MERGER SIMULATION MODELS: USEFUL OR JUST DANGEROUS?

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ABSTRACT

This paper considers the role that merger simulation models should play in European merger control. The use of these models, as off-the-shelf instruments to assess the economic effects of mergers, has become increasingly widespread in recent years. However, contrary to some claims, merger simulation models do not allow investigators to avoid much of the competitive effects analysis relating to the relevant economic market, nor do they necessarily provide more precision to merger control. Without understanding the limitations of such models and the circumstances under which they can and should be usefully applied, they may not just be useless, but dangerous in the sense of providing possibly spurious results with spurious claimed accuracy. This paper argues that any merger simulation models used should be "bespoke" models, rather than off the shelf models, but cautions that even bespoke models will frequently not be as useful as is often claimed. This is not to deny that there are occasions when well-constructed bespoke models are genuinely useful and do offer genuine improvements in merger control.

1. INTRODUCTION

There has recently been a considerable growth in interest in European merger control in merger simulation models.[2] These are models that attempt to estimate the price effects of potential mergers based on current and past market data. The European Commission (EC) has commissioned them in the past (e.g. Volvo/Scania merger[3]) as well as discussing them in recent decisions (e.g. Philip Morris/Papastratos[4] and Lagardere/Natexis/VUP[5]). Likewise at the national level, competition authorities are beginning to use, or at least assess the use of, merger simulation models. For example, the UK Competition Commission recently used one in Centrica/Dynegy[6]. Amongst the other Member

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2 They are already used fairly routinely in the US.

3 Case Comp/M.1672 (15/3/2000).

4 Case Comp/M.3191 (2/10/2003).

5 Case Comp/M.2978 (7/1/2004).

States, the Swedish Competition Authority claims to use them regularly,[7] while the German, Dutch and Irish authorities have all expressed interest in using them.

This raises the question of how useful are these models and how should they be used? Some argue that they are very useful as they allow investigators to compute directly the price effects of a merger without having to carry out a competitive effects analysis based on indirect measures such as market shares, barriers to entry and so on. Others argue that they are at best another potential piece of evidence in addition to the usual competitive effects analysis that is undertaken in mergers, and that they are frequently not worth the paper they are written on.[8]

This paper explains the regulatory background to the renewed interest in merger simulation models in Europe and critically assesses the role that such models should play in actual merger control proceedings.

2. BACKGROUND

European merger control is currently going through a period of considerable change. Traditionally, merger control in Europe has focused mainly on market share analysis: competition authorities have been concerned predominantly with the market share of the merged entity and with the level of concentration within the industry. The Merger Task Force of the European Commission, for instance, has tended to become agitated about a merger when the merged entity would have more than 40% of the market, or the largest three firms post-merger would have more than about 70%.[9] The UK authorities have historically become concerned at a lower threshold of 25% for the merged entity. Market shares at these levels created a (rebuttable) presumption that the merger would be anti-competitive. This has naturally meant that the market definition in a merger case has been key to the outcome of the competition authorities' deliberations. Ensuring that the authorities adopted a market definition that implied your clients had a market share of substantially less than 40% was usually the main concern of the lawyers working for the merging parties, whilst complainants focused on convincing the authorities that the correct market definition implied that the parties had a post-merger market share considerably above 40%.

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6 "Centrica plc and Dynegy Storage Ltd and Dynegy Onshore Processing UK Ltd: a report on the merger situation" Competition Commission, August, 2003.

7 Speech by Mats Bergman, Chief Economist at the Swedish Competition Authority, at "The Role of Economics in European Competition Policy", Brussels, 26 May, 2004.

8 For examples of the opposing views, see "The Emperor's New Clothes? - the role of merger simulation models" RBB Brief 12, January 2004 and "Not so *Rough*? Quantifying unilateral effects through merger simulation" Lexecon Competition Memo, January 2004.

9 Or perhaps the largest two firms more than 60%.

This description of traditional European merger control is, of course, not entirely fair. The presumptions based on market shares are rebuttable and frequently are rebutted. For instance, in the second half of 1994 the UK Office of Fair Trading (OFT) cleared the acquisition of Hays by Iron Mountain and of Billingtons by British Sugar.[10] Both led to market shares substantially above 50%. In GE-Instrumentarium,[11] the European Commission allowed market shares of over 50% in some Member States for some products.[12] Competition authorities have long known that competition can be intense even in concentrated industries and that factors such as the ease of entry into the industry, or ease of expansion by players already in the industry, could remove the possibility of anti-competitive effects. At the limit, competition authorities have long known about (though probably not really believed in) the theory of contestable markets.

Recent changes in the standards against which mergers are judged in Europe mean that there is likely to be less reliance on market shares in merger control in future. Until recently the merger standard under the European Merger Control Regulation has been whether the merger "created or enhanced a dominant position".[13] Under this standard a merger that was likely to create or enhance a dominant position should be prohibited. The dominant position could be single firm dominance by the merged entity, or joint dominance by a collection of firms including the merged entity. Economists have tended to equate the legal term "dominance" with some level of market power, but the legal basis for doing this was never clear. The competition law idea of dominance comes out of the German ordoliberal tradition and is about the protection of fair competition rather than directly the protection of consumers.[14] The result is that European merger control has historically not focused very clearly on consumer harm. An example of this was the Boeing-McDonnell Douglas decision in 1997.[15] The post-merger market share of the parties would have been 70%, a 6% increment on the pre-merger market share of Boeing. On purely structural grounds, that looked like a problematic merger and indeed the Commission did impose significant remedies on Boeing.[16] However at no point in the decision is there a discussion of how the merger might harm consumers, whilst there is much on how

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10 "A report under Section 125(4) Fair Trading Act 1973 on the advice given on 30 June 2003 to the Secretary of State for Trade and Industry under Section 76 of the Act: proposed acquisition by Iron Mountain Europe of assets of Hays plc, namely Hays IMS", OFT advice and "Anticipated acquisition by British Sugar plc of Billington Food Group plc", OFT advice, 4-8-2003.

11 Case Comp/M.3083 (2-9-2003).

12 For instance, the post-merger market shares for vascular C-arms in Austria, Belgium, France and Norway were 80-90%, 50-60%, 50-60% and 60-70% respectively (para. 231 of the decision).

