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MERGER SIMULATION IN COMPETITION POLICY: A SURVEY

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ABSTRACT

Advances in competition economics as well as in computational and empirical methods have offered the scope for the employment of merger simulation models (MSMs) in merger-control procedures during the past almost 15 years. Merger simulation is, nevertheless, still a very young and innovative instrument of antitrust, and, therefore, its "technical" potential is far from being comprehensively exploited, and teething problems in its practical use in the antitrust environment prevail. We provide a classification of state-of-the-art MSMs and review their previous employment in merger cases as well as the problems and limitations currently associated with their use in merger control. In summary, MSMs represent an important and valuable extension of the toolbox of merger policy. However, they do not qualify as a magic bullet and must be combined with other more traditional instruments of competition policy to comprehensively unfold its beneficial effects.

JEL: L40; C15; K21

I. INTRODUCTION

The computational simulation of welfare effects of real-world (proposed) horizontal mergers in oligopolistic markets has become an increasingly important instrument of competition policy since the mid-1990s, both in the U.S. and in the EU. Merger simulation models (MSMs) have been employed both by antitrust authorities and merging companies and by courts to assess the pro- or anticompetitive character of proposed mergers. Despite some setbacks, it seems likely that the merger policy tool "simulation models" will play an even more important role in the future. In general, every "[m]erger simulation uses a standard oligopoly model calibrated to observed prices and quantities to predict the effects of a merger on the prices and quantities of the

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merging firms and their rivals".[1] It aims at giving numerical predictions of price and quantity changes and, in doing so, constitutes a considerable departure from the more traditional structural merger analysis mainly based on changes in market shares and concentration ratios.

The reasons for the increased popularity of MSMs in antitrust practice are manifold.[2] First, progress in industrial economics has revealed new types of anticompetitive effects of mergers in oligopolies (in particular unilateral effects theory and auction theory), while, at the same time, emphasizing the importance of explicitly recognizing pro-competitive effects of mergers (for example, efficiency gains). An assessment of these effects requires a detailed analysis of the actual welfare impacts of a specific merger proposal. Second, progress in methods and computation techniques has allowed for increasingly complex simulations based upon real-world data. Third, the same technological progress has increased the availability of market data (such as prices and quantities, allowing for the empirical estimation of elasticities). In particular, data from scanner cash points must be mentioned in this context. Fourth, competition policy has increasingly embraced (industrial) economic theory and economic instruments. In the course of the so-called Post-Chicago Antitrust Economics in the U.S. (since the early 1990s)[3] and the so-called more-economic Approach in the EU (since the early 2000s),[4] the two most important antitrust regimes in the world have become more receptive of innovative economic assessment instruments and, moreover, contributed to their development by actively demanding a more sophisticated economic input.

We provide a survey on MSMs and their employment in merger policy that serves two goals: (i) providing an overview on the working mechanisms of this new tool and (ii) reviewing its performance in practical antitrust so far. After Section II introduces the basic features of MSMs, Section III reviews the mainstream of the currently available simulation techniques and approaches. Then, Section IV surveys the major antitrust cases in which merger simulations have been employed and, in doing so, identifies existing limitations and problems of MSMs as a policy instrument. Finally, Section V concludes.

II. AN INTRODUCTORY GUIDE TO MERGER SIMULATION

A. Oligopoly Theory

Modern game-theoretic oligopoly theory is predominantly built upon three standard models:[5] Cournot competition (quantity competition), Bertrand

[1] Froeb & Werden (2000), at 134.

[2] Baker & Rubinfeld (1999), at 386–387.

[3] Brodley (1995); Baker (1999).

[4] EAGCP (2005); Röller (2005); Neven (2006).

[5] We focus on mergers in oligopolistic markets because this is where modern theory yields new insights and considerably influences merger control. Mergers to monopoly or clear single-firm dominance are much better understood and easier to handle with traditional antitrust

competition (price competition), and auction theory. Although theory additionally explores alternative oligopoly models (including the quasi-oligopolistic models of monopolistic competition), antitrust analysis of horizontal mergers has recently focused on these three basic types whenever oligopolistic market structures have been identified.[6]

There is a widespread consensus that Cournot models are most adequate if products are rather homogeneous, that is, customers have no (or insignificant) preferences for specific suppliers of the product (so that the products approximate perfect substitutes). Examples include markets for natural resources (like crude oil), vitamins, electricity, and so forth. In such markets, suppliers experience strong incentives to either vigorously compete with each other or to drive the price above the competitive level in a coordinated way. In rather narrow homogeneous oligopolies, mergers tend to increase the probability of the collusive equilibrium because the reduction in the number of players facilitates tacit coordination. As homogeneous markets tend to endorse the rule of one price, competition via quantities (Cournot competition) is viewed to be an appropriate model, in particular with respect to the collusion effect (so-called "coordinated effects theory"[7]).

Things are different in markets for heterogeneous (differentiated) goods, where customers have considerable product-specific preferences, for instance, for brands or specific goods characteristics, like in most markets for consumer goods. If customers enjoy preferences, the competing products become rather imperfect substitutes. This involves several important implications that complicate analysis. For instance, the rule of one price does not apply anymore because customers are willing to pay a bit more for the preferred product compared with the competing ones. Second, if one competitor increases its price, some customers (but not all) will switch to another supplier; however, they will distribute unevenly among the competitors. In other words, the degree of substitution, the cross-price elasticity, among the differentiated products differs and thus matters. Two firms in a heterogeneous oligopoly can be close (that is, their products are close substitutes) or more distant competitors. As a consequence, mergers in heterogeneous oligopolies offer scope for the merged entity to increase prices of its products because a certain share of customers of merging company A will view the product of merging company B as the best alternative and thus react to an increase of price A by switching to product B. Although company A finds a price increase unprofitable in the pre-merger equilibrium, it might find it profitable post-merger because it now controls the best alternative for some of its customers. The assessment of

methods. Furthermore, we restrict our survey to horizontal mergers because this is the area in which merger simulation has exclusively been applied in antitrust up to date.

6 Kaplow & Shapiro (2007); Froeb & Werden (2008); Kerber & Schwalbe (2008).

7 Kühn (2008).

mergers becomes more complex, as the effect of a merger depends on the cross-price elasticities, that is, it matters who merges with whom. Generally, the anticompetitive effect of a merger increases with an increasing cross-price elasticity between the products of the merging companies, that is, a merger between product-differentiated firms is more harmful if close substitutes are involved (compared with more distant substitutes). This puts the meaning of market shares into perspective: a merger of close substitutes leading to a comparatively small combined market share might be more harmful than a merger between distant substitutes leading to a significantly higher combined market share. The effect of the merged entity experiencing a certain scope for increasing prices is usually called unilateral effects theory (because neither tacit nor explicit coordination among the oligopolists is required). Unilateral effects are predominantly ascribed to heterogeneous markets, and Bertrand competition[8] (price competition) is the preferred model to appropriately picture these effects.

Thus, there is a widespread consensus that Bertrand competition is the first choice for heterogeneous oligopolies, whereas Cournot competition is the first choice for more homogeneous oligopolies.[9] The pro- or anticompetitive effects of mergers in homogeneous Cournot oligopolies predominantly depend on present (in contrast to future) market characteristics, with market shares representing a meaningful indicator, as well as on the former interaction of the firms, in particular the pre-merger degree of interfirm coordination or collusion. In other words, the *analysis of the hitherto development* of the relevant market is of paramount importance. Therefore, empirical methods that estimate past market structure and behaviour represent the generally employed quantitative economic techniques (domain of econometrics). Demand is important regarding the own-price elasticity, whereas cross-price elasticities usually do not play a considerable role (quasi-perfect substitutes). In contrast, on heterogeneous markets, demand becomes the decisive aspect, in particular the probable reaction of customers to a unilateral post-merger price increase by the merged entity. Therefore, *predictive analysis*, in particular the accurate estimation of demand and cross-price elasticities, becomes more important: the focus is on predicting the behaviour of customers, that is, predicting prices and quantities in the post-merger equilibrium. Thus, unilateral effects cases represent one domain of merger simulation.

In some markets, products are traded in a way reminding of auctions. Next to suppliers that actually auction their products, these markets

[8] Note that analysing Bertrand competition with heterogeneous products departs from the standard textbook case, where Bertrand competition with homogeneous goods leads to the same results as perfect competition [the original Bertrand (1888) result]. Price competition with heterogeneous goods, in contrast, generally leads to prices above the competitive level.

[9] Kaplow & Shapiro (2007); Froeb & Werden (2008).

approximate the following characteristics: products are sold on a rather low-frequent basis, products include elements tailormade for the individual customer, customers call for tenders (thereby specifying their particular needs), suppliers then submit tenders and eventually a multiple-round selection procedure leads to a transaction. Examples include markets for business software, user-specific technical equipment (for example, mining) or services for the public sector like forest timber service or hospitals,[10] and so forth. If mergers occur on such kind of markets, auction models represent the first choice to simulate the competitive effects.[11]

B. Simulating Mergers

Because the various effects of mergers considerably depend on the characteristics of the underlying market, a variety of MSMs evolved. However, most merger simulations are based upon common basic assumptions and, generally,[12] can be described in roughly the same way as a four-step process.[13]

(1) A functional form of demand that matches consumer behaviour in the best possible way must be chosen. Frequently proposed models are linear, log-linear, logit, almost ideal demand system (AIDS), or multiple-step demand (see Section III). On the basis of the assumed demand function, cross-price and own-price elasticities can be estimated or empirically deducted.

(2) The next step consists of calibrating the demand systems. The parameters are specified in a way that the calculated elasticities yield the prices and market shares actually observed in the pre-merger market.

(3) The supply side is modelled by assuming an oligopoly model that describes the competition between firms in the simulated market as appropriately as possible. In many cases, Bertrand competition is the first choice, *inter alia* because it allows inferring marginal costs, describing the production process directly from the first-order conditions of profit maximization. Now, a complete empirical model of the pre-merger market can be calibrated.

(4) In a final step, the new equilibrium after the merger can be simulated using the model that was calibrated with pre-merger empirical data, but adjusting market shares to the post-merger situation. In doing so, one implicitly assumes that all firms behave non-cooperatively and

[10] In the U.S., hospitals bid for long-term contracts with so-called Preferred Provider Organizations (PPO), which provide individual health insurance. PPO insurants are obliged to go hospitals with such contracts in case of illness (Dalkir et al., 2000).

[11] Klemperer (2008).

[12] Simulations via auction models might differ in various points.

[13] *See, e.g.*, Crooke et al. (1999), at 208–209; Kokkoris (2005), at 330–331.

