OFFICE OF FAIR TRADING

Consumer savings from merger control

Merger simulation for impact estimation

April 2007

OFT917

David Stallibrass
Andrew Jones

OFT Evaluation Team
Fleetbank House
2-6 Salisbury Square
London EC4Y 8JX

CONTENTS

1 INTRODUCTION

1.1 In 2005 the Office of Fair Trading (OFT) published a 'lower bound' estimate of the impact of our merger decisions. We conservatively assumed that the consumer saving impact of our merger decisions is equivalent to one per cent of the relevant market turnover for one year.[1]

1.2 The OFT is publicly committed to assess the impact of our merger decisions as accurately as possible. Following the Public Accounts Committee hearing in December 2005 John Fingleton, OFT Chief Executive, highlighted the desirability of 'best-guess' estimates of our impact over the 'lower-bound' estimates so far published by the OFT.

1.3 The OFT is the first stage in a two-stage merger control regime. The Competition Commission (CC) is the second stage. The combined regime controls mergers in the UK and distinguishing between the consumer savings from the OFT's first stage and the CC's second stage is necessarily arbitrary.

1.4 As a matter of procedure, we have agreed with the CC that the OFT is responsible for estimating consumer savings from undertakings in lieu of a CC reference (UILs) and that the CC estimates the consumer savings from mergers which they block or amend. This way the body closest to the final decision is responsible for estimating the decision's impact.

1.5 This document summarises how, through the joint effort of the mergers branch and the evaluation team, we use merger simulation to provide 'best-guess' estimates of consumer savings from UILs. We do not use merger simulation in our substantive decision making process or to estimate consumer savings from cases referred to the CC.

1.6 Use of merger simulation for impact estimation after a UIL decision has been made should not be taken as the expression of an opinion, in any

[1] 'Positive impact: an initial evaluation of the effect of the competition enforcement work conducted by the OFT' (OFT 827).

way, on the suitability or validity of the use of merger simulation in the OFT's substantive decision making process.

1.7 We take as given that undertakings accepted by the OFT, and not overturned on appeal, are warranted: we implicitly assume that the institutional structure is sufficient to ensure that any incorrect decisions or planned decisions are identified and corrected.

1.8 We have programmed a set of economic models that simulate the effects of a merger.[2] The models have sound academic support and have been used by other competition authorities including the Federal Trade Commission in the United States.

1.9 Our methodology is a work in progress and comments and suggestions on how to improve it, or flaws in the current methodology, are welcome.

1.10 The models rely on a few key pieces of data to sketch the economic relationships between firms and products in a market. Based on these relationships the models calculate the equilibrium state of the market before and after a change in the market structure that a blocked merger would have caused. Comparison of the two states reveals the effect of the change.[3]

1.11 The models make strong assumptions to calculate complete pre- and post-merger market equilibria from just a few key pieces of data. However, the models are also highly flexible. The parameter and market structure assumptions of the models can be chosen (or calibrated) to best fit any available data. In this way the models make efficient use of available market information.

---

[2] The models have been programmed in Mathematica with the assistance of Gluonvision GMBH.

[3] 'The effects of mergers in differentiated product industries'. Werden, Gregory J and Luke M Froeb. Journal of Law, Economics and Organisation. Volume 10, Number 2, 1994. 'Merger simulation: a simplified approach with new applications'. Epstein, Roy J and Daniel L Rubinfeld. Antitrust Law Journal no 69. 2002

1.12 Given the data we usually have available the economic models we have used are, in our opinion, the best academically supported method for mechanically deriving estimates of the impact of a merger decision for the purpose of impact estimation. The models are used after the OFT has decided that it is or may be the case that a merger would lead to a Substantial Lessening of Competition and has accepted undertakings in lieu of referring the merger to the Competition Commission.

1.13 Case by case uncertainty about the level of impact is high, but when results are aggregated across multiple cases the aggregate uncertainty becomes acceptable. We believe the method strikes the right balance between accuracy and administrative overhead.

1.14 Section 2 discusses the process by which we apply the models to our work. Section 3 describes the models. Section 4 provides an analysis of the use of models for impact estimation based on the mergers we have modelled so far.

2 PROCESS

The UK merger regime

2.1 The OFT is the first stage in a two-stage merger control regime. The Competition Commission (CC) is the second stage. The combined regime controls mergers in the UK and distinguishing between the consumer savings from the OFT's first stage and the CC's second stage is necessarily arbitrary.

2.2 As a matter of procedure, we have agreed with the CC that the OFT is responsible for estimating consumer savings from undertakings in lieu of a CC reference (UILs) and that the CC estimates the consumer savings from mergers which they block or amend. This way the body closest to the final decision is responsible for estimating the decision's impact.

2.3 Where necessary, and as a matter of presentation, we have agreed to apportion consumer savings from mergers referred to the CC between the two phases roughly in proportion to cost. As such, we allocate to the OFT 20 per cent of consumer savings resulting from CC intervention, and 100 percent of the consumer savings from any undertakings in lieu of reference.

Scope of merger simulation

2.4 Due to time and resource constraints we only use merger simulation to estimate the impact of a subsample of the undertakings taken by the OFT in lieu of a reference. For each merger we estimate a lower, mid, and upper estimate of consumer savings reflecting uncertainty in model inputs.

2.5 We estimate consumer savings for the cases that we do not simulate by the following method:

- calculating the proportion of annual turnover accounted for by our 'low' estimate of total consumer savings for each of the undertakings which we have simulated. This represents a

conservative estimate of total consumer savings as a percentage of annual turnover

- taking an average of this calculation across all the cases simulated to obtain a conservative estimate of the average consumer savings as a percentage of annual turnover for the cases in which the OFT accepts undertakings in lieu of a reference

- applying this average to the turnover of the markets that we have not modelled.

