MERGER SIMULATION AS A SCREENING DEVICE: SIMULATING THE EFFECTS OF THE KRAFT/CADBURY TRANSACTION

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Abstract

In this article we present a method that can substantially reduce the amount of time to conduct a merger simulation, under alternative scenarios of cost efficiencies and substitution patterns between products, while still providing robust results. The proposed method produces a range of predicted post-merger price increases through calibration in the context of a nested-logit demand structure. It reduces the need to obtain econometrically precise estimates of the parameters of the demand function and can be successfully employed within the time constraints of Phase I, and therefore may be used a screening device in merger control. We used this methodology in the Kraft/Cadbury transaction, which received clearance from the European Commission DG Comp at Phase I.

A. INTRODUCTION

Merger simulation models are often used during competition investigations to simulate the price effects of mergers involving differentiated products. They use market data and assumptions about the behaviour of consumers and firms in order to predict prices and output. There are two main elements to a simulation model: a supply side which simulates how firms compete to maximise profits; and a demand side which simulates how consumers choose what to purchase to maximise their utility (satisfaction). In addition to assumptions about firm and consumer behaviour, the models require data on pre-merger prices and volumes for all major brands, estimates of suppliers' costs and estimates of the own-price and cross-price elasticities of demand for all products in the market. Price, volume and cost data is often readily available, whereas elasticities usually need to be estimated.

In this article we describe a method that can substantially reduce the amount of time to conduct a merger simulation under alternative scenarios of cost efficiencies and substitution patterns between products, while still providing robust results. This approach can be successfully employed within the

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time constraints of Phase I investigations. We used this approach in the Kraft/Cadbury transaction, which could only proceed if it received clearance from the European Commission DG Comp at Phase I.

The proposed methodology reduces the need for precise point estimates of demand elasticities under alternative assumptions about demand structure, instead using cost and market share data to work out the range within which the actual demand elasticities are likely to fall. The method works as, for any set of prices and costs, there is only a limited range of combinations of own-price and cross-price elasticities which are consistent with the underlying assumptions regarding profit maximisation behaviour and demand structure. This implies that it possible to calibrate a simulation model to deduce the feasible range of demand parameters combinations consistent with the prices, costs and volumes observed in the pre-merger market. The feasible range of elasticities can be obtained under alternative assumptions regarding the market segmentation and aggregated demand elasticity. Under each of these assumptions, one can simulate post-merger prices and volumes for each feasible combination of demand parameters. The results provides with a range of plausible price increases under each alternative market segmentation, thus allowing us to identify the likely upper and lower bound price effect of the merger.

If the upper bound simulated price increase is not material, then it is not necessary to further the analysis by estimating elasticities (and thus simulating price changes) precisely for each of the demand structures (market segmentations) under consideration. We used this approach in Kraft/Cadbury as a complement to econometric demand estimation and merger simulation under one specific demand structure (nest structure). The European Commission considered that the upper bound price increase from the merger simulation was sufficiently low to conclude that the merger would not result in significant anti-competitive effects in the UK, France or Ireland.[3]

In Section B of this paper we describe how a merger simulation model works and review cases in which merger simulations have been used. In Section C we provide background to the Kraft/Cadbury case and we explain how we refined the standard merger simulation methodology to screen for anticompetitive effects. In Section D we conclude.

B. THE USE OF MERGER SIMULATIONS IN COMPETITION INVESTIGATIONS

Unilateral effects concerns in mergers involving differentiated products

The main concern in most merger investigations is that the merger will lead to unilateral effects, such that the merged firm will be able to unilaterally increase its prices as a result of the reduced

[3] See European Commission Decision in Case No. COMP/M.5644 – Kraft Foods/Cadbury, available at: http://ec.europa.eu/competition/mergers/cases/

competitive constraint it faces. The removal of a competitive constraint in the market place may also deteriorate rivals' offerings.

The magnitude of the effect depends on the nature of competition in the market. If competition is largely driven by capacity or production (Cournot competition), then the price effect will often be directly proportional to the market shares of the merging parties (before taking into account countervailing factors such as entry).[4] In such cases, concentration measures are typically a good indication of the potential for unilateral effects. However, if competition is primarily on prices or quality then the price effect of a merger depends mainly on two factors: (i) the closeness of competition between the merging parties relative to remaining firms in the market, and (ii) the margins earned by the parties. In general, the closer the merging parties are as competitors and the higher their margins, the greater the potential for unilateral effects.

The closeness of competition between two firms' products can be quantified: *diversion ratios* and *cross-price elasticities* are both measures of product substitutability. Pre-merger, if a firm increases its prices, it will lose some sales to its competitors. A diversion ratio measures the proportion of sales lost to each competitor (e.g. if Firm A increases its price and loses 100 sales, of which 20 are recaptured by Firm B, then the diversion ratio from A to B is 20%). The cross-price elasticity measures the same movement of volumes, but relative to the volumes of the firm who gains the sales rather than the firm who loses them.[5] Diversion ratios and cross-price elasticities are thus closely related measures of the closeness of competition between two firms. The higher their values, the more likely it is that there will be unilateral effects from a merger, all else equal.

The other key factor which affects a post-merger firm's incentive to increase prices is the margin earned on the acquired products. The higher the margin of the target company, the greater the profit which is internalised from the sales which previously would have been lost following a price increase.

Because the key drivers of unilateral price increases in differentiated products mergers are the closeness of competition and profit margins, market shares are often poor indicators of the effect of this type of merger. This was illustrated by the Whole Foods/Wild Oats merger in the US where the parties were the only premium natural, organic supermarket chains in many local geographies, but faced competition from premium organic ranges in standard supermarket chains. In that case it was argued that defining the market to include only premium organic supermarket chains led to excessively high market shares, whereas defining the market to include all supermarket chains resulted in very small shares of supply for the parties. [6]

[4] See for example, Motta, M, *Competition Policy: Theory and Practice,* Cambridge, 2004, p. 236.
[5] Following on from the above example, this means that if Firm B had initial volumes of 500, and a 10% price increase by Firm A led to it gaining 20 volumes (a volume increase of 4%), then the cross-price elasticity of B with respect to A is (4%/10%) =0.4.
[6] Whole Foods and Wild Oats were national supermarket chains specialising in natural and organic goods. The Federal Trade Commission defined the market narrowly to include only premium natural and organic supermarkets. On this basis the parties were each other's closest rivals, with 100% market share in many of the geographic markets.

