

**CALCULATING REASONABLE ROYALTY DAMAGES
USING CONJOINT ANALYSIS**

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I. INTRODUCTION

In many recent high-stakes patent disputes, plaintiffs' experts have measured reasonable royalty damages using data obtained from conjoint surveys.¹ While the use of conjoint analysis in patent disputes is becoming increasingly popular, the method involves a number of highly technical analyses and calculations.²

This article provides a user-friendly primer on methods that use conjoint analysis to determine reasonable royalty damages. We present detailed descriptions of two such methods referred to here as the Market Share Method ("MSM") and the Equilibrium Profit Method ("EPM"). Both the MSM and the EPM focus on measuring profit that the alleged infringer would earn by, hypothetically, selling a non-infringing version of its product.³ The MSM makes

¹ See, e.g., *Visteon Glob. Tech., Inc. v. Garmin Int'l, Inc.*, No. 10-CV-10578, 2016 WL 5956325, at *2–6 (E.D. Mich. Oct. 14, 2016); *Apple, Inc. v. Samsung Elecs. Co.*, 67 F. Supp. 3d 1100, 1120–21 (N.D. Cal. 2014); *TV Interactive Data Corp. v. Sony Corp.*, 929 F. Supp. 2d 1006, 1020–22 (N.D. Cal. 2013); *Apple, Inc. v. Motorola, Inc.*, 869 F. Supp. 2d 901, 905 (N.D. Ill. 2012); *Apple, Inc. v. Samsung Elecs. Co.*, No. 11-CV-01846-LHK, 2012 WL 3283478, at *7 (N.D. Cal. Aug. 9, 2012); Memorandum Opinion and Order at 4–5, Memorandum Opinion, *VirnetIRNETX IncNC. v. Cisco Systems, Inc.*, No. 6: 10-CV-417 (E.D. Tex. Mar. 23, 2017) (No. 754); Memorandum Opinion and Order at 3–4, *ContentGuard Holdings, Inc. v. Amazon.com, Inc.*, No. 2:13-CV-1112-JRG (E.D. Tex. Aug. 26, 2016) (No. 825); Order at 18, *Microsoft Corp. v. Motorola, Inc.*, No. C 10-1823JLR (W.D. Wash. May 4, 2016) (No. 490); Memorandum Opinion at 9–10, *Rembrandt Social Media, LP v. Facebook, Inc.*, No. 1:13-CV-158 (E.D. Va. Apr. 4, 2016) (No. 351); Order re Apple's Motion to Exclude the Surveys, Expert Reports, and Opinions of Howard Marylander and James Berger and References thereto by Joseph Gemini at 4–5, *NetAirus Tech., LLC v. Apple, Inc.*, No. LA 10-CV-03257 (C.D. Cal. Jan. 20, 2015).

² See *infra* Part III (explaining in more detail that a conjoint survey is an advanced market research technique involving asking survey respondents to choose among various product profiles). Certain statistical methods—referred to collectively as conjoint analysis—are applied to these survey data to determine which product attributes were the drivers of the respondents' choices among the given profiles. See Lisa Cameron et al., *The Role of Conjoint Surveys in Reasonable Royalty Cases*, LAW360 (Oct. 16, 2013, 6:37 PM), <http://www.law360.com/articles/475390/the-role-of-conjoint-surveys-in-reasonable-royalty-cases> [<https://perma.cc/4AET-TL85>].

³ Typically, in these cases, the defendant has never sold a non-infringing version of its product, which makes a calculation of profit based on real

the simplifying assumption that the alleged infringer charges the same price for infringing and non-infringing versions of its product.⁴ In contrast, the EPM allows the alleged infringer to adjust its price in response to the actions of its competitors and changes in production costs.⁵ The latter method is more theoretically sound but involves more complex calculations and assumptions about the behavior and costs of competing firms.⁶

The article proceeds as follows. First, it reviews the economic framework that lies behind the calculation of reasonable royalty damages. Second, it provides additional background on the conjoint survey itself, explaining how such a survey elicits consumers' valuations of an infringing feature in a complex, multi-featured product. Third, it explains how the MSM and EPM are implemented and concludes with a brief review of the relative merits of these and other methods that rely on conjoint analysis to determine reasonable royalty damages.

II. BACKGROUND: THE ECONOMIC FRAMEWORK FOR CALCULATING REASONABLE ROYALTIES

In a reasonable royalty case, the goal of the damages calculation is to determine the amount of money that the alleged infringer ("defendant") would need to pay the patent holder ("plaintiff") to put the plaintiff in the same economic position that it would have been in if the infringement had not occurred.⁷ This goal is often formulated in terms of estimating the royalty amount that would have been agreed to in a hypothetical negotiation between the plaintiff and the defendant at the time of first infringement.⁸ The hypothetical negotiation is an economically reasonable approach for calculating damages because, in many cases, the loss suffered by the plaintiff as a result of the defendant's infringement is indeed the failure to collect license royalties that it

world data impossible. Hence, the damages expert uses conjoint analysis to determine how much profit the defendant would have made on the sales of this non-infringing version of its product in the market.