13 This is not quite the full story, but it is close enough to a first approximation.

14 For further details, see, for instance, Möschel [1989].

15 Case No IV/M.877 (8/12/97).

16 Principally, Boeing had to cancel its exclusive contracts with American Airlines, Delta and Continental and has to maintain McDonnell-Douglas as a separate legal entity for 10 years.

it might harm competitors. Indeed, consumers (i.e. large commercial airlines) were in favour of the deal. The same charge can be levelled against many Commission decisions.

The Commission has introduced a new standard for judging mergers in the new Merger Regulation.[17] The test now is whether the merger will create a "significant impediment to effective competition".[18] This is taken to be close to, if not equivalent to, the US standard of "significant lessening of competition" (SLC).[19] The SLC test is focused primarily on harm to consumers, so the expectation is that European merger control will also now focus on whether a merger will lead to consumer harm. The most obvious avenue for consumer harm is that the merger will lead to prices rising.

Empirical analysis has played a significant role in European merger control for a number of years. However, consistent with the use of an indirect proxy for consumer harm (i.e. dominance), the empirical analysis has only very rarely focused on consumer harm. Instead, it has focused on market definition, a necessary precursor to calculating market shares. Hence the empirical analysis has tended to be focused on the cross-elasticities between products and the own-price elasticities of groups of products (for product market definition) and on competition between regions (for geographic market definition).[20] The new test suggests that there is scope for empirical analysis that focuses directly on the potential price effects of a merger, which is where merger simulation models come in. Economic models that can be calibrated using current market data to predict what the price effect of a merger will be provide, in principle, a direct test of whether a merger will lead to a substantial lessening of competition that will harm consumers.

The question that this paper focuses on is to what extent can merger simulation models currently play this role? Would an increased use of merger simulation models be likely to result in an improvement in European merger control?

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[17] Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation).

[18] In fact this phrase was always part of the merger standard. Formally, the test was that

> "A concentration which creates or strengthens a dominant position as a result of which effective competition would be significantly impeded in the common market or in a substantial part of it shall be declared incompatible with the common market". (Article 2(3) Regulation 4064/89).

In practice, however, the second limb to the test was ignored or assumed to flow from the creation or strengthening of the dominant position.

[19] Within Europe, the SLC standard has also been adopted in the UK and Ireland.

[20] The standard test for market definition in Europe (and the US) in merger cases is the Hypothetical Monopolist test. This asks whether a hypothetical enduring monopolist over a group of products in a particular region could profitably raise prices by more than 5-10% above the current price level. If it could, that group of products and region is a relevant market. If not, more products or regions are added until the test is satisfied. The starting point for the test is the narrowest plausible set of products and regions. For further details, see Bishop and Walker [2002].

3. A BRIEF INTRODUCTION TO MERGER SIMULATION MODELS[21]

The idea behind merger simulation models is to compute directly the likely post-merger equilibrium. Rather than first defining the market, then calculating market shares, then carrying out a competitive effects analysis and then taking a view on the likely effect of the merger, a merger simulation offers the alternative of directly calculating by how much prices will rise post-merger. In theory this might allow us to avoid the need to engage in a market definition exercise at all. Those well versed in the practice of merger control will recognise that this would be a significant step forward that would avoid many difficult and often fruitless debates.

Most merger simulations start from the assumption that the industry in question can be modelled using a Bertrand differentiated products framework.[22] By making various assumptions about key industry parameters and calibrating the model using the current competitive situation, it is then possible to estimate the post-merger equilibrium. The necessary inputs include the identities of the competitors in the market, the products they sell, marginal costs, own-price and cross-price elasticities, how these elasticities vary as prices vary, expected marginal cost efficiencies and the nature of competition post-merger.

An example should make this clearer. In 1999 Volvo and Scania announced that they intended to merge. The European Commission investigated the deal.[23] The main area of concern in this merger was in heavy trucks (those over 16 tonnes) in Ireland and the Nordic countries. The post-merger market shares would have been well above the level at which the Commission usually becomes concerned about post-merger single firm dominance (Table 1).

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[21] Werden and Froeb [1996] provides a good starting point for learning about merger simulation models.

[22] Sometimes other approaches are used, such as Cournot competition or bargaining models.

[23] Case COMP/M.1672 (15/3/2000).

Table 1: **Pre-merger and post-merger market shares in *Volvo/Scania* (%)**

	Volvo	Scania	Post-merger total
Sweden	45	46	91
Finland	34	31	65
Denmark	29	30	59
Ireland	22	27	49
Norway	38	32	70

Source: Para. 65 of the Commission's Decision

As part of its analysis of the merger the EC commissioned a simulation of the merger on national heavy truck markets. The simulation was based on a nested logit model in which the nests corresponded to rigid trucks and tractor trucks. Rigid trucks are integrated trucks from which the trailer cannot be detached whilst tractor trucks have detachable trailers. The data were list prices for 16 EEA countries in 1997 and 1998. Using the econometric results of the nested logit model, the authors then simulated the model on the assumption that the post-merger outcome would be a price setting Nash equilibrium (i.e. they assumed no post-merger cooperative behaviour between the remaining players).

Table 2: Percent price changes after merger[24]

	Volvo/Scania		Competitors	
	Rigid	**Tractor**	**Rigid**	**Tractor**
Denmark	11.55	8.17	0.26	0.19
Finland	10.03	7.83	0.39	0.24
Ireland	10.87	7.36	0.21	0.30
Norway	13.17	8.63	0.32	0.28
Sweden	22.34	12.64	0.47	0.32

[24] This table is based on Table 5 of Ivaldi and Verboven [2002]. Although the authors report results for all 16 countries, we report results only for the five countries that the Commission was concerned about.

Table 2 shows that in all five countries of concern the model predicted post-merger price increases by the parties of between 10% and 23% for rigid trucks and between 7% and 13% for tractor trucks. It also predicted that competitors would raise their prices somewhat in response to the higher prices charged by the parties, but by much less than the parties. Even when post-merger marginal cost efficiencies of 10% were assumed, the model still predicted that consumer welfare would fall in all five countries (by between 2% and 14%).[25] The Commission blocked the merger due to competitive concerns in these five countries, although it was at pains in the Decision to emphasise that this decision was not based on the merger simulation (which had been heavily criticised by the parties' legal and economic advisors).[26]

The organisation of the rest of this paper is as follows. Sections 4 to 8 of this paper discuss some of the difficulties that arise with the use of merger simulation models. Section 9 outlines some of the potential advantages of merger simulation models. Section 10 contains our conclusions on the role that merger simulation models should play in European merger control.

