren't profitable in standard critical loss analysis can very well be profitable in critical loss analysis corrected for the specifics of horizontal merger control. However, Figure 6 shows further that that the critical loss plane becomes discontinuous with some single critical loss values reaching 250%.[54] As these very large values only appear for relatively large diversion ratios, Figure 6 shows a second graph with a restricted range for the diversion ratios to exclude the 'outliers'. Generally, it can be concluded that reality checks are important in any application of critical loss analysis. A mechanic application of formulas might lead to serious problems when the results are put to practice.[55]

The second group of proposals with respect to necessary adjustments in critical loss analysis in merger control basically argues that the critical loss formulas derived in Section B. above stay unchanged and the only difference in an application of critical loss analysis in a merger control context lies in the estimation of the actual loss. How this estimation of the actual loss should be conducted recently triggered a lively discussion among antitrust experts which will be sketched in the next paragraphs.

Generally, commentators agree that it is essential in every merger application of critical loss analysis not only to get an understanding of how many sales a certain product loses in case of a price increase but also to what extent this lost demand will be recaptured by the merging competitor. As described in footnote 52 above, it is generally possible to approximate this effect by the use of diversion ratios (which might be easier to derive than cross-price elasticities[56]). As a consequence, due to the diversion/ recapture effect, the actual loss calculation needs to be corrected for the diversion between the merging parties and the actual loss would therefore be smaller post-merger leading to a larger incentive of the merged entity to raise prices.

Apart from showing the importance of adjusting the actual loss equation to take account for the diversion/recapture effect, Langenfeld and Li[57] identify a second aspect that needs to be taken into account. This effect refers to the price reactions of other non-merging 'outsider' firms. In a market definition exercise, it is typically assumed that all firms in the candidate market are acting like a hypothetical monopolist and that all firms raise price by the same amount – consequently, the question of how other firms in the market respond to such an price increase is irrelevant. However, when using critical loss analysis in a merger control context, the reactions of other firms in the market to a price increase must be taken into account. As investigated in detail by Langenfeld and Li, there are three basic reaction possibilities: price increases, price decreases or no price changes. Typically, the loss of sales would be highest in the first case and lowest in case the competitors follow the price increase of the merged firm. The question of what is most profitable for the outsiders generally depend on various factors, however, in a differentiated product market, economic theory predicts that a price rise by the merged entity would typically create incentives for the outsider firms to unilaterally raise their price (absent any product repositioning issues). In such a scenario, the merged firm typically is expected to experience fewer losses of customers to competitors in the market than if all competitors kept their prices constant. As a consequence, it becomes more likely that a price increase is profitable and this must be included into the

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54 Technically, the large critical losses simply result from the denominator in Equation (17) becoming very small.

55 See RBB Economics, "Lost in Translation: The Use and Abuse of Diversion Ratios in Unilateral Effects Analysis", RBB Brief 19 (2006).

56 Technically, it can be expected that a merger with a direct competitor typically decreases the own-price elasticity by an amount proportional to the cross-price elasticity with the respective competitor.

57 Langenfeld and Li, *supra* n 22.

calculation of the actual loss to avoid an underestimation of the profitability of a certain price increase.[58]

Apart from the identification of these two key effects of critical loss analysis in a merger context – the 'diversion/recapture' effect and 'reaction by outsider firms' effect – a recent focal point of discussion is the more general question whether and how critical loss analysis can sensibly be applied in differentiated goods markets. Coate and Williams, for example, argue that the critical loss framework is generally inappropriate for such an analysis as it was explicitly developed for homogenous markets. For differentiated industries, however, they argue that equilibrium-based criteria are needed to undertake a proper analysis.[59] O'Brien and Wickelgren[60] as well as Farrell and Shapiro[61] develop this argument further by deriving critical loss conditions which impose the equilibrium conditions of particular economic models of differentiated products. In both approaches, it is argued that such an extension of basic critical loss analysis is needed to secure reliable results out of an application of critical loss analysis.