As such, economists, and competition authorities in the recent years, tend to place less emphasis on market shares in differentiated products mergers and instead analyse the likely price effects.

The use of merger simulation to measure the price effect of mergers

A merger combines the productive resources and decision-making of two firms. As a result, the merged firm may have the incentive to implement different competitive strategies than those of the two firms prior to the merger. Therefore any merger is likely to alter market outcomes.

Changes in market outcomes induced by a merger are referred to as the competitive effects of the merger. Competitive effects result largely from the elimination of competition between the products of the merging firms, the realisation of post-merger cost efficiencies for the merging parties and changes in the incentives to coordinate between rival firms in the post-merger world. Merger simulation in antitrust is typically used to predict the price effects of mergers that result from the elimination of competition between the products of the merging firms.[7]

The basic idea behind simulating a merger is to build a structural model of the industry that fits the pre-merger world, and use it to predict the market outcomes post-merger. Any structural model of an industry has two main elements: (i) a supply side which simulates how firms behave e.g. how firms compete with each other to maximise profits given a cost structure, and (ii) a demand side which simulates how consumers behave, e.g. how customers choose what to buy in order to maximise their own "utility" given a set of prices.

Typically merger simulation models are used in antitrust to directly estimate the price (and sometimes volume) effects of a merger. There are many different approaches. The simplest approaches have few data requirements but rely heavily on assumptions. An example is the model proposed by Shapiro (1996)[8], which has been used by the UK Office of Fair Trading (OFT) in many first phase merger assessments.[9] It requires only two inputs; a diversion ratio and a margin, from which it estimates how prices change as result of a merger.

$$\Delta p = \frac{mD}{(1-m-D)}$$

The formula is derived by Shapiro by comparing the profit maximisation function of a firm before and after a merger, taking into account the removed constraint from the competitor. The formula is

The FTC sought to block the merger on this basis. The District Court however ruled that the evidence instead indicated a relevant market that included the product range of conventional supermarkets as well. On this market, the parties would have a very low market share suggesting that the merger would not harm competition. The District Court's decision on market definition was later overturned on appeal. See Federal Trade Commission, Plaintiff, v. Whole Foods Market, Inc., and Wild Oats Markets, Inc. (United States District Court for the District of Columbia) at http://www.ftc.gov/os/caselist/0710114/0710114.shtm .

[7] Recently merger simulation techniques have been applied to analyse the likelihood of price-coordination among firms may arise (coordinated effects) following a merger. See Davis, P. and Huse, C. "Estimating the 'coordinated effects' of mergers", Competition Commission Working Paper, 2010.

[8] C. Shapiro, "Mergers with Differentiated Products", *Antitrust*, Spring 1996.

[9] See for example, CGL/Somerfield (see OFT, "Anticipated Acquisition by Co-operative Group Limited of Somerfield Limited", 2008), Love Film/Amazon (see OFT, "Anticipated Acquisition of the Online DVD Rental Subscription Business of Amazon Inc. by LOVEFILM International Limited", 2008).

simplified greatly through a number of assumptions: that the firms only sell one product; their prices and costs are identical; the diversion ratio is symmetric[10]; and the demand function facing the firms is isoelastic. This is also a partial equilibrium model; it does not take into account the response of remaining competitors.[11] Note also that while this model only requires limited data, obtaining robust diversion ratios can be tricky (the OFT usually does this through consumer surveys).

More sophisticated approaches require more data but impose less restrictive assumptions. A full-fledged merger simulation models the interaction between all firms, products and consumers in a market. A full-fledged simulation model is likely to be the most comprehensive and general approach to estimating the likely price effect of a merger accounting for the key features of an industry such as the market structure, the strategic interaction between the firms, cost efficiencies arising from the merger, and the behaviour of consumers.

This approach involves specifying an oligopolistic model that reasonably reflects the nature of competition in the market and a demand function reflecting the behaviour of consumers and the nature of product differentiation. The parameters of the simulation model (e.g. manufacturing costs for all firms) are then calibrated so that they accurately predict observed actual levels of prices and output in the pre-merger state.

Data used for the calibration of the parameters of the model (pre-merger prices and volumes for all products in the market) must be available. Typically, the parameters of the demand function, which determine the own-price and cross-price elasticities of demand for all products in the market, are estimated econometrically on the basis of the specified demand function. As we will emphasize in the next section, under certain demand specifications, the parameters of the demand function can easily be calibrated together with the parameters of the supply side of the model on the basis of readily available information on prices and volumes in the pre-merger state. That is, any input parameters which are not known with a high degree of certainty can be inferred from the observed price and volume data.

This calibrated model is then used to simulate the behaviour of the firms following the merger and measure the price impact of the merger.

In practice, a merger simulation is usually carried out in a number of steps:

1. Obtaining data on prices, volumes and product characteristics for all products, by firm. This data is most readily available for retail products where scanner data or household survey data has been collected.

[10] Meaning that the diversion ratio from Firm A to Firm B is the same as the diversion ratio from Firm B to Firm A.
[11] There are a number of versions of this model where one of the above assumptions is either changed or relaxed. In the same paper Shapiro presents a slightly different formula which assumes a linear demand function. Similar models have been derived which allow for cost asymmetries and diversion ratio asymmetries. See, for example, Bishop, S. and Walker, M. *The economics of EC competition law,* Sweet and Maxwell, 2010. In general, the more assumptions which are relaxed, the more unwieldy the formula.