4. SENSITIVITY TO ELASTICITY AND FUNCTIONAL FORM ASSUMPTIONS

The results of a merger simulation depend heavily on the various own-price and cross-price elasticities between the products in question. These measure the degree of competitive interaction between products and so measure the loss in competition caused by the merging parties merging (i.e. the cross-elasticities between the products of the merging firms) and the competitive constraint imposed by the other competitors (the cross-elasticities between the products of the non-merging firms and the products of the merging firms). Clearly, the greater the cross-price elasticities between the merging products, the greater the post-merger price rises, *ceteris paribus*. Equally, the greater the cross-price elasticities between the other competitors and the merging parties, the lower the post-merger price rises. It is therefore clear that the elasticity estimates that are used in the simulation are key to determining the results of the simulation. Note that this issue does not just relate to the elasticities at the current equilibrium. It is also necessary to make some assumption about how the elasticities vary as prices rise. Whilst it may on occasion be possible to get reasonably accurate estimates of elasticities at current price levels, it is less easy to get good estimates of how elasticities

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[25] See Table 7 of Ivaldi and Verboven (*op. cit*).

[26] "Given the novelty of the approach and the level of disagreement, the Commission will not base its assessment on the results of the study" (para.75 of the decision). In addition to being based on list prices, the study was also based on a standardized truck without many of the optional extras that buyers often choose. This led to the glorious characterization of the study by the parties as "a study based on prices nobody pays for trucks nobody buys".

vary as prices rise, particularly when the simulation model is predicting price rises above prices that have existed in the past (i.e. out of sample price rises).

Crooke et al [1999] looked at the effect on the results of a merger simulation of different assumptions about how elasticities vary as prices rise. They looked at four alternative functional forms (log-linear, linear, logit and AIDS) within a non-cooperative Bertrand setting using a setting of two firms merging in an industry with between four and eight firms. Using Monte Carlo analysis they found that average post-merger price rises for the merging parties were more than three times larger for a log-linear specification than for a linear specification, with AIDS giving average price increases double the linear specification and logit giving average price increases of 50% higher than linear. The hierarchy of these results is unsurprising. The log-linear specification implies that elasticities do not change as prices rise, whereas the other three specifications all have the own-price elasticities of the products rising as prices rise. The own-price elasticity rises fastest for the linear specification and so this implies the smallest post-merger price rise.

A natural response to this issue is, in the absence of good evidence in favour of one or other specification, to carry out the simulation using a number of alternative specifications, including at least linear and log-linear (in the expectation of getting minimum and maximum post-merger price rises). Although this is clearly the sensible thing to do at one level, it is clearly far from ideal. The actual level of price increase implied by a merger simulation model is typically what matters, particularly since we know that a simulation will always predict some post-merger price rise in the absence of marginal cost efficiencies. There may be times when the model predicts such small price rises (or even negative ones (see below)) that there is no concern under any functional form. Equally there may be times when it predicts large price rises under any functional form and then it might be argued that the model shows that the merger is a problem even under the assumptions most favourable to the merging parties (although we will argue against this proposition below). But in general potential variation in this figure by more than three times does not provide an adequate basis for merger policy.

This discussion of functional forms has been predicated on the assumption that the investigator had an accurate estimate of the various elasticities of demand at the current equilibrium. In reality, of course, this is rarely if ever true. Estimating elasticities is a hazardous exercise at the best of times and there is always a substantial element of uncertainty over the exact figures. This problem is made worse by the fact that merger investigations are not the best of times: timescales tend to be very short and the data that are available in this timescale for econometric work are often pretty inadequate. But incorrect elasticity estimates, even if functional form assumptions are correct, lead to substantial inaccuracies in the predictions of a merger simulation.

Consider the following example.[27] There are four single-product firms in the market and Firms 2 and 3 intend to merge. The own-price and cross-price elasticity matrix is given in Table 3.

Table 3: Elasticity matrix

	Firm 1	**Firm 2**	**Firm 3**	**Firm 4**
Firm 1	-1.5	0.09	0.03	0.16
Firm 2	0.5	-1.33	0.06	0.23
Firm 3	0.61	0.22	-1.81	0.3
Firm 4	0.47	0.12	0.04	-1.33

The marginal costs of the four firms are given in Table 4.

Table 4: Pre-merger marginal costs (£)

Firm1	**Firm 2**	**Firm 3**	**Firm 4**
0.33	0.25	0.45	0.25

This leads to a pre-merger equilibrium, assuming a price-setting Nash equilibrium, with the following pre-merger prices and market shares.

Table 5: Pre-merger prices and market shares

	Price (£)	**Market share (%)**
Firm 1	1.00	63
Firm 2	1.00	16
Firm 3	1.00	5
Firm 4	1.00	15

[27] The elasticity matrix comes from a submission by Professor Jerry Hausman to the FCC in the WorldCom/Sprint merger proceedings.

Now suppose we simulate the merger of Firms 2 and 3. Initially we choose three possible functional forms (linear, log-linear and AIDS) and assume no changes in marginal costs post-merger. The results are given in Table 6.

Table 6: Predicted post-merger price rises[28]

(%, no marginal cost reductions, initial elasticity matrix)

	Linear	**AIDS**	**Log-linear**
Firm 1	0.1	0.9	0.0
Firm 2	1.6	12.5	12.9
Firm 3	4.3	17.1	28.2
Firm 4	0.2	1.5	0.0

The interesting aspect of these results is how different the predicted price rises are depending on which functional form is chosen. The predicted price rise for Firm 2 ranges from just 1.6% (arguably *de minimis*) under the linear specification to 12.9% under the log-linear specification. The predicted price rise for Firm 3 varies even more, from 4.3% under the linear specification to 28.2% under the log-linear specification. One might rule out the log-linear specification on *a priori* grounds: surely Firms 1 and 4 would respond to such price rises, whereas the log-linear specification implies they would not. However, the differences in predicted price rises are substantial even between the linear and the AIDS functional forms, with the AIDS predicted price rises being at least four times larger than the linear predicted price rises.

Now suppose we alter the own-price elasticity assumptions. The estimates we used above were -1.33 for Firm 2 and -1.81 for Firm 3.