⁴ See *infra* Section IV.A.

⁵ See *infra* Section IV.B.

⁶ See, e.g., Greg M. Allenby et al., *Valuation of Patented Product Features*, 57 J.L. ECON. 629, 630 (2014).

⁷ See, e.g., MARK A. GLICK ET AL., *INTELLECTUAL PROPERTY DAMAGES: GUIDELINES AND ANALYSIS* 151–52 (2002).

⁸ *Id.*

would reasonably have collected “but for” the infringement of the plaintiff’s patent.⁹ The basic economic principle governing the negotiation is that a rational actor will only enter into agreements that make it better off.¹⁰ This consideration determines “the boundaries of a mutually beneficial license,” when one exists.¹¹ In such a negotiation, the patent-holding plaintiff will accept nothing less than the opportunity cost associated with granting the license to the defendant, while the defendant will be willing to pay nothing more than its potential profit attributable to use of the license.¹²

The *Georgia Pacific* factors provide a standard framework for determining the reasonable royalty that would emerge from the hypothetical negotiation.¹³ These factors address three general considerations that impact the reasonable royalty for the license at issue: (i) information provided by existing licenses regarding the likely royalty amount; (ii) costs to the licensor of granting a license; and (iii) benefits to the licensee of obtaining a license.¹⁴

Clearly, when the same intellectual property has already been licensed out to firms that are in a similar position to the defendant, the information provided by these firms’ license payments can be invaluable in establishing the reasonable royalty in the case at issue.¹⁵ In the absence of such data, however, the damages expert will want to determine: (i) the minimum amount that the plaintiff would be willing to accept for the license and (ii) the maximum amount that a defendant would be willing to pay for the license (which we will refer to,

⁹ *Id.* at 152.

¹⁰ *Cf. id.* at 156 (explaining that “a rational economic agent will not willingly enter into an agreement that makes him worse off”).

¹¹ *See id.* at 156–57 (explaining how the *Georgia-Pacific* factors consider both the hypothetical licensor’s costs and benefits in granting a license).

¹² *Id.* at 157.

¹³ *Georgia-Pacific Corp. v. U.S. Plywood Corp.*, 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970) (providing fifteen factual considerations relevant to determining the amount of a reasonable royalty).

¹⁴ GLICK ET AL., *supra* note 7, at 153 (explaining that *Georgia-Pacific* factors 1, 2, and 4 consider whether other licenses provide useful information; factors 4 and 5 consider costs to the licensor of granting a license; and 6, 8, 9, 10, 11, 12, and 13 consider the benefits to the licensee of obtaining a license).

¹⁵ *Id.* (“The *Georgia-Pacific* factors 1, 2, and 4 direct us to examine whether other licenses provide useful information.”).

hereinafter, as the defendant's "maximum potential payment," or "MPP").¹⁶ The value of the license will typically lie somewhere in the range defined by these two figures.¹⁷

Given that the defendant's MPP provides the upper bound on the damage figure, a plaintiff will usually focus the damages analysis on calculating the defendant's MPP. When the patent is tied to a particular product feature, the defendant's MPP is equal to the difference between: (i) the profit that the defendant earns from selling the product with the allegedly infringing feature and (ii) the profit that the defendant would earn from selling the exact same product (in terms of brand and other relevant characteristics) without this feature.¹⁸ In some cases, market data will be available to facilitate the calculation of the defendant's profit on each version of its product. For example, we may be able to observe the defendant's sales of its product before and after the addition of the infringing feature, or the defendant may have sold its product with the infringing feature in some geographic areas and without the infringing feature in others.

In many cases, however, we do not observe such "natural experiments."¹⁹ As a result, plaintiffs are increasingly turning to conjoint

¹⁶ *Georgia-Pacific Corp.*, 318 F. Supp. at 1121 ("[The] approach . . . requires consideration not only of the amount that a willing licensee would have paid for the patent license but also of the amount that a willing licensor would have accepted.") (alteration added). This amount is also often referred to as the defendant's maximum willingness to pay. However, we use the term MPP to avoid confusion with a term of art frequently used in conjoint analysis called consumer willingness to pay.

¹⁷ There are exceptions to this rule of thumb. For example, if the plaintiff competes in the same market as the defendant and is seeking reasonable royalty damages—as opposed to lost profits—the appropriate damages figure could potentially exceed the defendant's MPP.

¹⁸ See *Allenby et al.*, *supra* note 6, at 631–33. Note that in some cases, the defendant will need to drop the feature entirely in order to avoid infringement. In other cases, the defendant can modify the feature at issue so that it is no longer infringing. Often, the defendant will require some time to modify its product so that it is no longer infringing the patent at issue. However, in our analysis, we assume for the sake of simplicity that the infringing feature can be modified or removed instantaneously.

¹⁹ *Cameron et al.*, *supra* note 2.

analysis,²⁰ which can be used to determine respondents' valuations of infringing and non-infringing versions of the product even when both products are not available on the market at the same time.²¹

The next section outlines a hypothetical situation in which the plaintiff's expert runs a conjoint survey to determine how much consumers value the defendant's product without the infringing feature. It reviews the key elements of a conjoint survey and discusses several approaches towards estimating the defendant's MPP using conjoint survey data.

