Supply Side Considerations When Using Conjoint Analysis in Litigation

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Abstract

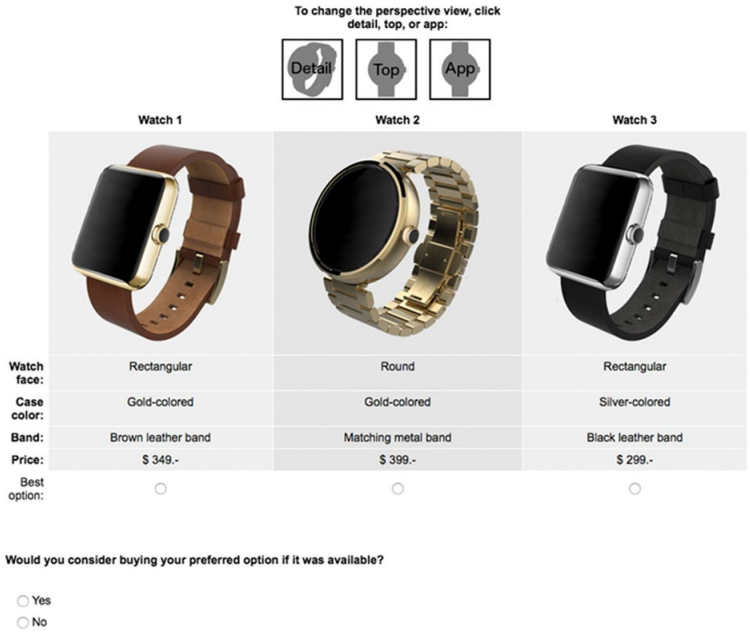
Conjoint analysis is used in patent, copyright, class action, false advertising, and product liability litigation. For over twenty-five years, conjoint analysis has been used to establish that a product or service characteristic (an attribute or attribute level) is important to consumers. Conjoint analysis has also been used to estimate consumers' willingness to pay for an attribute and to estimate how an attribute affects consumers' willingness to buy a product – the "demand side." More controversially, choice-based conjoint analysis is used to estimate the "but for" marketplace price (and profit) when an attribute is either added or deleted. Marketing and economic theory suggests that changes in marketplace prices are based on the interaction of supply and demand, hence many courts have asked experts to consider "the supply side," not just the demand side (the traditional focus of conjoint analysis). This chapter explores the supply side when using conjoint analysis to estimate price premia. Our evaluation includes the two most-commonly cited methods – the price-equilibrium method and the fixed-supply pricing method. After reviewing a representative set of thirty recent court decisions and the science underlying supply-side conjoint analysis, we summarize the conceptual and technical challenges that an expert should address when applying conjoint analysis to supply-side issues. We conclude with a comprehensive set of criteria with which to evaluate the reliability of conjoint-analysis supply-side analyses.

Keywords: conjoint analysis, price premium, supply-side issues, litigation

1. Introduction to the Use of Conjoint Analysis in Litigation

Conjoint analysis is one of the most-popular quantitative marketing research tools used by academics and practitioners alike (Orme 2014). With its roots in new product development, its purpose is to help researchers better understand consumer preferences for products and services. Underlying conjoint analysis is the notion that consumers conceive products as bundles of attributes, often referred to as features. Conjoint analysis "unbundles" these attributes and determines the impact of each attribute on consumer purchase decisions. Choice-based conjoint (CBC) analysis presents consumers with choice sets of product profiles, described by attributes, and asks consumers to pick the profile they most prefer from each choice set. In some formats, an "outside option" is included in the choice set, which consumers can choose if they do not like any of the options, and in other formats ("dual response") consumers indicate whether or not they would purchase the product as described. Figure 1 illustrates one dual-response choice set of three smartwatch profiles, each described by three attributes and price, holding brand and operating system constant.

Figure 1. Example Choice Set for Smartwatches (Hauser, Eggers, Selove 2019, p. 1070)



By asking consumers to compare product profiles and trade off product attributes, conjoint

analysis provides preference data with which to apply statistical models to determine the relative value of a change in an attribute (often called a partworth) indicating how much consumers value attribute changes – often relative to price. The data from conjoint analysis, partworths and an indicator of the magnitude of "error," allow experts to forecast the probability that a consumer will purchase a particular product profile from a defined choice set, which might include an outside option.[1]

Because conjoint analysis enables experts to understand and model how consumers trade off changes in a product's attributes relative to changes in price, conjoint analysis has been used widely in litigation to estimate the value of an attribute change. For example, in a patent (or copyright) case, a technical expert might indicate how the patent enables a consumer-facing attribute and the marketing expert might estimate the value of that consumer-facing attribute relative to that enabled by a non-infringing alternative. In false advertising cases, plaintiffs might allege that a firm promised a higher level of an attribute than was actually delivered to consumers. In such cases, damages might depend upon the amount that consumers value the promised and delivered levels of the attribute.

The role of a marketing expert, who relies upon conjoint analysis, varies. For example, the relative value of an attribute might be an indicator that consumers value the attribute and an economic or accounting expert might use other means to compute damages. In other examples, conjoint analysis might quantify demand and provide quantitative inputs used by the economic or accounting expert. In these cases, conjoint analysis provides "the demand side" and the economic or accounting expert models how firms, not just the at-issue firm, react to the demand side and to one another. Modeling how other firms react, taking competition, product costs, capacity constraints, investment, and/or profit maximization into account has become known as "the supply side." More recently, marketing and/or economics experts have used conjoint analysis data to explicitly model the demand side, the supply side, and their interaction. This chapter focuses on various methods to model the supply side. We highlight

[1] Throughout this chapter, we use "consumer" recognizing that some cases involve B2B products ("customers").

considerations in the application of CBC with supply-side models and provide a list of criteria to which the expert should attend (§9).

Damages in litigation are often based on the comparison of two scenarios, called "worlds." The baseline is the "as is" world. This is the scenario that is actually observed. For a patent case, it might be the marketplace in which the (allegedly infringing) patent enables a higher level of an attribute(s). In a class action or false advertising case, the "as is" world might be the marketplace in which a higher level of an attribute(s) was (allegedly) advertised (or otherwise communicated) than the level that was delivered or a situation in which a defect was not disclosed. By definition, the supply side is inherent in the "as is" world because prices, quantities sold, and attributes are as observed and the result of profit-maximizing market forces. The "but for" world is what would have happened had the plaintiff not acted as alleged. In a patent case, the "but for" world reflects attributes, prices, quantities, advertising, etc. that would be set in the marketplace had the patent not been infringed and, instead, had the offered products contained the best non-infringing alternative. Damages arising from the infringement can be based on comparing the "but for" to the "as is" world. Damages might include lost profits to the plaintiffs, restitution to consumers (benefit of the bargain cases), or other theories of damages.

Case law recognizes that it would be impossible to model absolutely every aspect of the marketplace because data are limited and "but for" predictions are imperfect because attempts to model phenomena might introduce other errors or sensitivities. "A defendant should not be permitted to profit on the basis that calculating damages may be theoretically challenging (Chen 2018, p. 23)."[2] The expert is asked to make informed decisions, based on the expert's experience and training and the scientific evidence, about what is to be modeled explicitly (both on the demand and supply side) and

[2] See also *Frank Music Corp. v. Metro-Goldwyn-Mayer, Inc.* 772 F.2d 505, 513 (9th Cir. 1985) as quoted in Chen (2018, p. 23). "Where it clearly appears that a party has suffered damage, a liberal rule should be applied in allowing a court or jury to determine the amount; and that, given proof of damage, uncertainty as to the exact amount is no reason for denying all recovery. …"

what is to be approximated. In short, the expert is asked to make informed tradeoffs when modeling the "as is" and the "but for" worlds.

In this chapter, we focus on supply-side considerations. The best method of modeling the supply side will depend upon the circumstances of the case, the theory of the case, case law, and the role of the conjoint analysis expert. We seek to lay out the issues and sensitivities that should be considered when using one of the supply-side methods. We believe that each of these issues should be considered for a valid supply-side application, with the experts deciding which are most critical and which are not. We recognize that some experts will cite these issues to support the use of conjoint analysis in supply-side modeling and other experts will cite these issues to critique the use of conjoint analysis in supply-side modeling.

2. When Damages are Based on Supply-Side Modeling

The earliest use of conjoint analysis in litigation of which we are aware was the use in 1994 of Casemap (Srinivasan 1988) by an expert for the defendant in *Lotus Development Corporation v. Borland International*. The expert sought to value a feature of Borland's spreadsheet software that enabled consumers to use Lotus' menu system.[3] By 2005, choice-based conjoint analysis (CBC) began to be used and figured prominently in a 2006 light cigarette case.[4] Since then, the use of conjoint analysis in litigation has become common and, in particular, the application of what the courts deem "supply side" modeling.

For this chapter, we reviewed thirty publicly available cases that represent the range of cases in which supply-side issues in the use of CBC were addressed. The Appendix lists and provides citations to all thirty cases. When publicly available materials allowed, we observed the reasoning that experts on

[3] *Lotus Development Corporation v. Borland International, Inc.* Case No. 516 US 233. United States District Court, District of Massachusetts, filed July 2, 1990.

[4] Applied in *TiVo v. Echostar et al.* Case No. 2-04CV-01 (Judge Folsom). United States District Court, Eastern District of Texas, Marshall Division. *Barbara Schwab et al. v. Phillip Morris et al.* Case No. 04-CV-1945 (JBW)(SMG), United States District Court for the Eastern District of New York.

both sides used with respect to supply-side modeling, including whether supply-side modeling would be required. In most cases, the courts offered opinions on the admissibility of the arguments and on the weight they afford to these arguments. Whenever the experts differ, we rely on the court opinions. Although we are personally involved in many more cases that involve conjoint analysis, we refrain from quoting any materials that are not publicly available.

Because the burden of proof is generally on the plaintiffs, the vast majority of cases involve CBC studies offered by the plaintiffs. In many cases, the CBC expert seeks to determine the monetary value of an attribute that was promised but was not provided to the consumer (benefit of the bargain). For example, in *In re General Motors LLC Ignition Switch Litigation*, the court defined benefit of the bargain. "As the Court will explain, each Bellwether State measures benefit-of-the-bargain damages in cases like this one as the lesser of the cost to repair the defective vehicle or the difference in market value between the vehicle as bargained for and the vehicle as it was actually sold."[5] In *Maldonado v. Apple* the court stated: "The `benefit of the bargain' is `the difference between the actual value of what plaintiff has received and that which he expected to receive.'"[6]

A second approach is a restitution framework in which the expert seeks to determine the monetary value of a product in absence of the product attribute at issue, and compares that value to the product's price paid by the consumer. If the consumers' valuation of a less-attribute-equipped product is below the purchase price, the expert can assume in the "but for" world that the consumer would not have purchased this product at the "as is" price. If the consumers' valuation of the less-attribute-equipped product is above the "as is" purchase price, the expert can assume the consumer would have purchased the product at the "as is" price, or perhaps a lower price, in a "but-for" world.

[5] "Opinion and Order," *In re GM LLC Ignition Switch Litigation*, 14-MD-2543 (JMF), United States District Court for the Southern District of New York, August 6, 2019, p. 42.
[6] "Order on Motion to Decertify the Class, Motions to Exclude," *Maldonado v. Apple*, Inc., 3:16-cv-04067-WHO, United States District Court for the Northern District of California, May 14, 2021, p. 22.

In other cases, the expert seeks to determine or provide input to the difference in profits between the "as is" and "but for" worlds. This difference can be the plaintiff's lost profits "but for" the patent infringement or copyright violation or it can be disgorgement of the defendant's unfair profits due to the patent infringement or copyright violation. CBC attempts to isolate the differences in profits between the "as is" and "but for" worlds due to a change in a product's attribute. CBC has also been used to argue that the attribute, or lack thereof, affects purchasing of the entire product in what is known as the nexus of demand.

In some cases, supply-side issues are not addressed because the CBC study is not used to provide a quantitative measure of the value of the attribute. These cases include Apple v. Samsung (2012), class certification for light cigarette smokers in *Schwab v. Phillip Morris*, In the Matter of *Determination of Royalty Rates for Digital Performance*, and *Qualcomm v. Apple*. For example, in *Apple v. Samsung* (2012, 1846 case), CBC was used to manifest the mere fact that consumers value a particular attribute; although the CBC expert presented willingness-to-pay calculations to the jury as an indicator of attribute value, an economist determined damages using other means that did not rely on the results from the CBC analysis.