> that the form of competition, the demand system, and the functional form of marginal cost do not change due to the merger. The only change that is implemented concerns the merging parties—the competition between them is internalized.[14]

The first step of the simulation process is usually called "front-end" analysis, whereas steps 2–4 are usually called "back-end" analysis.[15]

This is the simplest variant that usually must be extended by considering merger-specific efficiency gains, reactions of competitors (for example, product repositioning), market entry or exist, and many more to allow for reliable predictions of the comparative welfare effects of the post-merger equilibrium. Some effects can be introduced comparably easy. For instance, a merger-specific increase in productive efficiency (synergies) effectively leads to a reduction in variable costs. Hence, the possibility of improved efficiency needs to be checked and post-merger marginal costs must be adapted.[16] Yet, the formal inclusion of other effects into the simulation process as well as the cumulation and interaction of effects is often difficult and cannot be generalized.[17]

III. TYPES OF MSMS

A. Towards a Classification Scheme

A comprehensive classification of the various MSMs currently in use can rarely be found. To the best of the authors' knowledge, only Bergeijk and Kloosterhuis[18] suggest a differentiation between the six forms of models currently in use: logit models, auction models, Bertrand models, Cournot models, econometric models, and supply function models. This classification, however, causes some confusion because the two categories, logit and Bertrand models, are not mutually exclusive. Instead, most Bertrand models use a logit model to estimate the demand side of the model. Most other authors rather concentrate on models based on a certain form of competition and differentiate them according to the assumed form of demand. Goppelsröder and Schinkel[19], for example, distinguish only between simulation methods using an econometrically estimated demand model and methods assuming an appropriate functional form of demand.

We propose an alternative two-stage classification of MSMs based on different criteria. Crooke et al.[20] stated that a merger simulation is based on three key assumptions: the chosen form of competitive interaction, the shape

[14] Kokkoris (2005), at 332.
[15] Werden (1997), at 97.
[16] Crooke et al. (1999), at 209.
[17] Budzinski & Christiansen (2007).
[18] Bergeijk & Kloosterhuis (2005), at 6.
[19] Goppelsröder & Schinkel (2005), at 56.
[20] Crooke et al. (1999), at 206.

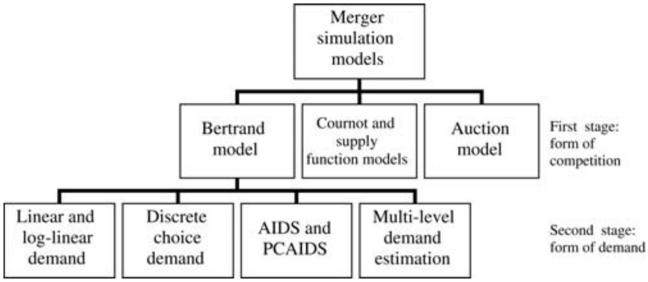

Figure 1. Classification scheme for MSM.

of marginal cost curves, and the demand system in the market. Whereas marginal costs are generally assumed to be invariant in the relevant range for merger analysis, several forms of competition and various functional systems of demand are used to develop MSMs. Therefore, a classification according to the assumed form of competition and system of demand seems appropriate and more consistent.

At the first stage, models are classified according to the assumed form of competition that best describes the market. Bertrand models, auction models as well as Cournot, and supply function models are identified as three different types of models. On the second level of classification, the most commonly used model type, the Bertrand model, is split up with respect to the chosen demand system. As explored in Section II(A), the demand system entails a specific importance in case of heterogeneous price competition, whereas quantity competition is predominantly used for more homogeneous markets where other factors drive the welfare effects. With regard to the demand specification currently in use, the following subtypes can be identified: linear and log-linear demand models, discrete choice demand models, AIDS and proportionality-calibrated AIDS (PCAIDS) models, as well as multi-level demand estimation. Figure 1 illustrates the described classification scheme.

B. Bertrand Models

The following models differ with respect to the chosen demand form but share the same basic assumptions of the Bertrand model. In particular, market entry shall not occur even in the case of a price increase, and marginal costs are supposed to be constant over the relevant range of output.[21] The empirical marginal costs that are needed to calibrate the supply side of the simulation model are recovered for all following models by using first-order conditions of profit maximization.[22] To solve these first-order conditions for marginal costs, information on prices and quantities as well as on own- and

21 Hausman & Leonard (1997), at 321.

22 For a formal representation, see, for example, Werden (1997), at 98–99.

cross-price demand elasticities is required. The latter can be derived by using one of the subsequently described demand forms. The decision for a certain demand system is of crucial importance, as each demand system is characterized by specific curvature properties that significantly influence the simulation outcome.[23] Everything else held equal, the log-linear demand predicts the greatest price increase, followed by AIDS, whereas logit and linear demand models yield significantly lower price increases.[24]

1. Linear and Log-linear Demand Models

The simplest models of demand are linear or log-linear functions. They enjoy the attractive property of constant own- and cross-price elasticities of demand that can be incorporated in a regression equation as coefficients.[25] Equations (1) and (2) show general representations of linear and log-linear demand, respectively, with z_k being a vector of demand shift variables, q and p being quantities and prices:

$$q_i = a_i + \sum_j b_{ij} p_j + \sum_k c_{ik} z_k, \tag{1}$$

$$\log q_i = \alpha_i + \sum_j \beta_{ij} \log p_j + \sum_k \gamma_{ik} z_k. \tag{2}$$

The linear demand model makes predictions of the price effects of a merger most convenient, because it allows solving the problem analytically rather than numerically.[26] The assumption of constant elasticities of demand, however, receives considerable criticism. It seems unrealistic that while a merger changes prices and market shares in a significant way, it does not change demand elasticities at all.[27] Instead, own and cross-price elasticities are usually expected to change with the level of prices. Moreover, the assumption of linear demand is generally criticized as an inadequate approximation of actual demand behaviour.[28] It often results in the prediction of negative quantities for highly asymmetric mergers unless one imposes non-negativity constraints.[29] In some cases, a log-linear demand system does not even provide a post-merger equilibrium at all.[30] As a result, linear and log-linear models are scarcely used. If applied, the resulting price

[23] Lundmark & Nilsson (2003), at 114. This is because mergers most likely have significant effects on competition. Therefore, a substantial movement along the demand curve away from pre-merger equilibrium must be expected (Crooke et al., 1999, at 206).
[24] Crooke et al. (1999), at 205ff.
[25] Werden (1997), at 99.
[26] *Id.* For a formal representation, see Werden et al. (1996), at 99–100 and Hausman et al. (1994), at 173–174.
[27] Werden (1997), at 99.
[28] *Id.* at 100.
[29] Crooke et al. (1999), at 209.
[30] *Id.* at 210.

increases of a merger are to be interpreted with caution and at best as rough indicators of a possible effect.

2. *Discrete Choice Demand Models*

Discrete choice models are commonly used to obtain the demand structure of differentiated products markets when market-level data on quantities, prices, and other product characteristics are available. It is a tractable and parsimonious method based on parametric restrictions of the demand structure.[31] The general idea of discrete-choice demand emanates from the assumption of a consumer utility function depending on observable product characteristics, including price, and unobservable product characteristics as well as individual-specific coefficients.[32]

In almost all discrete-choice models, an outside good or option is specified representing the possibility that a consumer may decide not to choose any of the available products.[33] Without the definition of an outside good, a general increase in price would have no influence on total demand—a contradiction to microeconomic theory. The problem resulting from the inclusion of the outside option is that market shares can no longer be calculated directly from observed quantities. Berry[34] and Berry et al.[35] propose to set the potential market size equal to the number of households or to estimate it using aggregate market-level data.

The choice of a functional form and the distribution of consumer-specific terms that influence utility designate the type of discrete choice model.[36] In the past few years, a variety of models has come into use for merger analysis. The most popular one is the simple logit demand or antitrust logit model (ALM). In addition to these models, nested logit and random coefficients models can frequently be found. Complexity and computational efforts increase while approximation becomes more realistic from ALM over nested logit to random coefficients models. A restrictive property of all discrete choice models is that only one out of a finite number of products is chosen only one time in the considered time period. In some industries, especially for day-to-day products, this does not represent actual consumer behaviour.[37]

Logit demand models. Formal delineations for logit demand models can be found in numerous papers.[38] It is assumed that N firms compete in a

[31] Berry (1994), at 244.
[32] If consumer-specific coefficients are to be considered, data on individual characteristics have to be available.
[33] *See, e.g.*, Berry (1994), at 245ff; Nevo (2000a), at 400–401.
[34] Berry (1994), at 247.
[35] Berry et al. (1995), at 845–846.
[36] Berry (1994), at 245.
[37] Nevo (2000a), at 401.
[38] *See, e.g.*, Berry (1994), at 245ff; Berry et al. (1995), at 845ff; Werden et al. (1996), at 85ff.

certain market, with each firm producing one product. The utility $U(\xi_i, p_j, x_j, \nu_j, \theta)$ that a consumer i derives from product j of firm j $(j \in N)$ is denoted as a random utility function, linear in parameters of observed product characteristics x_j, unobservable attributes ξ_i, price p_j, and demand parameters θ. The term ν_i captures consumer-specific terms not observed by the econometrician. If it is furthermore assumed that there is only one consumer-specific taste parameter ε_{ij}, the utility function can be written as:

$$\begin{aligned} &U(\xi_i, p_j, x_j, \nu_j, \theta) \equiv x_j\beta - \alpha p_j + \xi_j + \varepsilon_{ij} \equiv \delta_j + \varepsilon_{ij}, \\ &\delta_j = x_j\beta - \alpha p_j + \xi_j. \end{aligned} \tag{3}$$

In this case, variation in consumer tastes enters the model only through ε_{ij}, whereas ξ_j can be interpreted as the mean of consumers' valuations of an unobserved product characteristic like quality, and δ_j is the mean utility level of product j. If ε_{ij} is furthermore assumed to be independently and identically distributed (i.i.d.) across consumers and products with the "extreme value" distribution function exp $(-\exp(-\varepsilon))$, then the market share of product j, representing its choice probability, is given by the logit formula:

$$s_j(\delta) = \frac{e^{\delta_j}}{\sum_{k=0}^{N} e^{\delta_k}}. \tag{4}$$

If there exists an outside option 0 of not buying any of the products in the market and its mean utility is normalized to 0, it follows that:

$$\ln(s_j) - \ln(s_0) = \delta_j \equiv x_j\beta - \alpha p_j + \xi_j, \tag{5}$$

and δ_j is identified directly from algebraic calculation including market shares that can be estimated using simple instrumental variables regression on differences in log market shares on (x_j, p_j).[39] The own-price and cross-price elasticities of demand for a particular good, η_{jj} and η_{jk}, can be calculated using the estimated parameter α, observed prices p_j, and market shares s_j, as well as the aggregate elasticity of demand η that can be inferred from the estimated parameters. In detail:

$$\eta_{jj} = -\alpha p_j(1 - s_j), \tag{6}$$

$$\eta_{jk} = \alpha p_k s_k, \tag{7}$$

$$\eta = \alpha \bar{p} s_0.^{40} \tag{8}$$

[39] Berry (1994), at 250. Demand-side instrumental variables should ideally be variables that shift costs but are uncorrelated with the demand side. See Nevo (2000b), at 532ff for a detailed summary of possible instruments.