III. THE ROLE OF CONJOINT ANALYSIS

Consider a case in which a plaintiff has patented the means for including a Wi-Fi connection in a camera. Suppose further that there is a single producer whose camera allegedly infringes the patent, while the other producers offer cameras with no Wi-Fi connection at all.²²

In the absence of suitable data on the defendant's sales of its camera with and without the infringing feature, the plaintiff's damages expert may analyze consumer preferences for an infringing and non-infringing version of the defendant's camera using data obtained from a conjoint survey. In such surveys, respondents must make a series of choices among product profiles with different sets of features.²³

²⁰ *Id.*

²¹ See Allenby et al., *supra* note 6, at 632–33. The inability to observe products with and without the infringing feature in the marketplace at the same time is a fundamental problem in patent damages analysis. This same problem arises in product mislabeling cases. Typically, in such cases, we observe the market price of a product with a claim that is alleged to be fraudulent, but we do not observe the market price of the same product without the accused claim. In these product mislabeling cases, the role of conjoint analysis is to determine to what extent the claim influences or enhances demand for the product.

²² For the sake of simplicity, the discussion throughout this paper assumes that no other seller has access to the infringing feature.

²³ See Cameron et al., *supra* note 2. Survey respondents are screened for inclusion in the survey if they are willing and able to purchase the product. This is because the survey is meant to represent that portion of the population (say, U.S. residents) that may be willing to pay for the good or service. Respondents are anticipated to be active in the purchase decision (or

For example, a conjoint survey designed to assess the defendant's MPP with respect to an infringing Wi-Fi feature may ask a respondent to make a series of choices among camera profiles comprised of the following four features: brand, availability of Wi-Fi connection, resolution, and price.²⁴ These features are often referred to as attributes, while the values that characterize each attribute are referred to as levels.²⁵

Table 1. Sample Choice Task

Table 1 provides a single choice task for this study. In this choice task, for example, the brand attribute takes on three levels: X, Y, and Z.²⁶

	Profile 1	Profile 2	Profile 3	Profile 4
Brand	X	Y	Z	Purchase
Wi-Fi	Yes	No	No	none of
Resolution	High	Low	High	these
Price	\$60	\$60	\$50	

In the case of complex, multi-featured products, the conjoint survey will focus on only a subset of product attributes.²⁷ Nonetheless, the choice of attributes included in the survey should not have a significant impact on the results because respondents are told to hold constant attributes—such as the zooming capability of the lens or the camera screen size—that are not included in the survey.²⁸

recently active) and are assumed to have some knowledge of the brands and prices available in the marketplace.

²⁴ *Id.*

²⁵ *Id.*

²⁶ Similarly, the Wi-Fi attribute has two levels: yes and no. The resolution attribute has three levels: high, medium, and low. Finally, the price attribute can take on four levels: \$40, \$50, \$60, and \$70. Note that not all of these alternatives are depicted in the single choice task depicted in Table 1.

²⁷ The need to focus on a subset of attributes arises because extensive experience with conjoint surveys has shown that consumers cannot effectively weigh more than seven attributes. *See, e.g.,* Paul E. Green & V. Srinivasan, *Conjoint Analysis in Marketing: New Developments with Implications for Research and Practice*, 54 J. MARKETING, Oct. 1990, at 8–9.

²⁸ *See e.g.,* Cameron et al., *supra* note 2. As noted in this article, under some circumstances the concern may arise that consumers hold different views on

Profile 4 in Table 1 is often referred to as the “no choice” option.²⁹ Respondents select this profile when none of the other profiles is attractive enough to trigger a purchase. The “no choice” option indicates that the consumer chooses either to buy other brands of cameras with attributes and prices that are not explicitly described, or to make no purchase because the prices and attributes of the brands in the choice task are unattractive.³⁰ The inclusion of the “no choice” option in the choice task prevents the conjoint survey from forcing the respondent to choose among the limited number of profiles described in the choice task.

Conjoint surveys provide much more accurate information on consumer preferences than an approach in which survey respondents are asked directly how much they value individual product features (such as a Wi-Fi connection embedded in a camera).³¹ This is because respondents in a conjoint survey are asked to choose among product profiles just as they might do in a real shopping situation.³² In contrast, experience with direct questioning in market research shows that it is particularly difficult to obtain reliable stated values for products that consumers do not buy regularly or that require unfamiliar trade-offs.³³

“Today, most conjoint surveys are conducted in an online setting where survey respondents must choose among product profiles with different basic

which attributes are being held constant. Differing consumer perceptions of what is being held constant, however, will be a lesser concern when survey respondents are familiar with the product under consideration. It is also important to recognize that some brands may have unique features (i.e., the operating system of an Apple iPhone 6) that need not be mentioned in the conjoint survey but will instead be captured as part of the brand attribute.

²⁹ See *id.*; See also Allenby et al., *supra* note 6, at 640. The “no choice” option is also sometimes referred to as the “no buy” option.

³⁰ See Allenby et al., *supra* note 6, at 644.