2. Obtaining data on manufacturing costs, by product or by brand. This data may only be available at this level of detail from one of the firms.
3. Specifying a demand function. In mergers involving differentiated products, discrete choice models (logit and nested-logit models) are commonly used to assimilate the demand structure of differentiated products markets when market-level data on quantities, prices and other product characteristics is available, as they allow for heterogeneity in consumer choice.[12] These models provide a tractable and parsimonious way to model demand decisions based on parametric restrictions of the demand structure.[13] The key elements of the demand-side model are the own-price and cross-price elasticities of demand for all products in the market.
4. Specifying a model supply side of the market. Typically Bertand competition is assumed to characterize the behaviour of multi-product firms in merger simulation models in the context of differentiated products. In this model, each firm sets the prices of its products to maximize profits, taking into account the expected non-cooperative responses of its competitors. An equilibrium results when no firm can increase its profit by changing its prices. The level of supply will depend on the firms' costs, and thus margins, for any given set of prices.
5. Calibrating the model. The parameters of the model are adjusted so that they accurately predict actual levels of prices and output. When demand parameters are estimated econometrically, calibration entails recovering the marginal costs figures for all products in the market that are consistent with current market conditions (i.e. observed prices and volumes), estimated elasticities,and profit maximising behaviour of the firms.
6. Simulating the merger. Once the model has been calibrated, the supply side of the model can be adjusted to reflect changes in the ownership of products, and possibly cost efficiencies and potential divestitures, following the merger. The model is then used to compute a new profit-maximizing set of equilibrium prices and volumes.

Full-fledged merger simulation models like the one described above show the expected changes in prices and volumes for all products in a market following a merger. These models are usually very flexible and can be used to assess the likely effect of different divestment packages, or the effect of changing assumptions about the structure of demand or market segmentation. Simulations can also be conducted under alternative scenarios of cost reductions (efficiencies) following the merger.

This type of models has informed decision making on a number of cases both in Europe and globally. We consider some of the key cases in Europe below.

[12] There are other models of demand for differentiated products, such as linear and log-linear demand systems and Almost Ideal Demand System (AIDS) that can be used.
[13] Berry, S. T. (1994), Estimating Discrete-choice Models of Product Differentiation, *RAND Journal of Economics*, Vol. 25 (2), pp. 243-262.

Case precedent

Merger simulation has been commonly used to assess mergers since the 1990s.[14] In many of these cases, econometric analysis has played an important role in the European Commission's final decisions. In 1996 in the *Kimberly-Clark/Scott* case, the European Commission considered econometric studies submitted by the parties to the merger and a competitor that assessed the impact of the merger on toilet paper.[15] The focus of the studies was to assess whether prices for branded toilet paper were constrained by the prices for private labels. In 1999 in the *Volvo/Scania* case, the European Commission commissioned an econometric study by Professors Ivaldi and Verboven to directly assess the impact that merger would have on truck prices.[16] Ivaldi and Verboven used 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 different European countries in 1997 and 1998. In 2003 in the *Philip Morris /Papastratos* case the Commission took into account results of a merger simulation submitted by the parties.[17] The results of the study were that the post-merger price increase would be low. In *TomTom/Teleatlas* (2004) the Commission carried out an econometric estimation of the downstream price elasticities to measure the sales that the merged entity would capture if it increased map database prices for TomTom's competitors downstream.[18] The Commission found that the merged entity would have no incentive to increase prices in a way that would lead to anticompetitive foreclosure downstream. Also in 2004, the Commission constructed a model in the *Oracle/Peoplesoft* case to simulate the impact of the transaction on prices and the economic benefit to customers from participating in the market. [19]

It is notable that these cases were mostly Phase II cases. Economists are getting faster at designing and conducting merger simulations and competition authorities more comfortable at it; but they still have a lot of discussion especially around estimation of elasticities. The reason why the merger simulation in Kraft/Cadbury could be carried out in a shorter time frame was because we modified the basic methodology to bypass the elasticity estimation stage. We explain how in the next section.

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[14] For other examples see Budzinski, Oliver & Ruhmer, Isabel (2009). Merger Simulation in Competition Policy: A Survey*, Journal of Competition Law and Economics*, Vol. 6, Issue 2, pp. 277-319.
[15] See European Commission Decision in Case Case No IV/M.623 – *Kimberly-Clark/Scott*, para. 169-177, available at: http://ec.europa.eu/competition/mergers/cases/decisions/m623_en.pdf
[16] See European Commission Decision in Case No COMP/M.1672 *Volvo/Scania*, para. 72-75, available at: http://ec.europa.eu/competition/mergers/cases/decisions/m1672_en.pdf .
[17] See European Commission Decision in Case No COMP/M.3191 *Philip Morris/Papastratos*, para. 32, available at: http://ec.europa.eu/competition/mergers/cases/decisions/m3191_en.pdf .
[18] See European Commission Decision in Case No COMP/M.4854 *TomTom/Tele Atlas*, para. 221-230, available at: http://ec.europa.eu/competition/mergers/cases/decisions/m4854_20080514_20682_en.pdf .
[19] See European Commission Decision in Case No COMP/M.3216 *Oracle/Peoplesoft*, para. 191-205, available at: http://ec.europa.eu/competition/mergers/cases/decisions/m3216_en.pdf .

C. THE KRAFT/CADBURY CASE

Background to case

Kraft Foods, a global food and drinks company, announced a hostile bid for Cadbury plc in November 2009. The companies overlapped primarily in the supply of chocolate confectionary.[20] Chocolate confectionary products are differentiated products. They come in different sizes, different formats, have different levels of cocoa and sugar content; they may contain various additional ingredients such as nuts, caramel, honey or fruit; they may serve different needs (e.g. personal consumption, sharing, gifting) and consumers have particular preferences for different types of chocolate. Chocolate confectionary can broadly be grouped into three categories: countlines, tablets and pralines. Countlines are bars which are typically under 60g, usually consumed as a personal snack. Tablets are larger bars, usually ranging from 100g to 400g in size, which are rectangular and can usually be broken into bite size segments. Pralines are separate bite size pieces of chocolate that are usually sold in boxes or bags as gifts.

