Greater China Smartphones

The more the merrier: multi-cameras are the next mega trend in smartphones (Part 4)

- We forecast 180-353m triple-cam smartphones in 2019-20 (from 18m in 2018), driven by adoption from all top-tier brands
- Multi-cam adoption likely to rise to 45-58% in 2019-20E on the increase in triple-cams and widening dual-cam adoption, in our view
- Largan and Sunny are our picks under this theme; recent pullbacks on near-term customer inventory adjustments offer buying opportunities

What’s new: We have been highlighting the rise of multi-cameras as an emerging trend with positive implications for the smartphone camera supply chain (see The more the merrier: multi-cameras are the next mega trend in smartphones: Part I, Part II, Part III). In Part 4 of our series, we reiterate our positive stance and introduce our forecasts for triple-cam penetration in smartphones, which we view as key to accelerating multi-cam smartphone adoption in 2018-20E. Sunny (2382 HK, HKD73.95, Buy [1]) and Largan (3008 TT, TWD3,200, Outperform [2]) remain our top picks.

What’s the impact: Triple-cam adoption likely to accelerate in 2019-20E. We have previously highlighted that we view dual-cams as just the start of the multi-cam era and expect more cams to be adopted in smartphones given the enhanced camera function is one of its key selling points. Following the success of the first triple-cam smartphone, Huawei P20 Pro, released in March, we see rising interest from smartphone vendors on adopting the feature to provide a better imaging experience for consumers. We expect all the major Android brands (Samsung, Xiaomi, Oppo, Vivo, etc.) to adopt triple-cams for their flagship models in 2019. Our recent research also suggests a high possibility that Apple could adopt triple-cams for new iPhones (AMOLED version) in 2H19, despite the specs not being finalised yet. Overall, we forecast the number of triple-cam smartphones to grow to 180m in 2019 and 353m in 2020 from 18m in 2018, with the adoption rate reaching 11-21% in 2019-20 from only 1% in 2018.

Multi-cam adoption set to further rise in 2019-20E. In addition to rising triple-cam adoption, we continue to see brand vendors expanding the dual-cam feature to mid-to-low-end models with spec upgrades. Overall, we forecast the number of multi-cam (dual/triple-cam) smartphones to reach 710m in 2019 and 936m in 2020 (vs. earlier estimate of 690-856m) from 461m in 2018, with adoption rising to 45-58% in 2019-20 from 29% in 2018.

What we recommend: We reiterate our Positive sector view and believe the multi-cam trend should benefit the camera component supply chain, particularly the leaders – Largan, the leader in lens sets, and Sunny, the major camera module and lens supplier. These 2 stocks remain our top sector picks. We view the recent pullback on near-term customer inventory adjustments (Largan: iPhone volume risk - report and Sunny: China brands orders adjustment and industry competition - report and memo) as an opportunity for investors to gradually accumulate. Key risk: weaker triple-cam adoption.

How we differ: We are more upbeat than the market on the benefits from multi-cams for our preferred names.
Table of contents

Multi-cameras: the next mega trend for smartphones (Part 4) .......................... 3
  Multi-cam trends intact; adoption set to rise further in 2019-20E .......................... 3
  Triple-cam adoption likely to accelerate in 2019-20E ........................................... 3
  Triple-cam: major types and benefits to imaging quality ........................................... 5
  Dual-cam adoption to increase further over 2019-20E ............................................ 7
  Multi-cam trend intact with ongoing spec upgrades ................................................. 9
  3D sensing: long-term upside potential .................................................................... 11
  Positive on camera component supply chain: near-term headwinds offer good opportunity to accumulate ............................................................................................................. 12
  Risks to our view ....................................................................................................... 13

Appendix 1 .................................................................................................................. 15
  Triple-cams: merits and technology challenges ......................................................... 15

Appendix 2 .................................................................................................................. 16
  Major technologies in 3D sensing .............................................................................. 16

Appendix 3 .................................................................................................................. 17
  Dilemma: image quality vs. form factor ................................................................. 17
  Dual-cams as a solution to the dilemma ................................................................. 17
  Improved image quality ......................................................................................... 18
Multi-cam trends intact; adoption set to rise further in 2019-20E

We have been highlighting the rise of multi-cameras as an important spec upgrade trend in smartphones and the positive implications for the smartphone camera supply chain (see *The more the merrier: multi-cameras are the next mega trend in smartphones: Part I, Part II, Part III*). In this report, Part 4 in our report series, we reiterate our positive stance on the multi-cam trend and introduce our forecasts for triple-cam penetration in smartphones, which we view as the next key driver to accelerating multi-cam adoption in smartphones in 2018-20E, in addition to the ongoing widening adoption of dual-cams. We expect the adoption of triple-cams to materialise over 2019-20, and to accelerate multi-cam adoption in smartphones in 2018-20E. Overall, we forecast the multi-cam adoption rate to rise to 45% in 2019 and 56% in 2020 from 29% in 2018 and 17% in 2017.

Triple-cam adoption likely to accelerate in 2019-20E

We have previously highlighted that we view dual-cams as just the start of a multi-cam era and expect more cams to be adopted, given the enhanced camera function as one of the most compelling selling points of a smartphone. Indeed, the emergence of the triple-cam trend in March 2018, when it was introduced in Huawei P20 Pro, is a further step in the enhancement of image quality for smartphone cameras. The P20 Pro is capable of 3x optical zoom (vs. 2x in dual-cams) and better picture quality in a low-light environment, and has received positive feedback from consumers.

Following the success of the P20 Pro, Huawei is expanding the scope of triple-cam adoption in its flagship models, evidenced by the newly released Mate 20, Mate 20 X and Mate 20 Pro (launched in October 2018). The 3 models have all adopted the triple-cam design (vs. 1 model in the P20 series – P20 and P20 Pro). For 2019, our research suggests Huawei will take a more aggressive strategy for triple-cam adoption, putting the design in not only its flagship models but also mid-range to high-end models (ie, its Honor series). We also see strong interest among all other smartphone brands to adopt triple-cam features to provide a better imaging experience for consumers. From late 3Q18 to 4Q18, we saw Samsung releasing its first triple-cam smartphone – the Galaxy A7 (September 2018) and A9 (October 2018) with a quad-cam design, and LG launching its first triple-cam model – the V40 ThinQ in September 2018. Looking into 2019, we expect all the major Android brands (Samsung, Xiaomi, Oppo and Vivo) to release triple-cam models. In particular, we expect Samsung to become another strong advocate for triple-cams as it is likely to adopt the triple-cam design for its coming flagship models – the Galaxy S10 series in 1Q19.
As for Apple, our research shows that the camera would see one of the key upgrades for 2H19 new iPhones. We believe Apple is working on multiple solutions, including dual-cam + time of flight (ToF), dual-cam + structured light (SL), and triple-cam designs. It is also considering adding microwave ToF to enhance the overall camera performance. Among all the solutions, we see a high possibility that Apple will adopt triple-cam designs for new iPhones in 2H19 to further enhance the imaging experience for consumers. Overall, we forecast the number of triple-cam smartphones to grow to 180m in 2019 and 353m in 2020 from 18m in 2018, with the adoption rate reaching 11-21% in 2019-20 from only 1% in 2018.

**Global triple-cam penetration in smartphones**

![Graph showing global triple-cam penetration in smartphones]

**Source:** Companies, Daiwa

### Triple-cam adoption among major brands

**Apple** is likely to release 3 new iPhones in 2H19 – 2 AMOLED models and 1 TFT-LCD model – in our view. We expect Apple to adopt triple-cam designs for its 2 AMOLED models and dual-cam for the LCD one (vs. dual-cam for iPhone XS/XS Max and single-cam for XR in 2H18). Overall, we forecast the triple-cam adoption rate for Apple to reach 21% in 2019 and 44% in 2020 from none in 2018.

**Samsung** released the new Galaxy A7 in September 2018, which is its first triple-cam smartphone, followed by the new Galaxy A9 (launched in October 2018) that comes with a quad-cam design (including a telephoto camera, an ultra-wide camera, a depth camera and a wide camera that can achieve 2x optical zoom, wider shooting angle and adjustment for depth of field). Our research suggests that Samsung is likely to introduce 3 Galaxy S10 models in 1Q19 with triple-/triple-/dual-cam designs for each model vs. single-/dual-cam designs for its predecessor S9/S9+. We expect Samsung to be another strong advocate for triple-cam design, and forecast the company’s triple-cam smartphones to reach 40-70m in 2019-20 from 1m in 2018.

**Huawei** released its first triple-cam smartphone, P20 Pro, in March 2018, which has received positive feedback from consumers and enhanced Huawei’s brand image in the smartphone market, in our view. Following the success of P20 Pro, we expect Huawei to continue to be the most supportive of the triple-cam design. We also expect Huawei to not only adopt the triple-cam design for its flagship line-ups but also for mid-range to high-end models going forward, evidenced by the newly released Honor Magic 2 in October 2018, which is equipped with triple-cams and a sliding front-cam design. As such, we forecast triple-cam adoption for Huawei to reach 50-80m in 2019-20 from 16m in 2018.