[40] $\bar{p}$: share-weighted average pre-merger price of all goods.

It follows that the logit model consists of only two demand parameters: the aggregate elasticity of demand η, which controls for substitutability between the products in the market and the outside good, and α, which controls for substitution among the "inside the market" products.[41] The demand system of the simulation model can finally be calibrated by solving the logit probability functions for $x_j\beta$ after setting $x_0\beta$ to arbitrary values.[42]

The described logit model is estimated using maximum likelihood.[43] Emphasis must be put on possible endogeneity problems concerning prices and other product characteristics. To control for this problem, an instrumental variables approach can be used. In general, the use of logit models is advocated with reference to its computational simplicity and little information requirements.[44] Logit models offer at least rough estimates of merger price effects. This justifies its usage in cases with no priors about individual preferences or where preferences cannot be examined empirically. Finally, no matter how rough logit estimations may be, they are still considered a "quantum leap beyond traditional antitrust analysis".[45]

The greatest limitation of logit specification follows from its restrictive assumption "independence of irrelevant alternatives"[46] (IIA).[47] The IIA property states that the ratio of choice probabilities of any two alternatives is entirely unaffected by the systematic utilities of any other alternatives, that is:

$$\frac{s_j(\delta)}{s_l(\delta)} = \frac{e^{\delta_j} / \left(\sum_{k=0}^{N} e^{\delta_k} \right)}{e^{\delta_l} / \left(\sum_{k=0}^{N} e^{\delta_k} \right)} = \frac{e^{\delta_j}}{e^{\delta_l}}. \qquad (9)$$

This implies that consumers switch to other products in reaction to a price increase for one product in proportion to the relative shares of these products. The IIA property greatly facilitates estimation, because the model can be estimated using only a limited subset of the full choice set. Moreover, it enables the forecast of, for example, the demand for a new product. Nevertheless, it somewhat violates the core characteristic of heterogeneous markets, namely that consumers do not view all other products as equally substitutable.[48] A post-merger price increase, therefore, will not lead to a proportional redistribution of demand in many real-world markets. Instead,

41 Werden (1997), at 101.
42 *Id.*
43 *See, e.g.*, Ben-Akiva & Lerman (1991), at 118ff.
44 Werden & Froeb (1994), at 421; Werden et al. (1996), at 83.
45 Werden et al. (1996), at 84, 89.
46 Ben-Akiva & Lerman (1991), at 108–111.
47 The IIA property follows from several assumptions of the logit model from which the mutual independence of the ε_{ij} is viewed to be the crucial one (Ben-Akiva & Lerman, 1991, at 109).
48 Hausman & McFadden (1984), at 1222; Werden & Froeb (1994), at 420.

consumers view some products as closer substitutes to the differentiated product of the merged entity than others. If a logit model is nevertheless applied to a market with differentiated products, its data fit should be checked by a test of the IIA assumption.[49]

Nested logit models. The nested logit model is a generalization of the simple multinomial logit model that was developed to overcome the problem of IIA. To account for different levels of substitutability, the ε_{ij} are separated into an identically and independently distributed shock component and a nest-specific component, which is allowed to be correlated across products that are grouped into one of the multiple predetermined exhaustive and exclusive nests. In most papers,[50] one nest is defined that divides the choice set into two subsets: one for the outside good and another for the inside goods. Furthermore, the inside goods can be grouped into different nests on a second hierarchical level. Computational effort increases with the number of nests. The result of the nesting structure is that substitution across groups is smaller than within. Within the nests, however, the IIA property continues to hold.[51] Hence, a certain restriction of the substitution possibilities still exists.[52]

In general, the nested logit allows more realistic demand estimation while keeping the advantages in computability of the logit model, however, only if an *a priori* division into subgroups is reasonable. Whenever products can be classified according to multiple criteria, the hierarchical order of the nests according to these criteria matters because elasticity estimates are highly sensitive to a change of order of the classification criteria.[53] Furthermore, Bresnahan et al.[54] emphasize that there is no scientific way to identify the "right" ordering if several seem to be theoretically reasonable.

Random-coefficients logit models. Whereas logit and nested logit models assume that all consumers display the same preference for certain product characteristics and the consumer-specific influence was captured solely by ε_{ij}, the random-coefficients model allows for interaction between individual and product characteristics.[55] Utility for a certain good is composed of a mean utility component and a consumer-specific deviation from that mean that depends on the interaction between consumer preferences and product

[49] Hausman & McFadden (1984).
[50] *See, e.g.*, Werden & Froeb (1994), at 412.
[51] Nevo (2000b), at 523ff.
[52] Werden (1997), at 103.
[53] Nevo (2000b), at 525. The general extreme-value model (Bresnahan et al., 1997) solves the problem of ordering.
[54] Bresnahan et al. (1997), at 38.
[55] Berry et al. (1995), at 846.

characteristics.[56] Random-coefficients models are estimated using a general methods-of-moments estimator.[57]

Random-coefficients logit models possess several advantages in comparison with both the simple and the nested logit models. Most importantly, these models produce demand elasticities that are more realistic as they account for different levels of substitutability.[58] However, the price of these advantages is a considerable increase in the complexity of computation and in the need for consumer-specific data.[59]

3. *AIDS and PCAIDS Models*

The AIDS developed by Deaton and Muellbauer[60] attributes an arbitrary first-order approximation to any demand system. It is not based on a functional form of demand, but allows for a flexible representation of own- and cross-price elasticities determined by the data.[61] As the detailed formal development of the AIDS is very complex,[62] only the basic idea is presented here.[63]

Consider a market of N products, each one produced by a different firm. According to AIDS, the share s_i of a product i depends on the logarithmized prices of all brands in the market and on other demand-shifting variables in the following way:

$$\begin{aligned} s_1 &= a_1 + b_{11}\ln(p_1) + b_{12}\ln(p_2) + \cdots + b_{1N}\ln(p_N) + b_{1Z}Z \\ s_2 &= a_2 + b_{21}\ln(p_1) + b_{22}\ln(p_2) + \cdots + b_{2N}\ln(p_N) + b_{2Z}Z \\ &\vdots \\ s_N &= a_N + b_{N1}\ln(p_1) + b_{N2}\ln(p_2) + \cdots + b_{N3}\ln(p_N) + b_{NZ}Z. \end{aligned} \tag{10}$$

The coefficients $b_{ij}(i,j = 1,\ldots,N)$ need to be determined to calculate the own-price and cross-price elasticities used to simulate the merger price effect. If the market shares are positive and add up to 1, the so-called "own-coefficients" b_{ii} and the "cross-coefficients" b_{ij} have the same sign as the corresponding elasticities. The problem with AIDS is that the estimation of the coefficients is difficult to perform in cases of many different products. A market with N products gives rise to N^2 coefficients. Hence, estimation requires a large data set (for example, supermarket scanner data) or the imposition of additional assumptions that reduce the demand parameters to

[56] *Id.* at 848.
[57] *See, e.g.*, Berry (1994).
[58] For a detailed discussion of advantages, see Nevo (2000b), at 515ff.
[59] Nevo (2000b), at 532.
[60] Deaton & Muellbauer (1980).
[61] Hausman & Leonard (1997), at 327; Epstein & Rubinfeld (2001), at 888.
[62] Deaton & Muellbauer (1980).
[63] Following Coloma (2006); Epstein & Rubinfeld (2001).

be estimated.[64] The estimation of AIDS with scanner data, however, entails considerable econometric problems and is limited to products mainly sold in supermarkets, wherefore Epstein and Rubinfeld[65] proposed the PCAIDS model, which reduces the number of required parameters while retaining many of the properties of AIDS.

PCAIDS is a calibrated demand model that necessitates information only on product market shares, overall price elasticity, and the price elasticity of one single product in the market. Thus, the assumptions of proportionality, homogeneity, and symmetry are introduced.[66] According to Epstein and Rubinfeld,[67] the restrictive assumption of proportionality is arguable when data are limited and the merging firms do not sell unusually close or distant substitutes. Additionally, PCAIDS guarantees proper signs of and consistent magnitudes for the elasticities—in contrast to AIDS, whose estimation sometimes yields elasticities that contradict economic theory. Yet, PCAIDS is highly restrictive because its proportionality assumption resembles the logit's IIA assumption. Likewise concerning the logit model, a specification of nests was proposed for the PCAIDS model to overcome this problem.[68] Recently, Coloma[69] proposed an estimation of PCAIDS models instead of the above described calibration. His model resembles the AIDS estimation, but incorporates the restrictions of PCAIDS and allows estimation even if price data are limited to a subset of firms. Coloma admits, however, that estimates may be less precise than with the original AIDS model.

A general problem of both AIDS and PCAIDS is linked to the common use of scanner data. As these data are based on short time periods, first-order serial correlation represents a common problem in estimating demand.[70] Because AIDS specifications consider prices, quantities, and market shares in levels, the estimation results might be problematic. Capps et al.[71] suggest either introducing an autocorrelation correction or switching to demand systems that use first-differences of all relevant variables (for example, the Rotterdam demand system) to overcome this pitfall.

4. *Multi-level Demand Estimation*

Hausman et al.[72] as well as Hausman and Leonard[73] proposed to estimate demand in differentiated product markets using a model of multi-level

64 *See, e.g.*, Hausman et al. (1994); Hausman & Leonard (1997). As a consequence, AIDS has only been applied to few real mergers.
65 Epstein & Rubinfeld (2001).
66 Coloma (2006), at 589.
67 Epstein & Rubinfeld (2001), at 891.
68 Epstein & Rubinfeld (2004).
69 Coloma (2006).
70 Capps et al. (2003).
71 *Id.* at 29.
72 Hausman et al. (1994).
73 Hausman & Leonard (1997).

demand estimation. Their general idea is to divide the demand system into overall demand in the market—the top level—and competition between brands—the bottom level. An intermediate level that deals with different product segments is also possible. Suppose the car market is to be analysed. The top level describes total demand for cars, whereas on the second level, demand in different segments, for example, sports, family, and compact cars, is considered. On the bottom level, interest lies on the competition between the different brands in each segment. Overall own- and cross-price elasticities for each product can thus be detected on the basis of an estimation of all three levels and the combination of the resulting estimates. Proceedings are bottom-up, and the theory of price indices is used to guarantee consistent estimation on the higher levels. On the lowest level, AIDS specification is used, whereas second and top level estimates are based on log-linear demand.

