taxnotes® international

Volume 104, Number 4 ■ October 18, 2021

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Reprinted from *Tax Notes International*, October 18, 2021, p. 291

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In this article, the authors show how the Shapley value can be used by transfer pricing professionals to implement the OECD's value creation approach when several legal entities make development, enhancement, maintenance, protection, and exploitation contributions to a multinational group's profit.

The views expressed in this article are the authors' and do not reflect those of NERA Economic Consulting, Texas A&M University, BBW Hochschule — University of Applied Sciences, or any other person or institution.

The 2017 OECD Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations recommend that transfer pricing outcomes be aligned with value creation. The value creation approach is, however, difficult to apply when multiple legal entities in different tax jurisdictions contribute jointly to the profits a multinational enterprise earns on its intangible assets. This article argues that the Shapley value can be used to determine an appropriate arm's-length attribution based on each entity's contributions to the group profit. It briefly discusses the OECD's value creation approach to implementing the arm's-length principle, provides a brief literature review of the Shapley value concept, and argues that the Shapley value can help implement the value creation approach. An empirical case study using the Shapley value to attribute a multinational group's profits from marketing intangibles to the group's legal entities provides support for those arguments.

The Value Creation Concept

The BEPS Project and Value Creation

A key objective of the base erosion and profit-shifting project launched by the OECD in 2013 was to align transfer pricing outcomes with value creation — that is, "profits should be taxed where economic activities deriving the profits are performed and where value is created."[1] Four years later, the value creation approach to transfer pricing, as expressed in the OECD's final reports on BEPS actions 8-10, was incorporated into the 2017 OECD guidelines. The OECD echoed that statement in 2018, stating that the BEPS project was designed to guarantee that "profits will be reported where the economic activities that generate them are carried out and where value is created."[2] The goal was to ensure for all transfer pricing methods that "profits of the associated enterprises are aligned with the value of their contributions and the compensation which would have been agreed in comparable transactions between independent enterprises for those contributions."[3]

To implement the value creation approach, the OECD guidelines recommend a functional analysis to "identify all factors that contribute to value creation, which may include risks borne, specific market characteristics, location, business strategies, and multinational group synergies" and that the transfer pricing method account for "all of the relevant factors materially contributing to the creation of value, not only intangibles and routine functions."

The value creation approach to transfer pricing has been controversial. Some authors argue that value creation is unclear, both conceptually and practically.[4] That lack of clarity has opened the door to governments using it to stretch standards of corporate income taxation and invent new taxes.[5] Some authors disagree over what value creation means in the digital economy, particularly for developing countries.[6] The concept is also viewed as privileging wealthy countries at the expense of developing ones.[7] The overall assessment is that the "notion of value creation is just too limiting, too vague, [and] too problematic" to be used as a method for implementing the arm's-length principle.[8]

On the other hand, some authors believe the value creation approach to transfer pricing is "emergent," "has ancient roots and is consonant with long accepted ideals," and is "in principle the correct measure to the transfer pricing system."[9] They see the value creation concept as consistent with the arm's-length principle in that it has the benefit of emphasizing substance over form. At the same time, they recognize that work is needed to make the concept concrete and applicable to 21st-century multinationals[10] and the digital economy.[11] Value creation is "a new expression of an old idea"; according to these authors, what is missing are rules to operationalize the concept.[12]

[1] G-20, "G20 Leaders' Communiqué," at para. 13 (Nov. 16, 2014).

[2] OECD, "Revised Guidance on the Application of the Transactional Profit Split Method — BEPS Action 10," at 3 (June 2018).

[3] *Id.* at para 2.114.

[4] *See* Stefan Greil, "The Arm's Length Principle in the 21st Century — A Literature Review," 6(2) *J. Tax Admin.* 148 (2021); Ruth Mason, "The Transformation of International Tax," 114(3) *Am. J. Int'l L.* 353 (2020); and Werner Haslehner and Marie Lamensch (eds.), *Taxation and Value Creation* (2021).

[5] Wolfram F. Richter, "Aligning Profit Taxation With Value Creation," CESifo Working Paper No. 7589, at 2 (Apr. 2019).

[6] Michael Lennard, "Act of Creation: The OECD/G20 Test of 'Value Creation' as a Basis for Taxing Rights and Its Relevance to Developing Countries," 25(3) *Transnat'l Corp.* 55 (2018).

[7] Allison Christians, "Taxing According to Value Creation," *Tax Notes Int'l*, June 18, 2018, p. 1379.

[8] Richard Collier, "The Value Creation Mythology," in *Taxation and Value Creation*, *supra* note 4, at ch. 6.

[9] Stanley I. Langbein and Max R. Fuss, "The OECD/G20-BEPS-Project and the Value Creation Paradigm: Economic Reality Disemboguing Into the Interpretation of the 'Arm's Length' Standard," 51(2) *Int'l Law.* 259, 263, 288 (2018).

[10] Lorraine Eden, "The Arm's Length Standard: Making It Work in a 21st Century World of Multinationals and Nation States," in *Global Tax Fairness* 153 (2016).

[11] *See* Eden, Niraja Srinivasan, and Srini Lalapet, "Transfer Pricing Challenges in the Digital Economy: Hic Sunt Dracones?" 3 *Tax Mgmt. Int'l J.* 48 (2019); and Greil, *supra* note 4.

[12] Jinyan Li, Nathan Jin Bao, and Huaning (Christina) Li, "Value Creation: A Constant Principle in a Changing World of International Taxation," 67(4) *Canadian Tax J.* 1107, 1133 (2019).

Value Creation and Intangibles

A particularly controversial area of value creation has been hard-to-value intangible assets because identifying and locating the source of value creation in a multinational group is fraught with difficulties. According to the OECD guidelines, value creation for intangibles is based on the concept of the development, enhancement, maintenance, protection, and exploitation (DEMPE) contributions made by the members of the multinational group.