2.6 Mathematically:

$$CS_j = T_j \times \frac{\sum_{i=1}^{N} \frac{CS_i}{T_i}}{N} \qquad (5)$$

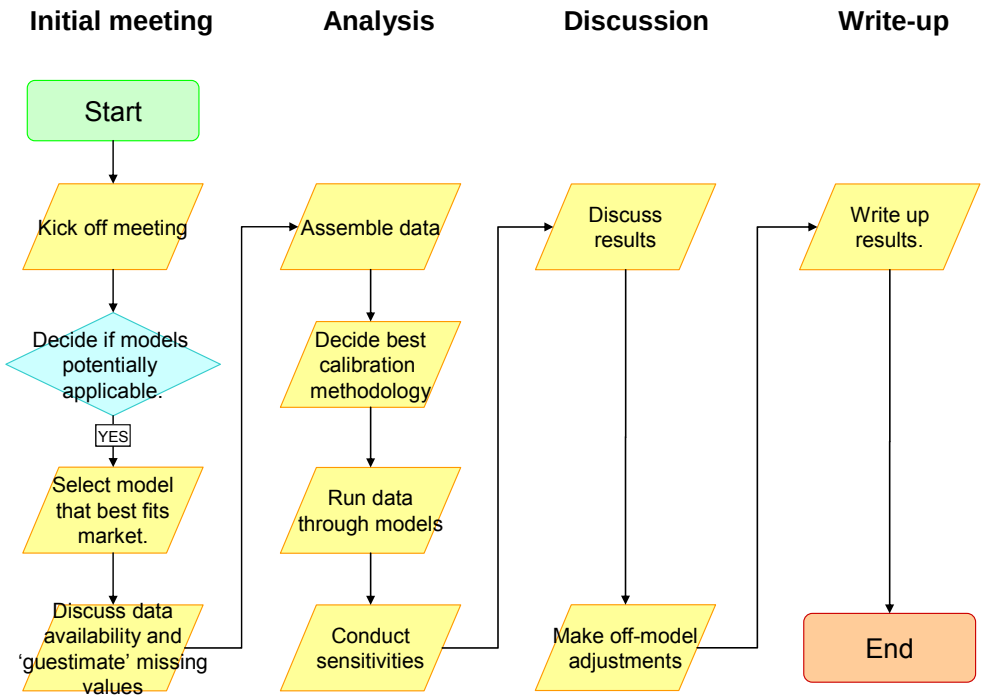
Where*:*

CS_j	=	Consumer savings from unsimulated undertaking *j;*
T_j	=	Turnover in relevant market in unsimulated undertaking *j*;
N	=	Number of simulated undertakings;
CS_i	=	Consumer savings from simulated undertaking *i;*
T_i	=	Turnover in relevant market in simulated undertaking *i*;

Merger simulation procedure

2.7 Figure 2.1 presents a flow chart of the procedure we follow when estimating the impact of a merger decision.

Figure 2.1: Procedure



2.8 At present, the models are insufficiently flexible to model all the nuances of our merger decisions, and in some cases are entirely unsuited. As such, case officers or economists make ad-hoc adjustments to the results of the models to better reflect their understanding of the likely impact of the merger. In this way the opinions of case officers and economists take precedent over the mechanistic result of the models at all times.

2.9 In addition, the merger modelling takes place after a substantial lessening of competition (SLC) decision has been found by the OFT decision maker. The SLC finding is thus an input into the modelling process.

3 THE MODELS

3.1 In most cases where the OFT makes an intervention, such as preventing a commercial agreement or supporting a voluntary consumer code scheme, the intervention causes a change. Since the OFT action has changed something, it can be relatively straightforward to observe the impact that the action had.

3.2 Merger control is different since the OFT intervention is to force the market structure **not** to change. As such, it is very hard to observe what our impact might be.

3.3 One way to estimate what the impact of a decision to block a merger might be is to use an economic model to simulate how prices, demand, and market share might have changed were the merger to have gone ahead.

Overview of modelling procedure

3.4 Simulating the effect of a merger is a three step process of comparative statics:

- Step 1: Calibrate the models to describe as accurately as possible the current pre-merger state of the market
- Step 2: Use the calibrated models to predict what effect a change in market structure would have on price and demand. Compare the pre- and post-merger price and demand estimates to assess the likely impact of the merger
- Step 3: Multiply this by an estimate of the amount of time it might take for entry and other market changes to correct for any anti-competitive effects of the merger.

3.5 Off model adjustments may be necessary during Step 3 to accommodate any properties of the merger or market not picked up by the models.

3.6 A more technical description of the individual models starts at paragraph 3.21.

Step 1: Calibrate the models

3.7 The data requirements for calibrated economic modelling are similar to the requirements for the analysis that informs our actual decisions. To determine whether a merger is likely to substantially lessen competition, it is necessary to have an understanding of the order of magnitude of: market concentration, demand side substitutability between products in the market, and demand side substitutability of the market in general.[4] The difference with calibrated economic models is that they require quantitative estimates of these inputs.

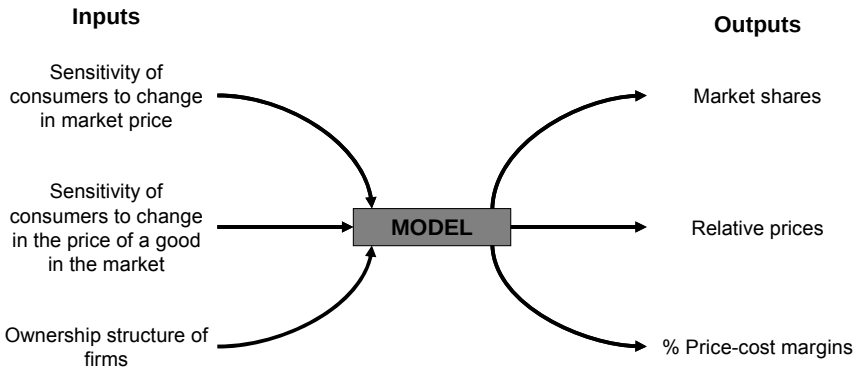
Table 3.1: Qualitative and quantitative data names

Qualitative name	Quantitative names
Market concentration	Market shares of brands, and market structure of brand ownership
Demand side substitution between products in the market price **or** sensitivity of consumers to change in the price for a particular good.	The elasticity of demand for a single good (the own-price elasticity of demand).
Demand side substitution of the market in general **or** sensitivity of consumer to change in average market price.	The market elasticity of demand

3.8 The models take the inputs and predict what the market shares, prices, and price-cost margins would be if the market were in equilibrium. The equilibrium assumption behind the models means that adjustments are likely to be necessary when modelling markets in states of change.

[4] OFT Merger Guidelines.

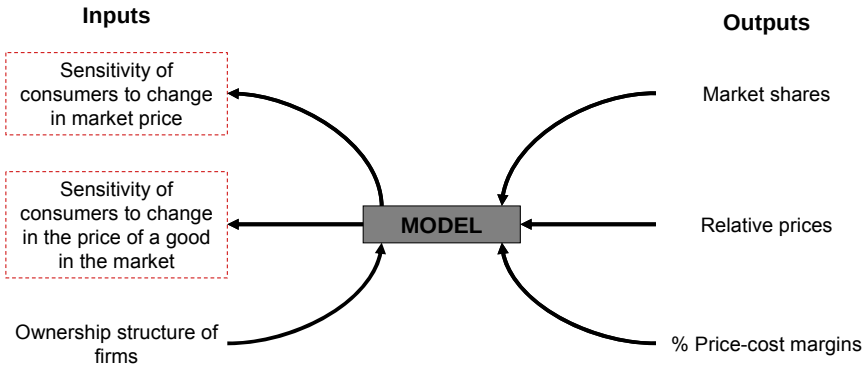
Figure 3.2: Simple model design



3.9 Pre-merger, we know more about the outputs of the models than the inputs. For example, market shares and price-cost margins are more visible than numerical estimates of price sensitivity. The models work in both directions: the inputs of the models may be calibrated to ensure that the outputs match the pre-merger status of the market.