**Xiaomi, Oppo and Vivo** have not released any triple-cam smartphones in 2018, yet we believe these brands will catch up with the triple-cam adoption trend to attract consumers’ interest. We expect these vendors to adopt the triple-cam design for high-end versions of their flagship models from 2019. We forecast triple-cam smartphones to reach 15m for Xiaomi, 10m for Oppo and 10m for Vivo in 2019, from none in 2018.

We are positive on the emerging trend of triple-cams in smartphones and forecast its adoption rate to rise further among brand vendors.
Global triple-cam adoption by brand

Source: Companies, Daiwa

Major triple-cam models in 2018

<table>
<thead>
<tr>
<th>Model</th>
<th>Huawei Honor Magic 2</th>
<th>Huawei Mate 20</th>
<th>Huawei Mate 20 X</th>
<th>Huawei Mate 20 Pro</th>
<th>Samsung Galaxy A9</th>
<th>LG V40 ThinQ</th>
<th>Samsung Galaxy A7</th>
<th>Huawei P20 Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model picture</td>
<td><img src="image1.png" alt="Model picture" /></td>
<td><img src="image2.png" alt="Model picture" /></td>
<td><img src="image3.png" alt="Model picture" /></td>
<td><img src="image4.png" alt="Model picture" /></td>
<td><img src="image5.png" alt="Model picture" /></td>
<td><img src="image6.png" alt="Model picture" /></td>
<td><img src="image7.png" alt="Model picture" /></td>
<td><img src="image8.png" alt="Model picture" /></td>
</tr>
<tr>
<td>Dimensions</td>
<td>157.3 x 75.1 x 8.3</td>
<td>158.2 x 77.2 x 8.3</td>
<td>174.8 x 85.4 x 8.15</td>
<td>157.8 x 72.3 x 8.6</td>
<td>162.5 x 77 x 7.8</td>
<td>158.8 x 75.7 x 7.6</td>
<td>159.8 x 78.6 x 7.5</td>
<td>155 x 73.9 x 7.8</td>
</tr>
<tr>
<td>Weight</td>
<td>206 g</td>
<td>158 g</td>
<td>232 g</td>
<td>189 g</td>
<td>183 g</td>
<td>169 g</td>
<td>168 g</td>
<td>150 g</td>
</tr>
<tr>
<td>ROM capacity</td>
<td>128/256GB</td>
<td>128GB</td>
<td>128GB</td>
<td>128GB</td>
<td>128GB</td>
<td>64GB</td>
<td>64/128GB</td>
<td>128GB</td>
</tr>
<tr>
<td>Diagonal</td>
<td>6.3&quot;</td>
<td>6.53&quot;</td>
<td>7.2&quot;</td>
<td>6.39&quot;</td>
<td>6.3&quot;</td>
<td>6.4&quot;</td>
<td>6.0&quot;</td>
<td>6.1&quot;</td>
</tr>
<tr>
<td>Resolution</td>
<td>2340 x 1080</td>
<td>2244 x 1080</td>
<td>2244 x 1080</td>
<td>3120 x 1440</td>
<td>1080 x 2220</td>
<td>8MP</td>
<td>1080 x 2220</td>
<td>1080 x 2240</td>
</tr>
<tr>
<td>Pixel density</td>
<td>403 ppi</td>
<td>381 ppi</td>
<td>346 ppi</td>
<td>358 ppi</td>
<td>392 ppi</td>
<td>392 ppi</td>
<td>392 ppi</td>
<td>400ppi</td>
</tr>
<tr>
<td>Main cam</td>
<td>16MP+16MP+24MP</td>
<td>16MP+12MP+8MP</td>
<td>40MP+20MP+8MP</td>
<td>40MP+20MP+8MP</td>
<td>24MP+10MP+8MP</td>
<td>24MP+8MP+5MP</td>
<td>24MP+8MP+5MP</td>
<td>40MP+8MP+20MP</td>
</tr>
<tr>
<td>3D sensing</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>SL at front</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Under-display</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>fingerprint</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OIS</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Front cam</td>
<td>16MP+2MP+2MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
</tr>
<tr>
<td>Price</td>
<td>-</td>
<td>EUR9799</td>
<td>EUR8999</td>
<td>EUR1,049</td>
<td>USD949</td>
<td>USD329</td>
<td>EUR8999</td>
<td></td>
</tr>
<tr>
<td>India/China price</td>
<td>CNY3,799</td>
<td>CNY3,999 (for 6GB)</td>
<td>CNY4,999</td>
<td>CNY5,999</td>
<td>CNY5,299</td>
<td>CNY3,999</td>
<td>CNY3,999</td>
<td>CNY3,999</td>
</tr>
</tbody>
</table>

Source: Companies, Daiwa

Triple-cam: major types and benefits to imaging quality

What are the benefits of triple-cam design?

We believe the emergence of dual-cams solved the dilemma between image quality and form factor to offer higher resolution and better pictures compared with single-cam models; dual-cam models are also thinner than single-cam (see Appendix 3). In our view, the triple-cam design further enhances the imaging quality compared with the dual-cam design. The major benefits of triple-cams include higher optical zoom (3x vs. up to 2x of dual-cams), broader angle, better image quality in a low-light environment, enhanced functionality for AI features (such as detection and recognition of faces, objects and scenes), and auto adjustments of multiple parameters for best image output (see Appendix 1). Triple-cams can also provide AR and 3D features by leveraging on 2 cameras in the design via the stereo system (see Appendix 2).

The benefits of triple-cam design include higher optical zoom, broader shooting angle, better image qualities in a low-light environment, and enhanced functionality for AI features.
Benefits of triple-cam design

- 3x optical zoom, 5x hybrid zoom and 10x digital zoom
- Wide shooting angle
- Better image in a low-light environment
- AI features: automatic scene recognition

Source: Company, Daiwa

Structure of triple-cams and major types

In smartphones, there are 3 major types of triple-cam design: 1) low-light focus: mono camera + wide-angle camera + telephoto camera; 2) wide-angle focus: super-wide-angle camera + wide-angle camera + telephoto camera; and 3) super zoom: folded telephoto camera + wide-angle camera + telephoto camera. In addition to these 3 types, we also see various designs, such as wide angle + super-wide + depth or wide angle + super-wide + mono, for different functionalities that smartphone vendors like to focus on.

Low-light focus. In addition to higher optical zoom (3x vs. 2x for dual-cams), this design can also achieve better low-light performance by fusing outputs from its mono camera. For example, the first triple-cam smartphone, Huawei P20 Pro (launched in March 2018), has adopted this design.

Wide-angle focus. The super-wide-angle camera in the system can deliver a broader shooting angle and seamless capture mode in panorama shooting, and at the same time, is able to capture fine details of distant objects by its telephoto camera, in addition to a higher optical zoom. LG’s V40 ThinQ (released in September 2018) and Huawei Mate 20 series (released in October 2018) have adopted this design.

Super zoom. By adopting the folded lens design in triple-cams, this design is able to deliver better image quality in a low-light environment with a higher optical zoom (5x optical zoom) than the normal optical-zoom-focus triple-cams. Our research suggests that smartphone brands are working on this solution and we expect Huawei to release the first smartphone with the super zoom design in 2019.

Major types of triple-cam design include low-light focus, wide-angle focus, and super zoom
Major triple-cam designs

<table>
<thead>
<tr>
<th>Design</th>
<th>Low-light focus</th>
<th>Wide-angle focus</th>
<th>Super zoom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optical zoom</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Shooting angle</td>
<td>Average</td>
<td>Average</td>
<td>Average/Good</td>
</tr>
<tr>
<td>Low-light shooting</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Others</td>
<td>Its mono camera enables better image qualities for low-light environment shooting</td>
<td>Its super-wide-angle camera enables better user experience in panorama shooting</td>
<td>It has excellent low-light shooting capability as its folded lens design in telephoto camera allows more lights into the sensor</td>
</tr>
</tbody>
</table>