The OECD guidelines are vague on how to assess DEMPE contributions and translate them into economic returns. That could open the door to different perceptions of how to value and price DEMPE contributions, making traditional tax dispute resolution more difficult and increasing the risks of double taxation for MNEs. As tax professionals attempt to implement the guidelines, legal entities may no longer be classified into routine or nonroutine; arbitrary black and white classifications are increasingly replaced by shades of gray. In field tax audits, some tax authorities increasingly assume DEMPE contributions to various intangibles in functions traditionally viewed as routine, such as sales and distribution. As a consequence, there is a risk that field tax auditors may increasingly reject traditional approaches involving transactional net margin method-type benchmarking of distribution functions by searching databases for presumed routine comparables or plain vanilla license-rate benchmarks.

To align with the value creation approach, taxpayers may now have to look for alternative economic analyses to corroborate, adjust results from, or replace traditional one-sided benchmarking approaches to document the arm's-length nature of their transfer prices. A transparent consideration of consolidated profits across the multinational group's global value chains may be increasingly necessary to mitigate and solve tax disputes. If functional contributions to intangibles take precedence over legal ownership of intangibles, quantifying a group entity's value contribution becomes even more demanding. For example, a functional analysis in a post-BEPS setting should recognize that cross-fertilization between functions or entities traditionally viewed as routine on the one hand, and those traditionally viewed as entrepreneurial on the other, is to be expected for MNEs. In fact, the vertical integration of different functions in a multinational group rests on cross-functional synergies, without which an MNE would be willing to outsource all noncore activities to external routine service providers. In other words, to be integrated in a group value chain, (almost) any function — even if traditionally viewed as routine — may be expected to contribute to group synergies that could not be generated with external independent service providers.

It follows that to implement the value creation approach to the arm's-length principle, the contributions of any group entity to unique group-specific synergies cannot properly be assessed by simple benchmarking of prices or profit-level indicators of stand-alone companies. That conceptual flaw has always been inherent to traditional pre-BEPS arm's-length economic analysis of transfer pricing. It was justifiable in a pre-BEPS consensus when the bulk of economic functions in a group could be considered routine according to either-or classification criteria, using intellectual property ownership as a steering rod. Implicitly, the conventional assumption was that for routine functions, the contribution to group synergies could, without in-depth analysis, be considered immaterial and thus safely ignored. Under that premise, distortions when compared with profit-level indicators of unrelated parties could be considered negligible.

In a post-BEPS DEMPE context based on the value creation concept, that assumption is no longer sustainable for preventing or managing future tax controversy. Without making it explicit, the DEMPE and value creation concepts put cross-functional synergies to intangible value at the heart of economic analysis. Because some form of DEMPE contribution can be suspected in almost any functional entity, transfer pricing professionals should now attempt to corroborate transfer pricing solutions through a value-contribution profit-split analysis that focuses on cross-functional spillovers in the generation of intangible-related profits and use the outcome of that complementary analysis to compute adjustments to traditional external benchmark results.

The Concept of Shapley Value

Modern economics offers several approaches for assessing the relative contributions of multiple players to a group project or enterprise. Cooperative game theory, perhaps the most common approach, reflects the business rationale of integrated companies by assuming that players can achieve a synergetic surplus by cooperating and describes how that surplus should be allocated among the players.[13] By cooperating, each player's share of the total is more than her stand-alone reward or, put differently, the cooperative result in total exceeds the sum of stand-alone payoffs. The players have common economic interests but compete for their share of the pie (for example, the joint profit). Stable cooperation ultimately requires that each player receive a share in the joint profit that is considered fair from the perspective of all players.

The usefulness of cooperative game theory for business problems is not a new insight. Martin Shubik argued for the application of cooperative game theory to various kinds of problems in taxation, management, tax accounting, and other business problems.[14] In those applications, the starting point is coalitions — that is, groups of players cooperating to achieve a jointly desired outcome. For the most part, two facts are taken as given: A coalition has been formed and is associated with a set of payoffs available to its members. Those assumptions ideally reflect the business rationale of integrated MNEs, with different functions and assets working together in a unique way to maximize consolidated profits.

The Shapley value is one of the most widely used solution concepts in cooperative game theory.[15] The concept has many desirable properties guaranteeing that the outcome is considered fair from the players' perspective. In his original contribution, Lloyd Stowell Shapley was interested in a fair and unique way to distribute a surplus among a set of players, considering the worth of each possible combination of players, or coalition.[16] Based on an axiomatic approach, he derived that a player should receive the average of her marginal contributions to each possible coalition — the value. The value to a player represents the a priori evaluation of a player's expected payoffs from participating in the cooperation.[17]

Two useful, nontechnical introductions to Shapley value come from Sergiu Hart and Hugo Chary and Lukas Hinteregger.[18] Assume a game has a finite number of players and is cooperative, that its value is set before the game is played, and that side payments among the players are possible. The Shapley value is a unique solution to the game and satisfies four axioms:

- Symmetry: If two players are identical, their values are equal —that is, they receive equal treatment.
- Dummy player: If adding a player to the game does not change the coalition's total worth, the player's value is zero — that is, the player is not essential to the game.
- Efficiency/Pareto optimality: The sum of the values of all the players equals the worth of the grand coalition, which is the maximum the players can jointly get from the game.
- Additivity/linearity: The value of the sum of two games is the sum of the values of the two games.

Assuming coalitions are random and that players join in a random order, the Shapley value is the expected marginal contribution of the *i*th player to a random coalition — in other words, the change in the coalition's worth caused by the addition of the *i*th player. Averaged across all possible coalitions, the Shapley value is therefore the average marginal contribution of the *i*th player to the possible coalitions.

Various business applications of the Shapley value can be found in the literature. Much work

[13] *See* Abhinay Muthoo, "A Non-Technical Introduction to Bargaining Theory," 1(2) *World Econ.* 145 (2000); and "Bargaining Theory and Royalty Contract Negotiations," 3(1) *Rev. Econ. Res. on Copyright Issues* 19 (2006).