3.10 Figure 3.3 shows how the inputs in the dashed boxed can be calibrated from known pre-merger outputs.

Figure 3.3: Calibrating difficult inputs from pre-merger information



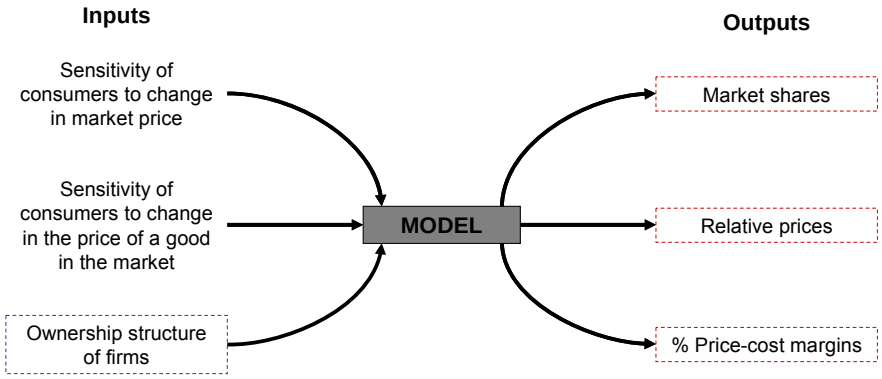
3.11 If we have incomplete information about the pre-merger state of the market then it may not be possible to calibrate **both** price sensitivity input variables. In particular, if we only have rough estimates of price-cost margins that do not accurately distinguish between the equilibrium profitability of different firms then complete calibration of the inputs is not possible. In such cases it is necessary to estimate off-model the unknown input variable on which there is least uncertainty.

Step 2: Predict the effect of the merger

3.12 The effects of a merger can easily be predicted by using the same calibrated input variables, but changing the ownership structure of the firms to reflect the merger. The model simulates the effect of the merger and predicts what the post-merger prices, margins, and market shares would be in equilibrium.

3.13 Figure 3.4 shows how new outputs can be estimated by changing the ownership structure input.

Figure 3.4: Post-merger model inputs and outputs



3.14 The impact of the merger can be observed by comparing the pre- and post-merger market shares and prices. In addition to estimating changes in the relative market shares of each firm the models will estimate any change to aggregate market demand.

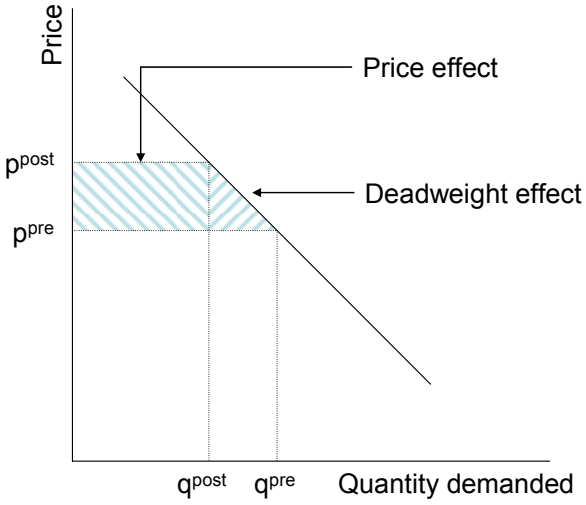
3.15 The models simulate price changes and do not simulate endogenous changes in quality or variety. We are unaware of any models that can numerically predict the impact on quality or variety of a merger with the relatively small amount of information available to the OFT as a first stage authority. However, many of the mergers we find likely to lead to a substantial lessening of competition would have such non-price effects. Where we believe a substantial lessening of competition would lead to a decrease in quality or variety we use price changes as a proxy for welfare changes as a result of non-price effects.

3.16 The impact of the merger consists of two effects:

- The '**price effect**': After a merger in which an SLC has been found, it is likely that the price in the market will increase. Those people who continue to buy products at the inflated price suffer a 'price effect' which is direct financial loss. It is equal to the percentage change in price multiplied by the annual turnover of the post-merger market.
- The '**deadweight' effect**: A number of other consumers will stop buying the good because of the increased price. These consumers lose the utility that they would have gained from purchasing the good at the pre-merger price. The deadweight effect is equal to the price effect multiplied by the percentage change in price, multiplied again by the market elasticity of demand, and finally divided by two.

3.17 Combining the price and deadweight effects gives an estimate of the annual consumer detriment that the merger was likely to have caused.

Figure 3.5: Price and deadweight effects



Step 3: Estimate duration and calculate total impact

3.18 The last element in the calculation is the likely duration of the consumer detriment effect before entry, technological change, or other events remove the anticompetitive effects of the merger. While this has to be estimated on a case by case basis we suggest a default minimum estimate of two years, since if we believed the market would rectify itself quicker we would be unlikely to find a substantial lessening of

competition in the first place.[5] The Federal Trade Commission (FTC) in the US and the Dutch competition authority (NMa) also assume in their estimated impact calculations that markets would rectify within two years.

3.19 We discount future consumer detriment at the Treasury social discount rate of 3.5 per cent per year.

3.20 The models are only able to simulate the 'unilateral horizontal effects' of a merger. These are effects that stem from changes caused by the merger in the response of demand to a price rise by an individual firm. The models do not simulate 'co-ordinated effects', which stem from an increased ability for firms in the market to collude to set price or quality levels; or 'vertical effects', which arise where firms may be able to prevent effective competition by foreclosing access to markets.[67]

Technical description of models

3.21 We have programmed two calibrated economic models for simulating the effects of a change in market structure when products are differentiated. The first is the Antitrust Logit Model (ALM) developed by Luke Froeb and Gregory Werden. The second is the Proportionally Calibrated Almost Ideal Demand System (PCAIDS) developed by Roy Epstein and Dan Rubinfeld. We also have access to a Cournot model, programmed by Gregory Werden, for simulating the effects of a change in market structure when products are homogenous.[8]

---

[5] OFT Substantive Merger Guidance, paragraph 4.23.

[6] Ibid, paragraph 4.11.

[7] Ibid, paragraph 5.1.