[28] The simulations were carried out using SimMerger Lite, available from www.antitrust.org.

Table 7 to

Table 10 shows what happens when we alter the own-price elasticities for Firm 2 and Firm 3 by relatively small amounts (+/- 10%).

Table 7: Predicted post-merger price rises

(%, no marginal cost reductions, Firm 2 own-price elasticity rises to -1.46)

	Linear	**AIDS**	**Log-linear**
Firm 1	0.1	0.6	0.0
Firm 2	1.5	8.1	8.9
Firm 3	3.9	14.9	24.6
Firm 4	0.1	1.1	0.0

Table 8: Predicted post-merger price rises

(%, no marginal cost reductions, Firm 3 own-price elasticity rises to -1.99)

	Linear	**AIDS**	**Log-linear**
Firm 1	0.1	0.8	0.0
Firm 2	1.5	11.1	11.6
Firm 3	3.9	13.0	21.8
Firm 4	0.1	1.3	0.0

Table 9: Predicted post-merger price rises

(%, no marginal cost reductions, Firm 2 own-price falls to -1.20)

	Linear	**AIDS**	**Log-linear**
Firm 1	0.1	1.5	0.0
Firm 2	1.8	24.6	23.4
Firm 3	4.8	20.6	32.6
Firm 4	0.1	2.5	0.0

Table 10:: Predicted post-merger price rises

(%, no marginal cost reductions, Firm 3 own price elasticity falls to -1.63)

	Linear	**AIDS**	**Log-linear**
Firm 1	0.1	1.1	0.0
Firm 2	1.8	14.4	14.4
Firm 3	4.8	24.5	40.2
Firm 4	0.2	1.8	0.0

The changes in the predicted price rises as the own price elasticities are changed by 10% are substantial. Table 11 summarises the results for the linear and AIDS functional forms.

Table 11: Summary of results of changing own-price elasticities

	D e_{ii}	**Before**		**After**		**% change**	
		Linear	AIDS	Linear	AIDS	Linear	AIDS
Firm 2	+10%	1.6	12.5	1.5	8.1	-6	-35
Firm 3	+10%	4.3	17.1	3.9	13.0	-9	-24
Firm 2	-10%	1.6	12.5	1.8	24.6	13	97
Firm 3	-10%	4.3	17.1	4.8	24.5	12	43

The figures for the linear functional form seem reasonable. To a first approximation, 10% changes in the relevant own price elasticity leads to changes in the predicted price change of about 10%. This is not so with the AIDS specification, where the change in the predicted price change range from 24% to 97%. The equivalent range for the log-linear specification is 22% to 81%.

It is worth putting the 10% figure into some sort of context. We are usually reasonably confident that the true value of an estimated parameter is within plus or minus two standard errors of the central estimate. If a 10% change in the elasticity estimate is within two standard errors, then the t-statistic for the parameter must be at least 20. That is a much higher level of certainty than we generally see for elasticity estimates, so the ± 10% range for the own-price elasticities is a very restricted range.

Now suppose that instead of changing the own-price elasticities, we alter the cross-price elasticities by 25% each. So we raise (lower) the cross-price elasticity of Firm 2 with respect to Firm 3 from 0.06 to

0.08 (0.045) and the cross-elasticity from Firm 3 to Firm 2 from 0.22 to 0.28 (0.16). Table 12 gives the results.

Table 12: Predicted post-merger price rises

(%, no marginal cost reductions, e_{23} and e_{32} changed by 25%)

	25% rise in e_{ij}			**25% fall in e_{ij}**		
	Linear	**AIDS**	**Log-linear**	**Linear**	**AIDS**	**Log-linear**
Firm 1	0.1	1.2	0.0	0.1	0.6	0.0
Firm 2	2.2	17.7	16.1	1.1	8.7	9.4
Firm 3	5.8	25.2	50.1	3.2	11.9	18.5
Firm 4	0.2	2.1	0.0	0.1	1.0	0.0

The predicted price increases rise by between 25% and 78% for Firms 2 and 3 and the predicted price reductions increase by between 25% and 34%. Again, these are considerable variations in the predicted post-merger price increases for relatively small changes in elasticity estimates. Following the logic presented above, a 25% variation in the cross-price elasticity is consistent with a t-statistic of 8, which is considerably above those normally found.

As noted above when discussing functional forms, results that vary this much based on different but plausible assumptions are unlikely to be useful for merger control purposes.

5. CHECKING THE FACTS FIT THE MODEL

Current facts

A model that does not fit the current facts of the industry is unlikely to be very good at predicting the future facts of the industry. It is clearly important to make sure that the simulation model is able to account for the current known facts of the industry. These facts should include at least estimates of marginal costs, elasticity estimates and current market shares. If we assume, as is standard, a Bertrand differentiated products equilibrium, then this implies a set of relationships between various observable variables.[29] For instance, for a single product firm we know that there is a particular relationship between marginal cost and the own-price elasticity (i.e. the price cost margin is equal to

[29] Of course, any assumed equilibrium model implies a set of relationships between the various variables.

one over the own-price elasticity). One, all too common, approach to merger simulation models is to decide that this means that you only need an estimate of one of these variables, as the other can then be derived from the equilibrium conditions of the model (e.g. if you know the price cost margin, then you can derive the own-price elasticity). This cannot be a sensible way to proceed. It means that we elevate our assumptions about the nature of competition to the level of established fact, and this is virtually never a reasonable thing to do. Instead, an investigator should independently estimate the important variables and then check that these estimates are consistent with the underlying model of competition that is chosen.

It is likely that the central estimates of the main variables will not be entirely consistent with the underlying model of competition. Elasticity estimates are often imprecise and marginal cost can be hard to measure. However, at a minimum an investigator needs to consider the possible reasons for inconsistencies before continuing with the simulation. If the marginal cost and elasticity estimates do not mesh, there are at least three possible explanations. One is that the elasticity estimate and/or the marginal cost estimate are poor estimates. The correct response to this issue is to try to find better estimates. The second possible explanation is that the investigator is looking at the wrong elasticity or the wrong marginal cost. Perhaps the periodicity of the elasticity estimate is wrong. This might actually convey some interesting information on the nature of competition.