In other cases, the courts have recognized that market prices are determined by the interaction of supply and demand and have opined that, while CBC studies model the demand side, price premia should also be based on supply side modeling. For example, in *In re NJOY* the court cites that "[the expert's] methodology completely ignores the price for which NJOY is willing to sell its products, what other e-cigarette manufacturers say about their products, and the prices at which those entities are willing to sell their products."[7] In *Saavedra v. Eli Lilly*, the court cites that "Plaintiffs' theory of injury is distinct from the typical benefit-of-the-bargain claim because it focuses only on the demand side of the

[7] "Order Denying Plaintiffs' Motion for Class Certification," *In re NJOY Consumer Class Action Litigation*, 14-00428 MMM (JEMx), United States District Court for the Central District of California, August 14, 2015, p. 45.

equation, rather than on the intersection of supply and demand."[8]

Defendant experts often cite the need to model a price equilibrium in which the at-issue firm changes its "as is" price in the "but for" world and competitors react until an equilibrium price results. *Price v. L'Oreal* matter appears to be the only publicly available example of which we are aware where the expert explicitly computed an equilibrium price model that allows such dynamic reactions by firms in the but-for world.[9] In the remaining cases, supply-side factors are either not implemented by the CBC expert, or are claimed to be accounted for in a fixed-supply-pricing approach that we describe in §7. Some experts claim it is sufficient to reflect supply-side factors though either the use of market-realistic price ranges when describing the products profiles, or by computing damages relative to the observed prices and sales in the "as is" world.

Examples of these fixed-supply-pricing (FSP) arguments include *Hadley v. Kellogg Sales*, *In re General Motors LLC Ignition Switch Litigation*, *In re MyFord Touch*, *Krommenhock v. Post Foods, LLC*, *Passman (Fishon) v. Peloton Interactive*, and various others. In these cases, rebuttals critique an insufficient consideration of supply side factors, arguing that, without determining how the relevant set of competing firms would adjust prices and quantities produced based on the interaction of demand and supply, the resulting price premia are not a reliable representation of the product's price in the "but for" world. Some courts have sided with the rebuttal arguments to exclude the CBC studies that rely on an FSP assumption (e.g., *In re GM Ignition Switch litigation*), or opined that the analysis had little weight (e.g., *Vizcarra v. Unilever; Zakaria v. Gerber*.) [10] Other courts have permitted the use of an FSP

[8] Order Denying Plaintiffs' Motions for Class Certification Pursuant to Federal Rules of Civil Procedure 23(b)(3) or 23(c)(4)," *Saavedra v. Eli Lilly & Co.*, 2:12-cv-9366-SVM (MANx), United States District Court for the Central District of California, December 18, 2014, p. 4.

[9] The court granted the defendants' motion to exclude the CBC expert in this case, but for reasons of "craft" unrelated to the supply-side arguments (Schofield 2020, p. 9).

[10] Example comments include: "The Court has found no case holding that a consumer may recover based on consumers' willingness to pay irrespective of what would happen in a functioning market (i.e. what could be called sellers' willingness to sell, *In re GM Ignition Switch litigation*); " "the opinions of [the expert] which *Vizcarra* relied upon to support […] motion for Class Certification have no persuasive value in the context of class certification analysis, because [the expert] did not specifically test […] whether consumers paid any price premium attributable

assumption (e.g., *In re Dial Complete, In re Lenovo Adware Litigation, Fitzhenry-Russel v. Dr. Pepper Snapple, Hadley v. Kellogg Sales, Maldonado v. Apple, Krommenhock v. Post Foods LLC)*.[11] In other cases, courts have allowed an FSP assumption for mislabeling cases, but not "where the alleged misrepresentations and omissions concern dangerous defects (Furman 2019, p. 55)." See also Bashant (2019, p. 5).

Overall, we observe a trend toward the discussion of supply-side issues in cases that involve CBC studies. Plaintiffs' experts, defendants' experts, and triers of fact all seem aware that it is important to consider supply-side issues even as they disagree on how the supply-side issues are to be modeled. Our goal is not to endorse any particular approach to supply-side modeling, but rather to highlight the issues and provide a set of criteria that a CBC expert should consider. We provide a list of issues that should be addressed by any CBC expert who seeks to undertake or critique a CBC study done for litigation. We begin by reviewing demand-side (willingness to pay) and supply-side modeling.

3. Demand Side (Willingness to Pay, WTP) vs. Supply Side Modeling

CBC assumes that the utility consumers derive from the attributes of a product is a linear sum of the product's attribute levels minus a (usually linear) function of price. The key outputs of CBC are

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to [the] alleged misrepresentations (*Vizcarra v. Unilever*)."; "Based on [the expert's] completed analysis, and Defendant's objections, it does not present a reliable method for determination of the price premium. It does not reflect the actual difference, if any, between the amount paid for Good Start Gentle and its value in the market. Specifically, Plaintiff has failed to show that the methodology employed by [the expert] sufficiently accounted for the actual price of Good Start Gentle, or the market conditions in which that product was sold. The conjoint analysis is not sufficiently tethered to actual market conditions, including pricing and premiums (*Zakaria v. Gerber*)."

[11] Examples include: "The number of products Dial sold with the offending claims is known (or can easily be calculated). Those products were sold at a price determined by the intersection of demand and supply in the actual market. (*In re Dial Complete*)"; "[the expert's] proposed conjoint analysis (1) utilizes prices that `mirror[] those actually observed in the market' and that are `based on actual sales data,' Gaskin Decl. at 12; and (2) holds quantity constant—by using the quantities of the challenged products that were actually sold during the class period (*Hadley v. Kellogg Sales*)."; "Per plaintiffs, the conjoint survey "was performed in a market that is long-established and efficient, where retailers' pricing is responsive to market forces," and that it took into account the fixed quantity of supply of Canada Dry because those sales occurred in the past. Therefore, it does appear that plaintiffs calculated the price premium consumers paid for the "Made from Real Ginger" claim, and not just a theoretical willingness to pay. The price premium study therefore passes muster under Daubert and Federal Rule of Evidence 702 (*Fitzhenry-Russel v. Dr. Pepper Snapple*)"

estimates of the weight of changes in the attribute levels, called partworths, and the weight of price. In some formulations the price coefficient is normalized to 1.0. In other formulations, researchers allow the price function to be non-linear. CBC uses the partworth estimates to calculate (1) the consumer's utilities for each product in the relevant choice set and (2) the probability that a consumer chooses each product under the conditions specified for the "as is" and "but for" worlds. Utilities are assumed to be measured with error; the relative magnitude of which is dependent upon the details and craft of the CBC study.[12]

Most CBC analyses in litigation use hierarchical Bayes (HB), which estimates a distribution over the partworths to represent heterogeneity across consumers. Heterogeneity is modeled by sampling from either the hyper-distribution of parameters or from sets of individual-consumer distributions of the parameters – the latter being more common. For simplicity of exposition, we consider one set or "draw" of partworths, recognizing that the expert will "integrate" over all draws.

We simplify the mathematical exposition further by considering attributes that are aspects—the product either has the attribute or it does not (Tversky 1972). All concepts discussed in this section extend readily to practical applications where the attributes have many levels and experts evaluate the differences in the levels of attributes. Our notation uses the McFadden (2014) specification where we set the price coefficient to 1.0 and define the "scale" of the utility function by a multiplicative factor, γ_i, for each consumer i. Technically, scale is the inverse of the standard deviation of the error term (Swait and Louviere 1993). Larger scale means forecast probabilities of choice are closer to 0 or 1 and more sensitive to changes in attributes or price. Other specifications include Sonnier, Ainslie, and Otter (2007) who normalize the price coefficient to 1.0 and estimate $\mu_i = 1/\gamma_i$ and Allenby et al. (2014a) who allow a price coefficient η_i and normalize scale to 1.0. Although maximum-likelihood estimation provides

[12] Because utility is unique to a positive linear transformation (Train 2009, p. 27), the partworths, the price coefficient, and the magnitude of the error cannot all be independently identified; the interpretations of the coefficients depend upon how the CBC model is specified.

identical estimates for the partworths and price coefficients for all three specifications, different specifications can provide different partworth and price coefficients when using HB (Sonnier et al. 2007). Salisbury and Feinberg (2010) and Swait and Louviere (1993) discuss how the variation in scale among consumers presents issues when interpreting partworths in specifications where scale is not isolated—issues beyond the scope of this chapter.

In the McFadden specification, the price coefficient is normalized to 1.0 recognizing that utility is unique to a positive linear transformation. The consumer's utility for product j, u_{ij}, is given by:

$$u_{ij} = \sum_{k=1}^{K} \beta_{ki}\delta_{kj} - p_j + \epsilon_{ij} \quad (1)$$

where β_{ki} is the partworth of attribute k for consumer i, δ_{kj} indicates whether or not product j has attribute k, p_j is the price of product j, and ϵ_{ij} is an error term. There are K attributes. Each consumer has a utility for the outside option, u_{io}.

In the McFadden specification, the probability that consumer i purchases product j from a set of J products, P_{ij}, is given by:

$$P_{ij} = \frac{e^{\gamma_i u_{ij}}}{\sum_{\ell=1}^{J} e^{\gamma_i u_{i\ell}} + e^{\gamma_i u_{io}}} \quad (2)$$

In the Allenby et al. specification, "scale" is subsumed in the partworth and price coefficients. Specifically, for the Allenby et al. specification, $\beta_{ki}^{A} = \gamma_i^{M}\beta_{ki}^{M}$ for attribute partworths and $\eta_i^{A} = \gamma_i^{M}$ for the price coefficient where the A and M superscripts indicate the Allenby et al. and McFadden specifications, respectively.[13]

3.1. Consumers' Willingness to Pay (WTP)

[13] Experts often use "monotonicity constraints" to assure that lower prices are preferred to higher prices. Such constraints may improve the accuracy of the estimation. Allenby et al. (2014a, p. 438) specify γ_i as $\exp(\eta_i)$ to assure positivity, but doing so risks an explosion in the sampled γ_i. This specification may also create a mass of coefficients that are very close to zero, which has implications for WTP calculations (§6.2). Allenby et al. mitigate this problem by changing the Bayesian priors. In practice, there is controversy with respect to which methods are most effective for monotonicity constraints (Johnson 2000).

WTP is the maximum amount a consumer would pay to add a (binary) attribute to the consumer's existing product. For example, a consumer might be willing to pay $150 to upgrade the current iPhone from 128 GB of memory to 256 GB of memory. Because a $150 WTP is above the $100 that Apple charges to upgrade the 2023 iPhone, we would predict that this consumer would upgrade the iPhone. If a consumer's WTP were below $100, we would predict that the consumer would not upgrade. Clearly, WTP is not the market price and, in most circumstances, WTP varies among consumers. Memory upgrades have market prices, but most attributes do not, hence experts use the CBC partworths to estimate each consumer's WTP.

The McFadden specification normalizes the price coefficient to 1.0 so that the β_{ki}'s are the WTPs. In the Allenby et al. (2014a) specification, WTP can be calculated for each consumer (actually, for each draw in HB whether from the hyper-distribution or consumer-level posterior distributions) as the partworth of the attribute divided by the price coefficient. In this interpretation, WTP is a demand-side only estimate. Supply-side considerations are not included directly.[14]

For HB CBC, there are challenges.

Large WTPs. Because both inputs to WTP – the partworth and the price coefficient (Allenby et al. specification) – are sampled, WTPs calculated using HB vary over respondents, or the distributions of WTP vary over samples from the hyper-distribution. Instances of sampled WTPs can be quite large or even negative; even expectations over samples for each consumer can be large or negative. If the sampled price coefficient is close to zero, sampled WTP estimates can be in millions of dollars.[15] If a

[14] Allenby et al. (2014a, eq. 2.11) advocate an alternative definition of WTP that rolls the supply side into the definition. Their proposal is based on social surplus as the "amount of income that will compensate for the loss of utility obtained from" not having the attribute in the product. Their alternative measure is explicitly dependent upon the standard deviation of the error term and likely highly sensitive to the craft of the CBC study (§4.3, §6.5). Unlike in the demand-side interpretation of WTP, the standard deviation of the error term in Eq. 2.11 does not directly cancel out. The only use of the Allenby et al. measure of WTP seems to be by an expert in *Price v. L'Oreal*. That expert testimony was disqualified for other reasons.