Kraft and Cadbury produced chocolates in all three segments, but their main overlap was in the tablets segment. This was particularly the case in France, the UK and Ireland.[21] Kraft's main brands were Toblerone, Milka and Côte d'Or, while Cadbury was present with Cadbury Dairy Milk, Green & Blacks and Bournville in the UK and Ireland, and Poulain and 1848 in France. In the UK and Ireland, the main brands of chocolate tablets are Cadbury's Dairy Milk, Mars' Galaxy and Toblerone (Kraft). Nestlé and Lindt also have a number of brands, and private labels are also present. The brands with most similar physical characteristics are Dairy Milk and Galaxy, which are made up of "British heritage" milk chocolate bite-sized squares.[22] Toblerone is a quite unique and singular product. It is prism shaped, contains honey and nuts, and has a distinct continental flavour. It is also highly seasonal, with most sales in UK and Ireland made around Christmas, St. Valentine's Day and Father's Day. In France, the main tablet brands are Milka, Côte d'Or, Poulain, 1848 and Nestlé. Private labels have a high share of the market. The Kraft brands are primarily milk chocolate, whereas Cadbury has a greater presence in dark chocolate confectionary.

The transaction was subject to the UK Takeover Code. This meant that Kraft had 60 days from the date on which the formal offer was made in which to obtain acceptance by a majority of the shareholders.[23] If it failed to achieve this target, the offer would have lapsed. This meant that a Phase I clearance was key as, if the investigation had carried on into Phase II, Kraft's offer would

[20] There were also minor overlaps relating to sugar confectionary.
[21] In Romania and Portugal the parties also overlapped to a significant extent, although the Cadbury owned brands were local brands which could be easily divested.
[22] British heritage chocolate like Cadbury Dairy Milk has a lower content of cocoa butter and a higher content of milk than typical continental European chocolate like Linds and Milka tablets, and all other continental European chocolates, including those offered by Cadbury in Poland and France. Typically, British heritage chocolates such as Mars, Galaxy, and Cadbury Dairy Milk contain vegetable fats instead of cocoa and use a different production process from that used to produce continental type of chocolate. The resulting difference in flavour, texture and taste limits significantly the appeal of continental chocolate in the British Isles.
[23] See UK Takeover Code, available at http://www.thetakeoverpanel.org.uk/wp-content/uploads/2008/11/code.pdf

have exceeded the 60 day limit. Furthermore, there was no obvious up-front remedy package which could be offered to ensure a Phase I clearance. As Kraft and Cadbury's brands are multinational brands, divestments to meet remedy requirements in any one country would have been very commercially unattractive.

Description of the merger simulation model

We developed a merger simulation model in order to estimate the likely price impact of the merger between Kraft and Cadbury in UK, Ireland and France.

The model relied on the following assumptions:

- Consumers perceive differences between products that belong to different categories (e.g. countlines, tablets, pralines);
- Consumers decide what to buy according to what will maximise their "utility" (the value that they get from the goods that they purchase);
- Each manufacturer sets the wholesale prices of its brands to maximise profits, taking into account the expected competitive responses of its rivals; and
- Retailers price so that they receive a constant cash margin on their products (e.g. if they make a margin of £0.20 on a bar of chocolate and the manufacturer increases prices, we assume that the retailer passes some of the price increase on so that it is still earning a margin of £0.20).[24]

Data description

The construction of the merger simulation model relied on two different types of data:

- Market data on prices and sales volumes. We used scanner data from AC Nielsen which records, for each chocolate confectionary SKU:[25] prices and volumes for each four week period; product characteristics (e.g. weight, milk vs. dark chocolate, whether the chocolate contains nuts, caramel etc); brand; owner (e.g. Kraft, Mars, Nestlé); and product categorisation into countlines, tablets or pralines.[26]

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[24] The results of the simulation are not significantly different if instead we assume that the retailers react to wholesale price increases by maintaining a constant percentage cash margin. The simulation model predicts the same retail price increases under the constant percentage cash margin pass through rule as under a constant cash margin rule. However, the merger of two manufacturers leads to smaller increases in wholesale prices under a constant percentage cash margin, since the pass through rate of a wholesale price increase is greater under a constant percentage cash margin rule than under a constant cash margin rule.

[25] Stock keeping unit. This is the most disaggregated level of product data, where even a promotion on a particular type of chocolate is recorded as a separate SKU.

[26] Calibration and merger simulation results were obtained using annual data at the brand level. To limit the size of the model, we excluded brands with a share of supply below 0.5% in themarket. The brands included in our simulation models represent above 90% of the volume sales of chocolate confectionery products in the UK, Ireland and France in 2008. Note that the inclusion of additional trivially small brands increases exponentially the time required for the computation of new equilibrium prices and quantities in the post-merger scenario. The impact of the

- Data on costs. We use data from Kraft Food's management accounts on the variable unit costs and wholesale price of chocolate by brand and by segment.[27]

Demand side of the simulation model: the nested-logit model

To reflect the differences that consumers perceive between groups of products, we use a particular functional form of demand called a "nested-logit". The nested-logit model belongs to the family of discrete choice models. This type of models represents consumer choices as driven both by prices and product characteristics.[28]

Their advantage in the context of heterogeneous products is that they capture the fact that demand does not depend exclusively on prices but also on various 'quality' attributes. For example, we would expect demand for each chocolate brand to depend on its price and on characteristics such as the size of the package, flavour and the intended use of the product (personal consumption, sharing or gifting, etc).

The nested-logit model takes into account the fact that certain products are more similar than others, and thus more likely to be substitutes than others.[29] The model allows the degree of substitutability between chocolate confectionary products within the same category or "nest" to be higher than the degree of substitutability between products in different "nests". This means that a consumer willing to purchase a particular chocolate product (e.g. a chocolate tablet) is more likely to select amongst other chocolate products in the same nest (other tablets) when faced with a price increase rather than to select products belonging to a different nest (pralines or countlines).