³¹ See Olivier Toubia et al., *Optimization-Based and Machine-Learning Methods for Conjoint Analysis: Estimation and Question Design*, in *CONJOINT MEASUREMENT: METHODS AND APPLICATIONS* 231, 233 (Anders Gustafsson et al. eds., 4th ed. 2007); see also, BRYAN K. ORME, *GETTING STARTED WITH CONJOINT ANALYSIS: STRATEGIES FOR PRODUCT DESIGN AND PRICING RESEARCH* 18 (2006); Greg M. Allenby et al., *Incorporating Prior Knowledge into the Analysis of Conjoint Studies*, 32 *J. MARKETING RES.* 152, 152–53 (1995).

³² See Cameron et al., *supra* note 2.

³³ *Id.*

features.”³⁴ Respondents to conjoint “surveys typically perform between 12 and 20 ‘choice tasks’” like the one illustrated in Table 1.³⁵ Each respondent-task provides a data point for the analysis. Hence, if 400 respondents take the survey and each respondent makes twenty choices, there will be 8,000 data points in the analysis. The attribute levels associated with the profiles change across the choice tasks and respondents vary their choices in response to these changes.³⁶

Given these types of data, the damages expert can then perform a statistical analysis—referred to as conjoint analysis—in which he uses each respondent’s choices to determine how much each level of each attribute contributes to the respondent’s overall valuation of the product.³⁷ “This contribution is referred to as the ‘part-worth’ of the attribute level.”³⁸ “In the patent infringement context, the part-worths are a key input in the determination of [the defendant’s MPP, and hence] the reasonable royalty.”³⁹ It should be noted that part-worths are measured in utils; in economic parlance, the term util is a measure of utility or value.

IV. USING CONJOINT ANALYSIS TO ASSESS PATENT DAMAGES

This section explains how the part-worths obtained through conjoint analysis are used to assess reasonable royalty damages. As noted above, the upper bound on reasonable royalty damages will typically be the defendant’s MPP, which is the difference between the defendant’s profit in two worlds: (i) the “infringing world” in which the defendant sells a product that includes the infringing feature and (ii) the “non-infringing world” in which the defendant

³⁴ *Id.* Survey respondents are screened for inclusion in the survey if they are willing and able to purchase the product. This is because the survey is meant to represent that portion of the population (say, U.S. residents) who may be willing to pay for the good or service. Respondents are anticipated to be active in the purchase decision (or recently active) and are assumed to have some knowledge of the brands and prices available in the marketplace.

³⁵ See Cameron et al., *supra* note 2.

³⁶ See Allenby et al., *supra* note 6, at 638–40.

³⁷ This survey format is known as a choice-based conjoint (CBC) survey. Respondents are often instructed to assume that all other brand attributes are constant across all alternatives. See *id.* at 641–42.

³⁸ See Cameron et al., *supra* note 2.

³⁹ *Id.*

sells the exact same product (in terms of brand and other relevant characteristics), but without this feature.⁴⁰

In a number of cases in which conjoint analysis was used to value patent damages, plaintiffs' experts did not calculate the defendant's MPP but instead focused on calculating the price premium that a consumer would be willing to pay for the infringing level of the attribute.⁴¹ This so-called consumer willingness to pay ("consumer WTP") was typically measured as the average part-worth of the attribute level at issue, expressed in dollar terms.⁴² Plaintiffs' experts then estimated damages through a calculation that essentially multiplied average consumer WTP by the defendant's unit sales in the "infringing world."⁴³

Still, such an approach is inaccurate because, in fact, there is no straightforward relationship between the calculation described above and the defendant's MPP.⁴⁴ This is because the average consumer WTP for a particular product feature does not dictate the market price of that product.⁴⁵ The market price of the defendant's product in the "non-infringing world" is determined by a variety of factors in addition to consumer preferences, including competition

⁴⁰ Allenby et al., *supra* note 6, at 631–33.

⁴¹ See, e.g. Allenby et al., *supra* note 6, at 647. In our simple example, if a Wi-Fi attribute is included in the camera, the camera infringes the patent. Thus, the attribute itself infringes the patent. In other cases, however, there may be multiple levels of the attribute, only one of which infringes the patent. For example, one could imagine a case in which the Wi-Fi attribute could take one of three levels—high speed, conventional speed, and none—and only the high-speed level of the Wi-Fi attribute infringes the patent at issue.

⁴² See e.g. John R. Howell et al., *Feature Valuation Using Equilibrium Analysis*, in HANDBOOK OF MARKETING ANALYTICS: METHODS AND APPLICATIONS IN MARKETING MANAGEMENT, PUBLIC POLICY, AND LITIGATION SUPPORT *5 (Natalie Mizik & Dominique Hanssens eds., 2016) (unpublished manuscript) (on file with author). Consumer WTP for a particular attribute level is determined by dividing the part-worth of the attribute level (which is measured in utils) by the part-worth of price in order to obtain a part-worth expressed in dollar terms.

⁴³ Allenby et al., *supra* note 6, at 659–60.

⁴⁴ Some studies also consider the median consumer's WTP. However, the same issues with using consumer WTP instead of defendant's MPP arise.