The advantages of the multi-level demand estimation are due to the merits of estimating the demand structure rather than assuming a certain functional form,[74] although the properties of AIDS and log-linear demand used on the different levels need to be taken into consideration. Most importantly, detailed product level data are needed to carry out AIDS on the lowest level.

C. Cournot and Supply Function Models

Due to the reasoning in Section II(A), only a few papers[75] employ Cournot or supply function models. Cournot models are used to calculate the price effects of a merger in markets where quantities are the strategic parameters to be chosen.[76] Supply function models can be interpreted as a generalization of the Cournot model, where firms choose their strategy using a supply curve with respect to prices instead of a fixed quantity. This type of a supply curve, which is upward sloping, generates a set of bids of price–quantity pairs.[77] In both models, the market price is determined as the Nash equilibrium, where every producer chooses his quantity q_i or supply function $q_i(p)$ such that he maximizes profit given the quantities or supply functions of his competitors. To reproduce real market behaviour more accurately, production capacity constraints may be incorporated.

To determine Nash equilibrium and market price, one needs information on the number of firms in the relevant market, their production capacities, cost structures, as well as information on market demand, which possibly

[74] *Id.* at 322.

[75] *E.g.* de Maa & Zwart (2005); Smidt (2005).

[76] It is somehow counterintuitive to calculate price changes instead of reactions in market shares when quantities are the strategic parameters though. This might be another reason why there cannot be found many simulations using Cournot models.

[77] de Maa & Zwart (2005), at 160.

must be estimated.[78] Whereas theoretical papers model marginal costs of production as functions not only of quantity, but also of firm characteristics like capital investment or capacity limits,[79] most simulation studies assume marginal cost structures to be linearly increasing functions of quantity supplied[80] or even constant.[81] In consequence, the equilibrium solution in a simple Cournot model is that mark ups are given by the market share divided by demand elasticity.[82] Although this solution will be unique and easily calculated in the simple case of constant market shares and no production constraints, simulation is necessary if capacity constraints are included and market shares are variable.[83] For supply function models, the strategy space is not one-dimensional but an infinitely dimensional set of functions, hence the solution becomes analytically and numerically more difficult.[84] The problem will be to predict which of the many equilibrium supply functions a producer will choose. In general, the merger price effects can be calculated by calibrating each of the two models with different capacity and cost structures pre- and post-merger when solving for the Nash equilibrium.

As already noted, Cournot models are relatively easy to simulate if all necessary data are available. In contrast, supply function models have a much more complex mathematical structure but seem to be more realistic in describing firms' behaviour. In general, Cournot models provide an upper bound on the results of supply function models.[85]

D. Auction Models

Hitherto, basically two distinguished types of auction models were used for merger simulation: second-price and first-price auction models.[86] Note that the exact specification of an auction setting, however, must be found on a case-to-case basis.

1. Second-price Auctions

The subsequent description follows Froeb et al.[87] as well as Brannman and Froeb.[88] Additional assumptions are that the valuations V of the bidders are private information and consist of two independent components: an

[78] *Id.* at 159.
[79] *See, e.g.*, McAfee & Williams (1992).
[80] *See, e.g.*, de Maa & Zwart (2005); Smidt (2005).
[81] Leonard & Zona (2008).
[82] Tschantz et al. (2000), at 204.
[83] de Maa & Zwart (2005), at 159.
[84] *Id.* at 160.
[85] *Id.* at 158.
[86] Dalkir et al. (2000); Tschantz et al. (2000); Brannman & Froeb (2000); Froeb et al. (1998).
[87] Froeb et al. (1998).
[88] Brannman & Froeb (2000).

idiosyncratic component X_i and a common component Y. X_i is assumed to be an independent extreme value process with location and spread parameters $(\eta_i \mu)$. Y is an independent random variable with mean zero and variance σ^2, which is seen as common knowledge and can be ignored in the following analysis, as it does not influence the identity of the winning bidder, the winning bid, or the change in winning bids after a merger. Now the winning probabilities of each bidder (that correspond to the expected market share), the prices (that correspond to the second highest value), and the merger effects can be calculated by using the simplifying properties of the extreme value-distributed idiosyncratic components.[89] The probability that bidder i has the highest valuation of the item to be auctioned and therefore will win has some interesting properties: first, if the variance of the value distribution increases ($\mu \to 0$), the winning probabilities converge to $1/n$, which means that the heterogeneity between the different bidders decreases. In contrast, if the variance decreases ($\mu \to \infty$), the heterogeneity is of high importance and the market share of the bidder with the highest valuation approaches 1. Second, the distribution of the maximum of bidder values satisfies the IIA property, meaning that the distribution does not depend on the ordering of the bidder values. Using the IIA property, the probability of observing a certain ordering among the two highest bidders can be inferred. Furthermore, the distribution of winning bids is derived as the distribution of the second-highest value conditional on the identity of the high-value bidder. It can be shown that the expected price or winning bid decreases if the expected share or winning probability rises. This is because the high-value firm does not bid against itself.

In principle, the moments of the distribution of the second-highest bid could be used to construct a methods-of-moments estimator for the winning bid using auction data. However, this is problematic because, at every auction, a unique item is sold or purchased so that the data are characterized by a significant level of heterogeneity across items. By including the common component Y, a between-auction variance is added to the estimation. Hence, a differentiation between the within-auction variance that one is interested in and the between-auction variance of the distribution becomes impossible. Therefore, Froeb et al.[90] propose to estimate the distribution parameters using the differences between losing bids. This eliminates the between-variance. Estimation of this difference is possible using a two-step, limited-information maximum-likelihood (LIML) estimator if data on bidder identities and shares, bidder characteristics including the ones of losing bidders, as well as the values of bids (including losing bids) across the sample of auctions are available. First, the firm- or bidder-specific

[89] For a detailed description of the properties of an extreme value function, see Froeb et al. (1998), at 3.

[90] Froeb et al. (1998), at 6.

characteristics are used to estimate the logit probability of winning and the expected values of winning bids simultaneously. In this case, the shares are used as proxies for the probabilities of winning. Second, the fitted probabilities are employed to construct the likelihood for the difference between the second- and third-highest bids.[91] Finally, the merger price effect is calculated using the estimated distribution parameters and the changed winning probability of the merged firm. The new winning probability equals the sum of the shares of each merging partner because the merged firm will win each auction that either of the original firms would have won. The price effect of the merger depends on the variance of the idiosyncratic component in two ways: a great variance increases both the amount and the variance of the price effect. The common component does not influence the price effect at all.

In summary, this method is suitable in industries where a second-price oral auction is the best way to describe market behaviour. Nevertheless, the model has some limiting properties. First, it is based on the IIA property whose disadvantages have already been discussed in detail in the section on logit demand models. Furthermore, detailed data on many auctions in the market are necessary to apply an LIML estimator. Eventually, the model treats every observed auction as independent. This might not be true if bidder-capacity constraints or bid-rotation schemes must be expected.[92]

2. *First-price Auctions*

A model for the simulation of merger effects in markets of asymmetric first-price, sealed-bid, private-value auctions is proposed by Dalkir et al.[93] In their model, sellers are bidding to sell a good to a unique buyer. The lowest price each bidder is able to bid corresponds to its cost. It is assumed that each bidder has some number k_i of cost draws from a technology density function from which he can choose the lowest one. The lowest cost draw c_i corresponds to the bidders valuation of the good and consists of a common and a bidder-specific random component, μ and ε_i, respectively.

$$c_i = \mu + \varepsilon_i. \tag{11}$$

Whereas μ is common knowledge, ε_i is private, and only its distribution is known to all bidders. It is assumed to be i.i.d. over a common support $[-\Delta, \Delta]$ with $\mu \geq \Delta > 0$. The buyer purchases a fixed quantity of the service or good at disposition at the lowest bid price. His valuation of the contract

[91] If no data on losing bids are available, this method cannot be applied. The only solution in this case is to drop step 2. A distinction between a large within-variance and a large common-variance is therefore not feasible.

[92] Brannman & Froeb (2000), at 284.

[93] Dalkir et al. (2000).

$v = \mu + \Delta$ is common knowledge. In consequence, the price in equilibrium, that is the lowest bid, ranges from $\mu - \Delta$ to $\mu + \Delta$.

If merger price effects are analysed in the described setting, two situations must be distinguished. First, consider a symmetric pre-merger market where each firm has only one cost draw to choose from. A merger will create asymmetry as only the merged firm will have the opportunity to choose the lowest from several cost draws. Second, firms might have different numbers of draws before the merger—an asymmetric situation. In this case, the post-merger situation can possibly lead to more symmetry in the auction. In the symmetric pre-merger setting, a bidder maximizes its profit by setting its bid equal to the best response with respect to price given its costs and the number of bidders in the market and the equilibrium can be found analytically. For the asymmetric case, Dalkir et al.[94] show that equilibrium exists under certain limiting conditions, but it must be found numerically. It is worth noting that, in this equilibrium, it is possible for another bidder than the one having the lowest cost to get the good. Hence, cost-inefficiencies may arise in asymmetric first-price auctions.

Merger effects are calculated by calibration of the model using pre-merger information on market shares and the range of the density function of costs $[\mu - \Delta, \mu + \Delta]$. Dalkir et al.[95] recommend gaining information on the spread of the cost function from technical staff or administrators. Then the change of prices can be simulated using the calibrated model. It is possible to estimate the effects that arise from asymmetric firms merging to become symmetric and vice versa. The simulation results that Dalkir et al.[96] present for hypothetical mergers[97] suggest that symmetry-increasing mergers display much smaller price effects than symmetry-decreasing ones.

Critique of the model first considers the simple form of cost density function that is assumed. As Tschantz et al.[98] note, merger effects crucially depend on the variance of the underlying distribution. Hence, the price effect can be totally over- or underestimated if costs would be better modelled by a more complex distribution. However, the authors state that "it appears that the uniform [distribution function], with its "fat tails" tends to represent a "worst case" scenario in terms of merger price effects".[99] This implies that the model results could serve as an upper bound. Nevertheless, it is questionable if reliable data for the cost structure and market demand (shares) needed to calibrate the model can be observed.

94 *Id.* at 404ff.
95 *Id.*
96 *Id.*
97 They vary the number of firms and the form of (a-)symmetry pre- and post-merger as well as the coefficient of spread that characterizes the cost density function.
98 Tschantz et al. (2000), at 211.
99 Dalkir et al. (2000), at 400.