Specifically, O'Brien and Wickelgren examine critical loss analysis using a standard Bertrand pricing model[62] with differentiated products.[63] Their key result shows that for a given degree of product substitutability between the products (i.e. a given cross-price elasticity or diversion ratio), larger margins make it less likely that the actual loss will exceed the critical loss from a price increase. This result holds under linear and constant elasticity demand and is determined by simple conditions which require estimation of

58 Given the importance of the behaviour of outsider firms, Langenfeld and Li, *supra* n 22, suggest to use the residual demand elasticity instead of the Marshallian demand elasticity in estimating the actual loss for the merged entity as the former takes the unilateral price increases of the outsiders into account. Given the fact that the residual demand is less elastic than the Marshallian demand, the actual loss of the merged entity would be smaller than would otherwise be the case.

59 However, Daljord, *supra* n 36, shows that it is possible to extent the critical loss criterion by Harris and Simons to a version that neither relies on the equilibrium conditions of a particular model of competition nor demands product homogeneity. Specifically, Daljord focuses on critical loss analysis in case of two asymmetric products. He argues that standard critical loss analysis can lead to misleading results in such a case and develops an exact critical loss criterion which is derived for any demand structure and which is valid regardless of the industry pricing game, however, assumes constant returns to scale over the relevant range of production. The criterion is a simple function of sales, the margins, and the price sensitivity of each product in the candidate market.

60 O'Brien and Wickelgren, *supra* n 3.

61 Farrell and Shapiro, *supra* n 35.

62 Instead of Bertrand models assumed by most commentators, an alternative way to model the actual loss in merger control would be to refer to a (dominant) firm with a (possibly competitive) fringe framework. In such a framework, an increase in price by the dominant firm will generally result in the fringe firms increasing production, "… so the residual quantity demanded from the dominant firm falls with an increase in price both because of the decreased quantity demanded (a shift along the demand curve) and because of the increase in the quantity supplied by the fringe firms. Thus, in order to get an estimate of whether such actions would be profitable, an estimate of the reaction curves of the remaining fringe firms to a price increase is needed in addition to the estimate of demand elasticity." In order to be able to estimate the expected expansion by the fringe firms, data on prices, production, and excess capacity of the competitive firms are required. See International Competition Network, "The Role of Economists and Economic Evidence in Merger Analysis", ICN Working Paper (2004), 7.

63 However, as remarked by O'Brien and Wickelgren, *supra* n 3, the result that high margins tend to make post-merger price increases more likely also emerges from standard theories of competition among producers of homogenous products.

the cross-price elasticities (or diversion ratios) between the products of the merging parties, in addition to the merging firms' margins.[64]

However, both modelling approaches were in turn criticised by Scheffman and Simons.[65] They argue that the key advantage of standard critical loss analysis is that it is 'just arithmetic' and that it does not rely on any kind of particular model of competitive interaction and is therefore robust for potential model misspecifications. As a consequence, they argue against the use of these kinds of models and suggest using qualitative case-specific evidence to come to a reasonable conclusion on the definition of the market or the likely competitive effects of a particular merger.

Although the view of Scheffman and Simons[66] cannot be disregarded completely, it needs to be remarked that the fact that standard critical loss analysis is just arithmetic and does not allow the immediate conclusion that the returned results of such an analysis are always reliable and guide the decision into the right direction. As corroborated by Daljord, Sørgard & Thomassen[67], there might be good reasons to apply equilibrium-based criteria, conditional on the particular model being appropriate in the industry. In other words, the particular specifics of the respective case should provide guidance whether a standard critical loss analysis can lead to reliable results or whether some form of economic model is needed to base the estimation of especially the actual loss on more solid grounds.

In general, it has to be pointed out that critical loss analysis in merger control can only be considered as a very simple form of merger simulation. Economists have developed more sophisticated 'merger simulation tools' to come to conclusions on the likely effects of a horizontal merger on market price.[68] In general, these tools use a model of consumer demand and a model of competitive interaction to predict the price effects of a merger.[69] In order to be able to apply such tools, market information, such as market shares and market demand elasticities, needs to be estimated as data input for the simulation of the effect of a merger-induced change in the ownership structure on market price. An especially helpful feature of merger simulation tools is that they allow simulating not only the post-merger prices but can also take account of changes in the cost structure (the so-called merger efficiencies) and antitrust-induced changes in the ownership structure (the so-called [structural] merger remedies). However, despite an increasing adoption of merger simulation tools in antitrust authorities and economic consultancies, the general suitability of such techniques is questioned by academics and practioners.[70] Given the potential problems of merger simulations, Carlton[71] views these

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64 SX Moresi, SC Salop and J R Woodbury, "Implementing the Hypothetical Monopolist SSNIP Test With Multi-Product Firms" (2008) *The Antitrust Source* 1-8, generalized the critical loss criterion derived by Katz and Shapiro, *supra* n 23, allowing for multi-product firms and asymmetric products.