The third possible explanation is that the underlying model of competition (e.g. non-collusive Bertrand differentiated products) is wrong. As a general matter, we think this is often the case. It is worth stepping back a moment to think about what the assumption of a Nash equilibrium within a Bertrand model really means when, as in virtually all mergers where market shares suggest there may be competition concerns, there are only a few players. As a behavioural assumption, it must be wrong. Firms in oligopoly situations are well aware that their competitors will respond to whatever they do, and so they take this into account when setting their strategy in the first place, knowing that their competitors will be responding to their strategy taking into account their response to their competitors strategy, and so on. This oligopoly interaction is entirely omitted from the Bertrand model. So if the Bertrand Nash equilibrium is a good description of reality, it is a good description of where a market ends up, not how it gets there. This is an empirical question and there is little reason to believe that in general that is where a market will end up.[30] Evidence that the facts of the market are not consistent with the Nash equilibrium assumption should not surprise us and should be taken

[30] In response to this criticism of the Nash assumption, Werden argues that the assumption is reasonable because what could be more natural than that firms end up in a position where they are doing the best they can given what other firms are doing? ("Whither merger simulation" *ABA Section of Antitrust Law 'Brown Bag', January 2004*) This is clearly an inadequate defence. The Nash equilibrium means firms are maximizing given the current price and output decisions of other firms in a short-run sense. This is not the natural equilibrium. The natural equilibrium is that firms are maximizing given what they expect other firms would do if they were to change their behaviour. This is a quite different equilibrium.

seriously. If the facts of the market are not consistent with a Nash equilibrium, then it makes little sense to model the industry as if the facts are consistent with a Nash equilibrium.[31]

An example of this is provided by the model commissioned by the EC in the Volvo/Scania merger. This simulation model of the heavy truck market in Europe predicted average Lerner indices ranging from 0.35 in Italy to 0.56 in Sweden. Industry experts apparently believed that the true gross margin was 0.3. The parties evidently used this information, amongst other things, to argue that the simulation model could not be relied upon by the European Commission.[32] The authors of the study have responded by noting first, that gross margins estimated from accounting data may not coincide with the economically correct gross margins and, second, that manufacturers may take into account future profits from after sales service when setting prices. The first of these responses clearly may be correct, but cannot just be asserted. The second response is fascinating: if it is true it tells us something very interesting about the nature of competition *that should be incorporated into the simulation model*. If firms price below the Nash equilibrium in the durable good market in the expectation of recouping the lost profits in the secondary market, then it does not make sense to use a model that assumes a simple Nash equilibrium in the durable good market and that does not take account of secondary market competition. Furthermore, the study was based on list prices as actual transaction prices were not available.[33] Given the widespread use of discounts (usually volume-related) in the heavy truck market, one would expect that margins calculated on the basis of list prices might well be higher than actual margins. So here the relationship between the calculated margins and actual margins might actually tell us something useful about the relationship between list prices and transaction prices (always assuming the model is specified reasonably correctly in the first place).

Past facts

It is generally not enough that a merger simulation is consistent with the current facts of the market. This should be considered a necessary, but not sufficient condition. The model should also be able to

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[31] Nevo [2001] provides a decomposition of market power (as measured by the Lerner index) into unilateral and coordinated effects. This effectively allows one to test whether a market is in a Nash equilibrium or not. Slade [2004], using on-trade data, applies the methodology to UK brewing and finds no evidence of coordinated effects, thus suggesting that the assumption of a Nash equilibrium would actually be reasonable for this industry. Peters [2003] looks at mergers in the US airline industry in the 1980s using merger simulation models based on Nash equilibria. He finds that post-merger changes in the conduct of firms are an important determinant of post-merger pricing (i.e. the post-merger equilibria, like the pre-merger equilibria, were not pure Nash).

[32] See footnote 26.

[33] List prices were also used in the simulation carried out for the Commission in the Lagardere/Natexis/VUP merger (*op. cit.*), apparently because reliable data on transaction prices was not available. We cannot help but feel that list prices are likely to be a very imperfect proxy for transaction prices in many cases, particularly in the presence of significant discounts to bulk buyers.

explain relevant recent past facts about the industry. For instance, have there been significant market share shifts in the recent past? If so, can these be explained within the assumptions of the model about the nature of competition? In a standard Bertrand differentiated products model significant changes in market share should be driven by changes in relative marginal costs or by shifts in demands curves. The first explanation can and should be checked. The second explanation provides rather more difficulties. Although it also can be checked, if demand curves have shifted significantly in the recent past, it is hard to be confident about our current estimates of where the demand curve is. This is for two reasons. First, it reduces the amount of historic data that we have with which to estimate the position of the current demand curve. Second, it raises the question of whether the demand curves could shift significantly again, particularly as a result of a merger. Simulations omit the possibility that products already in the market might be repositioned in the product space in response to a merger, or that the merger may lead to new entry if prices rise. Both of these would mean that the post-merger elasticity matrix was different to the pre-merger one.

If a simulation model is able to explain past facts, this clearly increases ones confidence in the model. For instance, if a model is able to explain past market share shifts, perhaps due to changes in marginal costs (e.g. a process innovation by one firm that reduced its marginal costs relative to its competitors), then that is strong evidence in favour of the model specification and so increases ones confidence in the results of the simulation.

Economists who produce models that do not fit the known facts of the industry should expect to have their models ignored by regulatory authorities and courts. A good example of this happening in the US is *Concord Boat v. Brunswick Corp*.[34] The plaintiff's economist argued that the behaviour of the defendant had had the effect of anti-competitively excluding the plaintiff and of increasing the market share of the defendant. The economist used a model to show this. The Court noted that the plaintiff's economic model implied the defendants would have had a 50% market share in the absence of the challenged conduct. However, the defendant had had a 75% market share even before it started the alleged anti-competitive behaviour. Since the economic model was at odds with known facts about the industry, the court threw out the economic evidence.

6. AT BEST, ONLY HALF THE STORY

The standard approach to merger control in Europe is to define the relevant market, calculate market shares and then carry out a competitive effects analysis if the post-merger market shares suggest there may be a competition problem with the merger. This competitive effects analysis looks at the post-

[34] 207 F.3d 1039, 1056 (8th Circuit. 2000).

merger constraints on the merged entity. The principle areas of focus are usually: barriers to entry, barriers to expansion, buyer power and the increased scope for co-ordinated behaviour post-merger.

