This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Semiconductors

2H19 Demand Stronger Than 1H; Supply-Side Remains Disciplined; Expect Continued Semi / Semicap Stock Outperformance

Semiconductors,Semiconductor Cap Equipment & Tech Hardware

Harlan Sur AC
(1-415) 315-6700
harlan.sur@jpmorgan.com
Bloomberg JPMA SUR <GO>

Bill Peterson
(1-415) 315-6766
bill.peterson@jpmchase.com

Andrew Nguyen
(1-415) 315-5611
andrew.nguyen@jpmchase.com

Alexander Kim
(1-415) 315-8828
alexander.kim@jpmchase.com

J.P. Morgan Securities LLC

While acknowledging volatility related to US-China trade, we continue to remain positive and expect semi/semicap stocks to continue outperforming through year-end. After bottoming in late 2018 on trade tensions, slowdown in China and cloud datacenter digestion, semi stocks have outperformed YTD 2019 with the SOX index up 28% as investors are beginning to positively discount improving industry growth trends following four rounds of earnings cuts (stocks typically discount recovery after 2-3 rounds of earnings revisions). Recently, the group has been volatile on US-China trade, Huawei ban and concerns on global recession. Historically, we typically see a sustainable move higher in stocks after the 2nd / 3rd round of estimate cuts (this has been a consistent pattern over the past three downturns), but this cycle has been different than the prior three cycles with the tariffs pushing out potential recovery into 1Q20. **However, assuming no further major negative developments on the trade front post the tariff increases this weekend, we expect semiconductor stocks to continue to outperform for the remainder of the year on + Y/Y inflection in 1H20**. On the demand side, we remain confident in a 2H pickup in overall demand with near seasonal demand in PC computing, wireless/wired infrastructure (around 5G), aerospace / defense, smartphones (ex-Huawei), consumer/gaming and a resumption in cloud/hyperscale spending trends (top cloud/hyperscale titans are forecasting ~9% infrastructure spending growth this year – or 20%+ 2H spend versus 1H). Supply-side metrics such as distribution inventories and lead times are at or slightly below normal historical levels, suggesting that management teams are under-shipping consumption trends to keep inventories lean. In semiconductor equipment, our preliminary expectation is for a return to equipment spending growth in 2020 as memory supply/demand fundamentals are likely to come back into balance exiting this year. Valuations are in-line with the S&P 500 (at ~16x), however margins and FCF generation continues to grow, trough earnings power is 30%+ higher versus prior down cycles, and capital return continues to be a focus. Similar to our recommendation last quarter, we would use any pullbacks to accumulate shares of our top picks as we remain constructive on the aforementioned 2H and 2020 demand trends, sustainability of strong earnings power and continued consolidation (M&A). In large cap stocks, we focus on diversified market leaders with strong margin/FCF expansion potential and exposure to content growth opportunities in areas such as cloud datacenter, automotive and industrial sectors. Our large cap top pick is OW-rated AVGO and we also favor OW-rated MRVL, TXN, INTC, MCHP, NVDA and MU, while our small cap top pick is OW-rated IPHI. In semicaps, we favor OW-rated KLAC.

- **Recap of 1H19: Fundamentals dampened by macro / trade uncertainty with >50% of our universe missing consensus expectations on 1Q/2Q earnings and overall semi industry revenue growth trending down 6% Y/Y ex-memory.** YTD, fundamentals have remained dampened for the group driven by macro / trade uncertainty with >50% of our semi universe missing consensus estimates for 1Q and 2Q on forward guidance. Semi industry revenues (ex-memory) are tracking down 6% Y/Y – down from the industry 2018 exit rate of +8% Y/Y, however we expect industry fundamentals to improve as we move through the remainder of the year. Supply-side metrics such as distribution inventories have remained lean and in fact have been coming DOWN, suggesting that semi companies have been UNDERSHIPPING consumption over the past 2-3 quarters and management teams will continue keeping close tabs of channel sell-through / inventories.

See page 9 for analyst certification and important disclosures.