[14] Shubik, "The Cooperative Form, the Value, and the Allocation of Joint Costs and Benefits," in *Cost Allocation: Methods, Principles, Applications* 79 (1985).

[15] Sergiu Hart, "Shapley Value," in *The New Palgrave Game Theory* 210 (1989).

[16] Lloyd Stowell Shapley, "A Value of N-Person Games," in *Contributions to the Theory of Games II* 307 (1953).

[17] Hart, "Advances in Value Theory," in *Game Theory and Applications* 166 (1990).

[18] Hart, *supra* note 15; and Hugo Chary and Lukas Hinteregger, "Allocation of Benefits Arising From Pure Economies of Scale Among Subsidiaries in an MNE," 157 *Global Tax Weekly* (Nov. 12, 2015).

has been dedicated to cost-sharing problems that are a natural field for the application of cooperative game theory, and concepts such as the Shapley value "have long been used implicitly by some organizations . . . without ever suspecting it."[19] Prominent examples from the literature on Shapley value applied to cost allocation are airport landing fees, with the costs of the airport facility allocated based on each aircraft landing's Shapley value, and internal telephone billing rates.[20] More recent examples involve healthcare, energy grids, railway infrastructure, German telecommunications, and decomposing the risk and return of optimal investment portfolios.[21] Google Analytics has even put the concept into practice, offering a data-driven attribution model based on Shapley value to assess the effectiveness of multichannel online marketing efforts.[22]

A Fair Way to Attribute Value Creation

Shapley Value Applied to Transfer Pricing

When cooperating parties bargain over how to share the total surplus, the Shapley value allows them to determine a fair allocation of the total profit based on each party's value contribution, which can vary. For that reason, the Shapley value is a highly suitable solution for the transfer pricing problem of attributing arm's-length profits from an intangible that several parties have contributed to. The concept recognizes how each company in the multinational group contributes to value creation and the corresponding payoff that each party can reasonably expect from its contribution. It can also address situations in which a local distribution company does not contribute more than routine functions, thereby allowing transfer pricing professionals to test or corroborate the traditional compensation for routine functions derived from benchmarking exercises.

Long before the OECD announced its BEPS goal of aligning transfer pricing outcomes with value creation, economists had shown how transfer pricing problems could be addressed using cooperative game theory and the Shapley value concept. Early work by Rene Manes and Robert Verrecchia used the concept of the Shapley value to allocate intragroup budgets and profits in an MNE and compute the transfer prices to achieve those profits for each department.[23]

Another early contributor was Stanley Langbein, who proposed Shapley value as a solution to attributing MNE profits within the group.[24] He argued that each entity's contribution should be measured by the cost imposed on the group should that entity withdraw, as "the best or only way, of identifying what hypothetically 'separate' enterprises were charging each other if they were dealing at arm's length." In effect, Langbein argued that the Shapley value could be measured in reverse by the average marginal cost imposed on the coalition by the exit of the *i*th player rather than by the average marginal contribution from the *i*th player joining the coalition.

Many years later, in their assessment of various methods for performing a contribution analysis under the profit-split method, Sébastien Gonnet and Pim Fris argued that Shapley value was an appropriate method for fairly allocating the gains among members of an multinational group.[25] Gonnet went on to write several papers exploring the use of Shapley value in transfer

[19] Hobart Peyton Young, "Cost Allocation," in *Handbook of Game Theory With Economic Applications* 1194 (1994). *See also, e.g.*, Alvin E. Roth and Robert E. Verrecchia, "The Shapley Value as Applied to Cost Allocation: A Reinterpretation," 17(1) *J. Acct. Res.* 295 (1979); Young, *Cost Allocation: Methods, Principles, Applications* (1985); and Stef H. Tijs and Theo Driessen, "Game Theory and Cost Allocation Problems," 32(8) *Mgmt. Science* 909 (1986).

[20] *See* Stephen C. Littlechild and Guillermo Owen, "A Simple Expression for the Shapley Value in a Special Case," 20(3) *Mgmt. Science* 370 (1973); and Louis J. Billera, David C. Heath, and Joseph Raanan, "Internal Telephone Billing Rates — A Novel Application of Non-Atomic Game Theory," 26(6) *Operations Res.* 956 (1978).

[21] Alexander Kolker, "The Concept of the Shapley Value and the Cost Allocation Between Cooperating Participants," in *Encyclopedia of Information Science and Technology* 2095 (2018); Jörg Bremer and Michael Sonnenschein, "Estimating Shapley Values for Fair Profit Distribution in Power Planning Smart Grid Coalitions," in *Multiagent System Technologies* 208 (2013); Vito Fragnelli et al., "How to Share Railways Infrastructure Costs?" in *Game Practice: Contributions From Applied Game Theory* 91 (2000); Telekom Deutschland GmbH, "Stellungnahme der Deutschen Telekom im Rahmen der Nationalen Konsultation BK3c-14/015" (2014); and Haim Shalit, "The Shapley Value of Regression Portfolios," 21(6) *J. Asset Mgmt.* 506 (2020).

[22] Google, "MCF Data-Driven Attribution Methodology" (2020).

[23] Manes and Verrecchia, "A New Proposal for Setting Intra-Company Transfer Prices," 12(46) *Acct. & Bus. Res.* 97 (1982).

[24] Langbein, "Transfer Pricing and Economies of Integration," in *Transfer Pricing: The International Tax Concern of the '90s* 27 (1991).

[25] Gonnet and Fris, "Contribution Analyses Under the Profit Split Method," *Int'l Tax Rev.* 8 (Dec. 2007).

pricing — for example, with Alexander Vögele and Bastian Gottschling on the application of cooperative game theory to the transfer pricing of IP and on the profit-split method in the banking industry.[26] Further details on using cooperative game theory, particularly on the application of the Shapley value in the transfer pricing analysis of IP with some practical insights are available.[27] One author has said that earlier work on cooperative game theory as applied to royalty rate negotiations[28] can be used in the transfer pricing of intangibles.[29] Other authors have provided examples of transfer pricing in vertically integrated supply chains using the Shapley value.[30]

Chary and Hinteregger provide one of the few empirical studies that apply the Shapley value concept to transfer pricing problems. They analyze three case studies of centralized services in a multinational group:

- centralized headquarter services with location-specific cost advantages;
- pooling of purchasing power in a centralized procurement entity; and
- pooling of borrowing capacity in a centralized treasury entity.[31]

Based on the results of their case studies, the authors argue that the Shapley value is particularly useful when MNE activities are centralized because they exhibit economies of scale at the multinational group level. They also show how group members that make differing contributions to the centralized services differentially affect their Shapley values.