[15] Using the plaintiffs' expert's CBC data in *Macdougall et al. v. American Honda Motor Co. Inc.* et al., an expert for the defendant calculates that the data imply that one respondent would be willing to pay more than $10 million

consumer uses price as a quality indicator and reacts positively to price increases, at least within the observed price range, the consumers' WTPs will be reversed and appear to be counterintuitive.

Craft. Measured WTPs vary depending the quality of the market research (craft), including decisions by the expert on incentive alignment vs. no incentive alignment, realistic stimuli vs. text-only, dual-response vs. one-shot outside options, types of instructions, animations, and focalism issues. We discuss craft issues further in §4.

Interactions. There might be empirical interactions among attributes (e.g., the WTP for an increase in the memory for a smartphone might depend on the availability of cloud storage services) or the empirical price response might be nonlinear as in Prospect Theory (Kahneman and Tversky 1979). Both phenomena require modifications in Equation 1 and imply that WTP is also dependent upon the level of the other attributes and the price of the product in the "as is" world and/or "but for" worlds.

Target population. WTP varies by the target population from which the expert draws a respondent sample. In patent, copyright, or false advertising cases, only those consumers who actually bought the product are "damaged." For example, in the 2012 *Apple v. Samsung* (1846) case, because WTP was used as an indicator of value and not used directly in damages, the expert sampled only consumers who had bought Samsung phones—thus focusing on only damaged consumers and alleviating the practical problem of requiring a large number of brand-specific constants to model the choices among different brands.[16] When it is important to model the impact on all consumers in the marketplace, as in most supply-sided models, the expert should aim to sample from all consumer

for a car without the alleged defect and another respondent would pay approximately $3 million more for a car with a defect. We have seen similar examples in other cases.

[16] Plaintiffs later used the conjoint analysis data to argue for a permanent injunction of all infringing Samsung smartphones. The permanent injunction required that the conjoint analysis establish that the attributes were a nexus of demand for the product rather than just for the infringing attributes. The series of judgments for and against this argument are beyond the scope of this chapter, but the courts ultimately decided that supply-side issues are necessary for a nexus of demand. The CBC study was judged sufficient for WTP as used in trial, but not for the nexus of demand as used to argue for a permanent injunction.

segments and consumers who bought both the at-issue product and competitive products. Sampling affects the interpretation and use of the demand- and supply-side models because we expect that consumers who purchased a product with the at-issue attribute might value that attribute more than consumers who did not purchase a product with the at-issue attribute.

Metrics to summarize WTPs. Experts are asked to summarize the WTPs for the relevant consumers. Averages are sensitive to outliers in partworths and scale that imply very large WTPs.[17] This is particularly acute in the Allenby et al. specification where WTP_i is the ratio of a partworth divided by the price coefficient, η_i. The Allenby et al. price coefficient, η_i, is numerically equal to scale, γ_i, in the McFadden specification. These large WTPs are often outside the range of the prices presented in the CBC profiles and, hence, violate the scientific principle of not extrapolating beyond the range of the data. At best, without extrapolation, the data only indicate that the WTP is above (or below) the range of the data – an inequality datum. To avoid extrapolating beyond the range of the data, many experts report medians rather than means or use a two-profile simulation in which only the attribute of interest and price vary. For example, one product might have the at-issue attribute and the marketplace price while the other product might <u>not</u> have the at-issue attribute and a (presumably) lower price. The simulator is used to determine the price of the reduced-attribute product that implies equal market shares for the two products.[18] The difference in the "as is" price and the reduced-attribute-but-equal-share ("but for") price is an estimate of the market's WTP. In practice, this simulation is driven by the median consumer and the resulting WTP is numerically close to the median.[19]

Experts use WTP in many ways. The courts have accepted testimony where WTP is used only to

[17] Explosion in partworths is mitigated when sampling from the hyper-distribution, but explosion remains an issue. Because the γ_i vary, it is not appropriate to define WTP as the average partworth divided by the average price coefficient (Salisbury and Feinberg 2010; Swait and Louviere 1993).
[18] If there were no outside option, then each product would have a 50% share of the market.
[19] Although rarely used in litigation, willingness to accept (WTA), the amount a consumer would accept to sell the product or not use a service could be used for goods that do not have a purchase price but rely on other revenue streams, e.g., digital platforms (Brynjolfsson, Collis, Eggers 2019), It differs empirically from WTP (Sunstein 2020).

demonstrate that consumers value the attribute (and rely on other means to compute damages (Cameron, Craig, and McFadden 2013). In *Apple v. Samsung* (2012, 1846 case), the damages expert did not use WTP directly; the role of the marketing expert was to provide an intuitive measure that the attributes were valued (Koh 2012, p. 14).[20] In *Schwab v. Phillip Morris*, the expert provided evidence that most, but not all, consumers value "health" (Law.com 2006).[21] WTP might be used qualitatively by comparing the at-issue attribute to an attribute with a known market price (memory in smartphones) in a hypothetical reasonable royalty negotiation.[22] The damages expert might cite the CBC study if the at-issue attribute has a measured WTP above the WTP for memory, arguing that that market price of the at-issue attribute would be above the market price of memory.[23] These applications of WTP depend less on the actual value of the estimated WTP and have the advantage that they are less sensitive to the issues in §§4-6. WTP is also used as a demand-side input to supply-side models.

3.3. Considering the Supply Side to Estimate Price in the But-for World

Depending on the theory of the case, CBC and WTP might be used as inputs to forecast the difference in profits between the "as is" and "but for" worlds. For example, plaintiffs might seek to disgorge unjust profits obtained from delivering a promised attribute by infringing on a patent.

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[20] In a subsequent *Apple v. Samsung* (2014, 630 case) case, the expert used willingness-to-buy (WTB) rather than WTP. In a WTB calculation, the predicted choice probability in a "but for" simulation is compared to the predicted choice probability in an "as is" simulation. Because, structurally, the logit model includes an error term, consumers who are known to have purchased the at-issue products (choice probability observed to be 1.0) have a predicted choice probability less than one. To account for this issue, the difference in choice probabilities is divided by the predicted choice probability in the "as is" world. This normalizes the "as is" probability to 1.0. WTB mitigates many of the issues with craft and provides an heuristic to account for competition. However, like WTP, WTB does not explicitly model the supply side. Courts have accepted WTB as a means to estimate damages (Koh 2014).

[21] Weinstein (2006) opines that "The survey of the plaintiffs' expert […] attempts to fix – within acceptable limits – the percentage of "light" smokers for whom health was a significant contributing factor to the decision to smoke "light" cigarettes."

[22] Damages can be determined in a patent case based on a reasonable royalty that would have been negotiated between the two parties, often subject to what has become known as the Georgia-Pacific factors, e.g., https://www.ipglossary.com/glossary/georgia-pacific-factors/.

[23] The technical issues pro and con relative to this use of WTP is beyond the scope of this chapter. However, we note that at least one decision argues that WTP alone cannot apportion value quantitatively because it does not establish a price that consumers would pay for the patented features and the non-patented features (Borman 2016).

Alternatively, class action plaintiffs might seek to "make the class whole" by recovering the difference in the price paid based on the undelivered attribute versus the price the class members would have paid had they known the product did not contain the promised attribute. Whether the metric of interest is the difference in profits or the difference in price paid, the CBC expert is asked to compare the "as is" marketplace price to the forecast "but for" marketplace price. The supply side is relevant for modeling prices in the marketplace – an interaction of supply and demand.

Price and sales are observed in the "as is" world and are true by historical record. However, when predicting the price and quantities sold in the "but for" world, the expert should decide whether and how to model how firms will adjust prices and quantities produced based on the interaction of demand (WTP) and the firm's ability to supply products. WTP can be an input to supply-side models, but WTP alone is not a supply-side model.

Predictions are complicated further because all competitors in the relevant marketplace are (potentially) affected by the difference between the "but for" and "as is" worlds. Each competitor might consider changing its price, and hence quantity sold, in response to the difference. These potential changes will, in turn, affect other competitors. It is not sufficient to consider competition via the outside option, which typically does not specify competitors' prices. The expert's task is to approximate how all of the actions and reactions play out to converge to marketplace prices and sales.

There are two common approaches which we label the price equilibrium method (PEM) and fixed supply pricing (FSP). PEM calculations use an analytical method to calculate the (Nash) equilibrium prices that would result if the CBC model accurately described how all consumers would respond to changes in products' attributes and prices. The PEM is based on modeling each firm's profit-maximizing competitive reaction (Allenby et al 2014a & 2014b; Eggers, Hauser, and Selove 2016; Hauser, Eggers, and Selove 2019, Selove 2010, Selove and Hauser 2010). Experts using these methods might also consider equilibrium changes in attributes, marketing, or other firm actions. There are many practical

and theoretical challenges with PEM calculations as discussed in §§4-6.

Because the challenges of applying PEM calculations (§§5-6) might make PEM calculations unreliable, some experts have approximated the supply side with FSP calculations. These experts cite that the "as is" prices and quantities sold are known as a matter of historical record. The experts assume that the supply curve does not change (substantially) in the "but for" world and focus on modeling the "but for" demand curve which might be depressed by the lack of the infringing patent or copyright or by the lack of the promised attribute. In cases where the change in profit is estimated, the experts claim to calculate the new equilibrium price based on the depressed demand and unchanged supply. FSP computes the highest price in the actual market at which the at-issue product would have "sold the same number of products without the challenged claim" and "would seem to capture the full measure of damages suffered by consumers who actually bought the allegedly misrepresented product (McAuliffe 2017, p. 10)."

We describe the details of FSP and discuss the issues with FSP in §7, but basically the price premia are calculated with a simulation that is either extremely similar to or the same as the two-firm simulation used to compute WTP. As a result, FSP price premia are approximately equal to median WTPs. FSP methods do not explicitly model how the prices and quantities of competitive firms change in the "but for" world, nor do they account for other actions that competitive firms might take.

4. The "Craft" of the CBC Has a Major Impact on the CBC Expert's Opinions

By "craft" we refer to the detailed decisions by the CBC expert when collecting data during a CBC study. Craft includes characteristics such as the realism with which attributes and profiles are presented to consumers, whether or not consumers are given incentives to answer truthfully, and the detailed wording of the instructions (the meaning of the choice sets, what is not varied in the choice sets, what it means to choose the outside option). Craft includes whether or not the survey itself highlights a particular attribute (focalism) and whether consumers understand "price" as used in the

product profiles. For example, price is not a simple construct when the product is bundled with other products, subsidized (e.g., lower cost smartphone with a service contract), part of a family plan, available at a reduced introductory price, or split into a multi-part tariff. Experts should address whether the "price" in the product profile addresses these issues and if the consumers understand how "price" is to be interpreted. Craft includes steps to identify and eliminate inattentive respondents with instructional manipulation checks (IMCs, Oppenheimer, Meyvis, and Davidenko 2009), steps to eliminate "bots" and respondents from questionnaire farms, and other issues that might add error or bias the data. Craft might include seemingly minor decisions such as the number of profiles in a choice set, the number of levels or attributes presented to consumers, whether the outside option is presented as part of the choice sets or in a "dual response" format—all of which have been shown in the academic literature to affect the accuracy with which consumers evaluate product profiles (DeShazo and Fermo 2002, Meissner, Oppewal, and Huber 2016, Orme and Hewett 2023, Wlömert and Eggers 2016).

Typically, the courts have opined that craft goes to weight in a conjoint analysis rather than exclusion of the study, but the effect of craft might be much larger than is commonly understood. Craft goes directly to the reliability of the CBC study. Our data suggest that craft has a substantial effect on forecast WTP, price, and profit. For example, Hauser, Eggers, and Selove (2019, p. 1059) argue that "image realism and incentive alignment affect scale sufficiently to change strategic decisions and affect patent/copyright valuations by hundreds of millions of dollars."

Clearly, higher-quality craft is to be preferred to lower-quality craft where higher quality might be realistic images, incentive alignment, carefully worded instructions, appropriate IMCs, and relevant prices. But does craft matter? For example, if an expert were to use highly-realistic images to describe products (close to how the products appear in the marketplace) rather than the standard text-only format, will the expert's key opinions (WTP, "but for" price, "but for" profit) change? If a difference in craft changes an expert's opinions, is the difference small enough to ignore or is the difference

sufficiently substantial to affect the reliability and validity of the expert's opinions? Further, what is the relative impact of craft? Do differences in craft affect expert opinions more or less than differences in whether and how the expert models the supply side?