This model places each product into a particular category or "nest". In our baseline model, each nest corresponds to one of the market segments as defined by the Nielsen data: countlines, tablets or pralines (see Figure 1). Consumers may choose not to purchase chocolate at all, and this is represented by an "outside good".[30]

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exclusion of these brands in the estimated weighted average price increase should be regarded as negligible due to the extremely low level of volume sales of these brands.

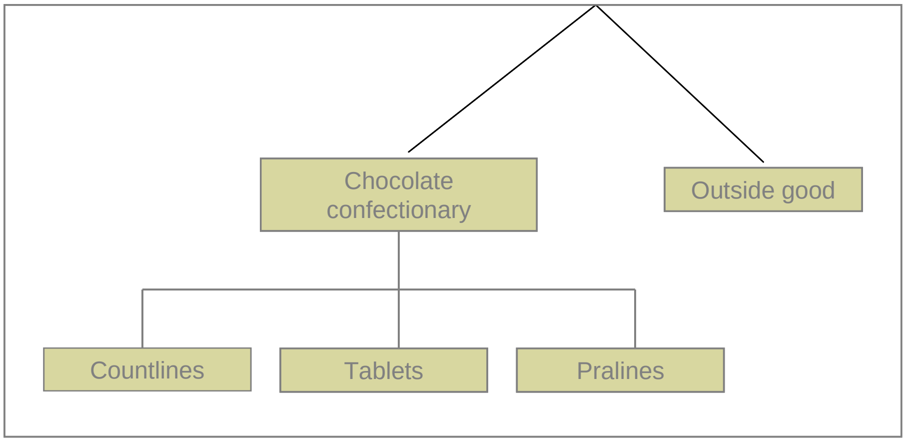
[27] Data on average variable unit cost was provided at the family brand level for 2008.

[28] See Greene, W. (2002), Econometric Analysis, 5th Edition, Prentice Hall, Chapter 21.

[29] We use the transformed nested logit approach that has the additional advantage that it permits estimation using instrumental variables. See Berry, S. (1994), "Estimating discrete choice models of product differentiation", *RAND Journal of Economics*, Vol. 25, Summer, pp. 242-263. See Annex for a more detailed discussion.

[30] Note that the size of the "outside good is linked to the aggregate or market elasticity of demand. When the market elasticity is large, then the outside good is important. The relationship between the aggregate demand elasticity and the outside good in a logit model is $\varepsilon = -\alpha\left(\frac{h}{1-h}\right)p$ where ε is the market elasticity, α is a parameter estimated by the model, h is the size of the outside good relative to the size of the inside good and p is the weighted average retail price. A market elasticity of -0.75 implies that the size of the outside good is just three times the size of the group of chocolate products in our dataset, so we consider this unrealistically low (note that chocolate confectionary sales in the UK are around £3 billion per annum compared with over £100 billion grocery sales).

Figure 1: Nested-logit tree



The demand side of the model estimates the probability that a consumer will select product j, as a function of its product characteristics, price, and its sales share of the nest that it inhabits. Two key parameters which are estimated in the demand function are α, which measures consumer responsiveness to changes in price and σ, which measures how likely consumers are to choose an alternative product in the same nest vis-a-vis a product in a different nest.

Own-price[31] and cross-price elasticities (intra-nest[32] and inter-nest[33]) in a nested-logit model can be expressed as a function of these two unique parameters (α and σ) and observed volume sales: [34]

Own-price elasticity: $$\varepsilon_{jj} = -\frac{\partial q_j}{\partial p_j}\frac{p_j}{q_j} = \alpha \cdot p_j\left[\frac{1}{1-\sigma} - \frac{\sigma}{1-\sigma}\frac{q_j}{Q_{G_j}} - \frac{q_j}{N}\right], \qquad (2)$$

Intra-nest cross-price elasticity: $$\varepsilon_{\substack{jk \\ k\in G_j \\ k\neq j}} = \frac{\partial q_j}{\partial p_k}\frac{p_k}{q_j} = \alpha \cdot p_k\left[\frac{\sigma}{1-\sigma}\frac{q_k}{Q_{G_k}} + \frac{q_k}{N}\right], \qquad (3)$$

Inter-nest cross-price elasticity: $$\varepsilon_{\substack{jk' \\ k'\notin G_j}} = \frac{\partial q_j}{\partial p_{k'}}\frac{p_{k'}}{q_j} = \alpha \cdot p_{k'}\frac{q_{k'}}{N}, \qquad (4)$$

[31] The own-price elasticity indicates the responsiveness of the quantity demanded of product *j* to a change in its own price, p_j.

[32] The intra-nest cross-price elasticity measures the responsiveness of the quantity demanded of any product *k* in the same nest as product *j* to a change in the price of product *j*. Indeed, under a nested logit demand specification, the intra-group cross price elasticity for each product *j* is constant for all possible pairwise combinations *jk* within the nest. If the products within the same nest are substitutes, the elasticity will be positive.

[33] The inter-nest cross-price elasticity measures the responsiveness of the quantity of any product k in any nest other than that of product *j* to a change in the price of product *j*. Under a nested logit demand specification, the inter-group cross-price elasticity for each product *j* is constant for all pairwise combinations *jk'* in all other nests. If the products across nests are substitutes, the inter-nest cross price elasticity will also be positive.

[34] See Annex for a more detailed discussion.

where q_j is the quantity sold of product j, p_j if the price of product j, Q_{Gj} are the total sales of nest G_j to which the product j belongs, and N is the total market size, including the outside good.

The interpretation of the two key determinants of the elasticities, α and σ, is the following. We expect the value of α to be positive as this means that consumers respond to a price increase by reducing demand. Everything else held constant, a high value of α implies that all elasticities are large in absolute terms. The value of σ should be between zero and one. A value of σ close to one means that both the own price elasticity and the intra-nest cross-price elasticity are large. On the other hand, if σ is close to zero, the own-price elasticity is small and the intra-nest and inter-nest cross price elasticities are identical and also small. This implies that consumers are equally likely to choose a product in the same nest or in a different nest when considering how to respond to a price increase.