J.P. Morgan does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

- **2H19 outlook not as bad as the market had feared as the industry gears up for a seasonally strong part of the year for PCs, smartphones, gaming, wired / wireless infrastructure, reacceleration in cloud spending trends…offset by stabilizing trends in industrial and weakness in auto and enterprise.** According to IDC, PC shipments are expected to grow 14% in the 2H vs. 1H. In PC gaming segment, a strong line-up of blockbuster games (NBA2K20, FIFA 20, Call of Duty: Modern Warfare, The Legend of Zelda) looks set to drive strong GPU/high-end desktop CPU sales and memory. In wireless infrastructure, despite the current ban on component shipments to Huawei, we continue to expect growth through the remainder of 2019 and into 2020 on 5G deployments. The Apple supply chain is ramping as seasonally as expected with companies such as Qorvo and Skyworks indicating a near seasonal ramp in this year's iPhone cycle in its recent earnings calls (though demand from China and Huawei is expected to remain weak over the next few quarters). Despite trade-related uncertainties impacting the near-term outlook, automotive and industrial continues to be driven more by increasing semiconductor dollar content gains. Cloud datacenter spending trends are improving here in the back half of this year, led by US-based hyperscale investments (see next bullet), while enterprise demand remains lackluster.

- **U.S. hyperscale cloud service provider capex remains robust- new workloads and expanding compute/networking capacity driving strong demand for compute, networking and storage/memory chips.** Last year was a very strong year for capex, in which Alphabet, Facebook (GOOGL and FB, both covered by J.P. Morgan's Doug Anmuth), and Microsoft (MSFT, covered by J.P. Morgan's Mark Murphy) had capex, led by investments in data center (compute, storage and networking), grow 91%, 107%, 64% Y/Y for 2018. While 2019 won't be as strong as 2018, we still expect cloud spending to be up 9-10%. Moreover, when comparing YTD cloud spending to full year budgets, it implies that the top cloud service providers will need to spend 20-30% more in the 2H vs. 1H, and we expect spending to continue to grow at a double-digit pace in 2020 and likely beyond. New computing workloads (AI/ deep learning) and cloud data center spending trends should continue to drive strong CPU, GPU, networking (switch, routing, optical connectivity), ASIC, and storage/memory (DRAM and NAND) demand over the next few years.

- **Memory fundamentals still tough, but NAND has likely bottomed and we expect DRAM to bottom exiting the year as improving cloud demand that should have a positive impact on pricing/bit shipment fundamentals.** Memory demand trends are set to improve in 2H19 as the inventory correction in data center, gaming and smartphones appears to be improving. In NAND, in particular, we are seeing price elasticity beginning to spur demand and price declines have begun to moderate with overall supply/demand fundamentals returning to relative balance. In DRAM, though supply is still exceeding demand, with multiple capex cuts and utilization reductions, we expect supply/demand fundamentals to exit the year in relative balance. The one clear trend is that memory companies continue to place a high priority on profitability and free cash flow generation, and trough earnings are vastly improved compared to prior cycles.

- **Near-term demand for Memory equipment remains weak, while Foundry/Logic demand is robust, but we expect overall equipment spending to grow in 2020 and expect semicap stocks under coverage to outperform.** With memory makers reducing DRAM and NAND output and focusing on profitability/free cash flow, memory equipment spending in 2019 is on pace to decline by >35%. On the other hand, Foundry/Logic spending, led by leading edge investments, remains robust. Looking ahead to 2020, our preliminary expectation is for wafer fab equipment (WFE) spending to return to growth as Foundry/Logic investments continue strong and as memory investments inflect positively led first by NAND investments

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC
Harlan Sur
(1-415) 315-6700
harlan.sur@jpmorgan.com

followed by DRAM investments later in the year. Despite weak memory demand, semicaps under coverage continue outperforming as service revenue growth is partially offsetting weaker demand. In addition, we are confident in companies under coverage outperforming on served available market (SAM) and market share expansion opportunities. Our positive view on semicaps is also supported by rising capital intensity associated with technology migrations. We favor OW-rated KLAC on diversified revenue streams, strong product cycles and positive exposure to EUV lithography adoption. We are also OW-rated on AMAT and LRCX.