[8] "The effects of mergers in differentiated product industries". Werden, Gregory J and Luke M Froeb. Journal of Law, Economics and Organisation. Volume 10, Number 2, 1994. "Merger simulation: a simplified approach with new applications". Epstein, Roy J and Daniel L Rubinfeld. Antitrust Law Journal no 69. 2002.

Models of differentiated products

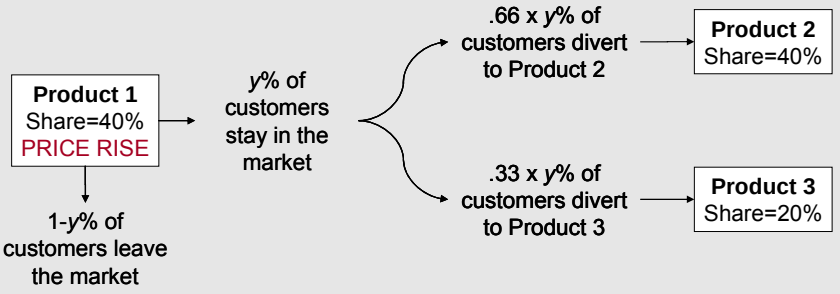
Shared intuition

3.22 Both models are designed to analyse the effect of changes in market structure on Nash Bertrand market equilibria. This is particularly suitable for modelling the unilateral effect of horizontal mergers between firms that sell differentiated products.

3.23 The intuition behind the two models is reasonably similar. To sketch the relationships between firms and products from just a few key variables, they make an assumption about the diversion of demand from one good to another following a price rise. Both models assume that demand lost to a product by a price increase is diverted to other products in the market or sub-market in proportion to their market share. This is often called the Proportionality assumption.

Proportionality Example:

Following a price rise by Product 1 a number of customers stop purchasing the product. Of these, 1-y% customers leave the market altogether and y% customers remain in the market and purchase either Product 2 or Product 3. Proportionality assumes that since the market share of Product 2 is twice the size of Product 3, twice as many customers will divert to Product 2.



3.24 The upshot of the proportionality assumption is that the cross-price elasticity of demand between two firms *i* and *j* is the same for all *i* (formally: $\varepsilon_{ik} = \varepsilon_{jk}$ all $i,j \neq k$). The effect of demand for Product 3 of a change in price of either Product 1 or Product 2 will be identical. Put

simply, it assumes that the only indicator of differentiation between products is their relative market shares.

3.25 In the absence of better information the proportionality assumption seems reasonable. Despite this, the authors of both the ALM and PCAIDS models realised that it was constraining. Sometimes it is obvious that two brands would react differently to a change in price of a third brand despite having similar market shares. For example, the demand for Audi cars might react differently to changes in the price of Mercedes cars than to changes in the price of Skoda cars. This is because Audi and Mercedes are members of the same sub-market, luxury cars.

3.26 Some markets, like cars, appear to contain sub-markets or nests of similarly grouped products. All else being equal, products within a nest are better substitutes for each other than for products in other nests. Nests in the car market, for example, might be superminis, family cars, SUV's, luxury cars, etc.

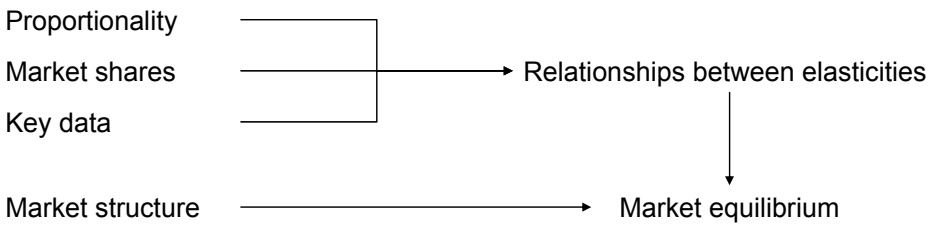
3.27 Both PCAIDS and ALM allow the establishment of nests to relax the proportionality assumption. However, the use of nests comes at the cost of additional data requirements. The level of product differentiation **between** nests needs to be specified. Due to data constraints, at present we do not use nests in our analysis.

3.28 One of the great flexibilities of the ALM and PCAIDS models is that all parameters can potentially be calibrated from other market information, such as firm or brand level price-cost margins.

3.29 Once the economic relationship between firms and products in a market are calibrated, it is relatively simple to calculate market equilibrium given any market structure. By comparing the market equilibrium before and after a change in market structure it is possible to estimate the impact of the change.

3.30 Figure 3.3.6 outlines the intuitive structure of the models.

Figure 3.6: Intuitive structure of models



Differences

3.31 Despite sharing a similar intuitive approach, the two models do make different assumptions about consumer demand. Put simply, all else being equal the ALM model generally assumes that consumer demand is more sensitive to changes in price than the PCAIDS model. This means that, with identical model inputs, firms have a lower ability to profitably increase prices. As such, the ALM model usually predicts lower price changes following a change in market structure.[9]

3.32 The different assumptions on consumer demand also affect how the models are calibrated.

ALM

3.33 The ALM is based on the Logit utility model in which consumers make a discrete choice among a set of alternative products, selecting the product that maximises their utility. The utility that each consumer derives from each product contains a random element:

$$U_{ik} = \alpha_i - \beta p_i + e_{ki} \qquad (2)$$

where

U_{ik} = the utility to consumer k of purchasing good i;

[9] 'Effects of assumed demand form on simulated postmerger equilibria'. Crooke et al. Review of Industrial Organisation volume 15 pp 205-217. 1999.

α_i = some generally perceived quality difference;

p_i = the price of good i;

β = the Logit β coefficient of the sensitivity of the consumer to price;

e_{ki} = an iid error term drawn from the extreme value distribution (this is the randomness part).

3.34 It is possible to derive the Logit β coefficient from market shares, the profitability of one or more of the firms in a market, prices, and the market elasticity of demand. This is the ALM calibration process.

3.35 Since the Logit β coefficient is a description of consumer preferences and is thus theoretically independent of market structure it is possible to calibrate the Logit β in one geographic market and apply it to other geographic markets with different market structures.

3.36 The extreme value distribution of the error term means that the ALM does not predict incredibly high price rises as markets tend to monopoly.

PCAIDS

3.37 The demand function of PCAIDS is very similar to the Almost Ideal Demand System (AIDS). This assumes the following relationship between demand and price for a three good market:

$$s_1 = a_1 + b_{11} ln(p_1) + b_{12} ln(p_2) + b_{13} ln(p_3)$$
$$s_2 = a_2 + b_{21} ln(p_1) + b_{22} ln(p_2) + b_{23} ln(p_3) \quad (3)$$
$$s_3 = a_3 + b_{31} ln(p_1) + b_{32} ln(p_2) + b_{33} ln(p_3)$$

where

s_i = market share of good i;

a_i = 'Quality' of good i;

b_{ij} = cross-price coefficients between goods i and j;

p_i = price of good i.