The supply side of the model

To model the behaviour of the firms we rely on the Bertrand oligopoly model with differentiated products, according to which each chocolate manufacturer sets the wholesale prices of its brands to maximise profits, taking into account the expected non-collusive responses of its rivals. An equilibrium results when none of the firms in the market can increase its profit by altering its prices.

Each multiproduct manufacturer sets wholesale prices of each of its brands so to maximize profits taking into account (i) the competitive responses of its rivals, (ii) the relationship between wholesale and retail prices, and (iii) the responsiveness of demand to retail price changes. See Annex for a more detailed description of the model equations.

Calibration of the model

Typically the calibration of the model in a merger simulation context requires estimating econometrically the parameters of the demand function that determine the own-price and cross-price elasticities of demand for all products in the market. Under the nested-logit demand function this entails obtaining point estimates for α and σ through estimation. As an alternative to calibrating the model using a point estimate of the nested-logit demand parameters, it is possible to use the simulation model to identify the range of the demand parameters (and hence the range of the own-price and cross-price elasticities) which are feasible for the first-order conditions of the suppliers to hold for each product in the market. The parameters of the demand function can be obtained through calibration together with the parameters of the supply side of the model on the basis of readily available information on prices and volumes in the pre-merger state.

The simulation model can be used to obtain, together with costs, the different combinations of the demand parameters (α and σ) that are consistent with profit maximising behaviour by manufacturers. Given that the values of α and σ together with observed volume sales determine own-price and cross-price elasticities, this is equivalent to calibrating the range of own-price and cross-price elasticities that are consistent with (i) utility maximising behaviour by consumers, and (ii) profit maximising behaviour by manufacturers, given the actual (observed) level of prices, sales and costs.

Our approach follows standard techniques for the calibration of simulation models. Specifically, we take the parameters α and σ as inputs into the model, and then calibrate a set of costs such that the corresponding retail prices predicted by the model match those in our data set and are consistent with optimal behaviour by the manufacturers.

The calibration procedure works in two stages. First, we calibrate marginal costs for each possible combination of the parameters α and σ in the nested-logit model of demand, given a value of the aggregate demand elasticity. Second, we select as plausible (feasible) those combinations of α and σ such that (i) the corresponding calibrated marginal costs are positive for all brands included in the model, and (ii) average calibrated costs are broadly consistent with the financial information provided by Kraft.

In terms of methodology, we proceed by assuming a value for the market elasticity of demand (and then checking robustness via sensitivity analysis), and then by obtaining combinations of α and σ and values of marginal costs via a calibration exercise.

For all plausible combinations of α and σ (elasticities) and aggregate demand elasticities we simulate the effect of the merger (i.e. a change in the ownership structure and potential efficiencies). This provides us with a range of predicted price increases, within which the true price increase is likely to fall.

Figure 1 below summarizes the variables and the data sources used in the calibration of the model.

Figure 2: Variables and parameters used in the merger simulation

Variables	Screening device
Prices	Market data
Quantities	Market data
α	Range
σ	Range (0-1)
Nest structure	Assumption / market data
Ownership structure	Market data
Marginal costs	Calibrated and market data
Market size	Assumption (aggregate elasticity)

- For each possible combination of α and σ, calibrate the model and obtain a vector of calibrated marginal costs.

- Select those combinations of α and σ that are consistent with actual cost information

- For each selected combination of α and σ, obtain the predicted price increase through simulation.

The intuition behind the procedure is as follows. For any set of prices and costs, there is only a limited number of combinations of the nested-logit demand parameters which are consistent with the underlying assumptions regarding profit maximising behaviour and market segmentation. Without having to econometrically estimate the demand parameters, our procedure allows for simulations to be carried out for all feasible combinations of the demand parameters, each of which will result in a different set of predicted prices and volumes.

The value of this methodology is that it allows simulating the range within which the actual post-merger price increase will fall, under alternative nest structures (i.e. narrowing the set of substitutes), classification of products into nests and assumptions about aggregate demand elasticity without the need for obtaining econometrically precise estimation of elasticities.

The proposed methodology is of particular value as a screening device in merger control, as it allows assessing the range within which the price effect of a merger will fall under many alternative scenarios within the time constraints of Phase I investigations. If the upper bound simulated price increase is not significant, then it is not necessary to further the investigations. On the contrary, if the range is sufficiently high, it may be clear that remedies are required (without the precise price effect being known), or that further investigation needs to be carried out to assess more precisely the competitive impact of the merger.

We applied this methodology in the Kraft/Cadbury in the UK, Ireland, and France. We found that the upper bound price increases were not material. In the three countries the merger simulation results using indicated a very modest (weighted) average price increase for the entire market as well as for the set of products included in each of the nests or market segments. This result held even when the model had been subjected to a number of robustness tests both by the authors and by the European Commission.

The robustness tests included: changes in assumptions about cost efficiencies; narrowing of consumer choice of substitutes through changes in the nest structure; changes in the assumed aggregate market elasticity, and changes in the classification of products into nests.[35] The results from this exercise were regarded by the Commission as significant evidence that the proposed operation was unlikely to lead to significant price increases in the UK, Ireland and France.[36]

At the request of the Commission, we also estimated econometrically the demand parameters in the UK, and Ireland, under one specific nest structure, and product classification.[37] The obtained point estimates of the demand parameters (α and σ) in both countries fell within the range obtained previously through calibration. Estimated elasticities were therefore consistent with those used to conduct merger simulation using "calibrated" elasticities, and were also consistent with estimated elasticities for chocolate products in the UK found in recent academic literature, and similar to estimated elasticities for other food products and consumer goods.[38] On the basis of these point estimates, and following the Commission's suggestion, we launched simulations, and found that the predicted price increase also fell within the range of predicted price increases previously obtained for UK and Ireland using calibrated elasticities. The Commission in its decision disregarded the use of the elasticities point estimates (and point estimate of the price increase) arguing the estimated demand parameters were sensitive to the inclusion of some controls (in particular nest dummy variables) and issues related with the set of selected instruments.[39]

However, the Commission regarded the merger simulation results obtained through "calibration" of the demand parameters as robust and sufficient evidence that the merger was unlikely to result in