65 D Scheffman and J Simons, "The State of Critical Loss Analysis: Let's Make Sure We Understand the Whole Story" (2003) *Antitrust Source* 1-9.

66 Scheffman and Simons, *ibid*.

67 Daljord, Sørgard and Thomassen, *supra* n 34.

68 For detailed overviews see G Werden and L Froeb, "Unilateral Competitive Effects of Horizontal Mergers", Working Paper (2007); American Bar Association, *Market Power Handbook: Competition Law and Economic Foundations* (Chicago, ABA Publishing, 2005).

69 See J Hausman and G Leonard, "Economic Analysis of Differentiated Products Mergers Using Real World Data" (1997) 5 *George Mason Law Review* 321-344.

70 See, for instance, C Peters, "Evaluating the Performance of Merger Simulations: Evidence from the U.S. Airline Industry" (2006) 49 *Journal of Law and Economics* 627-649; M Weinberg, "The Price Effects of Horizontal Mergers" (2008) 4 *Journal of Competition Law & Economics* 733–447.

71 See D Carlton, "Using Economics to Improve Antitrust Policy", NBER Working Paper (2003), 7-11.

tools as a useful complement for the more direct 'traditional' approaches for merger analysis, which basically build on 'natural experiments' aiming at answering the question, "What happens to price when the number of competitors diminishes by one?"

The same conclusion would obviously apply for critical loss analysis which is even less sophisticated than merger simulation tools and typically does not provide the flexibility needed to reach a sufficiently good fit between modelling assumptions and market realities. So in case of merger control, it is even more obvious that critical loss analysis can only be considered as one piece of evidence amongst others. This is especially true because of the need to include non-price aspects of competition into a merger assessment. While probably not of equally great importance in market definition, merger control regularly has to cope with various forms of non-price competition as well as many other market specifics such as the role of coordinated effects, product repositioning, countervailing buyer power, entry barriers, merger efficiencies or the impact of the merger on innovation incentives which typically cannot be investigated in a sensible way by some kind of critical loss analysis.[72]

E. APPLICATIONS OF CRITICAL LOSS ANALYSIS IN RECENT CASES

Following the characterisation of standard critical loss analysis and its key properties and applications, it is the aim of this section to give an idea of practical applications of the method in recent antitrust cases. Generally, it is fair to say that critical loss analysis is frequently applied in antitrust cases in the United States[73] while its use in the European Union seems to be rather modest to date – at least as far as the published merger decisions of the European Commission suggest.[74]

In the following, two cases in which critical loss analysis played a significant role are described in greater detail. The first case is the proposed acquisition of *Wild Oats Markets* by *Whole Foods Market*[75] which was investigated by the US Federal Trade Commission ('FTC') as well as (so far) two distinct US courts. The second case is the proposed merger by *Ineos* and *Kerling*[76] which was investigated by the DG Competition of the European Commission ('Commission').

72 At least some of the mentioned market specifics are essential in deciding how long-lasting possible price increases would be. For example, even in case a critical loss analysis comes to the conclusion that a price increase of 15% would be profitable in the short-term, an assessment of merger efficiencies, product repositioning or market entry could conclude that these factors can be expected to develop strong countervailing powers in the medium- and long-term perspective to constrain the merged entity sufficiently.

73 See MB Coate and JJ Simons, "Models, Mathematics and Critical Loss", Working Paper (2009) for several further examples.

74 This point of view is shared by Veljanovski, *supra* n 2, 14, who remarks that "[d]espite the increasing use of Critical Loss in US antitrust, it has been ignored by the EC Commission. In the UK the concept has been used, and identified as a useful quantitative technique."

75 *Federal Trade Commission, Plaintiff, v. Whole Foods Market, Inc., and Wild Oats Markets, Inc.* (United States District Court for the District of Columbia), Civ. No. 07-cv-01021-PLF, FTC File No. 071 0114, available at http://www.ftc.gov/os/caselist/0710114/0710114.shtm (accessed on 21 August 2009).

