SHAPLEY VALUE
Can Be Used as an Unspecified Method in Transfer Pricing

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AGENDA

I. Introduction - Shapley Value: A Fairer Way to Allocate Group Profits

II. Using Shapley Value to Attribute Value within the MNE Group

III. Why Shapley Value Should Be an Unspecified Method in Transfer Pricing Regulations

IV. Wrap-Up and Q&A
I. Shapley Value: A Fairer Way to Allocate Group Profits

Shapley Value - “for the theory of stable allocations and the practice of market design”

- Shapley Value is a solution concept in cooperative game theory.
  - Named in honor of Lloyd Shapley
  - Nobel Prize in Economics 2012

- Problem: A coalition of players cooperates and obtains a certain overall gain from that cooperation.
  - How important is each player to the overall cooperation, and what payoff can each player reasonably expect?

“They’ve led our breakthroughs in gaming theory.”
Useful Properties of Shapley Value

Assigns a unique distribution of the total surplus generated by a coalition of players in a cooperative game. Clear focus on business synergies from collaboration that add extra value to the players.

Takes account of (1) differences among players in their contributions to the coalition and (2) differences in their bargaining power when considering outside options.

Assesses the relative contribution of each player to the overall game and what payoff each player should reasonably expect from their respective contribution.
Example: Assume a three-player game. How should the total value be distributed among the players if they provide different contributions and differ in their bargaining power?

1. Calculate value to each player of playing alone or of playing with different sized coalitions

2. Take ordering into account by calculating, for each ordering, the marginal contribution each new player adds to the coalition

3. The average of the sum of each player’s marginal contributions is his/her Shapley Value.

4. The Shapley Value formula allocates all consolidated profit earned together.

http://shapleyvalue.com
Intuition behind the Shapley Value

**Player I**
- What Player I could achieve stand alone (i.e., the outside option)

**Player 2**
- What Player 2 could achieve stand alone (i.e., the outside option)

**Player 3**
- What Player 3 could achieve stand alone (i.e., the outside option)

Synergies when Player 1, Player 2 and Player 3 cooperate (i.e., the pie that we observe)

Synergies when Player I & Player 3 work together

Synergies when Player I & Player 2 work together

Synergies when Player 2 & Player 3 work together

Synergies when Player 1, Player 2 and Player 3 cooperate (i.e., the pie that we observe)

**How to calculate Shapley Value:**
Determine the marginal contribution of each player to each possible coalition and average each player’s marginal contribution across all possible coalitions to estimate that player’s Value Creation to the group.
II. Using Shapley Value to Attribute Value within MNE Group

MU
(MFG + contract R&D)

Synergistic DEMPE contributions

Manufacturing + R&D services

Principal

HQ

Strategy

Synergistic DEMPE contributions

R&D IP

Process IP

Marketing IP

CU
(Commercial Unit)

Commercial operations

Group profit allocation

Stand-alone Routine profit

Synergistic profit

Benchmarked Stand alone IP ownership profit

Synergistic profit

Stand-alone Routine profit

Stand-alone Routine profit

IP ownership profit
Economic Aspects to Consider for MNE Group

Stand-alone options of contributing entities in view of own capabilities, competitive market conditions, barriers to entry

Marginal DEMPE contributions & business synergies from collaborating with complementary companies

Observable market data & outcomes
Hypothetical Example: Estimated Coalition Values

Three players:
HQ: Headquarters as IP owner
MU: Manufacturing unit (+ contract R&D)
CU: Commercial unit

<table>
<thead>
<tr>
<th>Coalition</th>
<th>Lower Bounds</th>
<th>Synergies</th>
<th>Upper Bounds</th>
<th>Synergies</th>
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<tbody>
<tr>
<td>1 HQ</td>
<td>8.0%</td>
<td></td>
<td>10.0%</td>
<td></td>
</tr>
<tr>
<td>2 MU (+ contract R&amp;D)</td>
<td>2.0%</td>
<td></td>
<td>4.0%</td>
<td></td>
</tr>
<tr>
<td>3 CU</td>
<td>2.0%</td>
<td></td>
<td>4.0%</td>
<td></td>
</tr>
<tr>
<td>4 HQ, MU</td>
<td>14.0%</td>
<td>4.0%</td>
<td>22.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>5 HQ, CU</td>
<td>11.0%</td>
<td>1.0%</td>
<td>17.0%</td>
<td>3.0%</td>
</tr>
<tr>
<td>6 MU, CU</td>
<td>5.0%</td>
<td>1.0%</td>
<td>10.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>7 HQ, CU, MU</td>
<td>25.0%</td>
<td>13.0%</td>
<td>25.0%</td>
<td>7.0%</td>
</tr>
</tbody>
</table>