Source: Core Photonics, Daiwa

Triple-cam design in Huawei P20 Pro

Source: Company, Daiwa

Triple-cam design in Huawei Mate 20 Pro

Source: Company, Daiwa

Triple-cam designs in smartphone models in 2018

<table>
<thead>
<tr>
<th>Model</th>
<th>Huawei Honor Magic 2</th>
<th>Huawei Mate 20</th>
<th>Huawei Mate 20 Pro</th>
<th>Samsung Galaxy A9</th>
<th>LG V40 ThinQ</th>
<th>Samsung Galaxy A7</th>
<th>Huawei P30 Pro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model picture</td>
<td><img src="image1" alt="Model picture" /></td>
<td><img src="image2" alt="Model picture" /></td>
<td><img src="image3" alt="Model picture" /></td>
<td><img src="image4" alt="Model picture" /></td>
<td><img src="image5" alt="Model picture" /></td>
<td><img src="image6" alt="Model picture" /></td>
<td><img src="image7" alt="Model picture" /></td>
</tr>
<tr>
<td>Triple-cam</td>
<td>24MP + 16MP + 16MP</td>
<td>16MP + 12MP + 8MP</td>
<td>40MP + 20MP + 8MP</td>
<td>24MP + 10MP + 8MP + 8MP</td>
<td>12MP + 12MP + 16MP</td>
<td>24MP + 8MP + 5MP</td>
<td>40MP + 8MP + 20MP</td>
</tr>
<tr>
<td>-telephoto</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>-wide angle</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>-super wide angle</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>-mono</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>Second camera</td>
<td>16MP + 2MP + 2MP</td>
<td>24MP</td>
<td>24MP</td>
<td>24MP</td>
<td>8MP + 5MP</td>
<td>24MP</td>
<td>24MP</td>
</tr>
<tr>
<td>Price</td>
<td>CNY3,799</td>
<td>CNY3,999</td>
<td>CNY5,999</td>
<td>USD689</td>
<td>USD949</td>
<td>USD329</td>
<td>CNY4,988</td>
</tr>
</tbody>
</table>

Source: Daiwa

Led by increasing penetration of dual-cams in mid-range models, we forecast dual-cam smartphones to reach 530-583m in 2019-20 from 443m in 2018

Dual-cam adoption to increase further over 2019-20E

Driven by the strong demand from consumers for better image quality and to solve the dilemma of megapixel count vs. the form-factor design of smartphones, we see the adoption trend of dual-cams in smartphones remaining intact over 2019-20E. For high-end smartphones, we expect some flagship models to upgrade to triple-cam design as we have previously discussed, while the rest will adopt dual-cams with spec upgrades. We also see a broader penetration of dual-cam design in mid-range or low-end smartphones, and believe smartphone vendors will continue expanding dual-cam adoption over 2019-20E.

For high-end smartphones, Apple expanded the dual-cam design to 2 models (iPhone XS/XS Max) in its extended flagship product lines in 2018 (vs. iPhone X in 2017) with spec...
upgrades (telephoto: f/2.4 aperture in iPhone XS/XS Max vs. telephoto: f/2.8 aperture in iPhone X). Chinese brands are continuing to expand the dual-cam design from high-end to mid/lower-range models. In addition to Huawei, which has extended the dual-cam design to its mid/lower-range smartphones (Honor series), Oppo, Vivo and Xiaomi have been catching up quickly in 2018 in adopting this feature. For Samsung, after its first dual-cam smartphone Galaxy Note 8 (launched in September 2017), it has released multiple models with this feature across its high-end to mid/lower-range segments in 2018.

As such, we expect dual-cam smartphones to rise to 530m in 2019 and 583m in 2020 from 443m in 2018, with the adoption rate rising to 34% in 2019 and 36% in 2020 from 28% in 2018.

*Global dual-cam penetration in smartphones*

**Dual-cam adoption among global major brands**

**Apple** introduced 2 dual-cam models (iPhone XS/XS Max) in 2018 with upgraded camera specs, in line with our expectation (see report, 13 September). For its new iPhones in 2019, we expect Apple to adopt the dual-cam design for the LCD model (among 3 models – 2 AMOLED models and 1 LCD model). As such, we forecast the dual-cam adoption rate in all iPhones to reach 49-50% in 2019-20 from 49% in 2018.

**Samsung** launched its first dual-cam model Galaxy Note 8 in September 2017. In 2018, in addition to the flagship model S9+ (released in February), it also expanded the dual-cam design to mid-range models. We believe Samsung will further extend dual-cam adoption in its products, and forecast the company’s dual-cam smartphones to reach 75-90m in 2019-20 from 50m in 2018.

**Huawei** has been expanding the dual-cam design to its mid-range models in 2018. For example, Honor 7A (released in April 2018) comes with a dual-cam set-up of 13MP + 2MP, compared to the single-cam design of 13MP for its predecessor Honor 6A (released in May 2017). We forecast dual-cam adoption for Huawei to reach 90m in 2019 and 2020 from 88m in 2018.

**Xiaomi** has been expanding its dual-cam adoption and released over 15 dual-cam models in 2018 (vs. 4 models in 2017 and only 2 models in 2016). We estimate dual-cam adoption for Xiaomi to reach 62-67m in 2019-20 from 55m in 2018.

**Oppo** has launched multiple smartphones with the dual-cam design in 2018. In addition to its high-end models, Oppo has been aggressive in expanding the design to its mid-range segment. F9 Pro (launched in August 2018) has a dual-cam design of 16MP + 2MP, compared to a single-cam of 16MP in F7 (released in March 2018). We estimate dual-cam adoption for Oppo to reach 60m for 2019 and 2020 from 50m in 2018.

**Vivo** offered multiple dual-cam models in 2018, ranging from high-end (X21, X23 and NEX Series) to mid-tier models. We believe Vivo will continue to keep dual-cams as the key

---

**We expect broader adoption of dual-cams in smartphones with continuing spec upgrades over 2019-20**
feature in smartphones, in addition to triple-cams. As such, we estimate its dual-cam smartphones to reach 55m in 2019 and 2020 from 45m in 2018.

Global dual-cam adoption in smartphones by brand

![Graph showing dual-cam adoption by brand](image)

Source: Daiwa estimates and forecasts

**Major dual-cam models in 2H18**

<table>
<thead>
<tr>
<th>Model</th>
<th>OPPO R17</th>
<th>Samsung Galaxy Note 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model picture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>155.9 x 75.7 x 7.8</td>
<td>157.5 x 77.4 x 7.7</td>
</tr>
<tr>
<td>ROM capacity</td>
<td>64/256/512GB</td>
<td>64/256/512GB</td>
</tr>
<tr>
<td>RAM capacity</td>
<td>4GB</td>
<td></td>
</tr>
<tr>
<td>Display diagonal</td>
<td>6.4&quot;</td>
<td>5.8&quot;</td>
</tr>
<tr>
<td>Resolution</td>
<td>1080 x 2340</td>
<td>1242 x 2686</td>
</tr>
<tr>
<td>Pixel density</td>
<td>403 ppi</td>
<td>458 ppi</td>
</tr>
<tr>
<td>Camera</td>
<td>16MP + 2MP</td>
<td>12MP + 12MP</td>
</tr>
<tr>
<td>3D sensing</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Under-display</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>OIS</td>
<td>No</td>
<td>Dual OIS</td>
</tr>
<tr>
<td>Second camera</td>
<td>25MP</td>
<td>7MP</td>
</tr>
<tr>
<td>Launch date</td>
<td>Oct-18</td>
<td>Sep-18</td>
</tr>
<tr>
<td>Price (CNY/India)</td>
<td>230 g</td>
<td>1285/212GB</td>
</tr>
</tbody>
</table>

Source: Companies, Daiwa

**Multi-cam trend intact with ongoing spec upgrades**

Multi-cam adoption expected to rise further in 2019-20E

We expect multi-cam smartphones to rise further over 2019-20, driven by the emergence of the triple-cam design, in addition to continued rising penetration of dual-cams in mid/low-end smartphones with spec upgrades. Overall, we forecast the number of multi-cam (dual-cam/triple-cam) smartphones to rise to 710m in 2019 and 936m in 2020 (vs. our earlier estimates of 690m and 856m, respectively) from 461m in 2018, with the adoption rate rising to 45% in 2019 and 58% in 2020 from 29% in 2018.

We forecast broader penetration of dual-cams in mid-range models and increasing adoption of triple-cam design in smartphones over 2019-20
Greater China Smartphones: 14 November 2018

Global multi-cam penetration in smartphones

Source: Daiwa estimates and forecasts

Global multi-cam adoption in smartphones by brand

Source: Daiwa estimates and forecasts

**Spec upgrades in multi-cams**

Despite muted volume growth in the overall smartphone industry in the past 2 years, we believe component leaders will continue to benefit from the rising multi-cam adoption trend over 2019-20E, and expect this favourable industry trend to not only act as a key volume growth driver but also add more value to the supply chain during this period.

We note that smartphone brands have been upgrading their multi-cam specs to differentiate their product offerings, such as higher megapixel resolution, improved autofocus speed, larger aperture ratio, higher optical zoom, and the inclusion of optical image stabilisation (OIS). For example, Apple adopted the dual-cam design with higher specs in its extended product lines in 2018 (telephoto: f/2.4 aperture for iPhone XS/XS Max; telephoto: f/2.8 aperture for iPhone X). Meanwhile, we note that Chinese brands are also continuing to expand dual-cam adoption from high-end to mid/low-range models with spec upgrades. Huawei Honor 10 (released in April 2018) has a dual-cam design of 16MP + 24MP, compared to 12MP + 20MP in Honor 9 (released in June 2017). We also note that vendors have been pushing for innovative form factors in cameras for a full-screen design. Oppo launched Find X (June 2018) that comes with a 3D stealth camera based on its innovative sliding structure, followed by Vivo’s NEX series (released in June 2018) that has a screen-to-body ratio of 91% and a retractable camera at the front. Moreover, Xiaomi Mix 3, Huawei Honor Magic 2 and Lenovo Z5 Pro (all released in October 2018) feature a sliding front camera design.