In their model of centralized procurement, Svetlana Batrakova and Andreas Hoefele also found that the Shapley value can be useful for analyzing group synergies such as group economies of scale. They argue that the concept is a good way to satisfy the OECD guidelines' requirement that the benefits of those synergies should be shared among the group in proportion to their contributions to synergy creation.[32]

Shapley Value and DEMPE Intangibles

According to the OECD guidelines, if several entities provide DEMPE contributions related to an intangible whose exploitation generates entrepreneurial profits, each is entitled to an arm's-length share of the returns from successful commercialization efforts. The guidelines acknowledge that suitable comparables will often be difficult to find because intangibles tend to be unique and generate value while embedded in the MNE's integrated value chain, with company-specific cross-fertilization with other functions and intangibles. Thus, a profit-split method based on a contribution analysis might be best for determining arm's-length returns for the entities providing DEMPE contributions.[33] When there is a high degree of integration in the multinational group, the transactional profit-split method may be most appropriate.

Under a contribution analysis, the combined profits from exploiting the intangibles would be attributed to the parties based on "a reasonable approximation of the division that independent enterprises would have achieved from engaging in comparable transactions."[34] The guidelines also say that "contributions of each party to the transaction are specifically identified and their

[26] Vögele, Gonnet, and Gottschling, "Transfer Prices Determined by Game Theory: 1 — Underlyings," *Tax Planning Int'l Transfer Pricing* 1 (Oct. 8, 2008); and "Transfer Prices Determined by Game Theory: 2 — Application to IP," *Tax Planning Int'l Transfer Pricing* 1 (Nov. 8, 2008); and Vögele et al., "Transfer Prices Determined by Game Theory: 3 — Application to the Banking Industry," *Tax Planning Int'l Transfer Pricing* 1 (Dec. 8, 2008).

[27] *See* Yves Hervé and Philip de Homont, "H. Der Beitrag von Intangibles bei digitalen Geschäftsmodellen," in *Intangibles — Immaterielle Werte* 1507 (2021); Alexander Vögele and J.B. Vögele, "G. Bank — Lizenzgebühren für Marke — Spieltheorie," in *Intangibles — Immaterielle Werte* 1501 (2021); Alexander Vögele, Tom Braukmann, and de Homont, "H.III.2. Verhandlungstheorie — Spieltheorie zur Aufteilung gemeinsamer Einnahmen udn Zahlungsströme," in *Handbuch der Verrechnungspreise* 881 (2015).

[28] Muthoo, "Bargaining Theory and Royalty Contract Negotiations," *supra* note 13.

[29] DeForest McDuff, "Splitting the Atom: Economic Methodologies for Profit Sharing in Reasonable Royalty Analysis," *Les Nouvelles* 70 (June 2016).

[30] *See, e.g.*, Edward C. Rosenthal, "A Game-Theoretic Approach to Transfer Pricing in a Vertically Integrated Supply Chain," 115(2) *Int'l J. Production Econ.* 542 (2008); Mingming Leng and Mahmut Parlar, "Transfer Pricing in a Multidivisional Firm: A Cooperative Game Analysis," 40(5) *Operations Res. Letters* 364 (2012); and Lihua Chen, "Shapley Value Based Transfer Pricing in Supply Chains With Stochastic Demand," 4 *Decision Sci. Letters* 1 (2015).

[31] Chary and Hinterregger, *supra* note 18.

[32] Batrakova and Hoefele, "Group Synergies and the Shapley Value Analysis: A Game Theory Approach," 24(5) *Int'l Transfer Pricing J.* 351 (Sept.-Oct. 2017).

[33] *See* the OECD guidelines at paras. 2.115, 6.145, 6.209, and section D.2.6.2. *See also* OECD, *supra* note 2, at section C.3.1.

[34] OECD, *supra* note 2, at para. 2.150.

relative values measured in order to determine an arm's length compensation for each party in relation to the transaction."[35]

The Shapley value concept, which is widely adopted in practice between unrelated parties in different contexts, fits precisely that purpose: It builds on the marginal value contributions of each party toward the payoff the parties can reasonably expect from their combined DEMPE contributions. Accordingly, in these situations, the guidelines say (at paragraph 6.111) the functions performed by the parties, as well as their alternative options, must be considered: In applying the principles "to a transaction involving intangibles, a transfer pricing analysis must consider the options realistically available to each of the parties to the transaction."

In summary, the Shapley value is an appropriate concept to attribute arm's-length profits from the joint creation and exploitation of an intangible because:

- its logic is easy to understand;
- it has a solid theoretical foundation;
- it is relatively easy to implement compared with the leading alternatives and often yields appropriate results;
- it is consistent with the OECD guidelines on DEMPE contributions; and
- it is frequently used in corporate practice between independent parties.

Further, the Shapley value concept can build on insights gained from traditional well-known transfer pricing benchmarking approaches. Rather than replacing them, the concept may help to compute adjustments to traditional benchmarking results, such as to improve comparability by considering unique contributions to group synergies.

Below, using a case study with a fact pattern commonly observed in a range of industries, we illustrate how the Shapley value can be applied to the day-to-day work of transfer pricing specialists.

Case Study

Background

A leading multinational producer of branded industrial products operates in an oligopolistic market with a limited number of big competitors, all multinational groups also selling branded products. The brand owner and key strategic decision-maker (CH) is in Switzerland. A Benelux subsidiary (BNL) operates as the divisional headquarters for the relevant products. It is responsible for centralized marketing and optimized supply chain management, including the coordination of manufacturing sites worldwide. The finished products are distributed by local marketing and sales subsidiaries in various countries, one of which (DE) is in Germany.