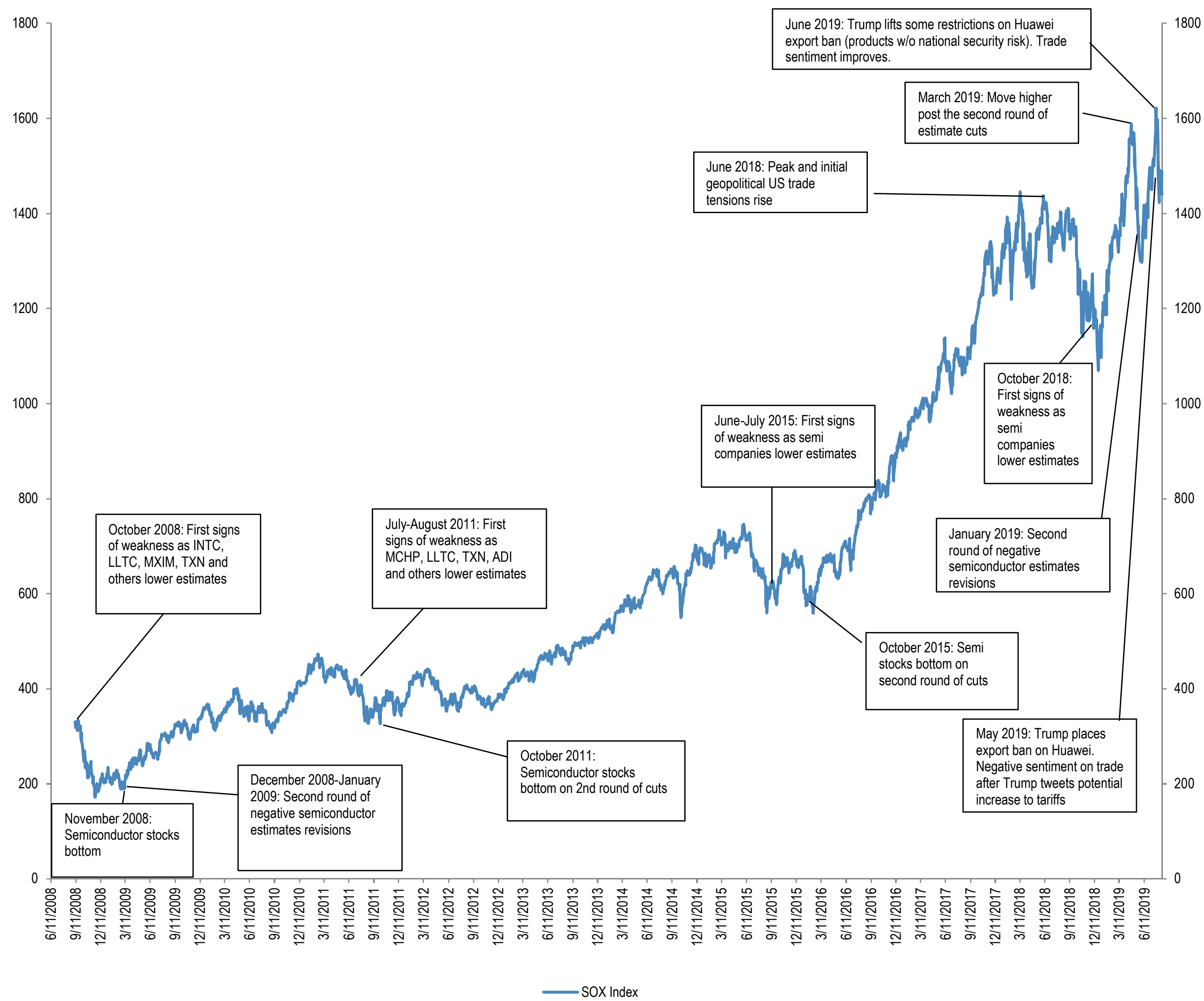
- **We remain positive on semiconductors/semicaps as we move into the back half of the year.** Semiconductor stocks have outperformed in 2019 with the SOX index up 28% YTD (vs. S&P at 16%) and we expect the group to continue to outperform broader indices this year assuming no further meaningful breakdown in trade discussions. Top picks include OW-rated AVGO, MRVL, TXN, INTC, MCHP, NVDA, MU, and IPHI. In semicaps, we continue to favor OW-rated KLAC.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Current cycle different than prior three cycles with recovery extended due to tariffs