We believe such a spec upgrade trend bodes well for our positive outlook for the supply chain, and expect this intact favourable trend to continue providing growth drivers for major beneficiaries, particularly industry leaders – Largan, the leader in high-end lenses, and Sunny Optical, the leader in camera module and a major lens supplier to mid-/high-end models.
Besides the existing upgrade trend for smartphones, we see emerging adoption trends for folded-lens designs. According to our industry research, multiple vendors are developing the technology for a periscope to deliver a folded-lens design in smartphones. We believe this technology will enable camera modules to achieve greater zoom-in capability and higher megapixels with a smaller space requirement, resulting in a slimmer form factor and better camera for the smartphone. While the adoption of the periscope approach is emerging, development progress depends on the build-up of the entire ecosystem (including camera modules, lens, algorithm and voice coil motor [VCM]), in our view.

According to our industry research, we expect Huawei to be the first to adopt triple-cams with the periscope design for its flagships in 2019. If this trend takes hold, we believe Largan and Sunny Optical will be well-positioned to benefit from it. However, we have not yet factored the possibility of such an upside into our forecasts.

Vivo: retractable front camera design in NEX Series

Source: Vivo

Xiaomi: sliding front camera design in Mix 3

Source: Xiaomi

Oppo: dual-cam with folded-lens design to offer 5x optical zoom

Source: Oppo

Apple’s patent: folded camera lens system

Source: Apple

3D sensing: long-term upside potential

We previously highlighted that we are optimistic on camera functions beyond capturing pictures/films with image quality enhancement in the long term, and believe new features (ie, AR/3D) will lead to an increase in the usage of cameras in smartphones from 2017. Apple, a strong supporter of 3D sensing, released its first 3D sensing smartphone, the iPhone X, in September 2017, and expanded its adoption to all new iPhones in 2018 (XS Max/XS/XR), as well as the newly released iPad Pro variants (11 inch and 12.9 inch models) in October 2018 (see memo), as we expected (see report). However, for Chinese brands, the adoption seems to be tracking behind our expectations due to the initial software and hardware bottlenecks. Chinese brands have either reduced the sales volume or pushed back their 3D-sensing models to 2H18 vs. 1H18 as planned earlier, in our view. As a result, despite all the major Chinese brands releasing their 3D sensing models in 2018, as we expected, the total volume of Chinese 3D sensing smartphones is likely to be 7m in 2018, significantly lower than our previous estimate of 40m.

We believe 3D sensing will provide long-term upside potential to the smartphone camera supply chain once the ecosystem is completed.
In 2019, our supply chain research suggests that all Android brands have various 3D sensing projects that adopt different types of solutions; however, due to the limited visibility and lack of ecosystem in the near term, we take a more cautious view on the adoption of 3D sensing in 2019-20E. We now expect 3D sensing adoption in smartphones to grow to 15-22% in 2019-20 from 7% in 2018 and 2% in 2017 (vs. our previous estimates of 23-34% in 2019-20). We could see upsides if the Android brands turn out to be more aggressive in adopting the feature after Apple released more applications to enhance the overall ecosystem. Our research also suggests that Apple is working on a 3D sensing solution on the back of iPhones (vs. the current adoption of 3D feature on the front), which could further drive long-term upside potential for its adoption, in our view.

Positive on camera component supply chain: near-term headwinds offer good opportunity to accumulate

We have been optimistic on the smartphone component supply chain, given the rising adoption trend of multi-cams (see Part 1, Part 2, and Part 3). Besides the increasing dual-cam adoption we expected, our recent research suggests that the emerging trend of triple-cams should further drive multi-cam adoption in 2019-20E. We also believe the multi-cam trends not only provide volume upside but also a potential ASP premium given the spec upgrades, as we previously discussed. Therefore, we think these favourable trends will act as both volume and value drivers for the component supply chain. In the Greater China smartphone supply chain, Sunny and Largan remain our top picks under the theme.

Sunny. We view Sunny as a major beneficiary of the multi-cam trend in both smartphones and smart cars, and forecast it to resume strong earnings growth of 42-45% YoY in 2019-20E on likely accelerated spec upgrades in smartphones (triple-cams/7P lens adoption) from 2019, vs. a flattish 2018E (+3% YoY), impacted by the near-term headwinds facing its HCM and VLS businesses on customers’ inventory adjustments and the US-China trade
war (see Favourable trends intact despite near-term headwinds, 11 October). Besides, we view the market’s concerns about the changing competition landscape due to the deal between O-Film and Fujifilm as overdone; we do not see this deal to have any significant impact on Sunny’s leading position in VLS. Also, for HLS, we see limited impact from the deal (see memo). We suggest investors use the recent pull-backs to accumulate the stock on the solid trends ahead. Sunny remains one of our top sector picks. We reiterate our Buy (1) rating and 12-month TP of HKD115, based on a PER of 30x (vs. its past-3-year trading range of 10-36x), on our 1-year forward EPS forecast.

Largan. On its leading position in lens sets, we view Largan as a major beneficiary of the intact long-term spec upgrades trend in smartphones and expect accelerated spec upgrades (triple-cams/7P) from 2019, despite near-term headwinds such as order adjustments from Chinese brands in 4Q18 and rising volume risks in new iPhones in 4Q18-1Q19 (see New iPhones: lukewarm demand; first round of order cuts in the supply chain, 6 November). We expect its share price to remain under pressure in the near term due to risks related to major customers’ inventory adjustments, but we view the pull-backs (if any) as a good opportunity for long-term investors to gradually accumulate the stock. We reaffirm our Outperform (2) rating and 12-month TP of TWD3,800, based on a PER of 18x (vs. its past-5-year range of 7-21x), on our 1-year forward EPS estimate.

Key downside risks to our call are slower multi-cam adoption, weaker smartphone sell-through, and increased price competition in the sector

We suggest long-term investors gradually accumulate shares of Sunny and Largan on likely pull-backs due to near-term headwinds

Smartphone camera module supply chain

Source: Companies, Daiwa

Risks to our view

The key risk will be potentially slower multi-cam adoption in smartphones. Although we believe multi-cam adoption will speed up due to the emerging adoption trend of triple-cams, in addition to continued enhanced penetration of dual-cams, we think consumer feedback will be the key to the final adoption rate. Poor acceptance from consumers could lead to lower revenue growth for companies focused on camera components, impacting players like Largan and Sunny Optical.

A secondary risk is weaker-than-expected smartphone sell-through. The volatilities and uncertainties arising from the US-China trade war, or other surrounding macroeconomic events, currency fluctuations, and high smartphone penetration in developed and developing countries could delay the smartphone replacement cycle or new purchases by
consumers. This could result in weaker-than-expected smartphone sell-through and lead to slower-than-expected revenue growth in the sector, in our view.

A third risk is an increase in price competition in the sector. After years of strong volume growth, the smartphone market saturation will likely lead to single-digit YoY volume growth in 2018-20E, based on our forecasts. Limited volume growth could contribute to intense price competition, ultimately leading to lower gross margins for companies within the sector, in our view.
Appendix 1

Triple-cams: merits and technology challenges

To achieve more features with enhanced functionality in cameras (such as broader shooting angle, higher optical zoom, better image quality in a low-light environment, and improved capability for more AI features), smartphone brand vendors have started adopting the triple-cam design. The addition of a third camera carries merits, but also brings challenges in terms of calibration, firmware/algorithm and power consumption.

Merits

Higher optical zoom and broader angle. By using wide-angle and telephoto cameras, in addition to the standard one, a triple-cam system could deliver better images with fine details of objects with a wider viewing angle.

Better image quality in a low-light environment. Triple-cams could deliver clearer and brighter images in a low-light environment by fusing outputs from the mono camera and standard camera.

Enhancing functionality for AI features. Triple-cams are able to capture more detailed and complex image signals. As such, they are able to offer more improved capability for AI features such as detection and recognition of faces, objects and scenes, as well as auto adjustments of multiple parameters for the best image output.

Technology challenges

Calibration. The cameras need to be carefully calibrated for optical properties of a triple aperture system. The calibration consists of recovering camera parameters, location and orientation for external parameters and focal lengths for internal parameters. In addition, the calibration should be completed in the camera manufacturing line for numerous tests on any dynamic physical changes, such as temperature variances and drop test.

Firmware/algorithm. A triple-cam system demands more complexity on the firmware side as the framework in a triple-cam system will have to deal with each of the 3 cameras to operate as one integrated camera. In addition, algorithms would have the same challenges to ensure reasonable processing run time and also maintain zero distortion of the image quality from multiple inputs.