For the use of the brand name, the local distribution companies pay trademark license fees in the form of a fixed percentage of net sales to CH. According to the submitted transfer pricing documentation using traditional benchmarking studies, the local marketing and sales organizations are considered routine distribution companies entitled to arm's-length operating margins of 1.5 to 5 percent with a median of 3 percent of net sales. Separate royalty benchmarking studies support the arm's-length nature of the applied trademark license fees.

German tax authorities challenged the trademark license fees, arguing that DE, the German subsidiary, performed nonroutine marketing and distribution functions, thereby contributing locally to the multinational group's marketing intangibles. Because of DE's alleged nonroutine contribution, the German tax authorities did not accept the use of standard transfer pricing methods and rejected the transfer pricing documentation, including both the distribution benchmarking and the royalty rate studies. They also significantly adjusted the brand license fees downward, driving the German distribution margin to close to 6 percent of net sales.

DEMPE Analysis

The dispute between the German tax authorities and the German subsidiary clearly identifies the core problem: How can transfer

[35] *Id.* at para. 2.122.

pricing allocate the returns from an intangible whose exploitation generates entrepreneurial profits when multiple group entities are entitled to an arm's-length share of the returns from their successful commercialization efforts? We argue that the Shapley value can provide a fair and appropriate solution.

We start with a detailed DEMPE analysis to determine the qualitative DEMPE contributions related to the trademarks. The analysis showed that in its relevant market, the multinational group consistently achieved above-average consolidated operating margins, both at the group and local levels. That superior performance relative to the competition was largely the result of a superior go-to-market and service strategy initiated and overseen by CH, organized by BNL, and executed by the local sales and distribution units including DE, the German affiliate. The strategy was so successful that it fostered strong group trademark name recognition with customers as *the* market leader in the respective industry. In contrast, product-related intangibles and technology were not considered key differentiators in the market. Therefore, excess profits measurable through premium margins were considered mainly attributable to the trademark and associated go-to-market strategy.

In the company's project-related business, the key value proposition associated with the trademark was largely associated with the flexibility of just-in-time delivery of a range of high-quality products in a mix tailored to customer need. That distinguished the group from all competitors and allowed it to reap premium margins. As the trademark owner, CH had developed and implemented the go-to-market strategy that established the trademark at the core of the marketing strategy and allowed it to generate premium prices in comparison with all competitors.

Under the strategic guidance of CH, BNL was the operative hub for managing and supervising the global manufacturing and supply chain operations and was responsible for international marketing, product development, and centralized training programs for local sales organizations, all of which were the key functions to guarantee brand recognition.

Local marketing and sales organizations such as DE exploited the brand by locally implementing the central distribution concept with limited autonomy over pricing and marketing activities. Local sales force engagement with business-to-business customers was of course critical for acquiring sales contracts, but the distribution subsidiaries did not own or develop their own valuable local marketing intangibles that allowed for profit attribution. The customer base was not exclusively tied to the group but rather selected suppliers on a project-by-project basis.

Based on the results of the DEMPE analysis, three group entities — CH, BNL, and DE — contributed to the brand value, albeit to a different extent, and thus were eligible to a share of the profits generated in the German market. The DEMPE analysis supported DE's role as a hybrid entrepreneurial company, combining mostly routine sales and distribution functions with some distinct value contributions related to the exploitation of marketing intangibles. The tax authorities were right to assume a fact pattern that would disallow one-sided transfer pricing methods.

The hypothetical arm's-length test in section 1(3) of the German Foreign Tax Code simulates hypothetical negotiations between unrelated third parties — for example, licensor and licensee — under the assumption that all bargaining parties have symmetric information on the relevant bargaining factors. The test therefore provided a suitable situation to put the Shapley value concept into practice to determine an appropriate reward for the distinct contributions of DE, BNL, and CH, including the returns for the whole manufacturing network.

Shapley Value Analysis

The detailed economic analysis for the brand revealed that the profit to be attributed to DE, BNL, and CH was a consolidated average operating margin (or earnings before interest and taxes (EBIT)) of 15 percent of net sales in Germany over the relevant tax audit period. To quantify the qualitative results of the DEMPE analysis that showed the relative importance of the three parties to creating value, we used the Shapley value to determine a fair allocation of the total EBIT margin of 15 percent, reflecting each party's DEMPE contributions.

The Shapley value concept starts with specifying all possible coalitions — that is, all possible combinations of the number of players in the game. The worth of each coalition is determined as the total payoff its members can obtain.[36] In the next step, a player's marginal contribution to a coalition is calculated as the worth of the coalition with that player minus its worth without her. In determining marginal contributions, different permutations depending on the order in which a player enters a coalition are considered. Finally, the Shapley value for each player is derived as the average of a player's marginal contributions to each permutation, assuming each permutation is equally probable.[37]

Coalitions and Coalition Values

In the first step, we specified the set of all possible coalitions (denoted by C) among the three players — CH, BNL, and DE. In general, there are 2^N - 1 possible coalitions with N players (excluding the empty set as an economically irrelevant possibility). Therefore, there are seven possible coalitions among the three players:

C = {CH}, {DE}, {BNL}, {CH, DE}, {CH, BNL}, {DE, BNL}, {CH, BNL, DE}.

In the next step, we determined the value of each coalition as an operating (EBIT) margin to be achieved by each coalition, using:

- available benchmarks for isolated functions of independent companies in comparable markets;
- simple economic modeling of coalition scenarios; and
- adjustment calculations to account for particular circumstances, such as the lack of synergies in coalitions other than the grand coalition (CH, BNL, DE), to estimate the value of each possible coalition.