Post the June earnings season (the 4th round of consensus estimate cuts), 67% of our companies missed consensus expectations on the forward guidance for September. Stocks in the past have usually started to positively discount recovery 2-3 quarters out and similar to the pattern seen in the past 3 down cycles, but this cycle has been different from prior cycles with tariffs extending recovery (more recently, $75B placed on US goods). However, assuming no further deterioration in US/China Trade negotiations, we believe that semiconductor stocks will continue to outperform the broader markets as they discount Y/Y industry positive inflection in 1H20.

Figure 1: Historical SOX Performance of Last Three Down Cycles



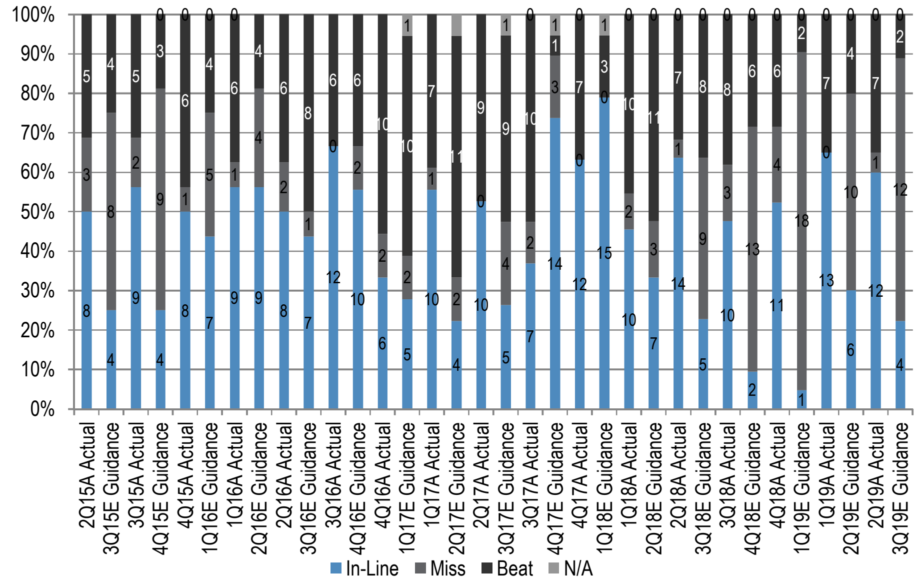
Source: Bloomberg

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Similar correction cycle to what was seen during the 2015/2016 slowdown

October earnings season marked the first quarter where 50% of our companies missed on forward guidance, followed by 67% of companies missing during the recent June earnings season (Figure 2). Similar to what we experienced during the 2015/2016 downturn, even though we model sub-seasonal demand trends through 4Q19, we expect stocks to continue discounting improving fundamentals after the fourth round of number cuts.

Figure 2: Semiconductor Coverage Universe Revenue Results and Guidance vs. Consensus – 1Q16A to 3Q19 Guidance



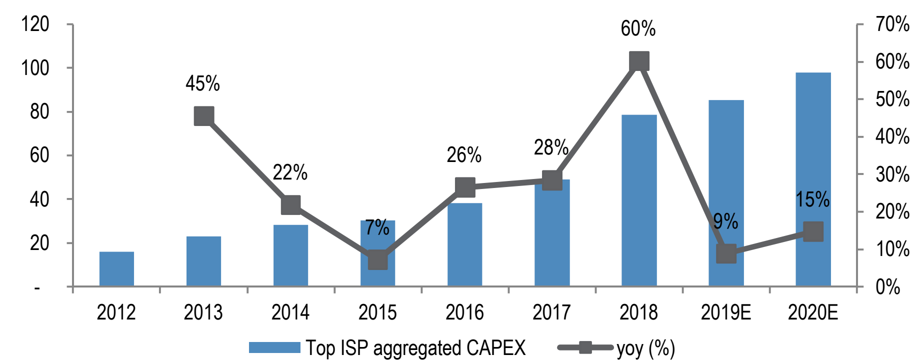
Source: Company reports, J.P. Morgan estimates and Bloomberg.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Cloud spending trends should result in spending reacceleration in 2H19