Power consumption. The complex algorithm and firmware, which require more processing power in power management, frame request and memory management, could lead to higher power consumption for the entire camera system (camera + processing platform).

Improved image quality in low-light environment

Source: Companies, Daiwa

Standard vs. wide angle

Source: Company, Daiwa
Appendix 2

Major technologies in 3D sensing

A 3D sensor (consisting of 2 main parts – receiver module [Rx] and transmitter module [Tx]) is a semiconductor that projects and receives light emission to deliver sensing capability into 3D. Applications of 3D sensing in smartphones include augmented reality (AR), face recognition, gesture recognition, 3D scanning and mobile payments. There are 3 approaches to drive 3D sensing: structured light, time of flight (ToF) and stereo system.

**Structured light.** By projecting infrared dots to form the pattern of the object, the device then measures the size of each dot, which represents the distance between the dot and device (the larger the dot, the longer the distance), to create a stereo image. The structured light system specialises in a very short to mid distance in 3D sensing, which is ideal to be adopted on the front-cam of smartphones.

**Time of flight.** The device measures the depth of an image by measuring the time it takes for an infrared beam to transmit to the object and to reflect to the device. The time-of-flight device has more merits in short- to long-distance sensing, thus making it more suitable to be applied in the rear-cam of smartphones.

**Stereo system.** Originated from the conception of the human eyes, the device captures a scene with 2 cameras to illustrate the same object from different views and generate a stereo vision of the object. The stereo system has the most complicated design, but it also can create the 3D image with the lowest power consumption, given active illumination is not required in this technology.

<table>
<thead>
<tr>
<th>Comparison between 3D sensing technologies</th>
<th>Structured light</th>
<th>ToF</th>
<th>Stereo system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td><img src="image" alt="Structured light" /></td>
<td><img src="image" alt="ToF" /></td>
<td><img src="image" alt="Stereo system" /></td>
</tr>
<tr>
<td>Latency</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Low light performance</td>
<td>Good</td>
<td>Good</td>
<td>Weak</td>
</tr>
<tr>
<td>Bright light performance</td>
<td>Medium</td>
<td>Medium</td>
<td>Good</td>
</tr>
<tr>
<td>Range</td>
<td>Short to mid</td>
<td>Short to long</td>
<td>Mid</td>
</tr>
<tr>
<td>Scanning speed</td>
<td>Medium</td>
<td>Fast</td>
<td>Medium</td>
</tr>
<tr>
<td>Active illumination</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Power consumption</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

Source: Companies, Daiwa
Appendix 3

Dilemma: image quality vs. form factor

Cameras are one of the key features that the brand vendors have been focusing on for upgrades to appeal to consumers. However, the nature of a smartphone’s form-factor design, especially the thickness requirement, has made it a challenge to improve image quality. For instance, a larger CMOS sensor, bigger pixel size, or more lens components in a lens set should allow more light into a camera module to catch more details of a subject, resulting in better image quality. However, this has also meant a bulky camera module with a higher Z-height (the height of the camera module) due to the increased size or pieces of the optical components. Thus, there is always a trade-off between better image quality and a thinner form-factor design for a smartphone.

This aforementioned dilemma became a more important issue with the migration of smartphone cameras to higher resolution. Due to the space constraints in a smartphone, the image quality of 16MP+ camera modules could be worse than that of the phones with 8-12MP camera modules because the pixel size becomes too small to ensure good light sensitivity. Conversely, assuming other criteria stay the same (such as field of view, sensor size, the level of design difficulty), higher resolution requires a longer focal length due to the smaller pixel size and consequently a higher Z-height for the camera module.

Dual-cams as a solution to the dilemma

The emergence of dual-cams solves this dilemma, in our view. Having a dual-cam in a smartphone means that it has 2 cameras on the back of the phone to take pictures/shoot images instead of just 1 camera, which is the design currently adopted in most smartphones. By incorporating 2 channels to collect picture details/light, the dual-cam design can reduce the Z-height significantly and deliver a similar or even better performance than a single-cam. Despite being thinner, dual-cam smartphones can offer a higher resolution and better image quality compared to single-cam models.
Improved image quality

Key benefits of dual-cam design include multiple focus/post-shot focus adjustments, improved resolution and higher optical zoom.

Besides reducing the thickness/height of the camera module to create a thinner form factor for smartphones, dual-cams can improve image quality in different areas by leveraging the different characteristics of each camera. The major benefits of dual-cams include multiple focus/post-shot focus adjustments, better image quality in a low-light environment, improved resolution/pixel quality, optical zoom function, and 3D depth mapping based on different dual-cam designs. The current dual-cam designs can be categorised into 4 major types: 1) identical type – high resolution (colour) + high resolution (colour), 2) twin type – high resolution (mono) + high resolution (colour), 3) twin type – telephoto camera + wide-angle camera, and 4) depth type – high resolution + low resolution. Each type plays an important role in improving the image quality (see the table below).

Dual-cams: multiple focus/post-shot focus adjustments

Dual-cams: improved resolution/pixel quality

Dual-cams: optical zoom function

Dual-cams: 3D depth mapping

Image quality and form factor comparisons: different types of dual-cams and single-cam

<table>
<thead>
<tr>
<th>Structure</th>
<th>Dual-cam Symmetric</th>
<th>Dual-cam Asymmetric</th>
<th>Single camera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>High + High Colour + Colour</td>
<td>High + High Colour + Mono</td>
<td>High + Low Colour + Colour</td>
</tr>
<tr>
<td>CMOS Sensor</td>
<td>Colour + Colour</td>
<td>Colour + Mono</td>
<td>Colour</td>
</tr>
<tr>
<td>Focal length</td>
<td>Same</td>
<td>Same</td>
<td>Depends</td>
</tr>
<tr>
<td>Camera Module Structure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of camera module</td>
<td>Thinner</td>
<td>Thinner</td>
<td>Thinner</td>
</tr>
<tr>
<td>Optical zoom</td>
<td>n.a.</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Low-light image quality</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Improved resolution/pixel quality</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>3D depth mapping</td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Multiple focus/Post-photo adjustments</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
</tbody>
</table>

Source: Companies, Daiwa
### Daiwa’s Asia Pacific Research Directory

#### HONG KONG

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Takashi FUJIKURA</td>
<td>(852) 2848 4051</td>
<td><a href="mailto:takash.fujikura@hk.daiwacm.com">takash.fujikura@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Jiro IOKIBE</td>
<td>(852) 2773 8702</td>
<td><a href="mailto:jiro.iokibe@hk.daiwacm.com">jiro.iokibe@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>John HETHERINGTON</td>
<td>(852) 2773 8787</td>
<td><a href="mailto:john.hetherington@hk.daiwacm.com">john.hetherington@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Craig CORK</td>
<td>(852) 2848 4463</td>
<td><a href="mailto:craig.cork@hk.daiwacm.com">craig.cork@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Paul M. KITNEY</td>
<td>(852) 2848 4947</td>
<td><a href="mailto:paul.kitney@hk.daiwacm.com">paul.kitney@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Kevin LAI</td>
<td>(852) 2848 4926</td>
<td><a href="mailto:kevin.lai@hk.daiwacm.com">kevin.lai@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Micaela ABAQUITA</td>
<td>(852) 2848 4970</td>
<td><a href="mailto:micaela.abaquita@hk.daiwacm.com">micaela.abaquita@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Fiona LIANG</td>
<td>(852) 2532 4341</td>
<td><a href="mailto:fiona.liang@hk.daiwacm.com">fiona.liang@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Jay LU</td>
<td>(852) 2848 4970</td>
<td><a href="mailto:jay.lu@hk.daiwacm.com">jay.lu@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Leon Qi</td>
<td>(852) 2532 4381</td>
<td><a href="mailto:leon.qi@hk.daiwacm.com">leon.qi@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Adrian CHAN</td>
<td>(852) 2848 4427</td>
<td><a href="mailto:adrian.chan@hk.daiwacm.com">adrian.chan@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Andrew CHUNG</td>
<td>(852) 2773 8529</td>
<td><a href="mailto:andrew.chung@hk.daiwacm.com">andrew.chung@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>John CHOI</td>
<td>(852) 2773 8730</td>
<td>john <a href="mailto:choi@hk.daiwacm.com">choi@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Carlos LAI</td>
<td>(852) 2532 4349</td>
<td><a href="mailto:carlos.lai@hk.daiwacm.com">carlos.lai@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Dennis IP</td>
<td>(852) 2848 4058</td>
<td><a href="mailto:dennis.ip@hk.daiwacm.com">dennis.ip@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Don LAU</td>
<td>(852) 2848 4469</td>
<td><a href="mailto:don.lau@hk.daiwacm.com">don.lau@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Anna LU</td>
<td>(852) 2848 4465</td>
<td><a href="mailto:anna.lu@hk.daiwacm.com">anna.lu@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Jonas KAN</td>
<td>(852) 2848 4439</td>
<td><a href="mailto:jonas.kan@hk.daiwacm.com">jonas.kan@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Cynthia CHAN</td>
<td>(852) 2773 8243</td>
<td><a href="mailto:cynthia.chan@hk.daiwacm.com">cynthia.chan@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Bryan CHIK</td>
<td>(852) 2773 8741</td>
<td><a href="mailto:bryan.chik@hk.daiwacm.com">bryan.chik@hk.daiwacm.com</a></td>
</tr>
<tr>
<td>Selwyn CHENG</td>
<td>(852) 2848 4970</td>
<td><a href="mailto:selwyn.cheng@hk.daiwacm.com">selwyn.cheng@hk.daiwacm.com</a></td>
</tr>
</tbody>
</table>