76 Case No. COMP/M.4734 - *INEOS/Kerling* [2008] C(2008) 379 final.

1. Whole Foods Market and Wild Oats Markets (2007)

In the proposed acquisition of Wild Oats Markets, Inc. by Whole Foods Market, Inc.[77] – the second largest and the largest supermarket chain focusing on premium natural and organic products in the United States – market definition was the focal point of interest and dispute. The FTC basically argued that Whole Foods and Wild Oats were part of so-called 'premium natural and organic supermarkets' (PNOS) distinct from conventional supermarkets and asserted that such conventional supermarkets do not constrain PNOS in nearly the same way that Whole Foods and Wild Oats constrain each another. As a consequence, the FTC concluded that the proposed acquisition would lead – in many geographic markets – to a merger to monopoly and would therefore substantially lessen competition in the operation of PNOS. The FTC therefore decided to challenge the proposed acquisition.[78]

In the subsequent district court opinion the judge focused mainly on the ability of conventional stores to constrain the pricing of the post-merger Whole Foods and concluded – largely relying on the testimony of the defendant's economic experts – that Whole Foods would not be able to sustain a price increase in a properly defined product market. As critical loss analysis was a key tool in the defendant's reasoning, this part of the much more detailed testimonies will be sketched in more detail in the following.

The key economic expert hired by the defendants, David Scheffman, applied a standard critical loss analysis (could-approach) using both a 5 % and 1 % SSNIP and basically concluded that actual loss would substantially exceed critical loss at either level of price increase.[79] Since there was no evidence in the record to determine cross-elasticity of demand between PNOS and conventional stores, Scheffman based his critical loss analysis on qualitative evidence he received from reviewing market studies. These studies showed that, first, grocery shoppers are price sensitive, second, Whole Foods and Wild Oats customers shift purchases between PNOS and other supermarkets (and can do so costlessly), third, most Whole Foods and Wild Oats customers frequently shop at other grocery stores, fourth, other supermarkets compete vigorously for Whole Foods and Wild Oats customers, and fifth, Whole Foods (and Wild Oats to a lesser degree) regularly price check other supermarkets to gauge their pricing and product assortments. Due to this collection of qualitative evidence, Scheffman concluded that the actual loss has to be substantially larger than the critical loss. As a consequence, price increases for the merged entity would not pay due to the presence of a sufficient amount of 'marginal customers' and the relevant market therefore is at least PNOS together with conventional supermarkets.

The key economic expert hired by the FTC, Kevin Murphy, however argued that Scheffman's methodology of comparing the critical loss for a hypothetical monopolist with qualitative evidence on price sensitivity of customers is not reliable. In particular,

77 *FTC v. Whole Foods Mkt., Inc. and Wild Oats Mkt., Inc.*, No. 07-1021, 2007 WL 2377000, at 16 (D.D.C. Aug. 16, 2007). See also W Baer and D Feinstein, "Changing Emphasis: How *Whole Foods* Advances the FTC's Efforts to Transform Merger Litigation", Arnold & Porter LLP Working Paper (2008).

78 C Varner and H Cooper, "Product Markets in Merger Cases: The *Whole Foods* Decision" (2007) *The Antitrust Source* 6.

79 The entire analysis by Scheffman can be subdivided into three areas. In addition to the critical loss analysis described in greater detail above, he also analyzed the source of sales for new Whole Foods Market stores and found that its sales were generated to a large extent from other supermarkets regardless of the existence of a nearby PNOS. Additionally, Scheffman analyzed Whole Foods and Wild Oats prices and found no variation in Whole Foods or Wild Oats pricing based on the presence or absence of the other. See Varner and Cooper, *ibid*.

Murphy brought forward that Scheffman's analysis fails to recognise that the fundamental issue is how the competitive constraints on the merged entity will change as a result of the acquisition, not whether Whole Foods currently competes, at some level, with other firms in addition to Wild Oats. Furthermore, Murphy stated that a correct form of critical loss analysis that uses precisely the evidence cited by Scheffman indicates that the proposed acquisition would have significant anticompetitive effects. Additionally, Murphy remarked that Scheffman's analysis focuses to a large extent on pricing from Whole Foods' perspective, thereby missing the anticompetitive motive of the closure of many Wild Oats stores following the acquisition.