4.1. Craft Matters

Craft matters in at least two ways. First, craft affects the partworths relative to one another and relative to price. These effects impact the reported WTP. Secondly, craft affects the error term and hence the scale parameter (γ_i). Because the implied sensitivity of profit to price is directly proportional to scale (and indirectly through the choice probabilities), and because scale is inversely proportional to the standard deviation of the error term, craft affects the calculated equilibrium prices (§6.3 and Equation 3). Notably, higher craft does not necessarily imply lower error variance and higher scale; high-quality craft is about identifying the right (i.e., realistic) standard deviation of the error term so that the CBC model predicts how consumers will actually behave in the marketplace.

Quantification of the impact of craft on WTP and equilibrium prices is nascent. We illustrate the impact with a study reported in Eggers, Hauser, and Selove (EHS 2016) and in Hauser, Eggers, and Selove (HES 2019). The studies are based on the same data, but analyzed differently as described below.[24]

4.2. Craft Affects WTP

To examine whether craft matters, EHS and HES studied a simplified smartwatch conjoint analysis in which the watch face (round vs. rectangular), the color of the watch (silver vs. gold), the watch band (brown leather, black leather, and matching metal), and price were varied. To isolate these attributes, consumers were instructed (and understood as verified in pretests) that all other attributes, and in particular, the brand and operating system, were held constant. For example, if the consumer currently owned an Apple Watch, the consumer was told to assume that all of the watches being

[24] Many decisions in the analysis of CBC and validation data affect both WTP and equilibrium prices. Such decisions are another instance where seemingly minor decisions by the expert on how to analyze the data affects the predicted price equilibria. See also Sonnier, Ainslie and Otter (2007) and Salisbury and Feinberg (2010).

evaluated were Apple Watches of a particular vintage and size.

To investigate the impact of craft, the study varied four aspects of craft in a 2 x 2 x 2 x 2 between-subjects design, each condition employing a smartwatch conjoint analysis.

- **realism of the stimuli**. Highly realistic images augmented with further information in roll-overs versus (mostly) text-only images similar to what is used by commonly-used conjoint-analysis software
- **incentive alignment**. Consumers were either incentive aligned or not. Incentive aligned means that 1 in 500 respondents would receive the smartwatch the respondent chose from a randomly-selected choice set, plus any remaining change from a budget. (Cash was given in the non-incentive aligned experimental cell.) The procedure was supported with an instructional video: https://youtu.be/DBLPfRJo2Ho.
- **training video**. Some consumers received video instructions that matched the craft of the conjoint analysis study in which they participated. Others did not. See example at https://youtu.be/oji_bw_oxTU. The training video might improve consumer understanding, but it might also increase fatigue and cause consumers to pay less attention to the profiles—an empirical question.
- **all-else-equal instructions**. Some respondents received carefully worded instructions that all other attributes, including brand and operating system, were the same in all profiles in the choice set. Other consumers did not receive these instructions.

Table 1 illustrates that craft affects WTP. Each column is a marginal effect: in the comparison of one aspect of craft, the other aspects of craft vary according to the experimental design. WTP is calculated with the two-product market simulation method where one product has the attribute at a given price and the other does not have the attribute but is offered at a lower price.

The impact of craft can be dramatic. For example, it appears that consumers value a metal band

relative to a black leather band substantially more when they see realistic images ($152 WTP) than when they see text only ($32 WTP). Other comparisons are not as dramatic, but nonetheless substantial. The HES/EHS study is but one study; experts can use this study as evidence that craft matters. The impact may be more or less in any given study, but cannot be ignored. We caution that the directional impact of craft on WTP may vary. For example, higher realism appears to have enabled consumers to evaluate better aesthetic attributes of smartwatches such as color, shape, and band material, leading to higher WTPs. But there is no guarantee that the WTPs will always be higher. Higher realism relative to text-only stimuli might also enable consumers to realize that a particular attribute is less valuable resulting in a lower WTP. It is easy to produce examples where lower realism inflates the WTP estimates, particularly when focalism bias is present (Kronstadt 2017, Reibstein 2024).

Table 1. Illustrative Effect of Craft on WTP (Smartwatch Study)

	Higher realism images	Lower realism images	Incentive alignment	No incentive alignment	Training video	No training video	Instruct all-else-equal	Not instruct a.e.e.
Round face to rectangular face	$107	$65	$104	$63	$98	$78	$82	$93
Gold to silver color	$74	$65	$85	$58	$85	$54	$77	$61
Brown to black leather band	$138	$76	$110	$91	$105	$90	$99	$96
Matching metal to black leather band	$152	$32	$92	$72	$87	$77	$80	$83

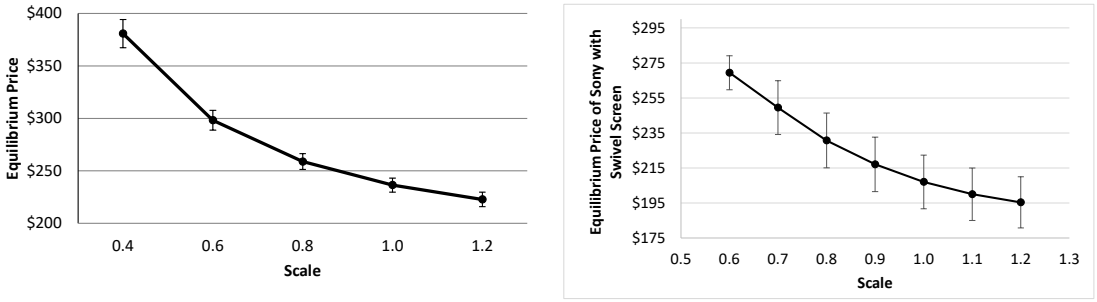
4.3. Double Whammy: Craft Affects WTP and (through Scale) the Price Equilibria Calculated by PEM

Because craft affects the relative partworths and price coefficients, craft directly affects PEM and FSP calculations. For example, in the HES data, WTP and PEM price premia are highly correlated – 0.74 when using the scale estimated in the CBC study and 0.66 when scale is corrected for external validity (see §4.4). However, craft also affects the error term in the logit model used in CBC. If the errors are unbiased, we expect that increased errors do not affect estimates of WTP. However, because greater errors make the market less sensitive to price, greater errors directly affect PEM calculations.

Price equilibria as calculated depend strongly on the standard deviation of the error term as measured in the CBC study (inversely proportional to γ_i in the McFadden specification). For example, incentive alignment might lead to less error within the CBC study implying a higher γ_i within the study, which in turn implies a lower equilibrium price as illustrated in Figure 2. Craft impacts PEM calculations above and beyond the impact of craft on WTP. These effects might reinforce one another or cancel out. Further, if price premia are calculated as the difference in price equilibria between the "as is" and "but for" worlds as in Allenby et al. (2014a §6.1), craft affects both price equilibria. The effect on the difference can go in either direction. At minimum, the expert should demonstrate either that the CBC study used the highest feasible craft or that neither WTPs nor scale ($\gamma_i's$) vary substantially with craft.

Figure 2 illustrates the variation in predicted price equilibria as a function of average scale holding the distribution of partworths equal (the distribution of the β_{ki}'s in the McFadden specification are held constant, all γ_i are varied by a multiplicative constant). Figure 2a is from the smartwatch study (HES, Figure 1). Figure 2b is from a study of cameras (data from Allenby et al. 2014a, HES Figure OA4.1a). Higher externally-valid equilibrium prices (lower average γ) are predicted for a CBC study with text-only and no incentive alignment (as in Allenby et al. 2014b, p. 639); lower equilibrium prices (higher average γ) are predicted for a CBC study using realistic images and incentive alignment. HES report similar curves for a study of dormitories (HES Figure OA4.1b) and for a stylized model (HES Figure OA1.1). From the CBC expert's viewpoint, calculated equilibria prices can change by as much as 100% depending upon the effect of the craft of the CBC study on γ. The "double whammy" is that craft effects the relative partworths and scale.

Figure 2. Predicted Equilibrium Price Depends Upon Scale (inverse of error term standard deviation)



(a) Smartphones (b) Cameras

4.4. Whether or not the Expert uses Marketplace Validation Affects the Calculated Price Equilibria

Ben-Akiva, McFadden, and Train (2019, p. 29) review extensive evidence that there are often substantial (and systematic) differences between partworths as measured in CBC studies and partworths as revealed by marketplace choices. They advocate that "stated choices [CBC] can be sharpened by calibrating them to revealed preferences." Because scale has a strong effect on PEM calculations and because the effect of market validation on relative partworths is already well documented, their admonition suggests we examine whether market validation affects the appropriate γ_i to use in PEM calculations.

Most CBC studies in our review of publicly-available litigation evaluate reliability with the ability of the CBC estimates to predict consumer choices among sets of profiles that are held out from the analysis – holdout profiles. However, suppose (1) choices among text-only stimuli are particularly unrealistic relative to choices in the marketplace and (2) the consumers evaluate choices among text-only profiles consistently. Then the CBC model might predict well choices in holdout profiles, but predict poorly choices in the marketplace. Without proper marketplace data (or a surrogate), it is impossible for the expert to establish how well the CBC model predicts actual marketplace choices.

HES (Table 2) show an example, using text-only stimuli with no incentive alignment, where consumers are consistent among profiles (high scale within the CBC study), but the scale for

marketplace choices is lower than for realistic images and incentive alignment. The examination of whether and how well the CBC model predicts marketplace choices is key because the CBC expert is asked to forecast the difference in the "but for" and "as is" prices as they occur in the marketplace, not just in the CBC study. To assess the reliability of the predicted marketplace prices, the expert needs marketplace validation data or an appropriate surrogate.

Suppose that we obtain marketplace measures such as from a simulated store, a set of validation questions, or actual marketplace observations. Suppose further that we use HB CBC to estimate the distributions of scale (γ_i's) and the distributions of the partworths (β_{ki}'s) using the profile-choice data as observed within the CBC study. (The γ_i are identified in the McFadden specification.) Let γ^{study} be the average over consumers (and/or draws) of the γ_i based on the profile-choice data. Given validation data, we can update the model based on the marketplace-choice data. Call this new average $\gamma^{marketplace}$. The two γ's may differ and hence provide different estimates of equilibrium prices.[25]

Table 2 compares the differences in PEM price premia as calculated using only data from the CBC study to the PEM price premia as calculated with data from the CBC study augmented with validation data.[26] For convenience we repeat the WTP estimates from Table 1. For example, the difference in the estimated equilibrium price premium for changing a round watch face to a rectangular watch face decreases from $55 without marketplace data to $51 with marketplace data in a CBC study

[25] Typically, marketplace-choice data are more difficult to obtain than profile-choice data. It's an open question on whether to place more weight on the rare marketplace data (e.g., HES observe 12 profile-based choices and one marketplace choice for every consumer in the sample). One method treats each datum as a single datum in a joint likelihood function (HES). This method has the advantage of sharpening partworths with marketplace data, but the disadvantage that it likely overweights profile-based data. Another method places more weight on the marketplace data in the likelihood function, but the weight must be set by the expert's judgment. A third method isolates the scale effect by using the profile-choice data to estimate a distribution of partworths coupled with a one-parameter logit model to adjust γ^{study} to $\gamma^{marketplace}$ (EHS). Both the HES and the EHS methods suggest an impact for validation adjustment that the CBC expert cannot ignore. In Table 2 we use the EHS method to place more weight on validation data. The basic insight that validation affects estimated WTP and both FSP and PEM price premia seems to be true for both methods tested.

[26] The results in Table 2 are based on the detailed methods of HES, modified for the EHS validation adjustment and vary slightly from those reported in EHS—yet another indication that slight changes in CBC methodology affect price premium calculations.

that uses incentive alignment.[27] As expected, both estimates of PEM price premia are below the $104 WTP because WTP measures the most the median consumer would pay for a rectangular rather than a round watch face. Unless the median customer is by chance the marginal customer, WTP does not measure what the marginal consumer would pay.[28] In Table 2, the incentive alignment study estimates higher WTPs, but we cannot conclude that incentive alignment will always lead to higher WTPs. In other cases, more-accurate measures of WTP enabled by incentive alignment might be lower.