⁴⁵ Allenby et al., *supra* note 6, at 652.

and cost considerations.⁴⁶ Recent court decisions have also recognized that damages calculations of this type are economically inappropriate.⁴⁷

For example, in *Visteon Glob. Tech.*, the plaintiff's damages expert relied primarily on a conjoint survey assessing consumer WTP for the infringing GPS features at issue in the case.⁴⁸ In assessing the credibility of plaintiff Visteon's damages expert and the reliability of his testimony, the court noted that his work provided no evidence of how the defendant Garmin's profit would have increased at the time of the hypothetical negotiation from incorporating the patented features.⁴⁹ The court concluded that Visteon's damages expert therefore provided no evidence that would enable a jury to determine how much Garmin would actually have been willing to pay to obtain the functionality of these features.⁵⁰ As a result of this and related considerations, the damages expert's testimony was ultimately excluded.⁵¹

Partially in response to critiques of the consumer WTP approach, damages experts have focused on two other approaches for assessing the defendant's MPP: the Market Share Method ("MSM") and the Equilibrium Profit Method ("EPM"). The remainder of this paper explains each method and concludes with a comparison of these two methods to the consumer WTP approach.

A. *Using the MSM to Assess the Defendant's MPP*

Under both the MSM and the EPM approaches, the damages expert calculates the upper bound on damages as the difference between the defendant's profit in the "infringing world" and the "non-infringing world."⁵² The key difference between the MSM and the EPM lies in how the defendant and its competitors behave in the "non-infringing world."

⁴⁶ Howell et al., *supra* note 42, at *19. Two of the authors of the present paper have published academic studies that specifically address this issue. *See, e.g., Id.*

⁴⁷ *See e.g., Visteon Glob. Tech., Inc. v. Garmin Int'l, Inc.*, No. 10-CV-10578, 2016 WL 5956325, at *6 (E.D. Mich. Oct. 14, 2016).

⁴⁸ *Id.* at *2-7.

⁴⁹ *Id.* at *17.

⁵⁰ *Id.*

⁵¹ *Id.* at *19.

⁵² GLICK ET AL., *supra* note 7, at 144.

In order to simplify the calculation of the defendant's "non-infringing world" profit, the MSM assumes that the price of the defendant's "non-infringing world" product is the same as the price of its "infringing world" product.⁵³ The defendant's profit in the "non-infringing world" is calculated as its "non-infringing world" unit sales multiplied by its "non-infringing world" operating margin (i.e., its "non-infringing world" price less its "non-infringing world" costs).⁵⁴ Because both elements of the "non-infringing world" operating margin are assumed to be known, the only remaining element of the "non-infringing world" profit calculation is the number of units sold.⁵⁵ An example is provided below that illustrates how the defendant's "non-infringing world" units can be calculated using the MSM.

In our example, we consider an "infringing world" in which there are only two-competing cameras available: (i) the defendant's (infringing) camera and (ii) a single camera made by a non-infringing producer. 5 million customers buy one of these two cameras; 2.5 million customers buy the infringing camera, and 2.5 million buy the competitor's camera. The defendant sells the infringing camera at a price of \$60, and its cost of producing this camera is \$54, so the "infringing world" operating margin is \$6 per unit. Multiplying this \$6 operating margin by actual units sold (2.5 million), we obtain the defendant's actual profit, \$15 million.⁵⁶

Next, we turn to the "non-infringing world" in which the defendant sells a non-infringing (defeated) version of its camera and the competitor's camera remains unchanged. Under the MSM, the price of the defendant's defeated camera in the "non-infringing world" is assumed to be \$60 (its "infringing world" price). However, the defendant's production cost decreases from \$54 to

⁵³ *Id.*

⁵⁴ *Id.*

⁵⁵ *Id.*

⁵⁶ Here, we use the term "actual" to refer to figures observed in the real world—as opposed to figures computed using the conjoint model. For the sake of simplicity, this example abstracts from the fact that a damages expert using the MSM will also typically use conjoint analysis to estimate "infringing world" unit sales for reasons discussed further below.

\$51 to reflect the infringing feature's marginal cost of \$3 per camera (assumed known).⁵⁷ Thus, the "non-infringing world" operating margin is \$9 per unit.

In order to complete the calculation of the defendant's "non-infringing world" profit, we must calculate its "non-infringing world" unit sales.⁵⁸ This calculation relies on conjoint survey data to construct a model of consumer demand for the products of interest.⁵⁹ Let us assume that the plaintiff's expert has administered a conjoint survey to 400 respondents in order to determine their valuations of various camera features. Conceptually, we can think about how conjoint analysis is used in calculating the defendant's "non-infringing world" unit sales as a series of four steps.