The type of auction model chosen to simulate the merger is of high importance in case of asymmetry, as the results might differ significantly according to the chosen framework. Tschantz et al.[100] compare prices, shares, and revenues, as well as expected merger effects in first- and second-price auctions. Their main conclusions are that low-value (high cost) firms win more frequently and at better prices in sealed auctions and that the effects of a symmetry-decreasing merger are smaller in sealed-bid auctions. Furthermore, the predictions of an auction model depend on assumptions about costs or value distributions. Finally, it is difficult to provide statistical measures for the reliability of the simulated price effects.[101]

IV. MSMS IN COMPETITION POLICY PRACTICE: PROSPECTS, PROBLEMS, AND LIMITS

A. Merger-Control Cases with Simulation Models: An Overview

Since the mid-1990s, merger simulations have been introduced to practical merger-control cases as an additional tool to assess expected competitive effects by both federal U.S. antitrust agencies [the Federal Trade Commission (FTC) and the Antitrust Division of the Department of Justice (DoJ)] and the European Commission (EC). Yet, the number of real merger cases where simulation models have been applied by an antitrust authority or one of the merging parties is still somewhat small. In the following, we review the most important cases in the U.S. and European merger litigation in chronological order.

1. Interstate Bakeries/Continental Baking Co. & Kimberly-Clark/Scott Paper

In 1995, the DoJ challenged two proposed mergers: the acquisition of Continental Baking by Interstate Bakeries and Kimberly-Clark's acquisition of Scott Paper. In both cases, MSMs had been prepared as evidence for litigation—in the first case by the competition authority, in the second case by one of the merging companies. However, the MSMs finally did not come to use as both complaints were settled with mutual agreements outside the court.

Continental Baking and Interstate Bakeries were two of the three largest producers of white pan bread in the U.S., and their merger would have resulted in a monopoly for Interstate Bakeries in Southern California and the Midwest. Werden[102] prepared an expert report on behalf of the DoJ that included a simulation model.[103] According to standard SSNIP

[100] Tschantz et al. (2000), at 207ff.

[101] Baker & Rubinfeld (1999), at 421.

[102] Werden (2000).

[103] With demand estimation still being preliminary, the draft report eventually came to use as an attachment to the author's declaration for the U.S. DoJ in opposition to Interstate

analysis,[104] bread industry studies, as well as own- and cross-price elasticity estimations, the relevant markets were the localized (in particular metropolitan areas) and brand-wisely differentiated markets for white pan bread. Therefore, simulations of post-merger prices for the Los Angeles and the Chicago areas were carried out assuming Bertrand competition and logit demand: "a relatively simple methodology for making more precise predictions of the price effects of mergers in differentiated products industries".[105] Only the merging firms' products and its closest substitutes were included because an exclusion of less close substitutes does not cause an overestimation of the price effects. Possible market entries were not considered and the problems involving the IIA assumption and other limitations of the logit demand model were not discussed. The results of the simulation based on point estimates for demand elasticity predicted a substantial increase of prices in both markets, thus supporting the complaint by the DoJ. Increases were biggest for the merging brands—10 percent for Continental Baking and 5 percent for Interstate Bakeries—whereas the overall price increase lies between 3.1 percent in Chicago and 5.9 percent in Los Angeles.[106]

The DoJ complaint against Kimberly-Clark and Scott Paper, seeking a clearance of the merger under certain divestitures, was based upon expected price increases and competition lessening in markets for facial tissue and baby wipes.[107] In preparing its defence, Kimberly-Clark commissioned an MSM by Hausman and Leonard as their economic consultants. They employed a multi-level demand estimation model to simulate prices for the bath tissue market based on weekly scanner data from 1992 to 1995.[108] The predicted price increases absent efficiency gains for the bath tissue brands of Kimberly-Clark (Kleenex) and Scott Paper (Scott Tissue and Cottonelle) were about 2.4, 1.2, and 1.4 percent and stated as not significantly different from zero. If efficiency gains[109] are taken into consideration, the price effects become smaller or even negative[110]—a result that was certainly in

Bakeries' effort to modify the final judgement three years after its pronouncement (Werden, 2000, at 139).

104 SSNIP: small but significant non-transitory increase in price; standardized hypothetical monopoly test regularly used by U.S. antitrust authorities to define relevant markets (Kerber & Schwalbe, 2008, at 262–280).

105 Werden (2000), at 145.

106 Note that when the upper bound of the confidence interval of demand elasticity estimates is used to calculate price effect, the results vary strongly between the two markets. In Chicago, the price increases are all only slightly smaller, whereas in Los Angeles, they drop to 2.3 and 1.9 percent for Continental and Interstate, respectively, and to 1.3 percent for all products due to the much wider confidence interval for Los Angeles.

107 DoJ (1995).

108 Hausman & Leonard (1997).

109 They have been estimated to correspond to a 24 percent marginal cost reduction by Kimberly-Clark.

110 Hausman & Leonard (1997), at 336.

line with Kimberly-Clark's interest. Yet, the model does not generate completely consistent results.[111] Several estimated cross-price elasticities are negative, which contradicts the assumption of all products in the market being substitutes. Furthermore, many of the estimated cross-price elasticities are of low precision, making the predicted price effects highly uncertain.[112] Alternative model approaches like logit demand simulation or PCAIDS do not produce completely different price changes though.[113] For example, logit predictions for Kleenex are higher than the multi-stage demand results, whereas those for Cottonelle are smaller. Hausman and Leonard[114] interpret this as a consequence of the restrictions put on cross-price elasticities in logit models.

2. *Volvo/Scania*

During the 1999 merger-control procedure of the proposed merger between Sweden's Volvo and Scania,[115] the EC commissioned a simulation study carried out by Ivaldi and Verboven. This study received some controversy throughout the proceedings and, eventually, the EC[116] declared that "[g]iven the novelty of the approach and the level of disagreement, [it] will not base its assessment on the results of the study". However, "the results of such econometric studies can be a valuable supplement to the way the Commission has traditionally measured market power".[117] Based upon more traditional analysis, the EC declared the merger to be incompatible with the common market as it would have created a dominant position of Volvo in the market for heavy trucks, touring, inter-city and city buses in several North-European countries.[118]

Ivaldi and Verboven[119] performed a simulation based on a nested logit model using panel data on list prices and horsepower for two types of trucks for each of the seven major truck manufacturers in 16 different European countries in 1997 and 1998. According to their model specification, three nests were distinguished: rigid trucks, tractor trucks, and outside goods. Furthermore, country- and firm-specific dummies as well as instrumental variables accounting for price endogeneity were included. The total number of products in the market including the outside goods was defined as average total sales in 1997–1998 multiplied by a market factor $r = 4.0$,

[111] Epstein & Rubinfeld (2001).
[112] *Id.* at 901.
[113] Epstein & Rubinfeld (2001).
[114] Hausman & Leonard (1997), at 336.
[115] Relevant markets included manufacture and sale of trucks, buses, construction equipment, and marine and industrial engines.
[116] EC (2000), at 22.
[117] *Id.*
[118] In Sweden, Finland, Norway, Denmark, and Ireland, the combined market shares of the merging parties were between 49 and 91 percent (EC, 2000, at 19).
[119] Ivaldi & Verboven (2005a).

which was chosen after sensitivity tests had proven this value to be rather conservative in prediction of prices. However, the strict time limit of EC merger-control proceedings restricted sensitivity analysis and caused some very simplifying and debatable assumptions.[120] In general, the results indicated serious anticompetitive price effects of more than 10–23 percent for rigid trucks and 7–13 percent for tractor trucks in the Scandinavian countries and Ireland for the merging parties, although the price responses by competitors were small. The 95 percent confidence interval of consumer surplus loss, measured as increase in the industry price index, was negative for all countries under consideration. Possible efficiency gains, a predicted 5 percent marginal cost saving, would not lead to an increase of consumer surplus in the five Nordic countries.

Volvo's own economic advisors criticized the model as flawed and unreliable.[121] They claimed substantial measurement errors in the data because it did not account for optional features. For instance, it referred to list prices instead of actual transaction prices and considered only two observations on each truck model in each country.[122] In consequence, a downward bias in the estimated price elasticities was expected, leading to an upward bias in predicted price effects. Furthermore, they criticized the lack of a specification test and performed several tests on their own, indicating inadequateness of the IIA assumption of the nested logit model and considerable differences in the demand parameters between several subgroups of countries. Other points of criticism concerned the choice of the market factor r and the compatibility of simulation results with economic theory and the particular market. The controversy among the economic advisors triggered an academic debate entailing mutual criticism of the employed tests, methods, models, and interpretation of the economic results.[123]

3. *Lagardère/Natexis/VUP*

In the 2003 Lagardère/Natexis/VUP merger, the EC actually referred to a simulation in its decision.[124] The model withstood the opposing parties' criticism and was accepted by the EC as robust and reliable. The transaction between Lagardère (communication, media, and publishing) and Natexis/VUP (*inter alia* creative publishing) was eventually cleared under several conditions including significant divestitures.[125]

The EC's experts, Foncel and Ivaldi, concentrated on the differentiated products market for general literature in paperback and hardcover formats

[120] *Id.* at 680, 690.
[121] Hausman & Leonard (2005).
[122] With the words of Walker: "a study based on prices nobody pays for trucks nobody buys" (Walker, 2005, at 478).
[123] Hausman & Leonard (2005); Ivaldi & Verboven (2005a); Ivaldi & Verboven (2005b).
[124] EC (2004a); Röller & Friederiszick (2007).
[125] EC (2004a), at 178.

and estimated demand using nested logit.[126] Data on prices and volume were provided by the IPSOS market research institute and made available by the merging parties. In their model, consumers' demand decisions were assumed to be hierarchical in that first the type of book, for example humour, thriller, or love story, and on a second level a specific book is chosen. The simulated price increase for the merging parties' books was reported as 4.84 percent if paperback and hardcover books are seen as one market, with a 95 percent confidence interval running from 3.74 to 5.45 percent. Distinctive estimations for the two book types lead to price changes of 5.51 percent for paperbacks and only 1.59 percent for hardcover books, wherefore the EC[127] concluded that the bulk of the average price increase must be due to the increase in paperback books.

The critique of the merging parties focused on market definition. First, they argued that the model neglects the vertical structure of the book market. Second, they claimed that the model does not sufficiently differentiate between paperback and hardcover. Finally, the model was said to not take into account the way how publishing and book price determination work in reality.[128] The EC refused all these objections as unfounded and declared the study as "particularly robust by reason of the very large number of observations, the stability of the various parameters estimated, the high degree of statistical power of the tests provided, and the simulation of a confidence interval for the calculation of a price increase".[129] In consequence, the study was used in support of its concerns for anticompetitive merger effects.

4. *Nuon/Reliant*

In 2003, Nuon, a leading Dutch energy utility company, notified its acquisition of Reliant Energy Europe, one of the major electricity generators in the Netherlands, to the national competition authority (Nederlands Mededingingsautoriteit—NMa). The following NMa investigation included two different simulation models developed by external consultants from Energy Study Center (ECN) and Frontier Economics. After their in-depth analysis, the NMa decided to approve the merger under serious divestiture conditions.[130] Nuon, however, appealed the NMa decision at the Court of Rotterdam, submitting critical reviews of the agency's MSMs by economists from NERA Economic Consulting.[131] After revision of all evidence, the court annulled the decision of the competition agency, dismissing the results

[126] Ivaldi (2005).
[127] EC (2004a), at 179.
[128] *Id.* at 179ff.
[129] *Id.* at 179, n.543.
[130] de Maa & Zwart (2005), at 150ff.
[131] NERA (2005).

of the MSMs as unreliable and the parties' interpretation of them as arbitrary.