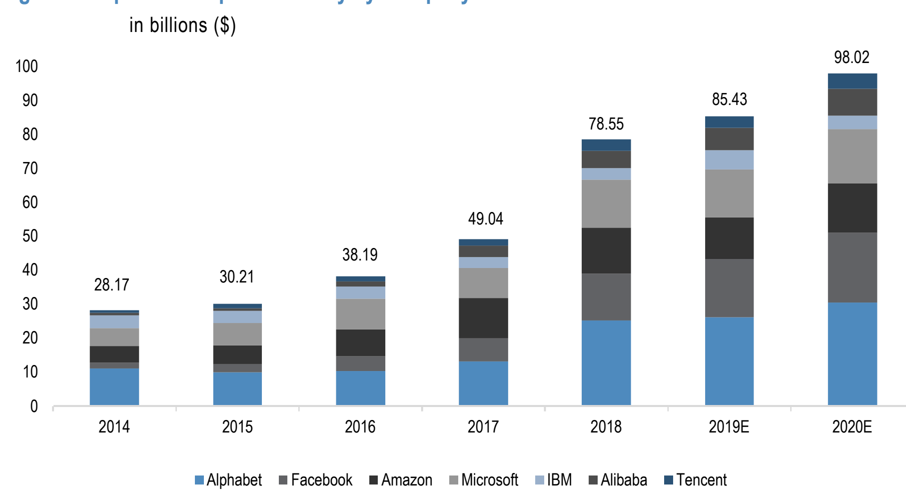
After a strong year of datacenter capex spending trends that saw 60% Y/Y growth in 2018, we continue to anticipate that 2H19 will be up 20-30% vs. 1H19 due to growth trends in cloud datacenter infrastructure spending on compute-intense applications (AI-based workloads, IoT, Deep Learning) post the June earnings season. Specifically, CSP capex looks positive as most of the top cloud providers expect to grow their capex. In the figure below, we aggregate total capex forecasts for the top 7 CSP companies – Google, Amazon, Facebook, Microsoft, IBM, Tencent and Alibaba. We note that top 7 CSP capex is expected to decelerate from 60% Y/Y in 2018 to 9% Y/Y in 2019E (see Figure 3).

Figure 3: Cloud Service Provider Spending - Top 7 CSPs (2012-2020E)



Source: Company reports, J.P. Morgan estimates and Bloomberg.

Figure 4: Top 7 CSP Capex Summary by Company



Source: Company reports, J.P. Morgan estimates and Bloomberg.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

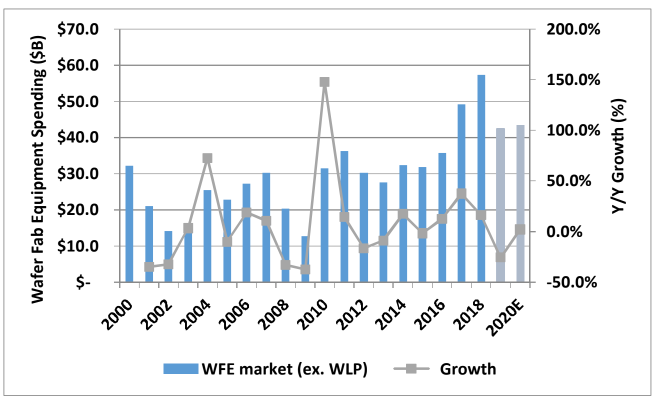
Harlan Sur
(1-415) 315-6700
harlan.sur@jpmorgan.com

Semiconductor equipment and Memory stocks beginning to discount improving S/D demand fundamentals