With the exception of the grand coalition, whose value — an average operating margin of 15 percent of net sales in Germany over the relevant time period — could be observed in real life through consolidated group data, all coalitions were counterfactual situations requiring careful modeling based on justifiable assumptions and the need to consider all available outside options and information on competitors. To specify unavoidable model uncertainties, we used best- and worst-case assumptions that allow us to test the strength of the results. The maximum-minimum range of values of each coalition were derived with reference to the DEMPE analysis, conducting performance benchmarking of suitable competitors and individual functions, using existing transfer pricing studies concerning stand-alone functions and IP.

Table 1 summarizes the model description of the different coalitions and the range of coalition values resulting from the economic analysis.

Shapley Values and Resulting Allocation

In the final step, we calculate the marginal contribution of each player to every coalition and take the average to derive the Shapley value for all players.

According to the Shapley value concept, the marginal contribution of each player depends on how the grand coalition is formed — that is, the order in which each player enters the grand coalition. If, for instance, DE enters a coalition with CH before BNL does, its marginal contribution to the coalition will be different than if it joined last. In our game with N = 3 players, there are six possible permutations (N * (N - 1) * (N - 2) * . . . * 1 = 3 * 2 * 1). All orderings are assumed to be equally probable.

The marginal contribution of a player *i* in each permutation is the worth of a coalition after that player joins minus the worth of the coalition of the players preceding player *i*. The resulting Shapley value for player *i* is given by the average of its marginal contributions in each permutation.

Table 2 reports the Shapley values for DE, BNL, and CH calculated with the minimum and maximum values of the above EBIT ranges. The detailed computations behind Table 2 are reported in the Appendix.

[36] Hart, *supra* note 17.

[37] Encarnación Algaba, Fragnelli, and Joaquín Sánchez-Soriano, "The Shapley Value, a Paradigm of Fairness," in *Handbook of the Shapley Value* 17 (2020).

Table 1. Coalitions and Coalition Value Ranges

Coalition	Summary of Basic Scenario	EBIT
DE	Stand-alone distribution company without a trademark or production facilities. Sales know-how and customer base are nonexclusive. Outside options as a stand-alone distributor would be limited. Existing competitors could replace their existing distributor with DE, which is an unlikely option (because they might be interested in only top sales personnel). Engaging with a new entrant into the market may be a more likely alternative but would involve start-up risks for both parties. Either way, neither option comes without prior investment. Therefore, realistically, working as a distributor for a new or existing manufacturer would yield no more than a margin toward the lower end of the range of independent distributors' margins because no significant synergies are expected in an independent, contractual relationship.	1.5-3%
CH	Entity owning the well-known trademark and controlling the brand management. It could license the trademark to third parties and generate net returns equal to the license rate minus brand-related cost. As a stand-alone company, it lacks the key assets (optimized supply chain network, centralized marketing, and training) to guarantee the brand promise and superior brand value. On a contractual basis with a third-party manufacturer, the potential for synergies would be much lower than with an integrated multinational. CH's return as a stand-alone licensor is determined based on comparable royalty rates applied between third parties, which otherwise do not collaborate on marketing efforts and do not benefit from synergies from an optimized manufacturing and supply chain network, less brand related costs.	0.5-2%
BNL	Main operating entity controlling a network of production facilities and the central supply chain organization with long-term business relations and an excellent reputation in the market. Lacks a well-known trademark and local sales organization in DE. Available stand-alone options involve the creation of its own brand or producing under a license for an existing brand. Its return can be derived from normal industry profits of competitors lacking a premium brand ranging from 5 to 10 percent (with a median of approximately 7 percent), subtracting normal distribution returns that would be granted to a third-party distributor, and a baseline trademark remuneration of 1 percent. The analysis of normal industry profits includes an economic analysis of the relative strengths of the competitors and their brands.	4.5-6%
CH and DE	Brand owner and distributor cooperate but lack production facilities and a reliable supply chain network. The coalition could engage numerous independent contract manufacturers but would still need to establish or oversee an effective supply chain management to ensure just-in-time delivery and high-end service. Because the supply chain organization is a key driver for success, synergies in this coalition would be limited; the contractual arrangements with independent manufacturers would normally not be able to guarantee the required level of cooperation and control. The joint profit in this coalition is estimated by the higher industry profit margin achieved by stronger competitors (lacking the maximum benefits from synergies) minus a comparable contract manufacturer's fee.	4-5.5%
BNL and DE	Manufacturing and supply chain operations cooperate with the local distributor, but the coalition lacks the trusted trademark crucial for brand recognition by customers. Outside options involve the creation of its own brand or producing and selling a competitor's branded good. Both options require upfront investment to create a strong level of trust with the customer. As the DEMPE analysis reveals, the particular go-to market strategy defined and executed by the brand owner over time was also key to the superior strength of the brand. Lacking that element in the short run, the success of this coalition would not necessarily be guaranteed. Taking all that into account, the value of this coalition is approximated by competitive margins ranging from a moderate to higher return of a normal market competitor lacking a strong brand.	5-9.5%
CH and BNL	Based on the DEMPE analysis, the coalition of the brand owner and manufacturing and supply chain operations can be considered the most valuable coalition other than the grand coalition that includes a local distribution entity. To consider the synergies from the cooperation between the brand owner and operations appropriately, the value of this coalition could be approximated by the total payoff of the grand coalition less the costs of engaging a distributor based on available industry benchmarks and suitable assumptions regarding expected synergies from working with that distributor.	8-12%
CH, BNL, and DE	The grand coalition in which all three group entities cooperate and exploit the optimum level of synergies.	15%

Table 2. Shapley Values

	Range of Shapley Values (rounded to one decimal place)	Average Shapley Value* (rounded to one decimal place)
DE	3.2-3.5%	3.3%
CH	3.9-4.5%	4.2%
BNL	7-7.9%	7.5%
Sum		**15%**

**Note*: Calculated with the average of the minimum-maximum range (see Appendix Table 4A).

Our Shapley value analysis showed that DE, the German distribution entity, should be compensated for its local marketing and distribution functions with a net operating margin between 3.2 and 3.5 percent. CH, the Swiss brand owner, should achieve an operating margin between 3.9 and 4.5 percent, and BNL, the operational hub in Benelux that included the manufacturing network, should be awarded the largest profit share of between 7 and 7.9 percent.