Interestingly, in his critical assessment of Scheffman's analysis, Murphy[80] frequently refers to the academic literature on critical loss analysis. One key argument he brings forward is the general problem with the accuracy of critical loss analysis in industries with low margins such as supermarkets. Furthermore, Murphy doubts that standard critical loss analysis is of great help in this case and argues that a meaningful critical loss analysis in such a case has to investigate "… how much profit the other party (in the case of a merger) or other parties (in the case of the SSNIP analysis) gains from an increase in price by one of the firms. The loss in sales from increasing price when each seller acts unilaterally is already factored in to setting the existing (pre-SSNIP) price." [81] Based on a very simple model, Murphy intends to show why the hypothetical monopolist of the merged firm would typically have an incentive to raise price above the current level (absent other factors such as entry): "The merged firm gets to capture this profit increase that would otherwise go to an independent seller, so the gains from raising prices are greater."[82] Based on this general so-called 'critical diversion' argument, Murphy argues that Whole Foods did not only have an added incentive to raise price but also an added incentive to close Wild Oats stores post-merger.

In the end, the district court did not follow the arguments of the FTC expert but agreed with Scheffman's conclusion that "… because so many people are cross-shopping for natural and organic foods and are marginal rather than core customers, the actual loss from a [small but significant and nontransitory price increase] would exceed the critical loss".[83] The court further concluded that the FTC's market definition was flawed because it focused on "core" or "committed" customers rather than "marginal" customers who are of key interest in the market definition exercise which has to assess the question whether *enough* customers would switch *enough* of their purchases that a post-merger price increase or quality decline would be unprofitable for Whole Foods[84] (see Baer and Feinstein[85] for possible wider implications of the Whole Foods decision).

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80 *FTC v. Whole Foods Mkt., Inc. and Wild Oats Mkt., Inc., supra* n 75, "Exhibit 2 - Public Version of the Rebuttal Expert Report of Kevin M. Murphy, Ph.D." (2007).

81 *Ibid*, 15.

82 *Ibid*, 17.

83 *FTC v. Whole Foods Mkt., Inc. and Wild Oats Mkt., Inc.*, No. 07-1021, 2007 WL 2377000, at 16 (D.D.C. Aug. 16, 2007). See also W Baer and D Feinstein, "Changing Emphasis: How *Whole Foods* Advances the FTC's Efforts to Transform Merger Litigation", Arnold & Porter LLP Working Paper (2008).

84 Comparing Scheffman's and Murphy's approaches, one crucial difference is that the former analysis depends only on the marginal loss of sales, while the latter used the average loss of customers. As explained in detail by Murphy, *supra* n 80, focusing on the average behaviour of customers is appropriate because a core of committed customers would continue to shop at PNOS stores despite a significant price increase post-merger.

85 Baer and Feinstein, *supra* n 83.

Interestingly, in a split decision in July 2008, the United States Court of Appeals for the District of Columbia reversed the decision of the district court that determined that the FTC failed to demonstrate sufficient possibility of anticompetitive effects of the acquisition.[86] Judge Janice Rogers Brown came to the conclusion that the district court committed an abuse of discretion and an error in considering only marginal consumers, and not core consumers, in performing its market analysis.[87] Although the decision was criticised by economists – arguing that the SSNIP idea is based on marginal rather than core customers[88] – the case remains undecided to date and already raised the question about possible consequences for the already merged parties in case the final court decision comes to the conclusion that the relevant market in this case has to be PNOS only.[89]

Independent from the question how the case will finally be decided, the first court decision has at least shown that the critical loss concept can be applied successfully in court even without the possibility to actually estimate the actual loss. A collection of anecdotal evidence can be sufficient to convince the court of a certain market definition.