Merger simulations do not in general take account of these factors. The result is that in the absence of marginal cost efficiencies,[35] they always imply that prices will rise as a result of the merger. This is of course a standard result: if two firms merge in an imperfect competition setting then they will raise prices unless the cross-elasticities between them are zero. Since there has not been an efficiency defence until very recently in Europe it seems unlikely that the competition authorities have been allowing mergers on efficiency grounds. It also seems unlikely that they have consistently been allowing mergers that they thought would raise prices. This suggests that the authorities believe that these other factors are important. As such, they need to be taken into account in the merger analysis.[36]

There appears to be a clear solution to this "problem". Carry out the simulation analysis, find an upper bound estimate for the post-merger price rise in the absence of these other constraints and then take account of these constraints. Although there is much to be said for this approach, there are two important caveats to note. Firstly, the merger simulation does not necessarily provide one with an upper bound estimate for the price rise. Ignoring the elasticity and functional form issues discussed above, the simulations are still based on the strong assumption that the post-merger equilibrium continues to be a Nash equilibrium. If there is any increase in co-operative behaviour post-merger, then of course the simulation model does not provide an upper bound to the possible price rise.[37] Secondly, once we adopt this approach (simulation analysis and then competitive effects analysis), we must accept that this undercuts the claim by some proponents of merger simulation models that they can directly compute the effect of a merger without the need to engage in a competitive effects analysis.

This discussion hints at another difficulty that arises with regard to the underlying model of the nature of competition. Mergers that raise competition concerns tend to be significant mergers that often represent a step change in the market. It would not be very surprising if mergers of this type often led to changes in the nature of competition post-merger. Note that this is not just to say that the merger may lead the market to become less competitive, although that is clearly one obvious possibility. It is also possible that the merger will increase the intensity of competition post-merger, perhaps because

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35 See below for a discussion of marginal cost efficiencies in merger simulation models.

36 An alternative explanation is that the authorities do not mind "small" price increases as a result of mergers.

37 Of course, you could carry out a simulation in which all the firms in the industry merge. This would be equivalent to the optimal cartel position and so would provide an upper bound. However, this still requires assumptions to be made about functional form. In the example in the text above, the linear specification would give post-merger price rises in the merger-to-monopoly scenario of 12.5%, 22.9%, 23.8% and 35.5% for Firms 1 to 4 respectively, whilst the AIDS and log-linear specifications give rise to much larger price increases.

the merger has created a significant sized number two firm with lower barriers to expansion than previously,[38] or because the merged entity has become the largest firm and this spurs the previously largest firm to respond vigorously. This requires some understanding of the strategies of the firms with respect to market share and market leadership. Simulation models typically do not capture this.

7. RETAIL DATA FOR MANUFACTURER MERGERS

Simulation models have been used most often in fast moving consumer goods markets as these markets tend to lead to copious amounts of price and quantity data, and hence reasonably precise elasticity estimates. The price and quantity data that is available is almost always retail data. However, the merging parties are often manufacturers who sell to retailers. So the price that the merging parties set is the wholesale price to retailers, but the price that we observe is the retail price to consumers. Ignoring this distinction may lead to serious inaccuracies when carrying out merger analysis.

Retail elasticities and wholesale elasticities usually differ, although obviously the wholesale elasticity is likely to be closely related to the retail elasticity. Specifically, the wholesale elasticity of demand facing the manufacturer will be equal to the elasticity of demand at the retail level multiplied by the elasticity of the retail price with respect to the wholesale price (formally, $\varepsilon_W = \varepsilon_R \, \varepsilon^p_{w)}$. This latter elasticity is the percentage change in the retail price engendered by a one percent change in the wholesale price. Clearly if the elasticity of the retail price with respect to the wholesale price is one ($\varepsilon^p_w=1$), then the retail elasticity and the wholesale elasticity are equal ($\varepsilon_W = \varepsilon_R$). This would be the case, for instance, if retailers set their prices so as to maintain a constant percentage mark-up over the wholesale price.[39] However, in general we might expect the elasticity of the retail price with respect to the wholesale price to be less than one, in which case the wholesale elasticity will be less than the retail elasticity. For instance, if retailers seek to maintain a constant absolute margin and if the wholesale price accounts for half of the retail price, then a one percent increase in the wholesale price will equate to a half percent increase in the retail price (i.e. $\varepsilon^p_w = 0.5$) and so the wholesale elasticity will be half the retail elasticity.

It is also worth noting that in some cases the wholesale elasticity can be larger than the retail elasticity. This would occur when a wholesale price increase led to the product being dropped by

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[38] The EC has traditionally argued that two large firms lead to more competitive outcomes than one large firm and several smaller firms, even though concentration (e.g. HHI) is higher in the former case than the latter.

[39] Assuming that one unit of the wholesale product translates into one unit of the retail product and there are no other variable costs of retailing the product.

retailers. In this case, the wholesale elasticity is infinite regardless of what the retail elasticity is. This scenario is likely to be relevant when shelf-space constraints are binding on retailers and so delisting is credible.[40]

But actually, the difficulties presented by the retail/wholesale distinction are substantially more serious than this. Froeb, Tschantz and Werden [2002] show that a simple model with a monopoly retail sector and Bertrand competition at the upstream level can lead to no pass-through or complete pass-through, depending on the exact form of contracts between manufacturers and the retailer and the exact rules of the game.[41] They argue that economists simply do not have a good analytical grasp of what the right model of competition is even in relatively simple situations of a few manufacturers facing a few retailers. This clearly raises serious concerns about using a merger simulation to predict the effect of a merger of manufacturers using estimates of retail elasticities. In reality, of course, it raises serious difficulties for any sort of coherent merger control analysis in this sort of situation, but it does serve to highlight how the apparent precision of merger simulation results may be entirely spurious.

8. NON-PRICE COMPETITION

Merger simulation models focus on price and hence omit non-price competition issues, but are often carried out in branded goods industries, where we know that non-price competition issues, such as advertising and promotions, are important. Frequently these mergers involve manufacturers who need to deal with retailers in order to get their product to consumers. Here competition for shelf space is typically important.