Table 2. Illustrative Effect of Craft and Marketplace Validation on Price Premia

	WTP		**Differences in PEM Price Premia (γ^{study})**		**Differences in PEM Price Premia ($\gamma^{marketplace}$)**	
	Incentive alignment	**No incentive alignment**	**Incentive alignment**	**No incentive alignment**	**Incentive alignment**	**No incentive alignment**
Round to rectangular watch face	$104	$63	$55	$34	$51	$36
Gold-colored to silver-colored case	$85	$58	$23	$22	$18	$15
Brown to black leather band	$110	$91	$52	$39	$47	$29
Metal to black leather band	$92	$72	$26	$24	$22	$15

4.5. Craft in the Academic Literature

Litigation applications are often justified by the academic literature. For example, Ben-Akiva, McFadden, and Train (2019) advocate high-quality craft in stated preference (CBC) elicitation. They advocate that the menus of products and descriptions realistically mimic the consumer's market experience (paraphrase, p. 11), that incentive alignment be used whenever possible (p. 24), that consumers be trained in the CBC procedure (but not more than would be present in the marketplace),

[27] As in the Allenby et al. (2014b) camera study, the smartwatch study was completed to explore methodological issues and, as a result, both the "as is" and "but for" prices are calculated. Table 2 should be interpreted as evidence that craft affects calculated PEM price premia. For use in litigation, the expert should assure that the predicted "as is" prices and quantities sold match the historically observed prices and quantities sold.
[28] FSP price premia, which are based on WTP-like simulations, are either the same or approximately the same as measured WTP.

tested on understanding and consistency (pp. 12, 26), that consumers be familiar with the products and attributes (p. 14), that the outside option be explained carefully (p. 18), and that the CBC results be tested against and calibrated to consumer behavior in the marketplace (p. 27).

We reviewed CBC studies published in major marketing journals.[29] We limited our review to those studies that report at least hit rates on holdout predictions. Hit rates are not the only measure, and many researchers have argued that information-theory based measures such as U^2 provide better insight, but hit rates are the most common measure of internal validity. Alas, there are not enough studies for a meta-analysis of external validity. Most of the studies focus on WTP or predictive ability. Few focus on PEM and none on FSP.

Academic CBC studies often have goals that differ from litigation CBC studies. For example, academic studies may seek to compare alternative methods of estimating partworths, alternative methods of adapting questions, or other methodological issues. Such studies seek to isolate the phenomenon of interest and may not require a focus on external validity or the highest feasible level of craft. Some papers explicitly include lower-craft studies as control studies. Nonetheless, we can look to academic studies to examine trends and whether or not craft affects internal validity.

We identified 184 observations nested in 86 studies (most studies compare variants of CBC providing more than one datum). Of these studies, 46% include brand-specific constants, 6.4% present stimuli in the form of realistic images instead of text, 17.4% use incentive alignment, 54% include an outside option as part of the choice sets, and 6.9% use a dual-response format. Moreover, 11.7% add a time delay before the internal validation to cleanse consumer's memory and prevent behavior learned in context, 13.9% show realistic stimuli in the holdout task (compared to 6.4% in the regular choice sets), 23.1% apply incentive alignment to the holdout task (compared to 17.4% in the CBC profile-choices), and

[29] *Journal of Marketing Research, Journal of Marketing, Marketing Science, Management Science, Journal of Consumer Research, Journal of the Academy of Marketing Science, Journal of Product Innovation Management, Quantitative Marketing and Economics, International Journal of Research in Marketing, Marketing Letters.*

25.5% of the studies increase the number of stimuli in the holdout task to better represent the available market options. There appears to be a trend towards higher craft in these publications. The number of studies that use forms of higher craft is higher in the last 10 years as in the time before, e.g., 23% use incentive alignment in the last 10 years (vs. 14% before), 11% use realistic images (vs. 4% before), and 17% provide a delayed validation task (vs. 8% before).

Our meta-analysis of the published studies suggests the following variables affect internal validity as measured by hit rate. Some of the variables do not necessarily imply improved internal validity because the variables also make the prediction task more challenging. For example, predictions are likely more difficult if there are more attributes varying in the choice sets.

- Incentive alignment increases holdout prediction significantly.
- The number of attributes, the number of alternatives in the choice set, and the number of holdout sets for validation each lower holdout prediction significantly. These variables make holdout prediction a more stringent test.
- Dual response and the realism of the stimuli increase holdout prediction, but the effect is not significant for internal validity. Recall in HES that, relative to lower realism stimuli, an increased realism of the stimuli decreased internal validity (predicting to the same type of task) but increased external validity (predicting to the marketplace).

4.6. Relative Impact of Craft, Validation, and Supply-Side Modeling

The smartwatch study illustrates the relative magnitude of the impact of craft, validation, and the methods of modeling the supply-side-based price premia. Suppose for the sake of illustration, we take as a baseline the comparison of a rectangular watch face relative to a round watch face. The PEM price premium based on a CBC study with incentive alignment and adjusted to marketplace validation is $51 (see Table 2).

- Using WTP rather than PEM inflates the price premium by 104%

- Not using incentive alignment deflates the price premium by 29%
- Not correcting for validation inflates this estimate by 8%.
- Not using incentive alignment and not correcting for validation deflates this estimate by 33%.

On average for the attributes in the smartwatch study, these percentages are 199%, – 34%, 7%, and – 13%, respectively. For the smartwatch study, the expert's decision on whether to use WTP (FSP) or PEM seems to have a bigger impact on price premia than the expert's decision on whether or not to use incentive alignment and validation – but these comparisons isolate a single aspect of craft. The effect of craft would be larger if all aspects of craft were considered simultaneously and could easily surpass that of the decision on WTP (FSP) vs. PEM. The effect of WTP (FSP) vs. PEM would be smaller if the issues of §5 are addressed. For example, both funnel issues and consideration sets mitigate price competition and could affect the price premia as calculated by the PEM.

These results are from a single study. They can be larger or smaller in other studies. The generalizable insight is that craft matters, often substantially.

5. Conceptual Issues with the Price Equilibrium Method (PEM)

The PEM makes many implicit assumptions that may or may not represent the marketplace. These implicit assumptions may have a greater impact on price premia (and profits) than the selection of the method to model the supply side. This section discusses issues in the practical application of PEM calculations. The next section discusses more-technical issues in the application of PEM calculations. Each subsection illustrates an issue that should be addressed if an expert is relying on PEM calculations to estimate price premia.

5.1. Does the PEM Model Reproduce Prices and Quantities in the "As Is" World?

Scientific principles suggest that both PEM and FSP models should correctly "predict" the "as is" world (e.g., Little's 1979 third principle, "Should not the model represent objective truth?"). This step is rare in litigation-based CBC studies, although various methods have been proposed in the marketing

literature (Gilbride, Lenk, and Brazell 2008; HES; Wlömert and Eggers 2016). Price premia are the difference in prices between the "as is" and "but for" worlds; if the PEM (or FSP) model cannot reproduce the "as is" prices in a scientifically valid test, then the price premia may not be reliable.

Some experts might argue that adding brand-specific constants to their model ensures the model reproduces the quantities sold in the "as is" world. Doing so is not a scientifically valid test. Brand-specific constants guarantee structurally that the model fits observed quantities rather than tests the reliability of the model. Often it makes sense to include brand-specific constants in the model, but it is incumbent upon the expert to demonstrate that the brand-specific constants are intuitive and not sensitive to seemingly minor changes in the craft of the CBC study.

5.2. Craft

Craft has a substantial impact on WTP (the demand side) and an additional impact on the price premia as calculated by the PEM. The expert should address incentive alignment, the realism of the stimuli, lack of focalism bias, all-else-equal instructions, dual-response questioning, instructions to consumers, IMCs, identification of bots and questionnaire farms, consumers' understanding of the outside option, number of attributes and attribute levels, number of profiles in the choice sets, the meaning of "price," the target population, and other issues. Validation is important because the scale (inverse of error term standard deviation) may differ between internal validation (holdout profile choices) and external validation (marketplace choices).

5.3. Marginal Costs

Price premia estimates depend upon the marginal costs of producing the product and the incremental costs due to the adding the attribute of interest, e.g., Allenby et al. (2014a, eq. 5.1). Occasionally, experts might argue that marginal costs are close to zero, say for a purely software

attribute.[30] In other applications, the expert needs a good estimate of marginal costs. Marginal costs for the at-issue firm might be obtained by subpoena (under a protective order), but obtaining the costs of non-involved competitors presents many problems due to the unavailability and confidential nature of marginal-cost data. Competitors' marginal costs may not be the same as for the plaintiff or defendant. For example, one firm might have greater economies of scale in producing the attribute.[31]

5.4. Number of Attributes and Brand-Specific Constants

The CBC task becomes extremely challenging for consumers if there are a large number of attributes (and attribute levels). In any CBC task, the expert should select sufficiently many "distraction" attributes so that the consumer does not unrealistically focus on the attribute of interest, yet not so many as to cause fatigue and unreliable data.[32] The CBC task should also assure that the respondent understands that all non-explicitly-modeled attributes are held constant in the choice task (all-else-equal instruction). When equilibria prices are modeled, the CBC task must include brand identifiers to estimate partworths for the brand-specific constants for (almost) all brands in the marketplace. The brand-specific constants represent all non-specified attributes and all non-specified marketing actions that vary among brands. In some markets, the number of brands may be huge making it infeasible to obtain the data for all of the brand-specific constants that are necessary for reliable PEM calculations. For example, in the *Apple v. Samsung* (2012, 1846 case) the major brands were Apple, Blackberry, HTC, LG, Motorola, Nokia, Sony, Ericsson, and Samsung with many sub-brands for each manufacturer – almost 50 for Samsung alone. For PEM calculations, these many competitors cannot easily be summarized in the

[30] The hypothesis of negligible marginal costs for adding a software attribute assumes that adding the software attribute does not require additional hardware, customer support, or marketing investment. Negligible marginal costs is an empirical issue that should not be simply assumed.

[31] An expert might be tempted to infer costs, brand-specific constants, and prices from the CBC data augmented with market-share data. However, such a model is likely "over-identified" and it is technically impossible to simultaneously identify all of these quantities. Such analyses often lead to absurd results.

[32] For example, in *Apple v. Samsung* (2012, 1846 case), the CBC study included six distraction attributes in addition to the one attribute that varied attributes made possible by the patents at issue. Because attributes were multilevel, there were a total of eleven distraction features. The survey was pretested extensively to assure the lack of focalism bias.

outside option because the value to the consumer of the outside option depends on the changes in the equilibrium prices of the brands subsumed in the outside option.

5.5. Competition on Non-Price Attributes

In many markets, competition takes place on non-price attributes as well as price attributes. For example, JD Power collects data on approximately 850 automotive attributes; similarly, smartphones often have hundreds of attributes, many of which are software attributes that can be added with low marginal costs. Because attributes change rapidly, sometimes with software updates in both the automotive and smartphone markets, the expert should argue after reviewing the characteristics of the relevant industry that competition on price is more relevant to a price/profit equilibrium than competition on non-price attributes.

Even if competition occurs in two stages – attribute-equilibria are set based on implied price equilibria, firms may or may not choose to copy the incumbent firm's attribute. The decision to copy depends upon price sensitivity which is related to the scale that applies in the marketplace. At minimum, the expert should demonstrate that the PEM model is consistent with the observed marketplace in the sense that the PEM analysis predicts that the profit-maximizing strategy for an alleged infringer is to copy an attribute enabled by the patent or copyright. When marketplace scale is high, a CBC model might predict that the profit-maximizing strategy for the (allegedly) infringing firm would be to differentiate from the incumbent by choosing a different, but lesser-preferred attribute (HES, Proposition 2). If the CBC model predicts competition on non-price attributes differently than is observed in the "as is" world, then the CBC model is unreliable.

5.6. Funnel Issues

CBC presents consumers with profiles that represent potential products. The CBC task assumes implicitly that consumers are aware of the products and the attributes and that the products have equal availability and distribution. Awareness and distribution cannot be assumed in a real market. In many

markets, consumers consider a small fraction of the available products and firms use marketing actions to compete on awareness (Hauser and Wernerfelt 1990). The price equilibria depend upon the equilibria in marketing spending and vice versa (Hauser and Wernerfelt 1989). The price-marketing equilibrium is related more to the average consideration-set size than to a competition among all firms in the marketplace (Hauser and Wernerfelt 1989), hence a PEM calculation based on all products in the marketplace may assume too much competition and predict unrealistically lower PEM prices. A PEM model that does not consider an equilibrium in marketing spending may be unreliable.