3.38 Since consumer preferences are never explicitly defined the PCAIDS model is calibrated by selecting an own or cross price product elasticity of demand consistent with a given market structure, market elasticity of demand, and the profitability of one or more firms. Since own and cross-price elasticities of demand are particular to a given market structure it is not possible to calibrate the PCAIDS in one geographic market and use the calibrated estimate of an own or cross-price elasticity of demand in another market.

3.39 The PCAIDS model predicts high price rises as markets tend towards monopoly. These price rises are often hard to intuitively defend and suggest that the PCAIDS model is not ideally suited to modelling mergers to monopoly.

3.40 The lack of a firm grounding in a utility function means that the mathematical formulation of the PCAIDS model is more flexible than the ALM and better suited, both mathematically and practically, to the use of nests in mergers between firms that own multiple competing brands.

Model of homogenous products

3.41 The Cournot model is named after Antoine Augustin Cournot who presented it in 1838. This model assumes that the decision variable for each firm is quantity produced (not price), and that equilibrium is the set of quantities such that no competitor wants to change its quantity, given the quantities set by rivals.

3.42 Like most other models, the Cournot model simulates markets in equilibrium. Since all firms produce the same product the only reason why one firm will sell more than another is that it is more efficient. This means that price-cost margins can be inferred from market share and market elasticity information. Since the products are identical the Cournot model does **not** require an estimate of an own-price elasticity of demand.

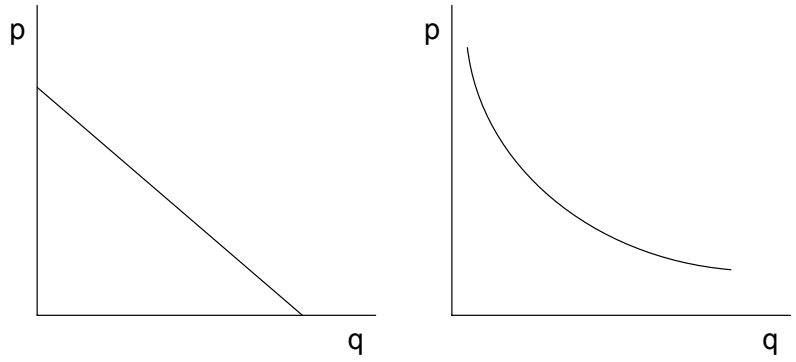
3.43 If larger firms do not have appear to be more efficient than smaller firms then either the assumptions behind the Cournot model do not apply or the efficiency information is inaccurate. The most likely assumptions to be incorrect are: homogenous goods, static market equilibrium, or competition in quantities. In such circumstances ad-hoc adjustments to the model outcomes will need to be made.

Demand and supply functions

3.44 The model we have access to simulate the effect of a merger between firms that produce homogenous goods both under standard linear demand and constant marginal cost assumptions, but also under isoelastic demand or parametric marginal costs.

3.45 The isoelastic demand function assumes that the elasticity of demand stays constant, and is more suitable to markets where demand will never sink to zero. It usually implies larger price increases as a result of a merger.

Figure 3.7: Stylised linear and isoelastic demand curves



3.46 Under standard Cournot assumptions when two firms merge the merged entity acts as if the less efficient of the two firms has ceased operation and the new merged firm continues producing at the marginal cost of the more efficient of the two firms. Under capacity based marginal costs the marginal cost is both increasing in quantity and decreasing in the capital employed by the firm:

$$C_i(X_i) = X_i^2 / 2K_i \quad (4)$$

where

C_i = total cost of producing X units of the good;

X_i = Number of units produced by firm *i*.

K_i = Capital stock of firm *i.*

3.47 Following merger the capital stocks of the two merged firms are joined and the post-merger firm has a lower marginal cost for the same output as either of the pre-merger firms.

Capacity constraints

3.48 The main driver of competition in Cournot models is the number of firms competing in the market. The effect of a merger is to reduce the number of firms, thus decreasing output and increasing price. In effect one of the two merging firms ceases to trade and all the other firms benefit from the decreased competition.

3.49 While margins improve as a result of the merger, because one of the pre-merger firms no longer trades the quantity produced by the two pre-merger firms decreases and the total profit of the two merger firms often decreases. The benefits of the merger are shared with the other firms in the market.

3.50 This poses problems when using Cournot models in merger simulation since in most situations it is unlikely that two firms would merge if they felt the merger would not be jointly profitable.

3.51 Cournot mergers may be profitable if the other firms in the market are unable, at least in the short term, to increase output in response to the decreased output of the merging firms.

Selecting the 'best-fit' model

3.52 Each of the three calibrated merger models available to the OFT is best suited to modelling mergers in markets with certain characteristics.

3.53 The Cournot model is best suited to markets where the goods produced by each firm are near identical (homogenous) and it is reasonable to think of the strategic interaction between the firms to be 'as if' they chose the quantity of production and not price.

3.54 The Antitrust Logit Model (ALM) and Proportionally Calibrated Almost Ideal Demand System model (PCAIDS) are best suited to markets where the goods produced by each firm are differentiated and it is reasonable to think of the strategic interaction between the firms to be 'as if' they chose the price of the goods they sold.

3.55 The PCAIDS model is particularly suited to modelling markets where prior knowledge exists about the relative differentiation between products, though appears relatively unsuited to modelling extreme mergers that lead to only 1 firm being active in a market.

3.56 The ALM model is particularly suited to modelling mergers with localised competition issues due to its ability to model extreme mergers that lead to only one firm being active in a market. It is also suited to modelling local mergers because it is calibrated around a measure of the importance of price to consumers, *B*, which may be assumed to be constant across local markets.

Model specific data requirements

3.57 As discussed in paragraph 3.7, the minimum data requirement for calibrated economic modelling is similar to the minimum requirements for the analysis that informs our actual decisions. However, the different models sometimes require this information to be quantified in different ways.

Market shares

3.58 Some form of market shares information is often available, especially in larger mergers between publicly traded firms. Even where this is not available, an estimate of the relative market shares of the firms in the market is essential for even a qualitative analysis of the mergers impact.

In the absence of better data we propose running calibrated economic models with estimates of market shares from case officers, perhaps to the nearest five percent. All of the models require market share information.

3.59 The ALM is based on a model of discrete consumer choice for products and market shares need to be in terms of quantity. PCAIDS does not model consumer choice directly and simulates the effect of a merger through changes in firms' reaction functions. As such, it requires market shares in terms of revenue.