[35] The calibrated models were used to simulate equilibrium prices and volumes of all products in the market after the merger under alternative scenarios about cost efficiencies of 0%, 5% and 10%. Calibration and the subsequent simulation of post-merger prices was also conducted for alternative values of the aggregated demand elasticity. In particular, and as a robustness test, we set aggregate demand elasticity of chocolate to take the values of -0.75, -,1 and -1.25, and found no material impact on our results in terms of predicted price increases. Other robustness test included changes in the treatment of private labels, the nest structure considered and the criteria used for the selection of plausible values for α and σ See European Commission Decision in Case No. COMP/M.5644 – Kraft Foods/Cadbury, available at: http://ec.europa.eu/competition/mergers/cases/

[36] In its decision, the Commission regarded the results of the merger simulation exercise as conservative in the sense that the independence of irrelevant alternatives assumption supposes that switching between products happens proportionally to market shares within a nest, while the qualitative and quantitative evidence gathered during the market investigation indicated that the parties' products were not seen as particularly close competitors.

[37] Demand estimation for the UK and Ireland was conducted using the original AC Nielsen market segmentation and product classification..

[38] See Bruno, H. A., and N. Vilcassim (2008): "Structural Demand Estimation with Varying Product Availability", Marketing Science, 27(6), 1126–1131, which estimates the own-price elasticity of demand for chocolate brands in the UK; Hausman and Leonard (1997): "Economic Analysis of Differentiated Products Mergers Using Real World Data", George Mason Law Review; Akbay and Jones (2006), "Demand Elasticities and Price-Cost Margin Ratios for Grocery Products in Different Socio-Economic Groups", Agric.Econ (5): 225-235.

[39] See European Commission Decision in Case No. COMP/M.5644 – Kraft Foods/Cadbury.

anti-competitive effects in the UK, France or Ireland. Thus, further analysis or discussion around the determination of point estimates for elasticities was not regarded as necessary.

The Commission concluded that the merger would not lead to a significant price increase and the transaction was cleared in Phase I with no divestments in the UK, Ireland, and France.[40]

D. CONCLUSIONS

The use of simulation techniques in merger control has been typically restricted to in-depth Phase II investigations. One reason behind this is that full-fledged merger simulation models require estimating econometrically own-price and cross-price elasticities of demand for all products in the market. The time needed to obtain reliable estimates of the assumed demand function parameters, together with the time constraints that apply in Phase I investigations, have significantly limited the use of merger simulation techniques in Phase I investigations.

In this paper we show a method that avoids the need to obtain econometrically precise point estimates of own-price and cross-price elasticities in the context of a nested-logit demand function, instead using cost and market share data to deduce the range within which the actual demand elasticities are likely to fall.

The proposed method can be used to assess the range within which the price effect of a merger is likely to fall under a wide range of alternative scenarios about nest structures (i.e. narrowing the set of substitutes), classification of products into nests, assumptions about aggregate demand elasticity, efficiency gains, and potential divestitures. This methodology can be successfully employed within the time constraints of Phase I and, therefore, is particularly suitable as a screening device for anticompetitive effects in merger control.

If the predicted price increase range is sufficiently low (i.e. the upper bound predicted price increase not significant), then the competition authority may reach comfort that the merger will have a limited effect on competition eliminating the need to estimate the precise price effect of the merger. Similarly, if that range is sufficiently high, it may be clear that remedies are required, without the precise price effect being known. There will be some situations where the precise point estimate may matter, indicating that further investigation is required.

[40] Divestments were though required in Romania and Poland, where Cadbury's products were local brands with a very significant presence in terms of market share.

E. ANNEX

The simulation model has a demand side and a supply side.

The demand side is modelled using a "nested-logit" model. It takes into account perceived differences between products by grouping them into nests.

The supply side of the model assumes that manufacturers set prices to maximise profits, taking into account the competitive responses of their rivals, and that retailers generate a constant cash margin on their products.[41]

The model takes into account actual constraints between manufacturers' products. However, it does not take into account other pricing constraints, such as buyer power and entry. The model can take into account cost efficiencies.

Demand side of the simulation model: the nested-logit model

This section reviews the theoretical underpinnings of the nested-logit model. The model is based on the assumption that products can be grouped into *G+1* sets or nests, *g = 0,1,...,G*, where group *0* represents the alternative of not purchasing any chocolate confectionery product (the "outside good"). The utility to consumer *i* from purchasing product *j* is given by:[42]

$$u_{ij} = \delta_j + \zeta_{iG_j} + (1-\sigma)\varepsilon_{ij} \qquad [1]$$

The first term, δ_j, is the mean valuation for product *j*, common to all consumers. It depends on the retail price of product *j*, p^r_j, a vector of observed characteristics of product *j*, x_j, and an error term reflecting unobserved characteristics:

$$\delta_j = x_j\beta - \alpha p^r_j + \zeta_j \qquad [2]$$

The second and the third term in [1], ζ_{iG_j}, and ε_{ij}, are random variables reflecting individual *i*'s deviation from the mean valuation. The term ζ_{iG_j} stands for consumer *i*'s utility, common to all products belonging to group G_j, whereas the term ε_{ij} represents consumer *i*'s utility, specific to product *j*. The parameter σ lies between 0 and 1 and measures the correlation of the consumers' utility across products belonging to the same product group or nest. If $\sigma = 1$, there is a perfect

[41] The results of the simulation are not significantly different if instead we assume that the retailers react to wholesale price increases by maintaining a constant percentage cash margin. In this latter case, the merger of two manufacturers leads to a smaller increase in wholesale prices, since the pass through rate of a wholesale price increase is greater under a constant percentage cash margin rule than under a constant cash margin rule. The predicted price increases at the retail level remain unaltered.

[42] See Ivaldi and Verboven (2000), "The European Heavy Trucks Market: an Economic Analysis," report for the Competition Directorate General of the European Commission for a detailed derivation of the demand equation.

correlation of preferences for products within the same group or nest; so these products are perceived as perfect substitutes. As σ decreases, the correlation of preferences for products within same group decreases. If $\sigma = 0$ there is no correlation of preferences and consumers are equally likely to switch to products in a different group or nest as to products in the same group in response to a price increase. This is the case of a logit model according to which all products in the market compete symmetrically with each other.