The attributes of interest may or may not be familiar to the consumers who complete the CBC task (Ben-Akiva, McFadden, and Train p. 14). The expert should assure that the attributes are sufficiently salient to consumers in the marketplace and that the CBC task itself is not the primary driver of consumer awareness of the attributes of interest (focalism bias). If in the marketplace, a consumer is unfamiliar with a minor attribute on a smartphone or an automobile, the CBC task itself might introduce the attribute to the consumer. Even if the attribute is familiar to the consumer, say the quality of the display of a smartphone screen, if display quality is presented to the consumer as a refresh rate of 60 Hz, 90, Hz, and 120 Hz, the consumer may not be able to visualize the impact of differing refresh rates. If refresh rate is presented by text alone, a consumer might simply revert to assuming that 120 Hz is twice as preferred as 60 Hz. Firms can also compete on awareness of an attribute. For example, if a patent-enabled attribute is valuable to consumers and if consumers are unaware of the patent-enabled attribute, the patent holder and infringer might compete by advertising the patent-enabled attribute.

5.7. Common Information Available to All Firms in the Marketplace

Allenby et al. (2014a, p. 441) highlight that PEM calculations assume that all firms have the same information about partworths and about price coefficients (scale). The common-information assumption might hold if every firm ran a comparable CBC study. Because price equilibria are extremely sensitive to the craft of the CBC study, the common-information assumption requires that all firms use comparable

methods and comparable craft. However, if the patent/copyright holder is the incumbent firm and the infringing firm is a follower, then patent/copyright holder and the infringing firm have different incentives to invest in the quality of the CBC study (HES pp. 1067-1068). Because marketing research is often proprietary, it is a strong assumption that all firms would complete the same CBC studies to the same level of craft.

We note that firms might rely on market experiments rather than CBC studies to set marketplace prices. If that is the case, the expert should address this issue.

6. Technical Issues with the Price Equilibrium (PE) Method

Even if we assume that all of the conceptual issues in §5 are addressed by the CBC expert, PEM calculations are extremely sensitive to a variety of technical issues. We discuss a few of these technical issues in this section.

6.1. The Price Equilibria May Not Exist and May Not be Unique

The CBC model as specified in Equation 2 is a mixed-logit model in the sense that each consumer's probabilities of choosing products (or the outside option) is given by the logit model and that the parameters of the logit model vary by consumer (or consumer segment). Nash price equilibria may exist in mixed logit models, but existence is not guaranteed. Aksoy-Pierson, Allon, and Federgruen (2013) demonstrate that the equilibria exist if for every consumer (or consumer segment) the probability of choosing any product is less than 0.50. The equilibria are unique if the probability of choosing any product is less than $0.3\overline{3}$.

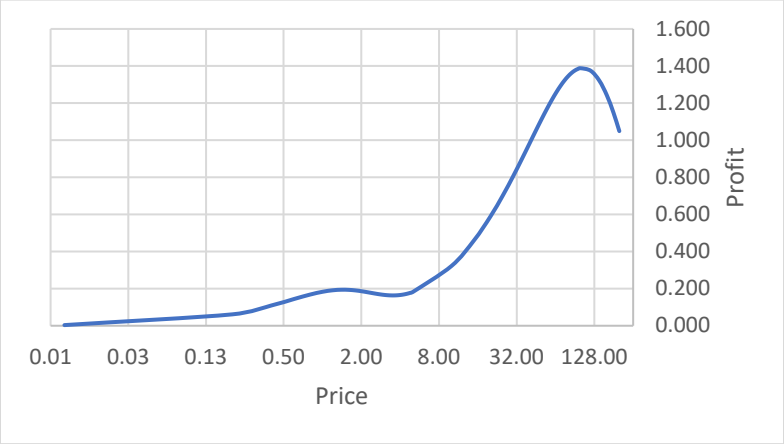
A CBC expert cannot assume that price equilibria exist in a market described by a CBC model. The expert should examine whether, for sufficiently many draws from the HB model, the equilibria exist and are unique. If not, the model may need to be modified. For example, Allenby et al. (2014a) modify the prior distribution on the price coefficient and draw from the hyper-distribution. In the studies we reviewed, experts typically draw from the consumer posterior distributions rather than the hyper-

distribution. The Allenby-et-al. modeling decisions increase the number of price equilibria that exist. Using standard prior distributions, the equilibria exist in their data for 70% of the typical-study draws dropping to 31% for draws from the hyper-distribution. After modifying the prior distribution, the price equilibria exist in more than 90% of the typical-study draws, increasing to 99.8% for draws from the hyper-distribution. In the smartwatch study, HES require that all price equilibria are bounded by the range of the data used in the product profiles. With these constraints, the equilibria exist in 99.6% of the draws from the hyper-distribution.

6.2. Sensitivity to Outliers in the Data

PEM calculations are particularly sensitive to consumers who are not sensitive to price differences within the range of prices provided in the CBC profiles. When the CBC analysis suggests some consumers are not sensitive to price, and extrapolates this lack of price sensitivity beyond the price ranges in the CBC profiles, profit maximization exploits these less-price-sensitive consumers to set unrealistically high profit-maximizing prices. The following example is based on three exemplary consumer segments, one of which is not price sensitive. The price range in the CBC profiles is $1 to $2. Within this price range, there is a local optimum at $1.40. However, the artifact of the price-insensitive segment implies an unrealistically high profit-maximizing price of $100 (Figure 3). If outliers are not addressed, then PEM calculations are not reliable.

Figure 3. Price-Insensitive Segments Imply Unrealistic Profit-Maximizing Prices



For example, in the Allenby et al. data, price equilibria exceed the price range in the CBC profiles for 3.9% of the draws from the hyper-distribution, which can be attributed to the tails of the distribution. But if we draw from the consumer posterior distributions, 52.5% of the draws suggest price equilibria beyond the range of the data. Thus, not only should the CBC expert using PEM calculations examine outliers, but the expert should also examine how drawing from the posterior distributions (hyper-distribution vs. consumer posterior distributions) affects the PEM calculations.

6.3. Why Price Equilibria are Highly Sensitive to Craft

When estimating WTP, the error term is a nuisance parameter. The error term affects the precision of the estimates of WTP, but does not necessarily bias the estimates. In §4.4, we demonstrated that changing the standard deviation of the error term affects price equilibria even if the relative partworths are held constant. In this section, we provide intuitive explanations for this phenomenon.

The effect of craft is particularly pronounced when computing price equilibria because high scale indicates that there are low errors in the CBC predictions, and vice versa. We expect that higher craft, such as higher realism and incentive alignment, leads to lower errors for external validation. For example, if consumers are not incentive aligned then consumers may pay less attention to the CBC study

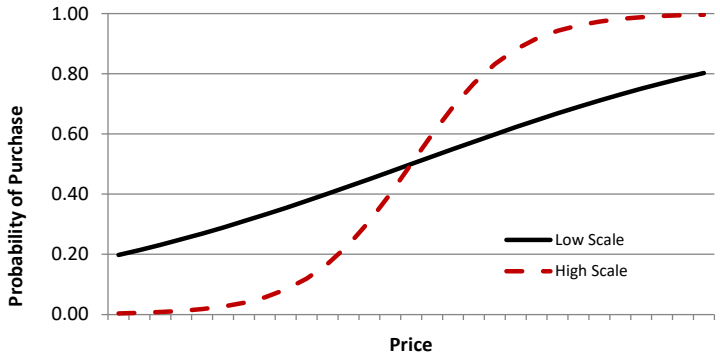
resulting in more errors in estimating externally-valid partworths (Ding 2007; Ding, Grewal and Liechty 2005). Similarly, if the stimuli (product profiles, attributes) are not presented clearly and realistically, more noise is likely in measurement. The error term also captures the effect of unspecified attributes, brand images not captured by brand-specific constants, unobserved marketing actions, and stochasticity in consumer decision making. Even if the error term is unbiased, craft affects scale and the effect can be large (review Figure 2).

Craft affects scale and scale affects price equilibria because scale is an indicator of price sensitivity. The sensitivity is intuitive because the price coefficient in the Allenby et al. specification, η_i, equals scale in the McFadden specification, γ_i. We gain further intuition by calculating the sensitivity of the consumer's purchase probability to scale. Price sensitivity (to a first order) is directly proportional to scale!

$$\frac{\partial P_{ij}}{\partial p_i} = -\gamma_i P_{ij}(1 - P_{ij}) \quad (3)$$

There is an indirect effect because P_{ij} also depends on scale, but the primary effect is strong as illustrated in Figure 4.

Figure 4. Sensitivity of Predicted Probability of Purchase to Price is Based on Scale



Because higher scale implies greater price sensitivity, higher scale predicts that competition will be more intense resulting in lower equilibrium prices. Alternatively, if scale is low (errors high but unbiased), the CBC model predicts that the marketplace is price insensitive implying less intense

competition and higher prices. Put more simply, the price equilibria predicted by CBC data depends upon the craft of the CBC study. A CBC study with text-only attributes predicts a different price equilibrium than a CBC study with realistic attributes because the stimuli presentation affects observed error (scale) and predicted price sensitivity is a function of scale. Even the number of profiles used in the CBC task might affect the predicted price equilibrium.

HES introduce the concept of γ^{true}, the scale that describes in the marketplace how consumers will react to changes in price. If the validation data are good, $\gamma^{marketplace} \cong \gamma^{true}$, but this approximate equality is an empirical question that depends upon the ability of the PEM model to predict marketplace prices and quantities. HES also demonstrate that $\gamma^{study} \neq \gamma^{marketplace}$, suggesting that price premia may be unreliable if they are based on a model estimated only on profile choices.

7. Issues with the Fixed Supply Pricing (FSP) Method

FSP calculations assume that the number of products sold is the same in the "but for" world as in the "as is" world. FSP calculations do not consider how other firms in the marketplace react to a change in the at-issue firm's attributes and price. As a result, FSP calculations depend only on "as is" prices and quantities and the demand curve (WTP or something approximately equal to WTP) for the at-issue product. In some cases, courts have articulated advantages of FSP relative to PEM.

Some courts have accepted experts' opinions that the number of products sold with the offending claims is known and the price at which they were sold is known and was determined by the intersection of demand and supply in the actual "as is" market. These courts have argued that, because the PEM assumes that supply and demand both change in the "but for" world, the PEM predicts that some consumers, who might be owed restitution from the offending actions, do not purchase the at-issue product in the "but for" world.[33] See decisions in *Hadley v. Kellogg* (Koh 2018, pp 25-27),

[33] "One apparent problem with that traditional [price equilibrium] approach (at least in this context) is that both supply and demand with respect to the product without the claimed feature can be expected to decline. Therefore, that approach can be expected to describe a price for the product at a point on the quantity sold axis

McMorrow v. Mondelez (Bashant 2021), and others. On the other hand, courts have excluded CBC analyses that are not sufficiently tethered to the "as is" market. See *Zakaria v. Gerber* (Kronstadt 2017). Our goal in this chapter is not to argue which "but for" world assumptions are justified based on the law, but rather to illustrate issues the expert should consider when FSP calculations are applied.

7.1. Examples of Fixed Supply Pricing (FSP) Calculations

We illustrate the basic idea of FSP calculations with Weir (2018, pp. 18-20), who uses a CBC market simulator to compare (1) a basic product with the at-issue attribute at the market-based price, p_1, and (2) the same basic product without the at-issue attribute at a lower price, p_2. Using the same simulator-based method used to calculate WTP, Weir identifies p_2 such that the two products have the same market shares. Weir does not use an outside option in the simulator, hence the target market shares are 50% (Weir 2018, Table 1). Weir reports the percentage reduction, $(p_2 - p_1)/p_1$, and "applies the price premium percentage calculated […] to all Class Members market-wide regardless of the absolute price they paid (p. 20)." If all class members had paid the same price, p_1, then the FSP price premium is mathematically equivalent to the simulation-based WTP.[34] Weir claims that the price premium is grounded to the "as is" price. However, in a two-product simulation with no brand-specific constants (50-50 simulation), grounding to any other price produces approximately the same estimated WTP, and hence the same price premium, as grounding to the "as is" price.[35] Damages are based on assuming the number of units sold in the "but for" world are the same as in the "as is" world—an assumption that implies that supply is fixed and that there is no competitive response.

below (perhaps significantly) the point that represents the actual number of offending products sold to class consumers in the actual market (McAuliffe 2017, p. 10).