We expect wafer fab equipment (WFE) spending to decline by 20%+ in 2019 as memory makers are actively reducing bit supply growth and ASPs have declined meaningfully since peaking in 2018. However, with a sharp decline in memory spending and with factory utilization being reduced, we are becoming more comfortable that supply/demand will likely come back into balance in the coming quarters (with NAND already likely back into relative balance), which provides a positive setup for both semicaps (improved spending environment as we look toward next year), and for memory stocks as ASP declines moderate (thus improving profitability). In the near-term, we believe we are near trough spending levels and likely to bounce along the bottom for a few more quarters. We would note that even with the current 'downturn', memory and semicap stocks are still highly profitable, a scenario that hasn't played out in prior downturns, and it is illustrative of a maturing industry focused on profitable growth and free cash flow generation. Figure 5 and Figure 6 illustrate our estimates for wafer fab equipment (WFE) spending and WFE spending by customer type (DRAM, NAND, Foundry, Logic and other), where we see Foundry and Logic increasing as a portion of spending (likely slightly up for the year). We estimate Memory WFE will likely decline in 2019 by >35% Y/Y before recovering in 2020 as supply/demand fundamentals improve and Foundry/Logic to be up slightly in 2019 with continued strength in 2020.

Figure 5: Wafer Fab Equipment Spending

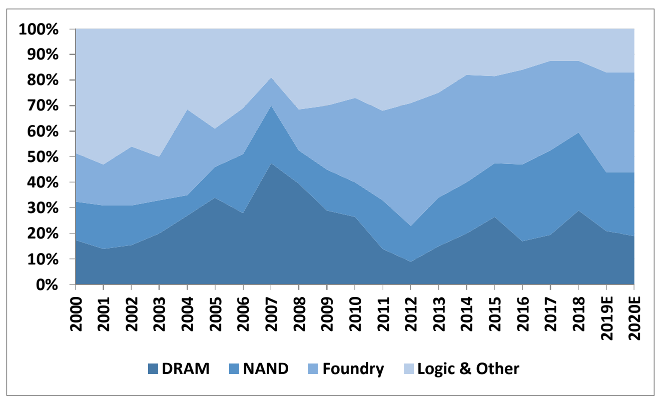
$B



Source: Gartner and J.P. Morgan estimates.

Figure 6: WFE Spend By Type

%



Source: Industry data and J.P. Morgan estimates.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Appendix I – Valuation and Comp Table