Market elasticity of demand

3.60 The market elasticity of demand is a quantitative measure of the amount of demand-side substitution away from the goods or services in a market to goods or services outside the market (or to not purchasing any good or service at all). Estimates of the market elasticity of demand are hard to come by, but can be calculated if large quantities of scanner and/or economic data are available. When this information is not available we use a market elasticity of demand for a similar type of market from a 'menu' of publicly derived market elasticity estimates. The range of likely estimates is relatively small and it is often quite easy to see how the particular properties of a market are related to its elasticity of demand. Annex 4.8 provides some empirically estimated market elasticities of demand that case teams can use as a reference.

Own-price elasticity of demand / Logit β coefficient

3.61 The own-price elasticity of demand and the Logit β parameter are quantitative measures of the amount of demand-side substitution **within** the market. They measure the substitution away from a particular branded good or service in response to an increase in price. They are substantially harder to estimate econometrically than the market elasticity of demand, requiring a lot of work and a lot of data. It is also harder to choose the own-price elasticity from a menu since the range of available estimates is quite large and it can be tricky to see how the particular properties of a product are related to its elasticity of demand.

However, calibrated economic models can calculate the own-price elasticity of demand from information regarding the profitability of one or more firms or products in the market, which is more often available. All models of differentiated product markets require an estimate of the own-price elasticity of demand or the Logit β parameter.

Prices

3.62 The ALM requires per-product prices. If prices aren't available then we assume that all prices are equal.

Model specific issues on calibration

3.63 'Calibration' is the process of fitting the pre-merger predictions of the models to available market data. In essence, this involves calculating the input value that we are least sure about (the n^{th} input) from the other input values that we know, or can at least guess (the *n-1* other inputs).

3.64 In some cases there isn't enough information to provide supported estimates of the other *n-1* variables and we are forced to estimate one or two of them. Where we estimate an input we calculate high and low sensitivities to try and capture the practical extent of the uncertainty. We also adopt a policy of linking uncertainty with conservatism: the more uncertain we are of our inputs, the more we err on the side of a number that will produce a low estimate of consumer detriment.

3.65 In Cournot models it is likely that the input we are least certain of is the market elasticity of demand. As such, the best calibration methodology would be to calculate the market elasticity of demand consistent with other known or estimated pre-merger information such as market shares and profitability. It may be that we are more certain of the market elasticity of demand and less certain of the profitability of the firms. The models can provide a sense-check by telling us the profitability that is consistent with our estimate of the market elasticity of demand.

3.66 There are two ways of estimating the market elasticity of demand:

1. **Using multiple estimates of profitability of different firms to estimate the market elasticity of demand.** The lower the market elasticity of demand the easier it is for firms in the market to increase prices without losing demand. This relationship between elasticity and potential profitability can be exploited. However, it is only statistically feasible where we are relatively certain of our estimates of profitability and market shares, and we are sure that the market is characterised by clear and unconstrained price competition.
2. **Selecting an estimate of market elasticity of demand based on qualitative information about the market.** In the absence of reliable other information it is necessary to select an elasticity of demand estimate supported by qualitative reasoning. A discussion of elasticities of demand is given in Annexe A.

3.67 In the ALM and PCAIDS models it is likely that the input we are least certain of is the Logit β coefficient or the own-price elasticity of demand respectively. As such, the best calibration methodology would be to calculate the Logit β coefficient or the own-price elasticity of demand that is consistent with other known or estimated pre merger information such as industry or firm profitability.

3.68 In some cases the only available information that we have is national even though competition is primarily on a local level. In such cases it is necessary to construct a model of competition that best represents the strategic interaction that takes place between the firms.

Modelling geographically differentiated products

3.69 We have not found an easily applicable theoretical economic model for estimating the effect on prices of local mergers between geographically dispersed undertakings. We explore the best way to model local market mergers on a case-by-case basis, and are looking into developing new approaches to the modelling of spatially differentiated products in the future.

3.70 As such, at present we do not use location data when modelling local markets and continue to use market share as a proxy for product differentiation.

3.71 The main practical problem this presents is ensuring consistency between local areas in the model calibration process.

3.72 The ALM requires calibration of the Logit β parameter. One of the properties of the ALM is that the own-price elasticity of demand changes with market structure even if the Logit β parameter stays constant.

3.73 This is helpful when modelling multiple local markets since we only need to calibrate the model once and it will automatically adjust the relevant pre-merger own-price elasticities of demand to fit each of the local market structures, and we have used the ALM for all the locally differentiated mergers we have modelled.

3.74 So far we have performed this calibration in one of two ways:

- Option 1: using the national market to calibrate the models but modelling each local market separately
- Option 2: using a 'representative' local market to calibrate the models, and then modelling each local market separately.

Option 1: Using the national market to calibrate the models

3.75 Ideally we would calibrate β from information about all the local interactions between all the different firms in the market. However, where this information is not available it may be that calibrating against national market shares and margins is a sufficient proxy for an average of the local interactions. This is probably an acceptable assumption to make where each local area has a roughly similar distribution of firms.

Option 2: Using a 'representative' local market to calibrate the models

3.76 Where we do not have information about the national market, or such information is highly unlikely to represent the markets in question, it may

be necessary to calculate the Logit β by calibrating against a 'representative' local market. The representative market should be constructed to best fit any profitability data that we have available.

Non-horizontal unilateral effects

3.77 Two of the available models are primarily designed to simulate horizontal mergers between differentiated product firms that compete at the same location. One of the models is designed to simulate horizontal mergers between homogenous product firms that compete at the same location.

3.78 None of the models are ideally suited to analysis of vertical mergers (such as between a retailer and a distributor), or mergers that involve potential dynamic and co-ordinated effects in the market. These issues are often integral to our analysis of mergers.

Vertical mergers

3.79 We propose applying the models separately to each sector of the supply chain where a substantial lessening of competition is found. Close co-operation with case officers should ensure this approach does not substantially exaggerate or underestimate the alleged affect of the merger. In the absence of a better methodology we believe that this is preferable to the one percent for one year methodology that we previously employed.

Dynamic effects

3.80 Dynamic effects include supply-side repositioning, entry, and innovation. Of these, only entry can be incorporated into a calibrated economic model, and then only indirectly. If case officers feel it is sufficiently important it would be possible to apply ad-hoc adjustments to model outputs to take account of these effects. One way to adjust the models to take account of dynamic effects is to divert from the default assumption of a two year duration for the anticompetitive effects arising from the merger.

Co-ordinated effects

3.81 Calibrated economic models simulate the effect of a merger on the Nash equilibrium pricing decisions of firms. They capture neither the increased chance of collusion nor the effect on price that the collusion might have. Promising academic work on incorporating co-ordinated effects into calibrated economic models is underway but at this stage we have not incorporated it into our models. Again, if case officers feel it is sufficiently important it would be possible to apply ad-hoc adjustments to model outputs to take account of these effects.