2. Ineos and Kerling (2008)

In *Ineos/Kerling*[90], the Commission had to investigate the production of 'Suspension Polyvinyl Chloride' (S PVC) as well as related products in the UK as well as Continental Europe. The proposed merger basically would have led to a merger to monopoly if the UK were found to be the relevant market (and not the broader market of the European Union). As part of geographical market definition, the Commission basically had to answer the question to what extent S PVC from Continental Europe can be seen as a substitute for S PVC produced in the UK. The question was especially important after UK customers expressed concerns with regard to the flexibility and reliability of supply, short lead times and precise timing of deliveries from sources outside the UK. The Commission approached the question by investigating, firstly, from a demand-side perspective, the sourcing and switching patterns of these customers, and

86 *FTC v. Whole Foods Market, Inc*., No. 07-6276 (D.C.Cir. July 29, 2008).

87 "In sum, the district court believed the antitrust laws are addressed only to marginal consumers. This was an error of law, because in some situations core consumers, demanding exclusively a particular product or package of products, distinguish a submarket. The FTC described the core PNOS customers, explained how PNOS cater to these customers, and showed these customers provided the bulk of PNOS's business. The FTC put forward economic evidence – which the district court ignored – showing directly how PNOS discriminate on price between their core and marginal customers, thus treating the former as a distinct market. Therefore, we cannot agree with the district court that the FTC would never be able to prove a PNOS submarket. We do not say the FTC has in fact proved such a market, which is not necessary at this point. To obtain a preliminary injunction under § 53(b), the FTC need only show a likelihood of success sufficient, using the sliding scale, to balance any equities that might weigh against the injunction." *FTC v. Whole Foods Market, Inc., ibid,* 20.

88 However, as discussed in Section C. above, the FTC argument can be valid if the customers of Whole foods can be separated into inelastic core customers and elastic marginal customers and it would be profitable for the merged entity to sacrifice the marginal customers in order to exploit the core customers. This is also acknowledged by Hovenkamp, *supra* n 45, 8: "If the increased profits that *Whole Foods* increased from the loyal core group of customers was greater than the revenue that it lost from the price sensitive marginal customers, and if this price increase were of sufficient magnitude, then the price increase would be profitable and the narrower market definition appropriate."

89 See K Forrest and S Jebejian, "Can we be forced to unwind our merger?", Cravatz, Swaine & Moore LLP Memo (2009).

90 *Ineos/Kerling*, *supra* n 76.

secondly, from the supply-side point of view, to what extent Continental European suppliers would be in a position to defeat a hypothetical price increase in the UK.

To answer the latter question, the Commission explicitly used a critical loss approach as one empirical method. On the basis of disaggregated data collected from the parties during the market investigation, the Commission estimated the critical loss for the year 2006 for both, the profit-maximization method (would-approach) and the break-even method (could-approach). The results of the exercise are presented in the following Table 2.

Table 2: The Commissions' critical loss estimates in *Ineos/Kerling*

	Would-approach				**Could-approach**	
	Linear		*Iso-elastic*			
	5%	*10%*	*5%*	*10%*	*5%*	*10%*
Variable cost Hypothesis 1	86,754	124,553	97,866	149,071	108,026	173,507
Variable cost Hypothesis 2	53,724	86,446	58,421	99,446	61,156	107,448

Unit: tons (t); Data Source: de la Mano and Amelio[91]

As shown in Table 2, the Commission did not only take account of the two methods to calculate the critical loss and considered two alternative price increase assumptions, but also applied two different variable cost hypotheses with the first one being the variable costs provided by the parties, and the second one deducting some of the variable costs which in fact were considered as fixed costs by the Commission. The substantial differences in the critical losses for both hypotheses show the general importance of the variable cost estimate that enters the critical loss analysis. The same conclusion is true – as already shown in Section C. above – for assumptions with respect to the general calculation method applied and the functional form of demand. For example, for the second hypothesis, the critical loss estimates lie between 10.7% (would-approach, 5% price increase, linear demand) and 12.2% (could-approach, 5% price increase) of the UK market size (which was around 500,000 tons in 2006 following a ballpark figure given in the decision of the Commission).

In a second step, the Commission had to derive an estimate of the actual loss of the merged entity in the event of a unilateral price increase of a certain percentage. However, the estimations of the inverse residual demand function undertaken by the Commission showed that the coefficient on the inverse elasticity of demand was in practically all tested specifications statistically insignificant and the values were not robust to slight modifications in the specification.[92] Furthermore, standard statistical tests showed that the instruments used to estimate the actual loss were too weak to draw strong conclusions from them.[93]

Given the inconclusiveness of the critical loss analysis, the Commission did not use its results and investigated the open question of supply-side market definition by using other forms of evidence such as the current level of imports, transport costs and reported

91 See M De La Mano and A Amelio, "M.4734 Ineos/Kerling. A story of an empirical exercise", Presentation at the ACE Conference (2008).