The electricity market belongs to the exceptional cases where the use of a Cournot or supply function model can be adequate (*inter alia* homogeneous product, lack of short-term demand elasticity, the absence of storage request to balance production and demand at every moment to a certain price, demand varies considerably by time, capacity limits of production and transmission are of great importance[132]). Most data needed to model oligopolistic price equilibria were available. The ECN employed a Cournot model for all electricity generators in the Netherlands, Belgium, Germany, and France. The calculated price effects were highest for peak hours of demand in winter (about 7.9 percent) and lowest for base hours in summer (3.4 percent), with an average price increase estimated to be about 5.9 percent.[133] Yet, it is questionable if the model adequately represents industry behaviour, because estimated and observed market prices differ by a considerable margin for demand elasticities that are assumed to be realistic. However, the difference might be the result of the generators' fearing of regulatory intervention if they set profit-maximizing prices or that longer term considerations not included in the model resulted in over prediction.[134]

In contrast to ECN, the Frontier Economics team estimated a supply function model restricted to Dutch generators with different supply curves for each hour of the day. To reduce possible strategies, supply functions were restricted to correspond to marginal cost curves multiplied by a constant mark up factor from a finite set lying between 1 and 15. As a result, multiple pre- and post-merger equilibrium prices for each demand level and all possible mark-up combinations for all producers were found.[135] Interpretation of these equilibria as well as the choice of the right equilibrium is therefore of special interest. Higher price equilibria seemed to occur earlier in the post-merger situation. In the following, the NMa chose to concentrate on the change of maximum, minimum, and median price equilibria due to the merger. Whereas the lower bound prices hardly increased at all, the median price level increased about 13 percent, averaged over all hours of the year. For the maximum price level, the increase was even higher. Sensitivity tests that allowed for a more realistic price responsiveness of industrial demand led to smaller price effects close to the above-mentioned Cournot results. Nevertheless, the NMa interpreted the model's outcomes as evidence for the strengthening of Nuon/Reliant's dominant position in the Dutch power market.

132 de Maa & Zwart (2005), at 153.
133 de Maa & Zwart (2005).
134 *Id.*
135 *Id.* at 166.

Nuon's economic advisors harshly criticized the supply function model.[136] As they were not allowed to view the original model, they built a "shadow model" based on the available general descriptions and investigated its properties. NERA's critique mainly consisted of two points. First, they found that the outcomes crucially depended on the assumption of large steps between the mark-up levels, which represented the strategies available to the generators. This was viewed to be unrealistic because it ruled out the possibility of small price reductions. Consequently, many Nash equilibria were only sustainable because small reductions in prices, which would have been profitable in reality, were ruled out by assumption. Second, no basis for the choice of median prices as the likely outcome in pre- and post-merger situations was provided. In NERA's opinion, the merger might possibly be a disturbance that changes industry from a pre-merger equilibrium of maximum prices to a post-merger equilibrium with minimum prices (structural interruption). Hence, a price increase can only be inferred from the multiple equilibria system with certainty if the maximum pre-merger price was smaller than the minimum post-merger price.

5. *Oracle/PeopleSoft*

So far, the most discussed case is probably the Oracle/PeopleSoft merger.[137] It allows for an explicit comparison of two different MSMs applied to the same industry as both the U.S. and the EU exerted jurisdiction over the merger proposal. Moreover, the Oracle/PeopleSoft case was the first to have a full-blown MSM to be discussed in a U.S. courtroom and the first to have a simulation model developed by EC economists in-house. Although the MSMs on both sides of the Atlantic pointed to considerable anticompetitive effects from the merger, neither the U.S. nor the EU competition agencies eventually managed to block the merger.[138]

In 2003, Oracle, a U.S. company that develops, manufactures, and distributes enterprise application software (EAS), database, and application server software, launched a hostile bid for its U.S. rival PeopleSoft.[139] Oracle and PeopleSoft were the second and third largest vendors of EAS worldwide behind SAP at that point of time, and both the DoJ and the EC started in-depth investigations expecting serious anticompetitive effects. The DoJ asked McAfee[140] to develop a simulation model measuring the unilateral effects of the merger.[141] An English auction model was chosen that

[136] NERA (2005).
[137] *See, e.g.*, Keyte (2004); Bengtsson (2005); Pflanz (2005); Botteman (2006); Werden (2006); Zimmer (2006); Budzinski & Christiansen (2007).
[138] EC (2004b); U.S. District Court for the Northern District of California (2004).
[139] EC (2004b), at 3.
[140] McAfee (2004).
[141] For the following details on the model, see U.S. District Court for the Northern District of California (2004), at 150–151, 195ff.

allowed for multiple bidders and multiple rounds of bidding. Necessary variables and assumptions for calibration included, *inter alia*, market shares, which should proxy the probability of winning bids, and a measure of the pre-merger level of competition. The market shares were calculated for two comparatively narrowly delineated relevant markets: high- function financial management systems (FMS) and high-function human resources (HR) software in the U.S., comprising only Oracle, PeopleSoft, and SAP as relevant competitors and ignoring smaller competitors and possible entrants. McAfee[142] decided not to include any efficiency gains because he found substantial support for small marginal costs in the software industry that are unlikely to fall as a result of the merger. The simulated price increases for different scenarios ranged from 5 to 11 percent for FMS and from 13 to 30 percent for HR.

The EC's expert team developed a sealed-bid auction model where the vendors know the identity of their competitors but cannot observe the monetary value customers assign to the different competing products.[143] The vendors choose their bid absent information on their competitors' bids based on a calculation of expected profits depending on price and winning probability. Costs are ignored in the model, as they are assumed to be sunk before the bidding. The relevant market was defined similar to the U.S. model as the high function HR and FMS software market, but worldwide instead of limited to the U.S. Different from the DoJ specification, however, the EC included possible efficiency gains through the differentiation of two scenarios—a pessimistic one where the product quality did not change after the merger and an optimistic one with an increase in product quality. Furthermore, the model was calibrated assuming different pre-merger quality levels and levels of uncertainty of the product quality for the products in the FMS and HR market. In consequence, this led to a wide range of price and consumer surplus effects. In the HR market, where Oracle's pre-merger product was assumed to be of minor quality in comparison with its competitors, price increases varied from 6.8 percent in the pessimistic scenario under high uncertainty to 25.5 percent in the optimistic scenario with low uncertainty. In the FMS market, the EC assumed that SAP offers a product superior to its two competitors but that Oracle could improve its quality post-merger by 10 percent in the optimistic scenario. As a result, price increases from 13.9 to 30 percent depending on the level of uncertainty and the underlying scenario were found. In general, customers were harmed through both the loss of choice options and the increase in price, both effects depending on the level of substitution between the merging products.[144]

142 McAfee (2004), at 2.
143 *See* Bengtsson (2005) for details.
144 Bengtsson (2005), at 147.

Table 1. Simulated price increases for the Oracle/PeopleSoft merger

Price increase	U.S. DOJ	EC[a]
Market for high function FMS	5–11%	6.8–21.1 %
Market for high function HR	13–30%	14.3–29.9 %

Source: Bengtsson (2005) and U.S. District Court for the Northern District of California (2004).
[a]These figures relate to the pessimistic scenario without efficiencies.

In summary, both models found high and rather similar price effects (Table 1) despite different auction forms and market definitions. This somewhat supports the robustness of the results.[145] Nevertheless, the U.S. model was rejected by a law court and the EU model abandoned by the EC, both with reference to (i) a lack of reliability of the results and (ii) false market definitions, in particular the ignorance of additional smaller competitors in the MSMs. Surprisingly, the simulation model was completely rejected rather than adjusted to the broader market definition both in the European and in the U.S. litigation.[146] Although the U.S. District Court[147] and the EC[148] explicitly highlighted the general usefulness of merger simulations,[149] high standards regarding the reliability and certainty of the predictions were set on both sides of the Atlantics, and the available MSMs struggled to meet them.

B. Problems of the Use of Merger Simulation as an Antitrust Instrument

The question whether merger simulation should be used as a competition policy instrument at all can easily be answered in the affirmative. Every method that adds information and improves decision-making in merger-control cases is welcomed to contribute to improve antitrust. In addition, MSMs force the experts to reveal the underlying assumptions of the models and, thereby, contribute to transparency and clearness of the line of argument. Nevertheless, a survey on merger simulation as an antitrust instrument must also point to the limitations and problems of this innovative instrument. After all, using merger simulation as an antitrust instrument

145 Budzinski & Christiansen (2007), at 153.

146 Zimmer (2006, at 693) supposes that it might have been due to a lack of time or the fact that the EC actually preferred to abandon the model and clear the case instead of risking to conflict with the before announced U.S. judgement. Botteman (2006, at 96) even reports that an economist from the EC engaged in the case had explained that the integration of additional buyers would have increased the complexity of the MSM to an extent that would have resulted in inconsistent price effects.

147 U.S. District Court (2004), at 45.

148 EC (2004b), at 48.

149 Zimmer (2006), at 693.

implies that real-world policy decisions are based upon its result and that it counts as evidence and must stand the requirements of law. In the following, we review seven fields of (sometimes rather practical) problems that have occurred in this context in the literature as well as in the actual case proceedings.

1. *Data Availability and Statistical Significance of Price Increases*

One obvious limitation for the use of merger simulation is data availability. Comprehensive and precise data are required to calibrate MSMs so that reliable results can be derived. In many markets, such data are simply not available. Most probably, this is the main reason why the number of cases involving merger simulation is still somewhat limited.[150] Although a lack of data also affects the quality of other methods of assessing mergers, for instance structural or qualitative analysis, the effect is particularly severe regarding quantitative tools because they cannot be carried out at all without sufficient data.