The use of a merger simulation model in these types of circumstances is only reasonable if the effect of the loss of price competition between the merging parties outweighs substantially the non-price effects. It may be that removing cannibalisation between the products post-merger is the most important effect of the merger, but this is an empirical question that cannot be assumed. As Scheffman argues:

> "Bertrand is a posted price model. … You post your price. You change it if sales were not consistent with your expectations about demand. There's nothing about trying to get business away from your competitors. There's nothing about positioning your product differently, doing

[40] For further discussion of the relationship between wholesale and retail elasticities, see Hosken *et al* [2002].

[41] They also note that with long-term contracts between retailers and manufacturers, it is even possible that fixed cost reductions could get passed-through. This is a possibility that merger control on both sides of the Atlantic does not currently allow for.

> any of the sort of things which real world marketing is all about. I think those things are likely to be very important, but it's the empirical issue. The issue is really, does internalisation of cannibalisation - which is all that drives Bertrand simulation models - dominate all the other stuff which is really very important?"[42]

9. ADVANTAGES OF MERGER SIMULUATION MODELS

This paper has so far been fairly negative about the usefulness of merger simulation models in European merger control. It is worth now looking at the reasons advanced for why merger simulations may nonetheless be worthwhile. These suggest that there is a potentially important role for merger simulations models, but it is more limited than is often claimed.

Simulations and cost efficiencies

An important potential advantage of merger simulations is that it is relatively easy to take account of the effect of claimed post-merger marginal cost efficiencies on post-merger prices. The European Commission has recently adopted what it refers to as an "efficiency defence". By this the Commission means that if there is good evidence that a merger will lead to such significant marginal cost reductions that prices post-merger will actually be lower than pre-merger, then the Commission will allow the merger even if it appears to lead to a significant reduction in competition between firms. This is not what the economic literature usually refers to as an efficiency defence, since it focuses only on consumer welfare and not on total welfare.[43] It is also hard to believe that this "defence" is even something that the Commission needed to formally adopt since it is so obviously sensible policy. However, as noted above, the previous focus on dominance led to the Commission typically not focusing on consumer welfare but rather on market shares.

There are two main approaches to accounting for marginal cost efficiencies in a merger simulation. The most obvious one is just to factor the reduction in marginal costs post-merger into the simulation. This then provides an estimate of post-merger price changes taking into account the efficiencies. If the efficiencies are large enough, the result may be that prices fall as a result of the merger. This

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[42] "Whither merger simulation" American Bar Association Section of Antitrust Law "Brown Bag", 29 January, 2004.

[43] Traditionally, the "efficiency defence" referred to the argument that a merger would lead to increases in producer surplus that outweighed losses in consumer surplus, thus leading to an increase in total social welfare as a result of the merger. See, *inter alia*, Bork [1995] for a defence of the social welfare criterion in competition policy.

approach suffers from the same problems outlined above with regard to the elasticity estimates and functional form assumptions. If these are wrong, then the computed post-merger price changes will also be wrong, although the sign of the price change will be correct (i.e. if prices fall under one functional form, then they fall under all the potential functional forms). However, it should be noted that the closer to zero the final results are, the less errors in the functional form will matter as the less price rises, the less the various elasticity estimates based on different functional forms diverge.

The other approach is due to Werden [1996]. He suggests calculating the marginal cost efficiencies that would be needed to restore the market to the same equilibrium post-merger as pre-merger. These can then be compared to the cost efficiency claims being made by the parties. The great advantage of this is that since the market is in the same place post-merger as pre-merger, the various elasticities should be the same post-merger as pre-merger, which avoids the need to make assumptions about the functional form of the demand curves. This approach still requires that the estimates of current elasticities are correct, but this is obviously a lesser requirement than that the functional forms are correct as well.

Using the same model as above, we can investigate the effect of small changes in the elasticity estimates on the critical marginal cost reductions. Table 13 shows how the critical marginal cost reductions vary in response to small changes in the elasticity estimates for Firms 2 and 3.

Table 13: Variations in critical marginal cost reductions as own price elasticities vary

Variation in own price elasticity		**Critical MC reduction (%)**	
Firm 2	**Firm 3**	**Firm 2**	**Firm 3**
0%	0%	13.0	19.1
+10%	0%	9.2	17.3
0%	+10%	11.8	15.5
+10%	+10%	8.4	14.1
-10%	0%	21.7	21.1
0%	-10%	14.4	24.6
-10%	-10%	24.1	27.3

It is clear that relatively small variations in the own price elasticity estimates lead to significantly different critical marginal cost reductions. If both elasticities are 10% higher than estimated, then the

critical marginal cost reductions for Firm 2 and Firm 3 are 8.4% and 14.1%, rather than 13.0% and 19.1%. These are differences of 35% and 26% respectively. Conversely, if both elasticities are actually 10% lower than estimated, then the critical marginal cost reductions for Firm 2 and Firm 3 are 24.1% and 27.3%, representing differences from the central estimates of 85% and 43% respectively.

So whilst the critical elasticity approach avoids the need to make assumptions about how elasticities vary as prices vary, it does not avoid the problem of simulation results being highly sensitive to variations in estimated elasticities. It may well be reasonable to argue that other approaches to taking efficiencies into account do no better in terms of precision, but this should not blind us to the potentially wide variations in critical elasticity estimates that are likely to come out of merger simulation models.

This conclusion should be seen in the context of the likelihood that the "efficiency defence" will be applied in Europe only rarely. There are two reasons for this. Firstly, even Professor Röller, the Commission's Chief Economist, has said that despite welcoming the efficiency defence, he does not expect it to be instrumental in clearing many mergers in the near future.[44] Thirdly, the conditions under which the efficiency defence is available in Europe are stringent. The new Merger Guidelines[45] state that efficiencies will only be considered if they are "merger specific", which is taken to mean they could not be achieved by a less anti-competitive alternative, such as a license or a cooperative joint venture.[46] This is a stringent requirement, since it goes beyond just showing that the post-merger situation is no worse for consumers than the pre-merger situation. By not choosing the current situation but instead choosing an alternative contractual arrangement as the relevant counterfactual, the Commission is requiring an assessment of the likely alternative mechanism that the market would use in the absence of the merger. Farrell and Shapiro [2001] have shown that this requirement significantly reduces the usefulness of the efficiency defence to merging parties. They have shown that those cases where efficiencies are most likely to be important and "merger specific" are also cases where there are likely to be real competitive concerns. The result is that arguing for an efficiency defence in a case is likely to be a double-edged sword. Resting such a defence on potentially rather fragile simulation results is therefore likely to be a high risk strategy for the merging parties.