#### SOUTH KOREA

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sung Yop CHUNG</td>
<td>(82) 2 787 9157</td>
<td><a href="mailto:sy.chung@kr.daiwacm.com">sy.chung@kr.daiwacm.com</a></td>
</tr>
<tr>
<td>Mike OH</td>
<td>(82) 2 787 9179</td>
<td><a href="mailto:mike.oh@kr.daiwacm.com">mike.oh@kr.daiwacm.com</a></td>
</tr>
<tr>
<td>Josh RHEE</td>
<td>(82) 2 787 9124</td>
<td><a href="mailto:josh.rhee@kr.daiwacm.com">josh.rhee@kr.daiwacm.com</a></td>
</tr>
<tr>
<td>Iris PARK</td>
<td>(82) 2 787 9165</td>
<td><a href="mailto:iris.park@kr.daiwacm.com">iris.park@kr.daiwacm.com</a></td>
</tr>
<tr>
<td>SK KIM</td>
<td>(82) 2 787 9173</td>
<td><a href="mailto:sk.kim@kr.daiwacm.com">sk.kim@kr.daiwacm.com</a></td>
</tr>
<tr>
<td>Thomas Y KWON</td>
<td>(82) 2 787 9181</td>
<td><a href="mailto:tkwon@kr.daiwacm.com">tkwon@kr.daiwacm.com</a></td>
</tr>
</tbody>
</table>

#### PHILIPPINES

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renzo CANDANO</td>
<td>(63) 2 737 3022</td>
<td><a href="mailto:renzo.candano@dbpdaiwacm.com.ph">renzo.candano@dbpdaiwacm.com.ph</a></td>
</tr>
<tr>
<td>Micaela ABAQUITA</td>
<td>(63) 2 737 3021</td>
<td><a href="mailto:micaela.abaquta@dbpdaiwacm.com.ph">micaela.abaquta@dbpdaiwacm.com.ph</a></td>
</tr>
<tr>
<td>Gregg ILAG</td>
<td>(63) 2 737 3023</td>
<td><a href="mailto:gregg.ilag@dbpdaiwacm.com.ph">gregg.ilag@dbpdaiwacm.com.ph</a></td>
</tr>
</tbody>
</table>

#### TAIWAN

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rick HSU</td>
<td>(886) 2 8758 6261</td>
<td><a href="mailto:rick.hsu@daiwacm-cathay.com.tw">rick.hsu@daiwacm-cathay.com.tw</a></td>
</tr>
<tr>
<td>Nora HOU</td>
<td>(886) 2 8758 6249</td>
<td><a href="mailto:nora.hou@daiwacm-cathay.com.tw">nora.hou@daiwacm-cathay.com.tw</a></td>
</tr>
<tr>
<td>Steven TSENG</td>
<td>(886) 2 8758 6252</td>
<td><a href="mailto:steven.tseng@daiwacm-cathay.com.tw">steven.tseng@daiwacm-cathay.com.tw</a></td>
</tr>
<tr>
<td>Kylie HUANG</td>
<td>(886) 2 8758 6248</td>
<td><a href="mailto:kylie.huang@daiwacm-cathay.com.tw">kylie.huang@daiwacm-cathay.com.tw</a></td>
</tr>
<tr>
<td>Helen CHIEN</td>
<td>(886) 2 8758 6254</td>
<td><a href="mailto:helen.chien@daiwacm-cathay.com.tw">helen.chien@daiwacm-cathay.com.tw</a></td>
</tr>
</tbody>
</table>

#### INDIA

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punit SRIVASTA</td>
<td>(91) 22 662 1013</td>
<td><a href="mailto:punit.srivasta@in.daiwacm.com">punit.srivasta@in.daiwacm.com</a></td>
</tr>
<tr>
<td>Saurabh MEHTA</td>
<td>(91) 22 662 1009</td>
<td><a href="mailto:saurabh.mehta@in.daiwacm.com">saurabh.mehta@in.daiwacm.com</a></td>
</tr>
</tbody>
</table>

#### SINGAPORE

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramakrishna MARUVADA</td>
<td>(65) 6228 6742</td>
<td><a href="mailto:ramakrishna.maruvada@sg.daiwacm.com">ramakrishna.maruvada@sg.daiwacm.com</a></td>
</tr>
<tr>
<td>David LUM</td>
<td>(65) 6228 6740</td>
<td><a href="mailto:david.lum@sg.daiwacm.com">david.lum@sg.daiwacm.com</a></td>
</tr>
<tr>
<td>Royston TAN</td>
<td>(65) 6228 6745</td>
<td><a href="mailto:royston.tan@sg.daiwacm.com">royston.tan@sg.daiwacm.com</a></td>
</tr>
<tr>
<td>Jame OSMAN</td>
<td>(65) 6228 6744</td>
<td><a href="mailto:jame.osman@sg.daiwacm.com">jame.osman@sg.daiwacm.com</a></td>
</tr>
</tbody>
</table>

#### JAPAN

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact Number</th>
<th>Email Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yukino YAMADA</td>
<td>(81) 3 5555 7295</td>
<td><a href="mailto:yukino.yamada@daiwa.co.jp">yukino.yamada@daiwa.co.jp</a></td>
</tr>
</tbody>
</table>
Daiwa's Offices

**Office / Branch / Affiliate**

**Address**

**Tel**

**Fax**

**DAIWA SECURITIES GROUP INC**

**HEAD OFFICE**
Gran Tokyo North Tower, 1-9-1, Marunouchi, Chiyoda-ku, Tokyo, 100-6753
(81) 3 5555 3111
(81) 3 5555 0661

Daiwa Securities Trust Company
One Evertrust Plaza, Jersey City, NJ 07302, U.S.A.
(1) 201 333 7300
(1) 201 333 7726

Daiwa Securities Trust and Banking (Europe) PLC (Head Office)
5 King William Street, London EC4N 7AJ, United Kingdom
(44) 207 320 8000
(44) 207 410 0129

Daiwa Europe Trustees (Ireland) Ltd
Level 3, Block 5, Harcourt Centre, Harcourt Road, Dublin 2, Ireland
(353) 1 603 9900
(353) 1 479 3469

Daiwa Capital Markets America Inc. New York Head Office
Financial Square, 32 Old Slip, New York, NY10005, U.S.A.
(1) 212 612 7000
(1) 212 612 7100

Daiwa Capital Markets America Inc. San Francisco Branch
555 California Street, Suite 4325, San Francisco, CA 94104, U.S.A.
(1) 415 955 8100
(1) 415 956 1905

Daiwa Capital Markets Europe Limited, London Head Office
5 King William Street, London, EC4N 7AX, United Kingdom
(44) 20 7597 8000
(44) 20 7597 8600

Daiwa Capital Markets Europe Limited, Frankfurt Branch
Neue Mainzer Str. 1, 60311 Frankfurt/Main, Germany
(49) 69 717 080
(49) 69 723 340

Daiwa Capital Markets Europe Limited, Paris Representative Office
17, rue de Sutro 75008 Paris, France
(33) 1 56 262 200
(33) 1 47 550 808

Daiwa Capital Markets Europe Limited, Geneva Branch
50 rue du Rhone, P.O.Box 3198, 1211 Geneva 3, Switzerland
(41) 22 818 7400
(41) 22 818 7441

Daiwa Capital Markets Europe Limited, Moscow Representative Office
Midlond Plaza 7th Floor, 10 Arbat Street, Moscow 103062, Russian Federation
(49) 207 597 8550
(49) 207 320 8000

Daiwa Capital Markets Europe Limited, Bahrain Branch
7th Floor, The Tower, Bahrain Commercial Complex, P.O. Box 30069, Manama, Bahrain
(973) 17 534 452
(973) 17 535 113

Daiwa Capital Markets Hong Kong Limited
Level 28, One Pacific Place, 88 Queensway, Hong Kong
(852) 2525 0121
(852) 2845 1621

Daiwa Capital Markets Singapore Limited
7 Straits View, Marina One East Tower, #16-05 & #16-06, Singapore 018396, Republic of Singapore
(65) 6387 8888
(65) 6282 8030