Normalizing the mean utility level for the outside good to 0, i.e., δ_0 =0, the probability s_j that a potential consumer chooses product *j* is given by:

$$s_j = \frac{e^{\frac{\delta_j}{1-\sigma}}}{D_{G_j}} \frac{(D_{G_j})^{(1-\sigma)}}{(1+\sum_{\forall G_j}(D_{G_j})^{(1-\sigma)})} \qquad [3]$$

where $D_{G_j} = \sum_{k \in G_j} e^{\frac{\delta_k}{1-\sigma}}$ and G_j denotes the group of products that belong to the same nest than product *j*.

Taking logarithms and rearranging [3], we get:

$$\ln s_j - \ln s_0 = x_j \beta - \alpha p_j^r + \sigma \ln s_{jG_j} + \zeta_j \qquad [4]$$

where $s_j = \frac{q_j}{N}$, $s_{jG_j} = \frac{q_j}{\sum_{k \in G_j} q_k} = \frac{q_j}{Q_{G_j}}$, $s_0 = \frac{N - \sum_{\forall k} q_k}{N}$ and *N* stands for the total size of the market.

Using the demand expression [4] described above we can derive the own and cross price elasticities at the retail level as a function of parameters *α* and *σ* and observed volume sales:[43]

<u>Own-price elasticity:</u> $\varepsilon_{jj} = -\frac{\partial q_j}{\partial p_j^r} \frac{p_j^r}{q_j} = \alpha \cdot p_j^r \cdot \left[\frac{1}{1-\sigma} - \frac{\sigma}{1-\sigma} \cdot \frac{q_j}{Q_{G_j}} - \frac{q_j}{N} \right]$, [5]

<u>Intra-nest cross-price elasticity:</u> $\varepsilon_{\substack{jk \\ k \in G_j \\ k \neq j}} = \frac{\partial q_j}{\partial p_k^r} \frac{p_k^r}{q_j} = \alpha \cdot p_k^r \cdot \left[\frac{\sigma}{1-\sigma} \cdot \frac{q_k}{Q_{G_k}} + \frac{q_k}{N} \right]$, [6]

<u>Inter-nest cross-price elasticity:</u> $\varepsilon_{\substack{jk' \\ k' \notin G_j}} = \frac{\partial q_j}{\partial p_{k'}^r} \frac{p_{k'}^r}{q_j} = \alpha \cdot p_{k'}^r \cdot \frac{q_{k'}}{N}$, [7]

[43] To obtain these elasticities, we use the logarithm approach for the calculation of elasticities, i.e. $\varepsilon_{jj} = -\frac{\partial q_j}{\partial p_j} \frac{p_j}{q_j} \cong -\frac{\ln q_j}{\ln p_j}$

where q_j is the quantity sold of product j, $p^r{}_j$, is the retail price of product j, Q_{Gj} are the total sales of nest G_j to which the product j belongs, and N is the total market size, including the outside good.

Supply side of the simulation model

To model the behaviour of the firms we rely on the Bertrand oligopoly model with differentiated products, according to which each chocolate manufacturer sets the wholesale prices of its brands to maximise profits, taking into account the expected non-collusive responses of its rivals. An equilibrium results when none of the firms in the market can increase its profit by altering its prices.

Each multiproduct manufacturer sets wholesale prices of each of its brands so to maximize profits taking into account (i) the competitive responses of its rivals, (ii) the relationship between wholesale and retail prices, and (iii) the responsiveness of demand to retail price changes.

To maximize profits manufacturer f chooses for each product j the wholesale price p_j^w to solve the following first-order condition:[44]

$$q_j + \frac{\partial q_j}{\partial p^r{}_j}\left(p_j^r - \widetilde{c}_j\right) + \sum_{\substack{k \in G_j \\ k \neq j \\ k \in S_f}} \frac{\partial q_k}{\partial p^r{}_j}\left(p_k^r - \widetilde{c}_k\right) + \sum_{\substack{k' \notin G_j \\ k' \in S_f}} \frac{\partial q_{k'}}{\partial p^r{}_j}\left(p_{k'}^r - \widetilde{c}_{k'}\right) = 0 \qquad [8]$$

where:

- p_j^r stands for the price set by the retailer for product j of wholesaler f;
- $\widetilde{c}_j^{\,r}$ stands for the sum of the marginal cost incurred by the wholesaler to produce product j plus the retailer's margin [$\widetilde{c}_j = (c_j^w + rm_j)$, and $rm_j = (p_j^r - p_j^w)$ constant for all values of p_j^w], and represents the full cost to the manufacturer of producing and marketing the product j;
- S_f is the set of products shipped by firm f; and
- G_j denotes the group of products that belong to the same nest as product j.

  Using the demand elasticity expressions [5], [6] and [7] and rearranging, the first order condition of the profit-maximization problem of the wholesaler f can be restated as:

$$(p_j^r - \widetilde{c}_j) = \frac{1}{\alpha}\left[\frac{1}{1-\sigma} - r_{G_j} Q_{G_j}^f - r_0 \Lambda_j \sum_{\substack{k' \notin G_j \\ k' \in S_f}} \frac{q_{k'}}{\Lambda_{k'}}\right]^{-1} \qquad [9]$$

[44] Note that a multiproduct firm takes into account all its products in the profit maximization decision.

where $r_{G_j} = \left[\frac{\sigma}{1-\sigma} \frac{1}{Q_{G_j}} + \frac{1}{N} \right]$, $r_0 = \left[\frac{1}{N} \right]$, $\Lambda_j = (r_0 - r_{G_j}) Q^f_{G_j} + \frac{1}{1-\sigma}$, and

$\Lambda_{k'} = (r_0 - r_{G_{k'}}) Q^f_{G_{k'}} + \frac{1}{1-\sigma}$.