Another point of critique is that post-merger prices are often solely stated as point predictions suggesting a "precise" simulation result. As all simulated price effects are based on certain demand restrictions and cost structure assumptions, more emphasis should be on providing confidence intervals or standard errors of simulated price changes to enable a superior assessment of their statistical and economic significance. To overcome this critique, some authors use bootstrapping procedures to calculate confidence intervals of predicted price or welfare changes of a merger,[151] whereas others employ the so-called delta method to calculate standard errors.[152]

2. *Form of Competition*

Obviously, the reliability of MSMs as antitrust instruments depends on an adequate identification of the underlying competition process. As seen in Chapter 3, oligopoly theory (as well as auction theory for markets with corresponding characteristics) with its basic distinction between price and quantity competition supplies the theoretical fundament. Thus, the quality of the results depends on how adequate (advanced!) Bertrand- and Cournot-type models describe real market competition. This might impose some limitations if neither class of models suffices to match a given case, as real-world competition is a complex and multifaceted phenomenon whose features reach beyond available advanced oligopoly models.[153]

[150] Ivaldi (2005), at 103.
[151] Capps et al. (2003); Ivaldi & Verboven (2005a, b).
[152] Hausman et al. (1994); Hausman & Leonard (1997).
[153] For instance, Slade (2006, at 22) argues that in case of differentiated product industries, focus should be shifted to "brand fit" instead of thinking about market definition and market shares. She claims that a 0/1 classification of whether brands belong to the same

This limitation should become lessened in the course of theory progress; however, it will not be completely erased.

A related problem refers to the possibility of structural interruptions that are caused by the merger in question. MSMs predict future prices and quantities by employing a model of the pre-merger market, calibrated with pre-merger data and adjusted to the post-merger situation by parameters like market share, cost variables, or measures of product variability. Capps et al.[154] specifically criticize that price increases are often approximated by assuming that elasticities and market shares (except for the merging parties) will be unchanged post-merger. This assumption highly simplifies the derivation of post-merger prices,[155] but might come at the cost of an inadequate extrapolation.[156]

Furthermore, it is usually assumed that the form of competition will not change due to the merger—for instance, Bertrand competition will remain Bertrand competition and not switch to Cournot competition. Although this assumption may be unproblematic in many cases, there is some plausibility, however, for the occurrence of other cases.[157] Mergers in narrow oligopolies are considered to be a particularly rewarding area for merger simulation (because of their complex economic effects). If the market structure changes in a narrow oligopoly, say for instance from 4 to 3 or 3 to 2, this implies a particularly severe change of the business environment for the oligopolists and, therefore, their adjustment of strategies might be more than marginal. Considerable changes in the way oligopolists are competing tend to overstrain MSMs because of the missing nexus to measurable past market behaviour. As insights from cognitive economics[158] demonstrate, decision-makers tend not to *create* alternative strategies until the "old" recipes fail (new framing; adjustment of mental models), in other words, changes in the form of competition can hardly be simulated because they are not predictable and non-anticipatable, as they are non-existent before the new situation actually takes place.

3. Neglect of Non-quantifiable and Long-run Competitive Effects

Currently available MSMs tend to focus on short-run price and output effects.[159] The underlying reasons are (i) the importance of these effects for welfare, (ii) the quantifiability of these effects, and (iii) the traditional

market or not is not helpful in many applications because the dimensions along which different brands compete might be continuous.

154 Capps et al. (2003).
155 Hausman & Leonard (1997), at 332.
156 Kokkoris (2005); Capps et al. (2003).
157 Werden (1997), at 98.
158 *See. e.g.*, Kahneman (2003a, b).
159 Bengtsson (2005), at 141.

dominance of these effects in theoretical industrial economics (availability of a large number of well-developed models with this focus). However, there is more to competition than short-run price and output effects—and these additional dimensions of competition also contribute to welfare.[160] Competition represents a superior coordination mechanism for economic behaviour because it induces allocative efficiency (short-term welfare effects), innovative efficiency (incentives to innovate and imitate; mid-term welfare effects), adaptive efficiency (keeping the economy flexible regarding changing environments; evolutionary welfare effects; long-term welfare effects), consumer sovereignty (producers are induced to adjust their supply according to the preferences of the consumers) and contributes to economic freedom (liberal welfare effects).[161]

Among others, Scheffman, Bengtsson, and Walker[162] note that even short-run (often) non-quantifiable and non-price elements of competition—for example, barriers to entry and exit, buyer power, brand, promotion and placement effects, shelf space competition, strategy effects on/of market participants, and so forth—can hardly be included in MSMs because the available oligopoly and auction models do not capture these dimensions of competition.[163] However, Froeb et al.[164] introduce promotional activities into the simulation model of the Häagen-Dazs/Dreyer's merger. On the one hand, this demonstrates that further research can alleviate the problem of neglecting non-price dimensions of competition. On the other hand, introducing promotional activities into the simulation leads to significant changes in the predicted welfare effects of the merger.[165] This demonstrates that non-price dimensions of competition matter in terms of welfare and their ignorance is likely to result in false predictions and merger-control decisions!

Although the problem of including selected non-price dimensions might be alleviated by further research, the simultaneous inclusion of multiple non-price dimensions represents a much tougher challenge. This is even truer for mid- and long-run effects like innovation or adaptability where some effects might remain being non-quantifiable due to their nature.[166] It must be emphasized that the tendency to neglect these kinds of welfare-relevant effects is not the result of some sort of appreciation or deliberate decision. Instead, it comes as an (unintended?) by-product: these effects are not included in MSMs because they cannot be modelled and/or quantified. However, lacking ability to make a phenomenon mathematically feasible or to quantify the respective variables does not mean that these

160 Farrell (2006); Budzinski (December 2009).
161 *See*, *e.g.*, Budzinski (2008).
162 Scheffman (2004); Bengtsson (2005); Walker (2005), at 487–490.
163 See, for an expert debate on this issue, Froeb et al. (2004).
164 Froeb et al. (2007).
165 *Id.*
166 Budzinski (forthcoming 2009).

effects carry less importance for real-world welfare. Therefore, reliance on MSMs in real-world merger cases might entail the risk of neglecting some important welfare effects, thereby causing deficient decisions. More structural or other more qualitative assessment tools, however, can provide information about non-quantifiable effects, and even if this information was restricted to plausibility arguments,[167] these methods would inject additional knowledge that is important to protect competition and increase welfare.

4. Competing Models

Each MSM inevitably must simplify the underlying real case (complexity reduction) to create meaningful information or, as Joan Robinson puts it: "A model which took account of all the variegation of reality would be of no more use than a map at the scale of one to one".[168] At the same time, the inevitable simplification and complexity reduction offers scope for the construction of competing models and their injection into antitrust cases by interested parties—as it has happened in some of the existing cases (Section IV(A)). As a consequence, a selection problem exists. Which MSM among the competing proposals is most adequate for a given case, that is, most appropriately mirrors the relevant features of the simulated real market? One way to deal with this selection problem is to define standards for the "technical" quality of MSMs acceptable for antitrust cases.[169] Although this important step should reduce the scope for arbitrarily composed models, it cannot completely prevent that competing models with incompatible predictions, all of which fulfil these standards and are injected into an antitrust procedure by the parties.[170] The complex multi-parameter character of merger cases in competitive markets implies that different models with mutually contrary conclusions regarding the pro- or anticompetitive impact of a given merger proposal most likely refer to differing ways of reducing real-world complexity. In other words, the elaborate modelling of one parameter usually comes at the expense of a stronger simplification of another, so that incompatible MSMs of the same case simplify on different parameters or, respectively, put their modelling emphasis on different

[167] In most cases, the more traditional instruments allow for a much deeper analysis and assessment than mere plausibility arguments.

[168] Joan Robinson (1962), at 33.

[169] Werden et al. (2004).

[170] Two examples that did not involve MSMs illustrate this point: both in the Microsoft cases and in the eventually aborted GE–Honeywell merger, well-respected economic experts came to completely contrary conclusions. This triggered to elaborate discourses within the scientific community of economics without achieving a consensus in regard to which side's analysis was more appropriate. See, for an illustrative reading, Bresnahan (2001); Fisher & Rubinfeld (2001); Gilbert & Katz (2001); Schmalensee (2001); Werden (2001); Evans & Salinger (2002); Nalebuff (2002); Reynolds & Ordover (2002); Gerber (2003); Evans et al. (2005).

parameters.[171] As a consequence, the solution of the selection problem becomes aggravated by the following two effects.

(i) The policy dimension of the selection problem refers to political interests of experts (working for the competition authority or the merging companies or their competitors, customers, or suppliers) as well as to the problem of whether law courts and judges are sufficiently equipped to understand and appropriately deal with the proposed models.[172] Partisan models injected by the parties to an antitrust case need not be of insufficient quality just because they are biased. Furthermore, from an economic perspective of self-interested agents and agencies, the competition authorities are not necessarily completely unbiased either. If each side to a trial sends (for instance, equally) high-ranked experts to defend their case, then it might become rather difficult for a decision body, for instance, a law court, to discriminate between the proposed models. "Neutral" experts appointed by the decision body (if it is non-partisan) might offer a solution (that, however, is associated with some practical caveats).

(ii) The analytical dimension of the selection problem refers to the theoretical availability of a "best" model. Even if no distortions by biased experts, interested parties, and insufficiently equipped authorities existed (*ideal antitrust procedure*), it might be impossible to unambiguously identify the most appropriate model among the available ones due to them being all imperfect and possessing the same "distance" to the underlying real case.[173]

Although the problem of contrary opinions in principle is inherent to all types of assessment methods for competitive impact, quantitative instruments are particularly vulnerable in this regard. The reason lies in the (unintended) effects that quantitative evidence has on the applied standard of proof.

5. *Problems of Predictive Quantitative Economic Evidence*

Injecting the results of MSMs as evidence into court procedures of merger cases has revealed an additional caveat. When it comes to assessing this type of economic evidence, the degree of certainty plays an important role. For instance, in Oracle, the clear and consistent predictions of the MSMs were dismissed due to an alleged lack of certainty because of an incomplete

171 A simultaneous increase in the complexity of each parameters modelling has its limits because of the necessity to reduce real-world complexity.

172 Mandel (1999); Posner (1999); Hovenkamp (2002). Slade (2006) discusses a respective trade-off between simplicity and accuracy of MSMs that somewhat constitutes a dilemma problem.

173 Budzinski (2009a).

modelling of the case (see Section IV(A)). Apart from the fact that economic modelling can never completely picture reality (see the preceding paragraphs), some confusion seems to result from a mix-up of forensic and predictive evidence. If one applies the same standard of proof to MSM results as to forensic evidence, then this actually implies the underlying assumption that the evolution of the world is deterministic. In an indeterministic world, an asymmetry between forensic and predictive methods exists: the results of an MSM can never achieve a degree of certainty comparable to the genetic fingerprint,[174] simply because future effects cannot be perfectly foreseen.[175] Now, of course, this is equally true for qualitative reasoning about merger effects. However, numerical predictions entail a sense of precision—actually a pseudo-precision[176]—that is suitable for mechanically increasing the expectations on the degree of certainty of that prediction. The problem of the interaction of predictive quantitative economic evidence and the standard of proof as well as the allocation of the burden of proof has not yet been sufficiently analysed. However, there is empirical indication from the U.S. that a stronger reliance on quantitative economic evidence might unintentionally weaken antitrust enforcement, in particular in the area of merger control, for exactly these reasons.[177]

6. Costs–Benefit Analysis of Merger Simulation

The use of MSMs in merger-control procedure targets an important benefit: improving the quality of the decisions to reduce erroneous decisions. However, as there can be no free lunch, the employment of MSMs comes along with additional costs.[178] This includes costs like costs of data collection, payment for expertise, computer hours, manpower, and so forth, as well as costs in terms of a potential extension of the duration of proceedings and a reduction in legal certainty.[179] The latter results from a decreased predictability of the outcome of the competitive assessment: a more structural analysis along the lines of rather rough proxies might be easier to anticipate by business companies in advance of the actual authority decision than the outcomes of a detailed simulation. Because rational business companies consider competition laws and authority practice when designing a merger project, decreased legal certainty represents additional costs for all kinds of

[174] In this respect, it is inappropriate to attempt to sell MSMs to courts as the "economic variant of the genetic fingerprint"—moreover, it entails the danger of raising non-accomplishable expectations.