First, the damages expert must determine how the 400 survey respondents value the two cameras available in the infringing world.⁶⁰ Table 2 presents—for a single survey respondent—sample valuations of these two camera profiles based on the results of the conjoint analysis. Panel A provides the respondent's valuations for both the defendant's camera and competitor's camera in the "infringing world"; Panel B provides the respondent's valuation for both cameras in the "non-infringing world."⁶¹ Comparing column [2] and [4]

⁵⁷ The defendant's marginal cost of producing the infringing product and its marginal cost of producing the infringing feature may be obtained through the discovery process or estimated from the company's public financial data. Note that we assume that the defendant's profit margin increases when it produces a non-infringing version of the camera. This is a conservative assumption from the plaintiff's perspective, because it will make "non-infringing world" profit larger, and therefore damages will be lower.

⁵⁸ Allenby et al., *supra* note 6, at 636.

⁵⁹ *Id.* at 638–45.

⁶⁰ *Id.* at 642–43. Note that this is the world in which the defendant infringes the patent. Competing producers, however, may not have similarly infringed, as in this example.

⁶¹ For the sake of simplicity, this discussion abstracts away from the fact that, for the statistical models implicitly underlying these estimates, there is typically a random component to utility in addition to the "systematic" component derived from part-worths. With this random component, we only know that—for any individual consumer—the product with the higher systematic valuation is more likely to be purchased than the product with the lower systematic valuation. However, when we aggregate each consumer's decision over the entire market, we know the market share associated with each product profile. To see this, consider a market with two

in Panel A, we see that the respondent values the defendant's infringing camera more than he values the sole competing camera; the respondent's overall valuation is forty utils for the defendant's infringing camera⁶² and only twenty-five utils for the competitor's camera.⁶³ Given that the respondent will purchase the product for which he has the highest valuation, this particular respondent would likely choose the defendant's infringing camera over the competitor's camera.

Table 2. Hypothetical Respondent's Valuations of Two Camera Profiles: Market Share Method (MSM).

Infringing World	Panel A			
	Defendant's Product		Competitor's Product	
	Feature [1]	Part-worth [2]	Feature [3]	Part-worth [4]
Brand	X	80	Z	65
Wi-Fi	Yes	20	No	0
Resolution	High	60	High	60
Price	\$60	-120	\$50	-100
Total Valuation		40		25

goods (A and B) and a single type of consumer. Due to the random component of utility, each consumer may have a 75% (25%) probability of choosing product A (product B). This implies that, considering the market as a whole, 75% of consumers pick product A and 25% pick product B. Allenby et al. (2014) provide further detail on how model-based estimates of demand are used to compute choice probabilities.

- ⁶² The higher the number of utils that an individual obtains from a product, the more likely the individual will be to purchase that product.
- ⁶³ Note that the (non-random) portion of each consumer's valuation is captured by the sum of his part-worths. Other consumers will have different part-worths for a camera with this profile and therefore different overall valuations.

Non-Infringing World	Panel B			
	Defendant's Product		Competitor's Product	
	Feature [1]	Part-worth [2]	Feature [3]	Part-worth [4]
Brand	X	80	Z	65
Wi-Fi	No	0	No	0
Resolution	High	60	High	60
Price	\$60	-120	\$50	-100
Total Valuation		20		25

Second, the damages expert must determine survey respondents' valuations of the defendant's camera in the "non-infringing world" in which the infringing feature has been removed.⁶⁴ Returning to Table 2, Panel A column [2] shows that in the "infringing world", the hypothetical respondent values the entire profile of the defendant's camera at forty utils and the Wi-Fi element in particular at twenty utils. Given this, we can predict that—in the "non-infringing world"—the respondent will value the defendant's defeatured camera at twenty utils⁶⁵ (see Panel B column [2]). Column [4] of Panel A and Panel B shows that the respondent obtains twenty-five utils from buying the competing camera in both the "infringing world" (see Panel A column [4]) and in the "non-infringing world" (see Panel B column [4]). Thus, we predict that in the "non-infringing world", the respondent would be more likely to purchase the competing camera (valued at twenty-five utils) than the defendant's defeatured camera (valued at twenty utils).

Third, the damages expert must compute market shares in the "non-infringing world" by adding up the choices that each survey respondent made in the prior step.⁶⁶ (Recall that Table 1 represents just one survey respondent's preferences; other consumers will have different preferences.) To calculate overall market shares, the damages expert must compare each respondent's valuations for three "non-infringing world" alternatives—the competing camera, the defendant's defeatured camera, and the no choice option.⁶⁷ Recall that the

⁶⁴ Allenby et al., *supra* note 6, at 634.

⁶⁵ Given that the respondent values the entire profile of the defendant's camera at 40 forty utils and he values the infringing feature at 20 utils, we can predict that he will value the defeatured camera at $40-20=20$ utils.

⁶⁶ Allenby et al., *supra* note 6, at 635.

⁶⁷ Note that the estimation method typically allows each survey respondent to have his own part-worths.

survey involves 400 respondents. Suppose that in the “non-infringing world,” forty of the total respondents value the defendant’s defeatured camera more than the competing camera or the no choice option. In that case, the survey expert can conclude that, in the “non-infringing world,” ten percent of camera buyers will choose the defendant’s defeatured camera. When we apply this ten percent figure to the total population of camera buyers (assumed to be 5 million consumers), we estimate the defendant’s unit sales in the “non-infringing world” to be 0.5 million.