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44 Comments made at a seminar in Brussels on 18 November, 2003, organised by Wilmer, Cutler & Pickering, Lexecon and the Centre for European Policy Studies.

45 "Commission Notice: Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings (30/1/2004)."

46 *Ibid.*,paragraph 85.

A rough cut?

One response to many of the criticisms made of merger simulation models is that simulation models can be a useful first cut at the appraisal of a potential merger. The idea is by that using a merger simulation you can get a "quick and dirty" estimate of the likely effect of a merger. This estimate, it is argued, can be useful at the planning stage of a merger to give the parties an indication as to whether a potential merger will run into competition policy concerns. This seems to us to be a very weak defence of simulation models. The discussion above has illustrated that the results of merger simulation models should not be trusted except under stringent conditions, such as that the investigator has good evidence on the actual values of the necessary inputs (elasticities, marginal costs and so on), has good evidence on the actual form of competition in the market and can show that the model is able to explain recent past data as well as current data. Ensuring that these stringent conditions are met is not consistent, in our view, with a "quick and dirty" approach. For instance, estimating good elasticity estimates is usually a long and pain-staking process.

The argument is sometimes buttressed with the further argument that a merger simulation model based on a log-linear specification provides an upper-bound to the possible post-merger price rise, and this can be useful. In particular, if this upper-bound is low, then no further is investigation is needed, whilst if it is high the investigator can then undertake the competitive effects analysis. However, it is important to remember that this upper-bound is only an upper-bound on the assumption that the post-merger equilibrium is a Nash equilibrium. If the post-merger equilibrium involves an increase in co-operative behaviour, then the upper-bound estimate is not a true upper-bound.

Part of the information matrix

Another defence is that merger simulation models provide further support to the case if their results are consistent with the rest of the market analysis. It is a defence of sorts, but it is important to note its limitations. A merger simulation whose results are consistent with the rest of the market analysis does increase one's confidence in the market analysis. However, the claim made by some proponents of merger simulation models has been that they avoid the need to engage in much of the market analysis. If instead the merger simulation is just additional support, then that implies that the market analysis still needs to be carried out.

But given all the concerns raised above, it is worth asking what the value added of the merger simulation is. If we are going to discount a merger simulation that does not fit with the market analysis facts, then how does the merger simulation advance our thinking? A recent European

Commission decision highlights this issue. In the *Philip Morris/Papastratos* decision[47] the Commission wrote the following:

> "The parties have provided the results of a merger simulation that shows that on average the market price increase post-merger would be minimal. The simulation model assumes that the merging parties' products compete in different segments, or in other words, that the degree of substitutability between their products is low. The market investigation has confirmed the market segmentation. The results of the simulation confirm that the present merger would not lead to significant price increase in the Greek cigarette market." (para. 32)

One has to wonder what the simulation exercise added. The simulation was based on the assumption that the degree of substitutability between the parties' products was low, so it was hardly a surprise that it showed minimal post-merger price rises. It was not necessary to do a simulation to reach this conclusion. The assumption of low substitutability, key to the result of the simulation, had to be confirmed by the Commission's market investigation. In other words, the competitive effects analysis was first needed, which then fed into a simulation that showed what the competitive effects analysis had already shown.

Divestment analysis

Merger simulations can be useful in the area of divestment analysis. Suppose that we are able to put together a simulation model that is a good description of the competitive reality of the relevant market and that this model predicts that a two firm multi-product merger will lead to significant price rises even allowing for expected marginal cost efficiencies. The regulatory authorities will likely require the parties to offer remedies. By altering the post-merger ownership assumptions in the merger simulation one can see what effect the divestment of different brands might have on post-merger prices. This might be a useful way of identifying those divestments that solve the competitive problems and those divestments that do not. However, it should be noted that even here a competitive effects analysis will be required. A regulatory authority will not be guided purely by the predictions of a simulation model. It will test any proposed divestments by talking to third parties (e.g. competitors and customers) and by checking them against its own competitive effects analysis. So whilst the merger simulation might be useful and time-saving at the point of needing to propose potential divestment solutions to the regulatory authorities, it does not provide a silver bullet.

10. CONCLUSIONS

Merger simulation models have the potential to be very useful in merger control, but this usefulness needs to be put into context. First, merger simulation models are not a substitute for the competitive

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47 *Op. cit.*

effects analysis. A merger simulation must be rooted firmly in the particular facts of the specific industry in question and this requires a competitive effects analysis. A model that is not based on the facts of the industry cannot be useful for analysing a merger in the industry. Obvious though this is, it often appears to be forgotten in practice. This implies that "standard" off-the-shelf simulation models should be treated with great care. For instance, the Bertrand differentiated products model may fit some markets, but will often not be fully appropriate. Our belief is that only bespoke simulation models, designed to fit the particular industry in question, are likely to be useful.

Second, the apparent precision of merger simulation models needs to be treated with care. The inputs (e.g. elasticity estimates) to the models are not known with certainty and this means that the outputs are also subject to uncertainty. At a minimum an investigator should report the results of a simulation with confidence intervals. Our analysis above suggests that these confidence intervals could easily be so large that the results are essentially worthless. It should, of course, be remembered that the inputs used in merger simulation models are also typically relevant to the traditional competitive effects analysis and it is not usually possible to put confidence intervals on the results of the competitive effects analysis. So the message here is to not be beguiled by apparent precision.

Third, merger simulation models typically miss out much that is competitively important in reality, such as the interaction between retailers and wholesalers, the nature of non-price competition and the scope for post-merger entry or product repositioning. Where possible, these should be included in a bespoke model. Where not possible, they need to be considered. Either way, it is important that they are included in the totality of the analysis.

"Useful" in this context has a rather different meaning to that which has often been claimed in the past. Even bespoke merger simulation models are unlikely, except on rare occasions, to provide "the answer" to the merger analysis. However, good models that pass the tests of fitting the facts (past and present) and providing reasonably narrow confidence intervals for their predictions, may be useful for putting efficiency claims into context and for facilitating the analysis of potential divestment remedies. They can also provide an indication of the burden that those factors omitted from the simulation model, such as potential new entry and product repositioning, must bear.

So whilst merger simulation models undoubtedly are dangerous when not carried out in the manner advocated above and when asked to bear too much burden of proof, they can also be useful.

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