[175] The effects from the inevitable complexity reduction and the fundamental uncertainty of future mutually reinforce each other.

[176] "Precise numerical outputs are reported, but with no sense of the confidence that can be placed in the estimates. This produces a false sense of precision" (Hansen & Heckman, 1996, at 98).

[177] Baker & Shapiro (2007); Farrell & Shapiro (2008).

[178] Voigt & Schmidt (2005); Christiansen (2006).

[179] Zimmer (2006).

merger activities, including efficiency-increasing ones. Furthermore, next to the increased costs for the competition agencies that employ MSMs, the merging parties (and its competitors) are likely to bear additional costs throughout the proceedings. On the one hand, notification and submission requirements increase with the use of simulation instruments.[180] On the other hand, the merging parties would possibly want to challenge the simulation by the authority by commissioning an own simulation with perhaps differing results. In some cases, even competitors might want to inject an own model to serve their interests.

Altogether, MSMs are not cheap instruments, and an economical merger-control procedure must assess whether the expected benefits (decision improvement) exceed the costs. If the effects of merger proposals are quite clear-cut, say for instance, in a monopolization case or in a case where no competition concerns arise at all, then the costs of MSMs are likely to exceed the benefits. However, if a merger proposal includes pro- and anticompetitive effects and the net effect on competition is rather unclear after a more general structural analysis, then additional information like simulation results is more likely to yield benefits that outscore the costs.

7. *Case-by-case Analysis versus Rule-based Competition Policy*

A related issue is the controversy between the proponents of a more rule-based merger control and the advocates of merger control by case-by-case analysis. In a way, this controversy relates to the more general debate on *per se* rule versus rule of reason in antitrust. However, in practice, merger control is virtually always a matter of rule of reason. Notwithstanding this, applying a rule of reason still offers scope for having more or less differentiated rules and assessment criteria, for instance classifying mergers and treating classes of mergers as a whole versus comprehensively analysing each single merger. The question is how in-depth should we look into a single merger case, or, in other words, what is the optimal degree of rule differentiation.[181]

The availability of the instrument MSM alone might favour a tendency towards more case-by-case analysis. The pros and cons of such a development somewhat mirror the cost–benefit analysis in the preceding paragraphs. However, MSMs might also play a useful role for a more rule-based merger control.[182] The application of MSMs might yield valuable insights into the competitive effects of certain types of mergers, thus allowing for designing better rules for these classes of mergers (without applying it on a merger-by-merger basis to all further similar cases).

180 Usually, merging companies do not receive any compensation for the costs of providing extensive materials to the competition authorities.
181 Christiansen & Kerber (2006); Kerber et al. (2008).
182 Budzinski (forthcoming 2009).

8. Conclusions for Merger Control

At times, comments about the potentials of MSMs seem to suggest that they are suitable to replace the structural analysis of competition cases: "[m]erger simulation . . . eliminates much of the subjective and idiosyncratic judgment otherwise inherent in the assessment of mergers",[183] or: "[with merger simulation, transparent formal economic modelling substitutes for intuition. Merger simulation thereby replaces subjective and unverifiable surmise with objective and verifiable calculation".[184] However, the discussion of the limitations of merger simulation as an antitrust instrument demonstrates that over-optimism might lead to welfare-endangering policy advice. Once again, MSMs represent an important and highly useful add-on to the more traditional instruments of merger control. However, a simulation-based analysis needs to be complemented by a more traditional analysis to actually reap its benefits. Furthermore, more research is necessary as to when a given case should be subject to an elaborate and costly simulation because, for economic reasons, its utility (improvement of decision quality) must cover its costs.

C. *Ex Post* Evaluation of the Performance of Merger Simulations

Although MSMs are frequently used in antitrust analysis, up to now only a few studies exist that try to review *ex post* how successful merger simulations have been in predicting price effects.[185] Nevo[186] applied a Bertrand-type simulation model with random-coefficients logit demand to two mergers in the ready-to-eat (RTE) cereal industry[187] and calculated the cost efficiencies necessary to compensate the price effect. Using post-merger data, he was able to partially evaluate the performance of the model and the sensitivity to different assumptions. In general, the model's predictions are fairly close to the actual outcomes, suggesting that simulation is potentially useful. However, due to a lack of detailed post-merger data, his statement is based on an informal analysis instead of formal tests. Besides, other dimensions of non-price competition between cereal producers like strategic decisions concerning advertising or new brand introduction could have had a direct, maybe countervailing influence on prices as well.

A second study conducted by Pinske and Slade[188] deals with two mergers in the UK brewing industry in 1995.[189] They used a semiparametric

[183] Crooke et al. (1999), at 206.
[184] Werden (2005), at 43.
[185] Ashenfelter & Hosken (2008), at 8; Werden et al. (2004), at 1.
[186] Nevo (2000a).
[187] These were the 1993 merger of Kraft Foods and RJR Nabisco as well as the acquisition of Ralston Purina's cereal brand Chex by General Mills in 1996.
[188] Pinske & Slade (2004).
[189] The merger of Courage/Scottish and Newcastle was allowed in 1995, whereas the one between Bass/Carlsberg and Tetley was eventually prohibited in 1997. Therefore, their

continuous-choice specification that combines the simplicity of logit and nested logit demands with the flexibility of random coefficients models. Marginal costs were not inferred from Nash–Bertrand equilibrium but obtained from a detailed engineering study of beer production, distribution, and retailing costs. In summary, their findings show that their model was able to produce price effects that closely matched reality despite neglecting several aspects of firms' behaviour. Furthermore, the results supported the case decision of the British antitrust authority.

Peters[190] predicted the price effects for five different U.S. airline mergers that have been completed between 1986 and 1987 and compared them with observed post-merger prices. He employed a rich publicly available data set and estimated both a nested logit model and a generalized extreme-value (GEV) model.[191] Comparing his simulation results with actual price increases,[192] he concluded that the predicted increases of the GEV are closer to the observed changes than those of the nested logit. However, even the GEV only modestly predicted the real changes. As a result, Peters' analysis did not prove merger simulation to be able to closely predict price changes due to mergers in the airline industry. However, merger simulation might be ill-suited to the airline industry in general, as the pricing cannot be described appropriately by any stationary oligopoly model employable in simulation.[193]

Eventually, Weinberg and Hosken[194] evaluate the performance of merger simulations for two branded consumer product mergers, one in the market for motor oils and the other in the breakfast syrup industry.[195] Although the authors judge both mergers as being well-suited to the assumptions of MSMs, the comparison of simulated and actual price changes uncovered that antitrust decisions based on the simulation results would have been the wrong ones.[196] The simulations reversed the rank order of price effects: although price increases for the motor oil merger were simulated as being small, those of the syrup merger were quite large. Retrospective evidence, in contrast, revealed an anticompetitive development of motor oil prices but no

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simulation using 1995 data concerned two scenarios: (i) undoing the Scottish/Newcastle merger and (ii) forecasting the effect of the Bass/Carlsberg and Tetley merger.

190 Peters (2006).

191 This model is a generalization of the nested logit that permits substitution to depend on multiple discrete characteristics. For details, see Bresnahan et al. (1997).

192 As some portion of the observed price change is assumed to be caused by other exogenous forces, like inflation, fluctuations in the fuel price, and so on, the author calculated a relative price change as the difference between observed percentage price change and an average industry-wide percentage price change across all markets.

193 Werden et al. (2004), at 1; Peters (2006), at 629.

194 Weinberg & Hosken (2008).

195 They employed a static Bertrand model and used AIDS, linear, and logit demand specifications.

196 Weinberg & Hosken (2008), at 32.

impact on prices for the syrup merger. Examining possible sources of the bias, Weinberg and Hosken concluded that neither demand curve changes between pre- and post-merger periods nor changes in marginal costs nor weaker assumptions on the magnitude of the outside option could explain the total amount of difference between actual and simulated prices.

In summary, very few *ex post* studies exist and they produce rather mixed results. From this, Ashenfelter and Hosken[197] conclude: "it seems that the evaluation of MSMs by a comparison of predicted and actual outcomes is in its infancy. In view of the extensive use to which these models are put, a careful evaluation of their effectiveness seems long over due". Taken seriously, this would imply a more cautious approach towards basing real merger-control decisions on simulation results until more *ex post* evaluations of the performance of MSMs are available.

For instance, a field study along the following lines would be of particular value for practical merger-control policy. A systematic testing of the tool MSM could be done by using real-world experiments or tournaments. Several experts are asked to submit an MSM for a specific real merger case in a certain market (without employing them in the merger-control decision). Then, the actual performance of the post-merger market serves as the benchmark for the submitted predictions. Despite being somewhat elaborate and expensive, such tournaments would be likely to produce important theoretical and practical insights, last but not least because of the inherent competitive character. They might be even superior to such *ex post* analysis that, in hindsight, attempts to reproduce actual market development (pseudo-predictions). In contrast to such doubtlessly valuable "hindsight simulations", the "tournament simulations" would entail real lack of knowledge about future market development at the time of simulation (real predictions), thereby enhancing the explanatory power of the performance test.

V. CONCLUSION

Advances in competition economics as well as in computational and empirical methods have offered the scope for the employment of MSMs in merger-control procedures during the past almost 15 years. Merger simulation is, nevertheless, still a very young and innovative instrument of antitrust and, therefore, (i) its "technical" potential is far from being comprehensively exploited and (ii) teething problems in its practical use in antitrust prevail. We provide a classification of state-of-the-art MSMs and review their previous employment in merger cases as well as the problems and limitations currently associated with its use in merger control. In summary, MSMs represent an important and valuable extension of the toolbox of merger policy. However, they do not qualify as a magic bullet and must be combined with other more

[197] Ashenfelter & Hosken (2008), at 36.

traditional instruments of competition policy to comprehensively unfold its beneficial effects. Next to providing even more detailed and complex models, further research should focus on the reliability of predictions from MSMs, for instance through *ex post* evaluations or (experimental) field studies.

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