Fourth, the damages expert computes the defendant’s “non-infringing world” profit.⁶⁸ Under the MSM, this figure is calculated as the difference between the actual price of the infringing camera (\$60) and the actual cost of producing the camera without the infringing feature (\$51), multiplied by “non-infringing world” units (0.5 million) determined in the previous step. This calculation yields “non-infringing world” profit of \$4.5 million ($\9×0.5 million).

The last step in establishing the defendant’s MPP is determining the defendant’s “infringing world” profit.⁶⁹ In principle, one could calculate this figure from accounting data on units actually sold by the defendant. As noted above, with actual prices of \$60, actual costs of \$54, and actual units sold of 2.5 million, the defendant’s infringing world profit would be \$15 million. The difference between actual profit of \$15 million and “non-infringing world” profit of \$4.5 million would provide a defendant’s MPP of \$10.5 million.⁷⁰

⁶⁸ Allenby et al., *supra* note 6, at 636.

⁶⁹ *Id.*

⁷⁰ See *supra* note 61 (noting that the damages expert typically will not use actual units sold in order to calculate “infringing world” profit. Noting instead, that the expert will predict the number of infringing units based on the results of the conjoint analysis, in the same way that he used conjoint analysis to calculate “non-infringing world” units sold). The expert will predict this way because—like all estimates—the “non-infringing world” estimate of units sold always contains a degree of prediction error. However, the expert can mitigate the impact of these prediction errors by calculating the change in units sold as the difference between MSM predicted units in the “infringing world” and MSM predicted units in the “non-infringing world”; this differencing helps to cancel out the prediction errors associated with each estimate. In contrast, if the expert compared actual units sold (in the “infringing world”) to MSM-predicted unit sales (in the “non-infringing world”), our damage results could be more heavily influenced by these prediction errors.

B. Using the EPM to Assess the Defendant's MPP

Although the MSM does tie the upper bound on damages to the defendant's MPP, the method is subject to criticism because it holds the defendant's "non-infringing world" price fixed. As a result, it does not allow the defendant to adjust the price of its defeated product in response to the actions of its competitors or to any change in its production costs.

In contrast, the EPM provides a mechanism that allows the damages expert to address these issues. Under this approach—just as under the MSM—the damages expert calculates the defendant's MPP as the difference between its profit in the "infringing world" and the "non-infringing world."⁷¹ Just as in the case of the MSM, the focus is on the calculation of "non-infringing world" profit, and we can again describe the analysis of the defendant's "non-infringing world" profit as a series of steps.

First, just as in the MSM, the damages expert must determine how the conjoint survey respondents value the two cameras available in the infringing world.⁷² Table 3 presents—for a hypothetical survey respondent—valuations of the two camera profiles that we considered in our discussion of the MSM. Panel A provides the "infringing world" attribute levels of the two cameras and their associated part-worths, just as it did in Table 2.

Table 3. Hypothetical Respondent's Valuations of Two Camera Profiles: Equilibrium Profit Method (EPM).

Infringing World	Panel A			
	Defendant's Product		Competitor's Product	
	Feature [1]	Part-worth [2]	Feature [3]	Part-worth [4]
Brand	X	80	Z	65
Wi-Fi	Yes	20	No	0
Resolution	High	60	High	60
Price	\$60	-120	\$50	-100
Total Valuation		40		25

⁷¹ Allenby et al., *supra* note 6, at 645–47.

⁷² See *id.* at 634–46.

Non-Infringing World	Panel B			
	Defendant's Product		Competitor's Product	
	Feature [1]	Part-worth [2]	Feature [3]	Part-worth [4]
Brand	X	80	Z	65
Wi-Fi	No	0	No	0
Resolution	High	60	High	60
Price	\$56	-112	\$51	-102
Total Valuation		28		23

Second, unlike in our prior analysis, we allow both the defendant and its competitor to re-optimize their prices once the infringing product is no longer available on the market.⁷³ In particular, the defendant may choose to reduce the price of its defeatured product to: (i) offset the lower value that its defeatured product provides to consumers and/or (ii) reflect the fact that the defendant's production costs for the defeatured product are lower than those for the infringing product.⁷⁴ At the same time, the competitor may choose to raise its price to take advantage of its improved position vis-a-vis the defendant's product. Both the defendant and the competitor choose prices and quantities that maximize their profit.⁷⁵ Table 3, Panel B, Column [1] provides the features of the defendant's "non-infringing world" product, including its re-optimized price (which has declined from \$60 to \$56), while Column [2] provides the associated valuations. Likewise, Panel B, Column [3] provides the features of the competitor's "non-infringing world" product, which are unchanged relative to those in the MSM approach except for the competitor's re-optimized price (which has increased from \$50 to \$51). Column [4] provides the associated valuations.

⁷³ *Id.* at 646.

⁷⁴ *Id.* at 655–57.

⁷⁵ The equilibrium concept that is commonly used in these cases is referred to by economists as a Nash Bertrand equilibrium. Under this equilibrium concept, each firm chooses its price such that it maximizes its profit given the prices chosen by other firms. Because each firm has chosen a profit maximizing price, none of the firms under study has a profit incentive to change its market offering. Consistent with common practice, our discussion of the EPM assumes that firms change prices rather than product features in the "non-infringing" world.