[34] Because p_1 cancels from the equation $[(p_2 - p_1)/p_1]p_1$, the only use of the market-based price in Weir is the anchor in the simulator that produces the FSP price premium. However, we argue in this section that the calculated price premium is not very sensitive to the "as is" price. See also Weir amended declaration in Maldonado et al. v. Apple et al. p. 12.

[35] The price premium is not exactly equal to the median WTP because of non-linearities in the logit model and potential asymmetry in the distribution of partworths – but empirically the price premium is often quite close to the median WTP.

Boedeker (2016) provides a slightly more complicated example. To account for different scenarios, p_1 is varied over simulations and the expert reports the "implicit market price" as the median percentage reduction calculated over simulations. Boedeker includes an outside option in the simulations thus requiring an additional assumption that the meaning of the outside option is the same in the "as is" and "but for" worlds. The Boedeker simulations are slightly more sensitive to the "as is" price than the Weir simulations because of the outside option. As the "but for" price is raised, consumers with lower WTPs, who would have bought the at-issue product if there were no outside option, are predicted to not buy the at-issue product with a (positively-valued) outside option. The net effect will raise the calculated price premium.[36] (The opposite would happen if the outside option were negatively-valued. Heterogeneity further complicates the comparison.) Applying FSP calculations to the smartwatch data suggests that including an outside option in the two-product simulation has a minor effect on the calculated price premia; the calculated price premia are still close to the median WTPs.[37] The closeness of an FSP price premium to the median WTP can be checked easily by an expert applying or critiquing FSP calculations with or without an outside option.

7.2. FSP Assumes the Supply Curve is Constant

One fundamental assumption in FSP is that the at-issue firm will supply exactly the same number of products in the "but for" world as in the "as is" world. This is an heroic assumption that is rarely tested. While the "but for" world is, by definition, not observable, the expert might examine natural experiments where the firm changed its price, advertising, or product attributes to establish whether or not supply stayed constant. Alternatively, the expert might demonstrate empirically for the situation being modeled that the FSP price premia are good approximations to those that would have

[36] Heterogeneity in how the consumers value the outside option or intercorrelation in the value of the outside option with partworths could change the direction of the impact.

[37] Boedeker argues that the price premia are based on modeling the WTP of the marginal consumer rather than the WTP of the median consumer. Our examples, and logic, suggest the price premia are close to the median consumer. We are unaware of any evidence that the median consumer is the marginal consumer.

been attained if supply were not assumed constant.

7.3. Theory of the Case

FSP is used primarily in class actions where damages are based on restitution to consumers rather than the profits of patent or copyright holders. FSP experts might hold supply constant so that the FSP experts can compute damages for all class members who purchased the offending product. FSP ignores the reactions of other products in the market and is not sensitive to demand for the other products, except through the outside option. The expert should establish that the benefit of providing price premia for all consumers who bought the at-issue product in the "as is" world is best addressed with a constant-supply assumption. Alternatively, the expert can provide an alternative theory of price premia for consumers who bought the at-issue product in the "as is" world but would be forecast not to buy the at-issue product in the "but for" world. It is also a matter of law whether consumers are damaged if they would still purchase the product willingly at the "as is" price even if the at-issue attribute were not present.

7.4. Craft and Other Issues as they Apply to WTP

FSP relies on partworth estimates using calculations that are the same or approximately the same as those used to calculate the median WTP. Hence, FSP is sensitive to all of the issues discussed in §3 (WTP) and §4 (craft). FSP calculations are also sensitive to most of the conceptual issues discussed in §5. On the other hand, the price premia estimated with FSP do not require equilibrium calculations and, hence, are not as sensitive to the issues discussed in §6 (technical issues with PEM calculations).

When applying FSP, the expert should address large WTPs (outliers), interactions, target sample, metrics to summarize WTPs (not projecting outside of the price ranges in the CBC profiles). Craft issues should be addressed including realism of the stimuli, incentive alignment, training, all-else-equal instructions, IMCs, steps to eliminate "bots" and questionnaire farms, dual response formats, number of attributes, number of levels, and number of alternatives in the choice set. FSP shares conceptual issues

with PEM including competition on non-price attributes and funnel issues, but is less sensitive to marginal costs, large numbers of attributes and brands in the marketplace, and common information among firms.

7.5. Grounded to the Marketplace

To be considered valid, FSP predictions should accurately represent the "as is" world (Little 1979). In *Fishon v. Peloton Inc.*, Liman (2023) argues that "historical prices reflect the influence of supply-side factors in the actual world, *not* the influence of supply-side factors in the but-for world […]"[38] In our review of FSP cases, it is rare that experts ground "as is" CBC predictions to the marketplace. The FSP expert might counter that the "as is" world provides known (equilibrium) prices and quantities for the "as is" world. However, FSP price premia predict the difference between prices in the "as is" world and the "but for" world. If the FSP CBC expert cannot provide evidence that FSP calculations reproduce the "as is" world without relying exclusively on brand-specific constants, then the expert has not demonstrated the reliability of the "but for" predictions.[39]

For example, an expert might seek to establish that the CBC model, as applied to the "as is" marketplace with extant products and prices, would reproduce current market shares and prices for all products in the marketplace with minimal reliance of brand-specific constants. It is not sufficient that the CBC model predicts holdout profiles. Predicting holdout profiles is a test of internal validity rather than a test of the ability of the CBC model to reproduce the marketplace (external validity).

7.6. The Outside Option

FSP price premia are sensitive to the value of the outside option when an outside option is

[38] "Opinion and Order," Passman v. Peloton Interactive, Inc., 19-cv-11711 (LJL), United States District Court for the Southern District of New York, May 2, 2023, p. 28.

[39] If there are J products in the marketplace, adding $J-1$ brand-specific constants to the logit model assures that the model matches observed market shares for any model whether or not the model is an accurate representation. While it makes sense to "calibrate" a CBC model to marketplace market shares, such calibration should not be interpreted as a validation of the ability of the CBC model to predict "but for" consumer behavior.

included in the simulations. In these applications, FSP is particularly sensitive to whether or not the consumer understands the outside option as presented in the CBC study. In FSP, the outside option represents the generic "don't buy" option and the option of purchasing any of the other products in the marketplace, some of which may contain attributes that are varied in the CBC profiles. This is not always consistent with a CBC task that asks consumers to select profiles that vary on brand before they choose whether to purchase the profile. (The profiles in the choice set might not adequately represent real products in the marketplace.) Furthermore, to evaluate the outside option, consumers should understand well the all-else-equal instructions that refer to attributes not explicitly mentioned in the CBC task. For example, if a study varies aesthetic attributes of a smartwatch, consumers also need to understand which attributes are held constant, such as a specific battery life, to make an informed decision whether to buy the watch or not. In the marketplace, such attributes may be correlated with the attributes varied in the CBC study implying that the estimated partworths have not reliably isolated the effect of changing an attribute.

7.7. Target Population

FSP calculations differ from PEM calculations because FSP calculations use the demand curve (WTP) only for the at-issue product rather than the demand curves for all firms in the marketplace. By the principle of revealed preference, we can expect those consumers who chose to purchase the at-issue product have differing preferences from those who chose not to purchase the at-issue product (partworths, scale, and/or the value of the outside option). Further, FSP calculations hold supply constant to focus on restitution to those consumers who, in the "as is" world, bought the at-issue product. The expert should address whether estimated damages are different if the simulations are based on the sub-sample of consumers who actually bought the at-issue product rather including consumers who, in the "as is" world, did not purchase the at-issue product.

7.8. Comparing WTP, FSP, and PEM Calculations

FSP vs. WTP calculations. FSP calculations seek a price where (1) the percentage of the consumers who would purchase the at-issue product with the at-issue attribute and the "as is" price is the same as (2) the percentage of the consumers who would purchase the at-issue product without the at-issue attribute and the FSP-calculated "but for" price. If there were no errors, the no-outside-option FSP price premium would exactly equal the WTP. These statements are approximate when there are errors in the logit model (γ_i finite), when there is heterogeneity in partworths or scale, and/or when there is an outside option.

FSP calculations are often grounded to the "as is" price. However, the resulting price premia are often not very sensitive to the "as is" price – this is particularly true for 50-50 simulations without an outside option. At minimum, if the CBC expert justifies the use of FSP because "it is grounded to the actual marketplace," then the expert should demonstrate that this grounding has an important impact.

We applied the FSP calculations to data from the smartwatch study which includes an outside option. For the CBC study with incentive alignment, the FSP price premium for the watch face is either \$108 (model based on γ^{study}) or \$112 (model based on $\gamma^{marketplace}$). Both FSP price premia are close to, but above, the \$104 WTP reported in Table 2. We obtain similar results for the other experimental cells in Table 1: the FSP price premia are close to and most often slightly above the WTPs.

FSP vs. PEM calculations. In *In re Dial Complete* (p. 30), the court opined that "it is not necessary that class damages be calculated to a mathematical certainty."[40] It is beyond the scope of this chapter to examine the ability of FSP calculations to approximate PEM calculations. We provide hypotheses based on the analytic model in HES which provides a "known" analytic benchmark for the PEM. We calculated FSP and PEM profits in a market in which the "as is" market contains two firms, one of which accurately

[40] "Opinion and Order," In re Dial Complete Marketing & Sales Practices Litigation, 11-md-2263-SM, United States District Court for the District of New Hampshire, March 27, 2017, p. 10.

advertises the attribute and the other does not. In the "but for" market, both firms accurately advertise the offending attribute. FSP predictions of the percent change in profits were within 5-10% of PEM predictions when price sensitivity (scale) is low and there is no or moderate heterogeneity. Predictions varied more dramatically when price sensitivity (scale) is large or when heterogeneity is high. We leave more complete analyses to future research.

8. Discussion and Summary

Case law and academic research for supply-side modeling is still being developed. The only application of PEM in the publicly available cases we reviewed was rejected on craft issues. On the other hand, the courts have varied in their willingness to accept FSP. The academic literature testing PEM is nascent, but we found no academic articles examining the reliability of FSP. Demand-side modeling (WTP) is well-established with hundreds of scientific articles in top marketing journals including issues of "estimation, adaptive questioning methods, methods to motivate respondents, more efficient design, noncompensatory methods, and other improvements (HES, p. 1067)."

Our review suggests that the qualitative use of WTP is on solid ground. Applications of WTP to motivate that an attribute is valued, to quantify the percent of consumers who value an attribute, and for use by other experts in hypothetical royalty negotiations have been accepted by the courts. If high-quality craft is used (§4) and other conceptual issues are addressed (§3), WTP provides an acceptable demand-side input to the estimation of price premia.

The PEM is theoretically appealing as a means to consider the decisions by all firms. However, to apply these methods reliably a CBC expert should address the non-trivial conceptual and technical issues summarized in §§4-6. These issues are challenging and are likely to have dramatic impacts on the estimated price premia, especially for complex markets with many products and many attributes and for markets in which there is competition on non-price variables and/or funnel issues.

FSP is less sensitive to many of the technical issues to which the PEM is sensitive. Furthermore,

FSP has been applied widely (albeit strongly critiqued by opposing experts). Unfortunately, there is little if any scientific literature that examines whether FSP is reliable or whether FSP is a valid approximation to price premia. Preliminary evidence suggests FSP price premia are approximately equal to calculated median WTPs, but further research would be welcome.

WTP, PEM, and FSP price premia calculations are extremely sensitive to craft. In addition, craft directly affects the error term in the mixed-logit model, which, in turn, strongly affects the predicted price equilibria in the PEM. Experts using CBC to calculate WTP, PEM, or FSP should focus on ensuring high-quality craft through study characteristics such as highly realistic stimuli, incentive alignment, and recalibration to the marketplace (external validity).

We do not wish to minimize the challenges and expense of high-quality craft. For example, while the use of incentive alignment has grown in the academic literature, there were few applications in our review of publicly available CBC-based litigation. Clearly not every respondent to a CBC study can be given an incentive-aligned product—that would be too expensive, especially for high-priced products. To control costs, researchers use lotteries. To mitigate the risk of high payouts for high-priced products and to handle varying state laws on lotteries, researchers use prize-indemnity insurance (Ding et al. 2011). Deciding how best to set the probability of winning an incentive-aligned product to balance incentives and costs remains an expert judgment that we expect will be clarified through academic research.