92 As argued by Small, one key reason for the insignificant results might have been the use of data aggregated by customer size in combination with a lack of firm-specific cost- or demand-shocks. This raises the question whether the Commission would have been able to derive robust results for the estimation of the actual loss if it would have used less aggregated data. See I Small, "Ineos/Kerling", Presentation at the ACE Conference (2008).

93 See de la Mano and Amelio, *supra* n 91.

planned capacity expansions compared with demand growth, and the assessment of barriers to expansion in the UK.[94]

Summarizing the case, the course of action by the Commission can be considered as sensible and correct. The case and data situation allowed a critical loss analysis and the Commission conducted the respective calculations considering its important properties. After realising that the results are not robust enough, the Commission decided to base its decision on other forms of evidence. This course of action was especially praised by Verboven[95] who argued that in other antitrust cases insignificant results have been (tried to) use(d) as evidence. From this perspective, the Commission was right not only in excluding critical loss analysis from the list of evidence in the case at hand but also in nevertheless including their attempt to apply critical loss analysis in the final decision. This can not only be seen as a signal that the Commission is able and willing to use such tools (if possible and suitable) but more importantly, that it is aware of the problems and drawbacks and only consider the results as evidence if they are sufficiently robust. Such an approach raises the acceptance of the economic analysis conducted by the Commission.

F. SUMMARY AND CONCLUSION

The last couple of years have seen an increasing interest in critical loss analysis, both, in academia and in practice. This development is documented by various research papers, high-level exchanges between antitrust experts as well as an increasing number of case decisions – in the United States as well as in Europe – which make use of some form of critical loss analysis.

In this context, it was the aim of this article to describe the general method of critical loss analysis, to assess important properties of the concept, to show how critical loss analysis has to differ between market definition exercises and the evaluation of the competitive effects of horizontal mergers and to discuss applications of critical loss analysis in recent cases.

As a general result it can be said that an application of critical loss analysis in practice is often not as straightforward as the initial presentation of the general theoretical concept might have suggested. In fact, the method has to be applied with great care in order to receive meaningful results. On the one hand, it was shown that the critical loss might be sensitive to changes in the calculation method as well as the underlying demand and cost functions. On the other hand, the success of a critical loss analysis critically depends on the accuracy of the estimation of the actual loss. As indicated by both high-level theoretical exchanges (sketched partly in Section D.) and the review of two recent antitrust cases (sketched in Section E.), this often turns out to be the key challenge in a critical loss analysis.

Critical loss analysis generally receives its attractiveness from the fact that "… it is easily calculated and requires amazingly little information."[96] On the one hand, this can be considered as an advantage of the concept; however, on the other hand, it cannot come as a surprise that such a simple tool is unable to fully absorb any type of market

94 As shown by de la Mano and Amelio, *ibid*, the Commission also undertook a so-called natural experiment in which it assessed the effect of an unplanned outage on Ineos plants in mid 2004. The results of the experiment suggest that both Kerling and Importers are in a position to swiftly react to any attempts of Ineos to constraint output so as to increase prices.

95 See F Verboven, "Ineos/Kerling. Assessment of the relevant geographic market for a plastic resin. The impact of imports on a national market", Presentation at the ACE Conference (2008).

96 Veljanovski, *supra* n 2, 14.

specification which might be present (and important) in a certain case. As a consequence, it is essential before conducting a critical loss analysis to check whether the market specifics as well as the data situation at hand can expect critical loss analysis to result in reliable results. Furthermore, it is advisable to view the results of critical loss analysis as one piece of evidence whose plausibility needs to be cross-checked with other evidence derived, for instance, from natural experiments or customer surveys. If these restrictions are taken into account, critical loss analysis can be a helpful method in antitrust cases especially to define the relevant market or even to get a first impression on the competitive effects of a proposed horizontal merger. The long-term success of the method, however, will nevertheless depend on the successfulness of its application in court: *"The proof of the pudding is in the eating."*