Third, once optimal prices have been determined for each product in the “non-infringing world,” the damages expert can then compute “non-infringing world” unit sales.⁷⁶ As in the MSM, the damages expert calculates each survey respondent’s valuation for the various alternatives, given the optimal price for the defeatured camera that was calculated in the prior step. Each respondent is assumed to purchase the camera that provides him with the greatest value (or forego purchase if the “no choice” option provides the greatest utility).

Fourth, the damages expert computes the defendant’s “non-infringing world” sales by adding up the choices made by each survey respondent in the prior step.⁷⁷ Recall that our hypothetical conjoint survey involved 400 respondents. Suppose that the defendant lowers the price of its defeatured camera so that 140 respondents assign the highest valuation to the defendant’s defeatured camera. In that case, the survey expert can conclude that—in the “non-infringing world”—35% will choose the defendant’s defeatured camera.⁷⁸ Recall that the entire population of camera buyers is 5 million. Thus, in the “non-infringing world”, the defendant will sell 1.75 million (defeatured) cameras.

Finally, the damages expert computes the defendant’s MPP as the difference between the defendant’s “infringing world” and “non-infringing world” profit.⁷⁹ With an operating margin of \$5 and sales of 1.75 million units, the defendant’s “non-infringing world” profit is \$8.75 million. As in the case of the MSM, the defendant’s “infringing world” profit under the EPM could—in principle—be calculated using real world accounting data on prices and units sold. If that were done in this case, the defendant’s “infringing world” profit would be \$15 million and the defendant’s MPP would be the difference between \$15 million and \$8.75 million, or \$6.25 million.⁸⁰

⁷⁶ Allenby et al., *supra* note 6, at 645–47.

⁷⁷ *Id.* at 657.

⁷⁸ Recall that the number of consumers who would still buy the defendant’s product was only 0.5 million under the MSM. The increase in the defendant’s market share in the EPM results from the price re-optimization described in the second step of Section IV.B.

⁷⁹ Allenby et al., *supra* note 6, at 657.

⁸⁰ In practice, however, the defendant’s “infringing world” price and unit sales, like its “non-infringing world” price and unit sales, are predicted using the EPM, for the same reasons that “infringing world” unit sales are predicted using the conjoint model under the MSM. *See supra* note 70.

V. CONCLUSIONS: COMPARISON OF APPROACHES USING CONJOINT ANALYSIS TO ASSESS DAMAGES

In a number of high stakes patent infringement cases, experts have introduced evidence based on conjoint analysis to calculate reasonable royalty damages.⁸¹ These analyses have been approached in a variety of ways. Although some damages experts have used what we refer to as the consumer WTP approach, this approach has been justly criticized.⁸² This is because there is no straightforward relationship between the outcome of this approach and defendant's MPP, which is the difference between the defendant's profit in the "infringing world" and the "non-infringing world."⁸³

Two other methodologies, the MSM and the EPM, avoid this problem. Under both of these methods, the damages expert calculates the defendant's MPP when it provides an upper bound on damages. The key difference between the MSM and the EPM is in their treatment of how the defendant and its competitors behave in the "non-infringing world."⁸⁴

The MSM is the simpler approach and requires less data for its implementation.⁸⁵ Nonetheless, its simplifying assumption—that the defendant charges the same price for its "infringing world" product and its "non-infringing world" product—is subject to criticism.⁸⁶ As a result of this assumption, the MSM approach will overstate the defendant's MPP, and thus overstate the plaintiff's damages.⁸⁷

While we would expect the defendant's "non-infringing world" sales (and profit) to decline relative to "infringing world" sales (and profit), the defendant could mitigate this decline by lowering its price in the "non-infringing world." Because the MSM assumes that the defendant charges the same price in

⁸¹ See, e.g., *supra* note 1.

⁸² See *supra* Part IV.

⁸³ *Id.*

⁸⁴ *Id.*

⁸⁵ See *supra* Section IV.A.

⁸⁶ *Id.*

⁸⁷ *Id.* In our numerical examples, we showed that—under the MSM—the defendant's MPP was almost 70% greater than that produced by the EPM. Under the MSM, the defendant's MPP was \$10.5 million, while under the EPM, the defendant's MPP was \$6.25 million.

the “infringing world” and in the “non-infringing world,” the MSM will produce “non-infringing world” profit that is—from an economic perspective—too low, making MSM-based damages too high.⁸⁸

In contrast, the EPM provides a more theoretically sound damages estimate, because it takes into account the competitive interactions of the defendant and its rivals and provides a more unified framework for addressing changes in production costs. The EPM, however, involves more complex calculations. It also requires the damages expert to make assumptions about the nature of strategic interactions among competitors and inferences about competitors’ costs, all of which may be vulnerable to criticism depending on how closely they reflect reality.⁸⁹ Thus, those deciding between the EPM and the MSM must carefully consider these costs and benefits in selecting their damages methodology.

⁸⁸ *Id.*

⁸⁹ See discussion *supra* Section IV.B.