Table 1: Semiconductor Valuation and Comp Table

	JPM	Market	9/3/19	Non-GAAP EPS		P/E		Revenue		P/S		EV/Sales		Consensus Non-GAAP EPS		Consensus Sales		Consensus P/E		Consensus P/S	
	Rating	Cap	Price	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E	C19E	C20E
Harlan Sur, Lead Coverage																					
phone: 415-315-6700, email: harlan.sur@jpmchase.com																					
PC Semiconductors																					
INTC	OW	$212,491	$46.98	$4.40	$4.75	10.7	9.9	$69,500	$71,350	3.1	3.0	3.2	3.1	$4.37	$4.44	$69,406	$71,050	10.7	10.6	3.1	3.0
NVDA	OW	$101,129	$164.17	$5.41	$7.13	30.4	23.0	$10,776	$13,006	9.4	7.8	8.7	7.2	$5.07	$6.96	$10,489	$12,729	32.4	23.6	9.6	7.9
AMD	N	$34,268	$30.90	$0.62	$0.94	49.8	32.9	$6,781	$8,113	5.1	4.2	5.0	4.2	$0.61	$1.05	$6,753	$8,383	50.6	29.5	5.1	4.1
Memory																					
MU	OW	$50,794	$44.99	$3.47	$1.79	13.0	25.1	$19,607	$18,669	2.6	2.7	2.4	2.6	$3.28	$3.32	$19,543	$21,397	13.7	13.5	2.6	2.4
WDC	N	$16,896	$57.47	$1.19	$4.31	48.3	13.3	$15,403	$18,041	1.1	0.9	1.6	1.3	$1.35	$4.89	$15,407	$17,053	42.6	11.8	1.1	1.0
Enterprise/Networking/Datacenter Semiconductors																					
XLNX	UW	$25,896	$100.40	$3.85	$4.01	26.1	25.0	$3,347	$3,708	7.7	7.0	7.1	6.4	$3.87	$4.30	$3,364	$3,728	25.9	23.3	7.7	6.9
MRVL	OW	$15,455	$23.29	$0.70	$1.17	33.3	19.9	$2,679	$3,074	5.8	5.0	6.2	5.4	$0.72	$1.10	$2,704	$3,087	32.2	21.1	5.7	5.0
AVGO	OW	$115,649	$274.05	$21.22	$25.05	12.9	10.9	$22,174	$24,010	5.2	4.8	6.4	5.9	$21.38	$24.15	$22,520	$23,937	12.8	11.3	5.1	4.8
MLNX	NR	$6,043	$107.00	$6.35	N/A	16.9	N/A	$1,253	N/A	4.8	N/A	4.2	N/A	$6.39	$7.13	$1,258	$1,389	16.7	15.0	4.8	4.4
IPHI	OW	$2,717	$60.13	$1.52	$2.23	39.6	27.0	$354	$430	7.7	6.3	7.9	6.5	$1.48	$2.03	$354	$423	40.5	29.6	7.7	6.4
Mobile Devices																					
SWKS	N	$12,861	$74.17	$5.86	$6.30	12.7	11.8	$3,244	$3,367	4.0	3.8	3.6	3.5	$5.92	$6.63	$3,274	$3,547	12.5	11.2	3.9	3.6
QRVO	OW	$8,513	$70.28	$5.21	$5.99	13.5	11.7	$2,974	$3,155	2.9	2.7	2.9	2.8	$5.23	$5.71	$2,975	$3,091	13.4	12.3	2.9	2.8
KN	UW	$1,860	$20.11	$1.13	$1.25	17.8	16.1	$862	$908	2.2	2.0	2.3	2.2	$1.13	$1.26	$859	$905	17.8	15.9	2.2	2.1
Analog/Microcontrollers																					
TXN	OW	$116,018	$121.74	$5.35	$5.70	22.8	21.4	$14,710	$15,364	7.9	7.6	7.9	7.5	$5.43	$5.86	$14,685	$15,456	22.4	20.8	7.9	7.5
ADI	N	$39,688	$106.38	$5.04	$5.53	21.1	19.2	$5,884	$6,187	6.7	6.4	7.5	7.2	$5.09	$5.41	$5,931	$6,148	20.9	19.7	6.7	6.5
NXPI	N	$28,272	$99.17	$7.54	$8.60	13.2	11.5	$8,792	$9,258	3.2	3.1	4.4	4.2	$7.59	$8.81	$8,832	$9,372	13.1	11.3	3.2	3.0
MCHP	OW	$21,554	$84.89	$5.75	$6.81	14.8	12.5	$5,350	$5,754	4.0	3.7	5.6	5.2	$5.78	$6.64	$5,354	$5,738	14.7	12.8	4.0	3.8
MXIM	OW	$14,826	$53.75	$2.08	$2.62	25.9	20.5	$2,159	$2,345	6.9	6.3	6.3	5.8	$2.10	$2.43	$2,168	$2,292	25.6	22.1	6.8	6.5
MXL	N	$1,369	$19.31	$0.83	$1.07	23.2	18.0	$327	$355	4.2	3.9	4.8	4.4	$0.83	$1.03	$328	$356	23.2	18.7	4.2	3.9
Diversified/Consumer/Standard Components/Other																					
ON	N	$7,289	$17.45	$1.56	$1.60	11.2	10.9	$5,494	$5,696	1.3	1.3	1.8	1.8	$1.56	$1.74	$5,502	$5,759	11.2	10.0	1.3	1.3
MTSI	UW	$1,285	$19.48	N/A	$0.52	N/A	37.2	$460	$485	2.8	2.6	3.9	3.7	($0.61)	$0.31	$451	$474	(32.0)	63.9	2.8	2.7
VSH	N	$2,257	$15.56	$1.27	$1.13	12.3	13.8	$2,646	$2,583	0.9	0.9	0.8	0.8	$1.34	$1.26	$2,653	$2,568	11.6	12.4	0.9	0.9
CY	NR	$8,420	$23.03	$1.12	N/A	20.6	N/A	$2,210	N/A	3.8	N/A	4.1	N/A	$1.11	$1.25	$2,207	$2,339	20.8	18.4	3.8	3.6
Semiconductor Capital Equipment																					
AMAT	OW	$44,611	$47.61	$2.91	$3.70	16.3	12.9	$14,446	$16,030	3.1	2.8	3.2	2.9	$2.95	$3.52	$14,474	$15,909	16.1	13.5	3.1	2.8
LRCX	OW	$32,894	$212.94	$13.35	$14.90	16.0	14.3	$9,122	$9,631	3.6	3.4	3.3	3.1	$13.47	$13.47	$9,149	$9,997	15.8	15.8	3.6	3.3
KLAC	OW	$24,279	$149.93	$8.18	$10.24	18.3	14.6	$5,096	$5,630	4.8	4.3	5.0	4.5	$8.14	$8.14	$5,095	$5,635	18.4	18.4	4.8	4.3
Large Cap Semi Average						**21.8**	**16.6**			**5.8**	**5.3**							**17.6**	**15.9**	**5.8**	**5.4**
Small-Mid Cap Semi Average						**20.6**	**19.5**			**3.6**	**3.0**							**14.7**	**22.1**	**3.6**	**3.2**
Semi Group Average (ex-outliers)						**19.1**	**17.8**			**4.5**	**4.2**							**16.2**	**19.0**	**4.5**	**4.1**
SOX Index			**1,478**	**80**	**96**	**18.4**	**15.3**			**4.4**	**4.0**							**18.4**	**15.3**	**4.4**	**4.0**
S&P500			**2,906**	**165**	**183**	**17.6**	**15.9**			**2.1**	**2.0**							**17.6**	**15.9**	**2.1**	**2.0**