Discussion

Using the Shapley value to allocate profits according to the DEMPE contributions made by multiple entities in a multinational group might require no more effort than traditional transfer pricing approaches and it could deliver strong results. It might also streamline discussions with tax authorities and focus them on specific economic markers. The method might also offer important benefits in terms of providing more rigor to the OECD's value creation approach.

While traditional benchmarking studies are increasingly challenged by tax authorities — notably on the ground of presumed DEMPE contributions — they still provide reliable insights into outside options of the group entities. The general criticism of benchmarking studies used for transfer pricing documentation is that the subsidiary of a vertically integrated multinational generally is in a different position than an independent comparable.

In a Shapley value analysis, benchmarking studies are used to assess the outside option in the stand-alone case — that is, the hypothetical case in which the party would no longer be a subsidiary benefiting from vertical integration. In that situation, the tested party finds itself in a much more comparable situation to the independent companies in the benchmarking sample. To that end, traditional benchmarking studies remain a valuable analytical tool when applying the Shapley value concept. Further, the Shapley value analysis can also refer to available benchmark data of direct competitors, avoiding the difficulties of relying solely on searches for presumably comparable independent companies, which tax authorities often reject.

A comparison of tables 1 and 2 illustrates one powerful benefit of the Shapley value analysis for dispute resolution. While the range of coalition values resulting from the economic analysis reported in Table 1 is fairly high, the effects of individual outliers (or possible assumption errors) tend to be offset in the Shapley value computations reported in Table 2, in which the resulting range of results is quite narrow. The strong results effect of the Shapley value computations could thus help reduce controversial discussions about appropriate functional returns in dispute resolution.

In the case at hand, that profit allocation basically corroborates the results of the traditional benchmarking studies for the German distribution entity and allows a narrowing of the range of the traditional benchmarking results. The synergetic contributions of the German distribution entity explain why an appropriate return would not be at the lower end of a traditional benchmarking interquartile range, especially when the multinational is highly profitable on a consolidated basis. For super-profitable companies, the Shapley value analysis would often likely yield distributor margins above the interquartile range of traditional benchmarking of independent companies whenever the distributor provides significant synergistic contributions.

The qualitative analysis of DEMPE contributions reveals that the superior performance of the group cannot be attributed only to the brand owned, developed, and protected by the Swiss owner. The contribution of the Benelux hub is critical to leverage the brand's core value for the benefit of customers. Still, the license rates for the Swiss trademark owner that can be determined from the Shapley value analysis are higher than that revealed by the

traditional license database benchmarking. That is not entirely surprising: Group companies licensing valuable trademarks to third parties mostly do not compete with the third party in the relevant market segment considered noncore by the licensor. In most cases, one would expect a licensee to contribute a greater share of DEMPE contributions for the relevant market segment in third-party license transactions. Consequently, the licensor's higher contribution in intragroup transactions will often justify higher royalty rates than those revealed by benchmarking data between independent parties.

Summary and Conclusions

The OECD guidelines recommend that transfer pricing outcomes be aligned with value creation. The devil, however, lies in the details because the value creation concept is difficult to apply. In the real world, MNEs have multiple legal entities in various tax jurisdictions contributing in different ways and amounts to the global profits they earn on their intangible assets.

This article argues that the Shapley value provides a useful and workable way to determine a fair and strong arm's-length attribution of multinational group profits based on each entity's contributions to value creation. It makes an important contribution to the literature on value creation and DEMPE intangibles, provides one of the few empirical applications of Shapley value to transfer pricing, and suggests how the Shapley value can be used to help transfer pricing practitioners implement the OECD's value creation concept.

The value creation concept introduced in the OECD guidelines has been a controversial subject among international tax and transfer pricing specialists. A key criticism is that the concept is fuzzy and insufficiently concrete to be useful to practitioners and tax authorities. That is one reason behind the OECD inclusive framework's pillar 1, amount A initiative, which proposes arbitrary (and we believe distortionary) solutions to address presumed local marketing intangible contributions.[38] Because the outcome of the pillar 1 initiative is uncertain, this article does not consider it. However, our proposed solution based on applying the Shapley value concept to apportion DEMPE contributions, which we believe is fully in line with the 2017 OECD guidelines, would, if properly applied, make the pillar 1 solutions redundant.

Our case study highlights the potential of applying the Shapley value concept as an analytical tool to solve an intangible-related tax dispute that lacks agreement on the amount of local DEMPE contributions to a multinational's total profit. The Shapley value as a cooperative game theory solution helps overcome several challenges of transfer pricing documentation based on one-sided methods relying on traditional benchmarking studies to determine arm's-length returns.

However sophisticated traditional database searches for comparables may have become by applying consistency checks and adjustments to increase comparability with the tested party, the search results are always prone to cherry-picking by tax authorities on the ground of deemed weak comparability, leading to controversial discussions and, in the worst case, to high income adjustments and rejection of the transfer pricing documentation.

The basic economics of vertically integrated multinationals indicates an expectation of synergetic benefits so that any integrated subsidiary is always in a different position than a functionally comparable but independent party. As long as the pre-BEPS OECD consensus of an arbitrary classification of group companies into many routine companies (assumed to generate no significant synergetic benefits) and few nonroutine companies (solely entitled to residual profit arising from intangibles) prevailed, that was not a major concern in field tax audits. With the establishment of the DEMPE concept in the 2017 OECD guidelines, the consensus is conceptually shattered. Potential DEMPE contributions can be found in almost any group company, and because the OECD provides hardly any practical guidance on how that should translate in an international profit allocation of a multinational, tax administrations will have the incentive to challenge one-sided benchmarked functional returns.

[38] Eden, "The Simple Analytics of Pillar One Amount A," 50(3) *Tax Mgmt. Int'l J.* 137 (2021).