Daiwa Capital Markets Australia Limited
Level 34, Rialto North Tower, 525 Collins Street, Melbourne, Victoria 3000, Australia
(61) 3 9916 1300
(61) 3 9916 1330

DBP-Daiwa Capital Markets Philippines, Inc
18th Floor, Citibank Tower, 8741 Paseo de Roxas, Salcedo Village, Makati City, Republic of the Philippines
(632) 813 7344
(632) 848 0105

Daiwa-Cathay Capital Markets Co Ltd
14/F, 200, Keelung Road, Sec 1, Taipei, Taiwan, R.O.C.
(886) 2 2723 9698
(886) 2 2345 3638

Daiwa Securities Capital Markets Korea Co., Ltd.
20 F & 21F, One IFC, 10 Guikjeoeryung-Ro, Yeongdeungpo-gu, Seoul, Korea
(82) 2 787 9100
(82) 2 787 9191

Daiwa Securities Co. Ltd., Beijing Representative Office
Room 301/302, Kerry Center, 1 Guanghua Road, Chaoyang District, Beijing 100020, People's Republic of China
(86) 10 6500 6688
(86) 10 6500 3594

Daiwa (Shanghai) Corporate Strategic Advisory Co. Ltd.
44/F, Hang Seng Bank Tower, 1000 Lujiazui Ring Road, Pudong, Shanghai China 200120, People's Republic of China
(86) 21 3858 2000
(86) 21 3858 2111

Daiwa Securities Co. Ltd., Bangkok Representative Office
18th Floor, M Thai Tower, All Seasons Place, 87 Wireless Road, Lumpini, Pathumwan, Bangkok 10330, Thailand
(66) 2 252 5650
(66) 2 252 5665

Daiwa Capital Markets India Private Ltd
10th Floor, 3 North Avenue, Maker Maxity, Bandra Kurla Complex, Bandra East, Mumbai - 400051, India
(91) 22 6622 1000
(91) 22 6622 1019

Daiwa Securities Co. Ltd., Hanoi Representative Office
Suite 405, Pacific Palace Building, 83B, Ly Thuong Kiet Street, Hoan Kiem Dist, Hanoi, Vietnam
(84) 4 3946 0460
(84) 4 3946 0461

**DAIWA INSTITUTE OF RESEARCH LTD**

**HEAD OFFICE**
Gran Tokyo North Tower, 1-9-1, Marunouchi, Chiyoda-ku, Tokyo, 100-6756
(81) 3 5555 7011
(81) 3 5520 2021

**MARUNOUCHI OFFICE**
11th Floor, Financial Square, 32 Old Slip, NY, NY 10005-3504, U.S.A.
(1) 212 612 6100
(1) 212 612 8417

**New York Research Center**
3/F, 5 King William Street, London, EC4N 7AX, United Kingdom
(44) 207 597 8800
(44) 207 597 8550
Important Disclosures and Disclaimer

This publication is produced by Daiwa Securities Group Inc. and/or its non-U.S. affiliates, and distributed by Daiwa Securities Group Inc. and/or its non-U.S. affiliates, except to the extent expressly provided herein. This publication and the information herein are intended for general informational purposes only and may be changed without further notice. Any use, disclosure, distribution, dissemination, copying, printing or republication of this publication for any other purpose without our prior consent or approval is strictly prohibited. Neither Daiwa Securities Group Inc. nor any of its respective directors, holding, subsidiaries or affiliates, nor any of its respective directors, officers, employees, agents or representatives, accept any liability or responsibility whatsoever for any use or re-use of or reliance upon this publication or any of the contents hereof. Neither this publication, nor any content hereof, constitute, or are to be construed as, an offer or solicitation of an offer to buy or sell any of the securities or investments mentioned herein in any country or jurisdiction nor, unless expressly provided, any recommendation or investment opinion or advice. Any view, recommendation, opinion or advice expressed in this publication may not necessarily reflect those of Daiwa Securities Group Inc. and/or its affiliates nor any of its respective directors, officers, employees and agents where the publication states otherwise. This research report is not to be relied upon by any person in making any investment decision or otherwise advising with respect to, or dealings in, the securities mentioned, as it does not take into account the specific investment objectives, financial situation and particular needs of any person.

Daiwa Securities Group Inc., its subsidiaries or affiliates, or its or their respective directors, officers and employees from time to time may have an actual or potential financial interest in or any other interest in the securities or investments mentioned herein. Daiwa Securities Group Inc., its subsidiaries or affiliates do and seek to do business with the company(s) covered in this research report. Therefore, investors should be aware that a conflict of interest may exist. The following are additional disclosures.

Ownership of Securities

For "Ownership of Securities" information, please visit BlueMatrix disclosure link at [https://daiwa3.bluematrix.com/sellside/Disclosures.action](https://daiwa3.bluematrix.com/sellside/Disclosures.action)

Investment Banking Relationship

For "Investment Banking Relationship", please visit BlueMatrix disclosure link at [https://daiwa3.bluematrix.com/sellside/Disclosures.action](https://daiwa3.bluematrix.com/sellside/Disclosures.action)

Japan

Daiwa Securities Co., Ltd. and Daiwa Securities Group Inc.

Daiwa Securities Co., Ltd. is a subsidiary of Daiwa Securities Group Inc.

Investment Banking Relationship

Within the preceding 12 months, the subscribers and/or affiliates of Daiwa Securities Group Inc. * has lead-managed public offerings and/or secondary offerings (excluding straight bonds) of the securities of the following companies: Cromwell European REIT (CERT_SP), Beijing Enterprises Water Group Ltd (371 HK), Mira Asset Daewoo Co Ltd (068800 KS).

*Subsidiaries of Daiwa Securities Group Inc. for the purposes of this section shall mean any one or more of: Daiwa Capital Markets Hong Kong Limited (大和資本市場（香港）有限公司) ("DHK") which is regulated by the Hong Kong Securities and Futures Commission. Recipients of this research in Hong Kong may contact DHK in respect of any matter arising from or in connection with this research.

Relevant Relationship (DHK)

DHK may from time to time have an individual employed by or associated with it serves as an officer of any of the companies under its research coverage.

Singapore

This research is distributed in Singapore by Daiwa Capital Markets Singapore Limited and it may only be distributed in Singapore to accredited investors, expert investors and institutional investors as defined in the Financial Advisers Regulations and the Financial Services Act (Chapter 289), as amended from time to time. By virtue of distribution to these categories of investors, Daiwa Capital Markets Singapore Limited and its representatives are not required to comply with Section 36 of the Financial Advisers Act (Chapter 110) (Section 36 relates to disclosure of Daiwa Capital Markets Singapore Limited's interest and/or its representatives' interest in securities). Recipients of this research in Singapore may contact Daiwa Capital Markets Singapore Limited in respect of any matter arising from or in connection with the research.

Australia

This research is distributed in Australia by Daiwa Capital Markets Australia Limited and it may only be distributed in Australia to wholesale investors within the meaning of the Corporations Act. Recipients of this research in Australia may contact Daiwa Capital Markets Stockbroking Limited in respect of any matter arising from or in connection with the research.

India

This research is distributed in India to Institutional Clients only by Daiwa Capital Markets India Private Limited (Daiwa India) which is an intermediary registered with Securities & Exchange Board of India as a Stock Broker, Merchant Bank and Research Analyst. Daiwa India, its Research Analyst and their family members and its associates do not have any financial interest save as disclosed or otherwise undisclosed material conflict of interest in the securities or derivatives of any companies under coverage. Daiwa India and its associates, may have received compensation for products other than investment banking (as disclosed) or brokerage services from the subject company in this report or from any third party during the past 12 months. Daiwa India and its associates may have debt holdings in the subject company. For information on ownership of equity, please visit BlueMatrix disclosure link at [https://daiwa3.bluematrix.com/website/BdpIndia](https://daiwa3.bluematrix.com/website/BdpIndia).

There is no material disciplinary action against Daiwa India by any regulatory authority impacting equity research analysis activities as of the date of this report.

Associates of Daiwa India, registered with Indian regulators, include Daiwa Capital Markets Singapore Limited and Daiwa Portfolio Advisory (India) Private Limited.

Taiwan

This research is solely for reference and not intended to provide tailored investment recommendations. This research is distributed in Taiwan by Daiwa-Cathay Capital Markets Co., Ltd. and it may only be distributed in Taiwan to specific customers who have signed recommendation contracts with Daiwa-Cathay Capital Markets Co., Ltd. and non-customers including (i) professional institutional investors, (ii) TWSE or TPEx listed companies, (iii) upstream and downstream vendors, and specialists that offer or seek advice, and (iii) potential customers with an actual need for such research. Recipients of this research shall not provide it to others or engage in any activities in connection with this research which may involve conflicts of interests. Neither Daiwa-Cathay Capital Markets Co., Ltd. nor its personnel who writes or reviews the research report has any conflict of interest in this research. Since Daiwa-Cathay Capital Markets Co., Ltd. does not operate brokerage trading business in foreign markets, this research is prepared on a "without recommendation" to any foreign securities basis. Daiwa-Cathay Capital Markets Co., Ltd. and it's subsidiaries or affiliates may have received compensation for products other than investment banking (as disclosed) or brokerage services from the subject company in this report or from any third party during the past 12 months. Daiwa India and its associates may have debt holdings in the subject company.