4 ANALYSIS

Summary results

4.1 For reasons of commercial confidentiality we are not able to give named case by case results of our analysis. Table 4.1 presents anonymised results from the four cases that we have modelled while first piloting the above methodology and then applying it to some of the UIL's the OFT took during the financial year 2006-2007.

Table 4.1: Case by case results of total consumer savings resulting from OFT intervention as a percentage of annual market turnover

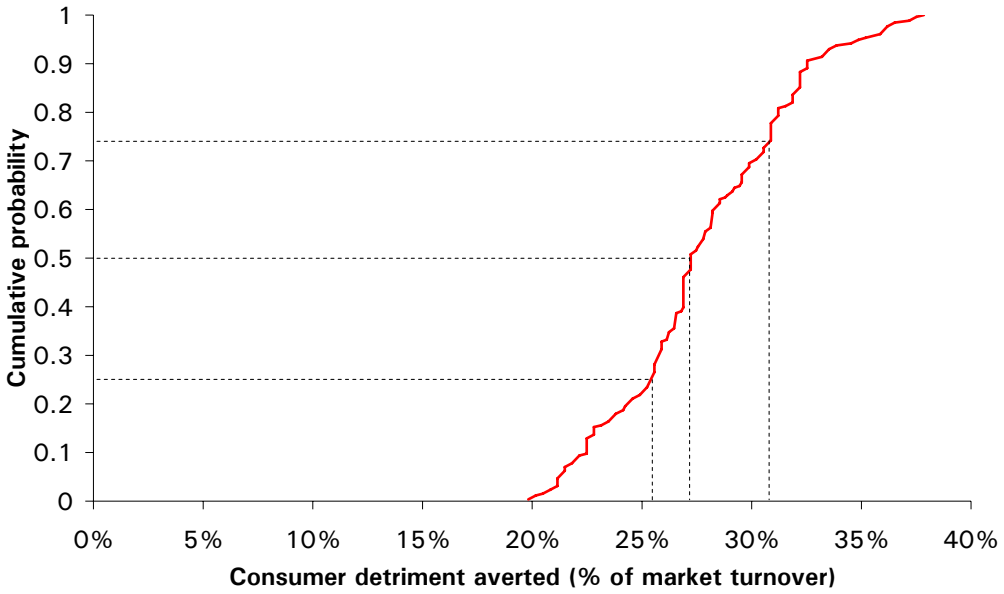
Case	'Low' sensitivity	Best guess	'High' sensitivity
Case A	n/a[10]	40%	52%
Case B	16%	20%	n/a[10]
Case C	11%	14%	30%
Case D	6%	7%	8%

4.2 On average the higher sensitivity is about 50 per cent greater than the best guess and the lower sensitivity is around 25 per cent less. This implies that the upper range of a reasonable estimate is likely to be almost twice that of the lower range. This is a relatively high level of case by case statistical inefficiency.

4.3 If we assume that the probability of the low and high sensitivities being correct is 25 per cent each and that the probability of the best guess

[10] While we tried to find a model variant that worked given the assumptions we were unable to do so. The inability to find a solution suggests that the proposed sensitivity was inconsistent with the other assumptions behind the models such as: the calibration methodology, average profitability, static market equilibrium, or the demand function.

being correct is 50 per cent then we can construct a probability distribution curve of the likely impact of our four sample cases.[11]



4.4 The inter-quartile range from the four aggregated cases is from around 25 per cent to around 31 per cent, with a mean at around 27 per cent. This is a relatively low degree of uncertainty and is acceptable for the purposes of ex-post evaluation. Crucially, however, the increase in accuracy from aggregation is caused by an assumption of a lack of bias.

Bias and consistency

4.5 It is not possible to directly observe the effect of OFT merger control since the effect after the UIL interventions needs to be compared with what might have happened had the intervention not been applied. Imagining what would have happened had the merger taken place is the

[11] The distribution curve is constructed in three steps. First, all the possible permutations of high, medium and low scenarios are ranked in terms of impact. Second, the chance of each permutation occurring is calculated. Third, a cumulative probability curve is constructed by calculating the cumulative probability of an impact equal to or less than each possible permutation.

only way to estimate impact. Adopting merger simulation forces a level of procedural and theoretic consistency between case specific estimates of impact. This consistency is additionally assured by a member of the OFT evaluation team overseeing the modelling process.

4.6 No guarantee can be given of a lack of bias because there is no way to compare our estimates of impact with actual impact: actual impact can not be observed. Understanding this we try to ensure that if our estimates are wrong, they are conservatively low rather than aggressively high. We therefore adopt a policy of linking uncertainty with conservatism: the more uncertain we are of our inputs, the more we err on the side of a number that will produce a low estimate of consumer detriment. This approach is reflected in the asymmetry between our central estimate and our low and high sensitivities.

4.7 In addition, the case specific methodologies and assumptions are discussed with an external academic advisor both before and after the simulations are run.

Fit for purpose

4.8 Our methodology is a work in progress and comments and suggestions on how to improve it, or flaws in the current methodology, are welcomed. However, to the best of our knowledge it is theoretically sound and has proven to be efficient in practice.

4.9 Given the data we usually have available, the economic models we have used are, in our opinion, the best academically supported method for mechanically deriving estimates of the impact of a merger decision for the purpose of impact estimation after a potential Substantial Lessening of Competition (SLC) has been made by the Office.

4.10 Despite the case by case statistical inefficiency of our estimates of impact, aggregating the results of multiple simulations decreases the inaccuracy of estimates of total impact to an intuitively acceptable level for the purpose of ex post impact estimation.

4.11 The use of merger simulation for impact estimation after a potential SLC decision has been made should not be taken as the expression of an opinion, in any way, on the suitability or validity of the use of merger simulation in the Office's substantive decision making process.

A ELASTICITIES OF DEMAND

Concepts

A.1 Demand elasticity quantitatively measures changes in the demand for a good or service, in response to changes in a factor responsible for determining demand. For example, 'income elasticity' would measure the response of the demand for a good to a change in consumers' incomes. The most commonly used demand elasticity is 'price elasticity', the response of the demand for a good to a change in the goods' price.

A.2 Price elasticity comes in several guises, one of which is the 'market elasticity'. This measures the aggregate demand response for all the goods in a market to a change in the average price.

A.3 Two other useful concepts are 'own-price elasticity', which measures the response of the demand for a single good to changes in the price for that good; and 'cross-price elasticity', which measures the response of the demand for a good to a change in the price of some other good.