Given those likely developments, the Shapley value concept offers a complementary framework for more sustainable transfer pricing documentation and international tax dispute resolution. It follows a different path from traditional approaches by considering outside options realistically available to the tested party and derives the payoff the tested party should receive if it joins the cooperation with the other group entities. That type of economic analysis is a much closer reflection of the arm's-length behavior of a prudent and conscientious business manager.

Further, the concept can be applied to test the arm's-length nature of individual transactions in a non-transactional way. By assuming a player-centric perspective, examining a party's outside options given the entirety of relevant functions and risks, the Shapley value concept can better address intragroup transactions in which synergies between functions exist.

In summary, the Shapley value concept is ideally suited to address the post-BEPS requirement to evaluate functional value contributions. The DEMPE analysis reveals qualitative functional contributions of group companies to an intangible's value, which the OECD guidelines provide limited guidance on quantifying. Based on the qualitative analysis and considering the relative value contribution of each party, the Shapley value concept can help determine a fair allocation of profits across different contributing parties. The arbitrary classification of companies as routine and nonroutine is no longer necessary because the relative contributions are appropriately considered, whether local subsidiaries contribute to intangible value or not.

The proposed approach is no more complex than traditional comparability analyses. Tax authorities in many jurisdictions increasingly employ trained economists to apply sound industrial economics to transfer pricing cases. Because the analysis is highly transparent across the value chain, it potentially provides a superior framework for settling tax disputes in mutual agreement procedures or advance pricing agreements that might otherwise fail because the involved tax administration could simply not agree on an entity's baseline economic characterization. Even though some divergent opinions on evaluating outside options may remain, frustrating discussions on the acceptability of individual comparables or the arbitrary classification of routine and nonroutine functions in transfer pricing audits may be avoided to the benefit of both taxpayers and administrators.

Appendix: Shapley Value Calculations

Table 1A. Inputs

Coalition	Lower Bound	Synergies	Upper Bound	Synergies
CH	0.5%		2%	
BNL	4.5%		6%	
DE	1.5%		3%	
CH and DE	4%	2%	5.5%	0.5%
CH and BNL	8%	3%	12%	4%
DE and BNL	5%	-1%	9.5%	0.5%
CH, BNL, and DE	15%	8.5%	15%	4%

Table 2A. Calculations Using Lower Bounds

DE				
Orderings	**Set of Players Before DE**	**Value Without DE**	**Value With DE**	**DE Marginal Contribution**
CH, BNL, **DE**	CH, BNL	8%	15%	7%
CH, **DE**, BNL	CH	0.5%	4%	3.5%
BNL, CH, **DE**	BNL, CH	8%	15%	7%
BNL, **DE**, CH	BNL	4.5%	5%	0.5%
DE, CH, BNL		0%	1.5%	1.5%
DE, BNL, CH		0%	1.5%	1.5%
			DE Shapley Value	**3.5%**
CH				
Orderings	**Set of Players Before CH**	**Value Without CH**	**Value With CH**	**CH Marginal Contribution**
CH, BNL, DE		0%	0.5%	0.5%
CH, DE, BNL		0%	0.5%	0.5%
BNL, **CH**, DE	BNL	4.5%	8%	3.5%
BNL, DE, **CH**	BNL, DE	5%	15%	10%
DE, **CH**, BNL	DE	1.5%	4%	2.5%
DE, BNL, **CH**	DE, BNL	5%	15%	10%
			CH Shapley Value	**4.5%**
			BNL Shapley Value	**7%**
			Sum	**15%**

Table 3A. Calculations Using Upper Bounds

DE				
Orderings	**Set of Players Before DE**	**Value Without DE**	**Value With DE**	**DE Marginal Contribution**
CH, BNL, **DE**	CH, BNL	12%	15%	3%
CH, **DE**, BNL	CH	2%	5.5%	3.5%
BNL, CH, **DE**	BNL, CH	12%	15%	3%
BNL, **DE**, CH	BNL	6%	9.5%	3.5%
DE, CH, BNL		0%	3%	3%
DE, BNL, CH		0%	3%	3%
			DE Shapley Value	**3.2%**
CH				
Orderings	**Set of Players Before CH**	**Value Without CH**	**Value With CH**	**CH Marginal Contribution**
CH, BNL, DE		0%	2%	2%
CH, DE, BNL		0%	2%	2%
BNL, **CH**, DE	BNL	6%	12%	6%
BNL, DE, **CH**	BNL, DE	9.5%	15%	5.5%
DE, **CH**, BNL	DE	3%	5.5%	2.5%
DE, BNL, **CH**	DE, BNL	9.5%	15%	5.5%
			CH Shapley Value	**3.9%**
			BNL Shapley Value	**7.9%**
			Sum	**15%**

Table 4A. Calculations Using the Average of the Lower and Upper Bounds

DE				
Orderings	**Set of Players Before DE**	**Value Without DE**	**Value With DE**	**DE Marginal Contribution**
CH, BNL, **DE**	CH, BNL	10%	15%	5%
CH, **DE**, BNL	CH	1.3%	4.8%	3.5%
BNL, CH, **DE**	BNL, CH	10%	15%	5%
BNL, **DE**, CH	BNL	5.3%	7.3%	2%
DE, CH, BNL		0%	2.3%	2.3%
DE, BNL, CH		0%	2.3%	2.3%
			DE Shapley Value	**3.3%**
CH				
Orderings	**Set of Players Before CH**	**Value Without CH**	**Value With CH**	**CH Marginal Contribution**
CH, BNL, DE		0%	1.3%	1.3%
CH, DE, BNL		0%	1.3%	1.3%
BNL, **CH**, DE	BNL	5.3%	10%	4.8%
BNL, DE, **CH**	BNL, DE	7.3%	15%	7.8%
DE, **CH**, BNL	DE	2.3%	4.8%	2.5%
DE, BNL, **CH**	DE, BNL	7.3%	15%	7.8%
			CH Shapley Value	**4.2%**
			BNL Shapley Value	**7.5%**
			Sum	**15%**

■