Philippines

This publication is distributed in the Philippines by DBP-Daiwa Capital Markets Philippines Inc. which is regulated by the Philippines Securities and Exchange Commission and the Philippines Stock Exchange, Inc. Recipients of this research in the Philippines may contact DBP-Daiwa Capital Markets Philippines Inc. in respect of any matter arising from or in connection with the research. DBP-Daiwa Capital Markets Philippines Inc. recommends that investors independently assess, with a professional advisor, the specific financial risks as well as the legal, regulatory, tax, accounting, and other consequences of a proposed transaction. DBP-Daiwa Capital Markets Philippines Inc. may have positions or may be materially interested in the securities in any of the markets mentioned in the publication or may have performed other services for the issuers of such securities. For relevant securities and trading rules please visit SEC and PSE links at [http://www.sec.gov.ph](http://www.sec.gov.ph) and [http://www.pse.com.ph](http://www.pse.com.ph) respectively.

Thailand

This research is distributed to only institutional investors in Thailand primarily by Thanachart Securities Public Company Limited (“TNS”).

This report is prepared by analysts who are employed by Daiwa Securities Group Inc. and/or its non-U.S. affiliates. This report is provided to you for informational purposes only and it is not, and is not to be construed as, an offer or an invitation to make an offer to sell or buy any securities. Neither TNS, Daiwa Securities Group Inc. nor any of their respective partners, holding, subsidiaries or affiliates, nor any of their respective directors, officers, employees and agents accept any liability whatsoever for any direct or consequential loss arising from any use of this research or its contents.

The information and opinions contained herein have been compiled or arrived at from sources believed to be reliable. However, TNS, Daiwa Securities Group Inc. nor any of their respective partners, holding, subsidiaries or affiliates, nor any of their respective directors, officers, employees and agents may have positions and financial interest in securities mentioned in this research. Thanachart Securities Public Company Limited, Daiwa Securities Group Inc., their respective parent, holding, subsidiaries or affiliates may from time to time perform investment banking or other services for, or solicit investment banking or other business from, any entity mentioned in this research. Therefore, investors should be aware of conflict of interest that may affect the objectivity of this research.
United Kingdom
This research report is produced by Daiwa Securities Co. Ltd. and/or its affiliates and is distributed in the European Union, Iceland, Liechtenstein, Norway and Switzerland. Daiwa Capital Markets Europe Limited is authorized and regulated by the Financial Conduct Authority (FCA) and is a member of the London Stock Exchange and Eurex. This publication is intended for investors who are not Retail Clients in the United Kingdom within the meaning of the Rules of the FCA and should not therefore be distributed to such Retail Clients in the United Kingdom. Should you enter into investment business with Daiwa Capital Markets Europe’s affiliates outside the United Kingdom, we are obliged to advise that the protection afforded by the United Kingdom regulatory system may not apply; in particular, the benefits of the Financial Services Compensation Scheme may not be available.

Daiwa Capital Markets Europe Limited has in place organisational arrangements for the prevention and avoidance of conflicts of interest. Our conflict management policy is available at http://www.uk.daiwaecm.com/about-us/corporate-governance-regulatory.

Germany
This document is distributed in Germany by Daiwa Capital Markets Europe Limited, Niederlassung Frankfurt which is regulated by BaFin (Bundesanamt fuer Finanzdienstleistungsaufsicht) for the conduct of business in Germany.

Bahrain
This research material is distributed in Bahrain by Daiwa Capital Markets Europe Limited, Bahrain Branch, regulated by The Central Bank of Bahrain and holds Investment Business Firm – Category 2 license and having its official place of business at the Bahrain World Trade Centre, South Tower, 7th floor, P.O. Box 30069, Manama, Kingdom of Bahrain. Tel No. +973 17534452 Fax No. +973 535113

United States
This research is distributed into the United States directly by Daiwa Capital Markets Hong Kong Limited and indirectly by Daiwa Capital Markets America Inc. (DCMA), a U.S. Securities and Exchange Commission registered broker-dealer and FINRA member firm, exclusively to “major U.S. institutional investors”, as defined under Rule 15a-6 promulgated under the U.S. Securities Exchange Act of 1934, as amended, and as interpreted by the staff of the U.S. Securities and Exchange Commission (SEC). This report is not an offer to sell or the solicitation of any offer to buy securities. U.S. customers wishing to effect transactions in any designated investment discussed in this report should do so through a qualified salesperson of DCMA. Non-U.S. customers wishing to effect transactions in any designated investment discussed in this report may not be eligible for sale in some jurisdictions.

Analysts employed outside the U.S., as specifically indicated elsewhere in this report, are not registered as research analysts with FINRA. These analysts may not be associated persons of DCMA, and therefore may not be subject to FINRA Rule 2241 restrictions on communications with a subject company, public appearances and trading securities held by a research analyst account.

ADDITIONAL IMPORTANT DISCLOSURES CAN BE FOUND AT:
https://daiwa3.bluematrix.com/sellside/Discl

Ownership of Securities
For “Ownership of Securities” information please visit BlueMatrix disclosure link at https://daiwa3.bluematrix.com/sellside/Discl

Investment Banking Relationships
For “Investment Banking Relationships” please visit BlueMatrix disclosure link at https://daiwa3.bluematrix.com/sellside/Discl

DCMA Market Making
For “DCMA Market Making” please visit BlueMatrix disclosure link at https://daiwa3.bluematrix.com/sellside/Discl

Research Analyst Conflicts
For updates on “Research Analyst Conflicts” please visit BlueMatrix disclosure link at https://daiwa3.bluematrix.com/sellside/Discl. The principal research analysts who prepared this report have no financial interest in securities of the issuers covered in the report, are not (nor are any members of their household) an officer, director or advisory board member of the issuer(s) covered in the report, and are not aware of any material relevant conflict of interest involving the analyst or DCMA, and did not receive any compensation from the issuer during the past 12 months except as noted: no exceptions.

Research Analyst Certification
For updates on “Research Analyst Certification” and “Rating System” please visit BlueMatrix disclosure link at https://daiwa3.bluematrix.com/sellside/Discl. The views about any and all of the subject securities and issuers expressed in this Research Report accurately reflect the personal views of the research analyst(s) primarily responsible for this report (or the views of the firm producing the report if no individual analyst is named on the report), and no part of the compensation of such analyst (or no part of the compensation of the firm if no individual analyst is named on the report) was, is, or will be directly or indirectly related to the specific recommendations or views contained in this Research Report.

Disclosure of investment ratings

Rating | Percentage of total
--- | ---
Buy* | 72.1%
Hold** | 19.7%
Sell*** | 8.2%

Source: Daiwa
Notes: data is for single-branded Daiwa research in Asia (ex Japan) and correct as of 30 September 2018.
* comprised of Daiwa’s Buy and Outperform ratings.
** comprised of Daiwa’s Hold ratings.
*** comprised of Daiwa’s Underperform and Sell ratings.

Additional information may be available upon request.

Japan - additional notification items pursuant to Article 37 of the Financial Instruments and Exchange Law
(This Notification is only applicable where report is distributed by Daiwa Securities Co., Ltd.)

If you decide to enter into a business arrangement with us based on the information described in materials presented along with this document, we ask you to pay close attention to the following items.

- In addition to the purchase price of a financial instrument, we will collect a trading commission* for each transaction as agreed beforehand with you. Since commissions may be included in the purchase price or may not be charged for certain transactions, we recommend that you confirm the commission for each transaction.
- In some cases, we may also charge a maximum of ¥ 2 million (including tax) per year as a standing proxy fee for our deposit or margin account.
- In addition, depending on the nature of the transaction, the loss could exceed the amount of the collateral or margin requirements.

* There may be a difference between bid price etc. and ask price etc. of OTC derivatives handled by us.
* Before engaging in any trading, please thoroughly confirm accounting and tax treatments regarding your trading in financial instruments with such experts as certified public accountants.
* The amount of the trading commission cannot be stated in advance because it will be determined between our company and you based on current market conditions and the content of each transaction etc.

When making an actual transaction, please be sure to carefully read the materials presented to you prior to the execution of agreement, and to take responsibility for your own decisions regarding the signing of the agreement with us.

Corporate Name: Daiwa Securities Co. Ltd.
Financial instruments firm: chief of Kanto Local Finance Bureau (Kin-sho) No.108
Memberships: Japan Securities Dealers Association, The Financial Futures Association of Japan, Japan Securities Investment Advisers Association, Type II Financial Instruments Firms Association