Similarly, just using pictures, animations, or videos does not assure high-quality craft. The expert should demonstrate that the stimuli, choice tasks, and outside options are judged by consumers to be realistic representations of marketplace decisions. Practical impact-vs.-cost concerns apply to many aspects of craft.

Supply-side calculations are sensitive to whether the CBC model is calibrated to the actual marketplace. This concern is particularly acute for PEM calculations but applies to the reliability of WTP, PEM, and FSP calculations. Marketplace data are often rare and expensive to obtain. Future academic

research might identify how best to obtain these data and how best to use these data to calibrate partworths and scale to the marketplace.

9. Criteria by Which to Evaluate Supply-Side Models

Because supply-side models in litigation are still being developed and evaluated, we provide a table of considerations that a CBC expert (or an opposing expert) can use to examine the reliability of a CBC supply-side model. These criteria are provided in Table 3. We assume that the CBC estimates are obtained with scientifically-valid statistical procedures and that the data are collected following the principles set forth in Diamond (2011). While many of these concerns go to weight rather than admissibility[41], we note a quote by Schofield (2020, p. 9) "there are only so many questions of weight that can be tolerated; as each flaw in a survey diminishes its reliability and probative value, and correspondingly increases the risk of jury confusion and prejudice, eventually the cumulative effect of the flaws mandates exclusion."

[41] For example, while agreeing with the merit of defendant's objections to the craft of the CBC study, Moreno (2021, p. 9) opines that the objections go to weight not admissibility of the CBC study.

Table 3. Criteria With Which to Evaluate the Reliability of CBC Supply-Side Analyses
(*WTP = willingness to pay, PEM = price equilibrium method, FSP = fixed supply pricing*)

A. Issues of craft for partworths for WTP, PEM, and FSP. Additional considerations for scale in PEM.	
Issues	**Criteria**
(1) Realism	Are the stimuli sufficiently realistic (pictures, videos), not just text only?
(2) Incentive aligned	Are respondents given appropriate incentives to tell the truth and think realistically?
(3) Understanding the CBC task	Are respondents trained appropriately to assure understanding of the CBC task?
(4) Understanding attributes	Are the attributes described in language consumers use? Do the consumers understand the attributes and the levels?
(5) Focalism	Does the format, number of attributes, and description of the attributes avoid focusing consumers on at-issue attributes more so than would be the case in the marketplace?
(6) Distraction attributes	Are there sufficient distraction attributes?
(7) Number of attributes, levels	Does the CBC study use enough, but not too many, attributes and attribute levels?
(8) All else equal	Does the consumer understand what other attributes exist and are held constant in the CBC profiles?
(9) Choice tasks	Has the expert established an appropriate number of choice tasks and an appropriate number of profiles within each choice task?
(10) Attention checks	Are instructional manipulation checks used to assure consumers pay appropriate attention to the CBC task (and think realistically)?
(11) Bots	Does the questionnaire use methods to avoid "bot" and questionnaire farms?
B. Issues in modeling the demand side for use in WTP, PEM, and FSP.	
(1) Large WTPs and/or outliers	Have steps been taken to avoid relying on individual-consumer WTPs that are unrealistically large or negative?
(2) Appropriate price range	Has the analysis avoided forecasting either WTPs or prices outside the range in the CBC profiles?
(3) Interactions	Has the analysis addressed any interactions between the at-issue attribute(s) and other attributes that are either explicit or implicit in the CBC study?
(4) Target sample	Is the target sample defined appropriately, especially for how the supply-side is modeled? If the focus is on WTP for at-issue products only, does the sample reflect that focus?
C. Conceptual issues in the application of PEM and FSP.	
(1) Validation of "as is" predictions	Does the CBC model predict (fit) the marketplace in the "as is" world without overly relying on brand-specific constants?
(2) Competition on non-price attributes	Has the expert assured that the competition in the marketplace is primarily on price and not primarily on non-price attributes or marketing actions?
(3) Funnel issues	The CBC model assumes that consumers are aware of the products and attributes and that the products are available to all consumers. If this is not the case, has it been considered when modeling the price premia?

Table 3 (continued). Criteria With Which to Evaluate the Reliability of CBC Supply-Side Analyses

D. Additional conceptual and technical issues when applying PEM.	
(1) Marginal costs	Does the CBC expert have a means to estimate marginal costs independently of the CBC data?
(2) Number of competitors	Is this feasible to do PEM calculations given the number of competitors in the marketplace?
(3) Consideration sets	Consideration sets often soften competition. Has the PEM method taken consideration sets into account?
(4) Price/positioning equilibrium	Does the PEM examine a price & positioning equilibrium? Does the CBC model predict if it is more profitable to copy an infringing attribute than to differentiate?
(5) Common information	PEM calculations assume that all competitors have equal access to high-quality CBC studies or equivalent data. Do they?
(6) Existence and uniqueness	Do price equilibria exist for a sufficient percentage of the draws? Are they unique?
(7) Outliers	Has the expert assured the profit maximization calculations do not unreliably exploit outliers for unrealistically high prices?

E. Additional issues when applying FSP.	
(1) Constant supply curve	Has the expert established the validity of the fundamental assumption of FSP that the supply curve is constant?
(2) Grounded to "as is" prices	If historical "as is" prices are used, do they really affect the price-premium calculations, or are FSP calculations relatively unaffected by "as is" prices?
(3) Theory of the case	Does FSP match the theory of the case?
(4) Median vs. marginal consumer	Has the expert examined whether the FSP price premia are close to the WTP of the median consumer (as is often the case)? If the expert argues the FSP price premia are based on the marginal consumer, has the expert established that the FSP simulations reflect the marginal consumer.?
(5) Outside option	In FSP, the outside option represents other products in the market and generic options? Does the consumer understand how the outside option is interpreted and has the expert established that the interpretation of the outside option does not change in the "but for" world?
(6) Target population	Has the expert established that the demand curve for FSP represents consumers who purchased the at-issue product? Do consumers who purchased the at-issue product have the same partworths as those consumers who chose not to purchase the at-issue product?

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Appendix: Legal Citations for Review of CBC in Litigation

Apple, Inc., a California corporation, v. Samsung Electronics Co., Ltd., a Korean corporation; Samsung Electronics America, Inc., a New York corporation; and Samsung Telecommunications America, LLC, a Delaware limited liability company, 11-CV-01846-LHK, United States District Court Northern District of California San Jose Division.

Apple, Inc., a California corporation, v. Samsung Electronics Co., Ltd., A Korean corporation; Samsung Electronics America, Inc., a New York corporation; Samsung Telecommunications America, LLC, a Delaware limited liability company, 12-CV-00630-LHK, United States District Court Northern District of California San Jose Division.

Dayna Craft (withdrawn), Deborah Larsen, Wendi Alper-Pressman, individually and on behalf of all others similarly situated vs. Philip Morris Companies, Inc., a corporation, and Philip Morris Incorporated, a corporation, 002-00407-02, Missouri Circuit Court Twenty-Second Judicial Circuit (City of St. Louis).

Jackie Fitzhenry-Russell, et al., v. Dr. Pepper Snapple Group, Inc., et al., 17-cv-00564 NC, United States District Court Northern District of California.

Stephen Hadley v. Kellogg Sales Company, 16-CV-04955-LHK, United States District Court for the Northern District of California, San Jose Division.

In re Dial Complete Marketing & Sales Practice Litigation, 11-md-2263-SM, United States District Court for the District of New Hampshire.

In re GM LLC Ignition Switch Litigation, 14-MD-2543 (JMF), United States District Court for the Southern District of New York.

In re Lenovo Adware Litigation, 15-md-02624-RMW, United States District Court Northern District of California San Jose Division.

In re MyFord Touch Consumer Litigation, 13-cv-03072-EMC, United States District Court for the Northern District of California. 52

In re NJOY Consumer Class Action Litigation, 14-00428 MMM (JEMx), United States District Court for the Central District of California.

In the Matter of Determination of Rates and Terms For Digital Performance In Sound Recordings And Ephemeral Recordings (Web IV), 14-CRB-0001-WR, Before the Copyright Royalty Board Library of Congress Washington, DC.

IPA Technologies Inc., vs. Amazon.com, Inc., And Amazon Digital Services, LLC, 1:16-cv-01266- RGA, United States District Court for the District of Delaware.

Krommenhock v. Post Foods, LLC, 16-cv-04958-WHO, United States District Court for the Northern District of California.

Lotus Development Corporation v. Borland International, Inc., 516 US 233, United States District Court for the District of Massachusetts.

Dennis MacDougall, Ray Seow, Prabhanjan Kavuri, Richard Frick, Joseph Ryan Parker and Bryan Lents, individually and on behalf of all other similarly situated, v. American Honda Motor Co., Inc., and Honda North America, Inc., 17-cv-1079, United States District Court Central District of California.

Vicky Maldonado, et al., v. Apple Inc, et al., 3:16-cv-04067-WHO, United States District Court Northern District of California San Francisco Division.

Patrick McMorrow, Marco Ohlin and Melody DiGregorio, on behalf of themselves, all others similarly situated and the general public, v. Mondelez International, Inc., 3:17-cv-02327-BASJLB, United States District Court Southern District of California.

Morales, et al. v. Kraft Foods Group, Inc., et al., 14-cv-04387-JAK-(PJWx), United States District Court for the Central District of California. 53

Eric Passman and Ishmael Alvarado, individually and on behalf of all others similarly situated, vs. Peloton Interactive, Inc., 19-cv-11711 (LJL), United States District Court for the Southern District of New York.

Brandi Price and Christine Chadwick, individually and on behalf of all others similarly situated, v. L'Oreal USA, Inc. and Matrix Essentials LLC, 17 Civ. 614 (LGS), United States District Court for the Southern District of New York.

Qualcomm Incorporated, v. Apple Inc., 17-cv-1375-DMS (MDD), United States District Court for the Southern District of California.

Jennifer L. Saavedra, Dr. Melissa Strafford, Carol Jacquez, and David Matthews, Jr., on behalf of themselves and all other persons similarly situated, v. Eli Lilly and Company, an Indiana corporation, 2:12-cv-09366-SVM (MANx), United States District Court for the Central District of California.

Toby Schechner, et al., v. Whirlpool Corporation, 2:16-cv-12409, United States District Court for the Eastern District of Michigan Southern Division.

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Jeff Young, individually and on behalf of all others similarly situated, v. CREE Inc., 4:17-cv- 06252-YGR, United States District Court for the Northern District of California Oakland Division.

Oula Zakaria, individually and as a representative of the class, v. Gerber Products Co., a corporation d/b/a Nestlé Infant and Nestlé Nutrition North America, 2:15-cv-00200-JAK-GJS, United States District Court for the Central District of California, Western Division.

Supply Side When Using Conjoint Analysis in Litigation – Alt Text

Figure Number and Page	Alt Text
Figure 1, Example Choice Set for Smartwatches, (p. 2)	A conjoint-analysis choice stimulus displaying images of three watches with varying watch face, case color, band, and price.
Table 1, Illustrative Effect of Craft on WTP (p. 21)	WTP varies dramatically depending on the realism of stimuli, incentive alignment, training videos, and instructions.
Figure 2, Predicted Equilibrium Price Depends on Scale (p. 23)	Predicted equilibrium prices (smartphones or cameras) decrease by hundreds of dollars based on the "scale" of the CBC study.
Table 2, Illustrative Effect of Craft and Marketplace Validation on Price Premia (p. 25)	WTP and price equilibria vary with and without incentive alignment. Price equilibria in the study vary from the marketplace.
Figure 3, Price-Insensitive Segments Imply Unrealistic Profit-Maximizing Prices (p. 35)	Price equilibria calculations suggest an unrealistic global maximum of $120 and a realistic local maximum of $1.40. Study range $1-$2.
Figure 4, Sensitivity of Predicted Probability of Purchase to Price is Based on Scale (p. 36)	Plots of probability of choice vs. price. High "scale" implies an S-shaped curve; low scale implies an almost-linear curve.
Table 3, Criteria With Which to Evaluate the Reliability of CBC Supply-Side Analyses (p. 47)	Summary of criteria with which to evaluate the reliability of expert reports that rely on CBC supply-side analyses.