Consolidated value chain profit
Business & group synergies

Determined through stand-alone functional or IP benchmarking (e.g., CPM, TNMM, CUT)

In consideration of local market conditions and relative bargaining power, to be assessed through case-specific fact finding
## Hypothetical Example: Shapley Value with Lower Bounds

### MU

<table>
<thead>
<tr>
<th>Ordering</th>
<th>Set of players before MU</th>
<th>Coalition value before MU</th>
<th>Coalition value with MU</th>
<th>Marginal contribution of the MU</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>HQ, CU, MU</td>
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</tr>
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<td>2</td>
<td>HQ, MU, CU</td>
<td>{HQ}</td>
<td>8.0%</td>
<td>14.0%</td>
</tr>
<tr>
<td>3</td>
<td>CU, HQ, MU</td>
<td>{CU, HQ}</td>
<td>11.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>4</td>
<td>CU, MU, HQ</td>
<td>{CU}</td>
<td>2.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>5</td>
<td>MU, HQ, CU</td>
<td></td>
<td>0.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>6</td>
<td>MU, CU, HQ</td>
<td></td>
<td>0.0%</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

**MU Shapley value**

### HQ

<table>
<thead>
<tr>
<th>Ordering</th>
<th>Set of players before HQ</th>
<th>Coalition value before HQ</th>
<th>Coalition value with HQ</th>
<th>Marginal contribution of the HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HQ, CU, MU</td>
<td>0</td>
<td>0.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>2</td>
<td>HQ, MU, CU</td>
<td>0</td>
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<td>{CU, MU}</td>
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<td>25.0%</td>
</tr>
<tr>
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<td>14.0%</td>
</tr>
<tr>
<td>6</td>
<td>MU, CU, HQ</td>
<td>{MU, CU}</td>
<td>5.0%</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

**HQ Shapley value**

### CU

**CU Shapley value**

**Total**

Profit margins in % of external sales

<table>
<thead>
<tr>
<th></th>
<th>Quad</th>
<th>Set of players</th>
<th>Coalition value before QUAD</th>
<th>Coalition value with QUAD</th>
<th>Marginal contribution of the QUAD</th>
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<tbody>
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<td>0</td>
<td>0.0%</td>
<td>2.0%</td>
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</tbody>
</table>

**MU Shapley value**

**HQ Shapley value**

**CU Shapley value**

**Total**

25.0%
### Estimate of Shapley Value with Upper Bounds and Comparison

#### MU

<table>
<thead>
<tr>
<th>Order</th>
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#### Upper Bounds

Profit margins in % of external sales:

| MU Shapley value | 7.0% |
| HQ Shapley value | 13.5%|
| CU Shapley value | 4.5% |
| Total            | 25.0%|

#### Note:

Difference in Shapley Values using Upper Bounds and Lower Bounds estimates is small
III. Why Shapley Value as Unspecified Method in TP Regulations

Robust Economic foundation for crucial quantitative findings

| Multi-sided analysis | Tailoring to specific market or business line conditions | validation and corroboration of profit split solutions |

Tax audits: focus on quantitative-economic arguments, allowing for an informed and constructive discussion with tax authorities

Litigation and arbitration: Helping to resolve disputes in a principled manner in corroboration with traditional methods (e.g., adjustment of benchmarked CPM/TNMM margins in consideration of some local DEMPE contributions)

- Shapley Value can help establish, support and defend a fair and robust profit allocation
Post-BEPS Non-Routine Profit Allocation Considerations

- Legal IP concept replaced by broader concept of **intangibles and entrepreneurial roles and risks**
- Tension between legal ownership of intangibles and significant **DEMPE functions**
- Distinction between routine and non-routine functions blurred

- MNE theory suggests MNEs strive to maximize **cross-functional synergies to outcompete their peers**
- Different entities within the MNE group can have **entrepreneurial roles and assume strategic risks**

At the legal entity level, bargaining power depends on:
- available outside options (including status quo)
- Entity's functional bundle, risks, and local market position

- Shapley Value can also establish, support and defend a fair and robust profit allocation under the OECD *Transfer Pricing Guidelines*
IV. Wrap-Up and Q&A

Some Reading Materials on Shapley Value


Comments? Questions? Thank-you!

To share additional comments and questions, contact us at:

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