Estimation

A.4 To estimate an elasticity we first need to specify a demand function. The simplest of these are linear demand functions. Actual estimation requires complex econometric specifications that correct for any potential missing variables. For simplicity in exposition we ignore these complications. Say we have a linear demand function for a market with 2 goods, 1 and 2:

$$Q_{1t} = \alpha P_{1t} + \beta P_{2t} + \chi C_t \qquad (6)$$

Where

Q_1 is the quantity of good 1 demanded
P_1 and P_2 are the prices of good 1 and good 2 respectively
C is a bundle of other factors affecting demand

A.5 The coefficients on P_1, P_2 and C express the effect a change in that variable has on demand, as long as the other two variables are held equal. Thus α measures the own-price elasticity of good 1, while β measures its cross-price elasticity with respect to good 2.

A.6 To estimate market elasticity, we need a new demand function, expressing combined demand for goods 1 and 2 as a factor of average price in the market:

$$Q_t = \phi P_t + \chi C_t \qquad (7)$$

Where

Q_t is the combined quantity of goods 1 and 2 demanded

$P_t = \sigma P_{1t} + (1-\sigma) P_{2t}$, and thereby represents the average market price.

φ thus measures market elasticity.

What elasticity to chose? Some pointers

A.7 Cross-price elasticity can be either negative or positive, depending on whether the goods in questions are complements or substitutes.

A.8 Own-price elasticity is invariably negative. An own-price elasticity of -0.5 would mean that in response to a one per cent rise in the price of the good in question, demand fell by 0.5 per cent.

A.9 Market elasticities have a lower magnitude than own-price elasticities. For example, a rise in the price of Car Brand X may lead many customers to switch to other car brands giving Car Brand X a high own-price elasticity of demand, while consumers are not able so easily to switch away from cars as a whole. Not having a particular brand of car instead of another has a negligible impact on their daily existence. Not having a car of any kind most likely would.

A.10 The table below shows some published estimates for market demand elasticities.

A.11 A market's elasticity becomes more negative as the goods within it become less essential. This is borne out by the table below, which contains some published market elasticities. A more generic market definition will lead to market elasticities of lesser magnitude: the more narrowly-defined Long Haul Leisure Flights market has a much higher elasticity than the International Flights market. Anyone seeking to insert a market elasticity value into one of the simulations could start by considering which of the markets above bears most resemblance to the one they are studying.

A.12 It is important to bear in mind that truly authoritative estimates of market demand are almost impossible to come by, as different researchers will choose different data sets to estimate a market demand function. In their 2004 paper for the Federal Trade Commission,[12] Werden, Froeb and Scheffman discuss modelling the predicted effects of the Sprint-Worldcom merger. In doing so they do not specify an individual value for the market elasticity of long-distance demand, but present the outcomes arising from market elasticity values ranging from -0.5 to -1.5, thus bracketing estimates in the academic literature.

[12] 'A Daubert Discipline for Merger Simulation', Gregory J. Werden, Luke M. Froeb, David T. Scheffman, 2004

Table A.1: Market elasticity of demand estimates

Market	Country	Source	Elasticity	Comments
Prescription Drugs	USA	Phelps, Newhouse (1974)	-0.07	Wide market definition. Very essential good.
Private Car	Australia	Hensher and Smith (1986)	-0.237	Price of car travel measured by price of fuel
Cigarettes	USA (42 states and DC)	Huang, Yang and Hwang (2004)	-0.41	
Intrastate phone carriers	USA	Taylor (1980)	-0.65 (+/- 0.15)	Those wishing to model a telecommunications merger would be advised to bear in mind the massive technological change in communications generally
US Grapefruit	USA	Tang (1980)	-0.74	
Interstate phone carriers	USA	Taylor (1980)	-0.75 (+/- 0.20)	See 'Intrastate Phone Carriers' above
International Flights	USA	Agarwal and Talley (1985)	-0.76 to -0.84	Includes essential business flights: compare with Long Haul Leisure Flights figures
US Grapefruit	Canada	Tang (1980)	-1.26	In the US, there is most likely a higher proportion of US grapefruits than in Canada. Canadians can more readily switch away from US grapefruits than US consumers.
Inland waterway freight	USA	Hauser, Beaulieu and Baumel (1985)	-1.48 to -1.62	Elastic demand: many alternatives available
Long haul leisure flights	UK	Doganis (1985)	-1.5	Elastic demand: non-essential market

A.13 In a 2004 article[13], Epstein and Rubinfeld describe running AIDS, Logit and PCAIDS simulations for the US beer and Toilet Paper markets. All of these simulations use a market elasticity of -1.0. In a 2001 article, the same two authors are more explicit:

> 'Absent independent information about the magnitude of that (industry) elasticity, we suggest an industry elasticity of -1.0 as a good starting point for a preliminary merger simulation.'

A.14 In their aforementioned PCAIDS simulations, Epstein and Rubinfeld specify an own-price elasticity for certain brands. To take an example from each, Budweiser's is -2.5, while Charmin's is -3.5. These own-price elasticities are of far greater magnitude than the relevant market elasticity of -1.0.

A.15 PCAIDS also calculates cross-price elasticities. These should be positive. Epstein and Rubinfeld[14] include a table to highlight the similarities between the average cross price elasticities calculated by PCAIDS, and those calculated in a far more time-consuming way by Hausman and Leonard using econometric techniques, for the US toilet paper industry. A selection of comparisons is shown below:

Table A.2: Cross-price elasticity of demand estimates (tissue)

Brand	PCAIDS	Hausman-Leonard
Kleenex	0.16	0.13
ScotTissue	0.36	0.24
Angel	0.19	0.26
Average	0.27	0.24

[13] 'Technical Report: Effects of Mergers Involving Differentiated Products', Roy J. Epstein and Daniel J. Rubinfeld, 2004

[14] 'Merger Simulation: A Simplified Approach with New Applications', Roy J. Epstein and Daniel J. Rubinfeld, 2001

A.16 A useful table is published by Hausman, Leonard and Zona in a 1994 article,[15] showing own- and cross-price elasticities in the US light beer industry:

Table A.3: Cross-price elasticity of demand estimates (beer)

	Genesee Light	Coors Light	Old Milwaukee Light	Lite	Molson Light
Genesee Light	-3.763	0.464	0.397	0.254	0.201
Coors Light	0.569	-4.598	0.407	0.452	0.482
Old Milwaukee Light	1.233	0.956	-6.097	0.841	0.565
Lite	0.509	0.737	0.587	-5.039	0.577
Molson Light	0.683	1.213	0.611	0.893	-5.841

A.17 As can be seen, cross-price elasticities are of a smaller magnitude and different sign to own-price elasticities. The considerable variation in cross-price elasticities (0.201 to 1.233) is also noteworthy.

[15] 'Competitive Analysis with Differentiated Products', J. Hausman, G Leonard, J.D.Zona, 1994