Source: Company reports, Bloomberg and J.P. Morgan estimates. Pricing as of the market close 09/03/19.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Companies Discussed in This Report (all prices in this report as of market close on 30 August 2019)
Alphabet Inc. (GOOGL/$1190.53/Overweight), Applied Materials (AMAT/$48.02/Overweight), Broadcom Inc (AVGO/$282.64/Overweight), Inphi (IPHI/$61.19/Overweight), Intel (INTC/$47.41/Overweight), KLA Corporation (KLAC/$147.90/Overweight), Lam Research (LRCX/$210.51/Overweight), Marvell Technology Group (MRVL/$23.97/Overweight), Microchip Technology (MCHP/$86.33/Overweight), Micron Technology (MU/$45.27/Overweight), Microsoft (MSFT/$137.86/Overweight), NVIDIA Corporation (NVDA/$167.51/Overweight), Texas Instruments (TXN/$123.75/Overweight)

Analyst Certification: All authors named within this report are research analysts unless otherwise specified. The research analyst(s) denoted by an "AC" on the cover of this report certifies (or, where multiple research analysts are primarily responsible for this report, the research analyst denoted by an "AC" on the cover or within the document individually certifies, with respect to each security or issuer that the research analyst covers in this research) that: (1) all of the views expressed in this report accurately reflect his or her personal views about any and all of the subject securities or issuers; and (2) no part of any of the research analyst's compensation was, is, or will be directly or indirectly related to the specific recommendations or views expressed by the research analyst(s) in this report. For all Korea-based research analysts listed on the front cover, if applicable, they also certify, as per KOFIA requirements, that their analysis was made in good faith and that the views reflect their own opinion, without undue influence or intervention.

Important Disclosures

Company-Specific Disclosures: Important disclosures, including price charts and credit opinion history tables, are available for compendium reports and all J.P. Morgan–covered companies by visiting https://www.jpmm.com/research/disclosures, calling 1-800-477-0406, or e-mailing research.disclosure.inquiries@jpmorgan.com with your request. J.P. Morgan's Strategy, Technical, and Quantitative Research teams may screen companies not covered by J.P. Morgan. For important disclosures for these companies, please call 1-800-477-0406 or e-mail research.disclosure.inquiries@jpmorgan.com.

Explanation of Equity Research Ratings, Designations and Analyst(s) Coverage Universe:
J.P. Morgan uses the following rating system: Overweight [Over the next six to twelve months, we expect this stock will outperform the average total return of the stocks in the analyst's (or the analyst's team's) coverage universe.] Neutral [Over the next six to twelve months, we expect this stock will perform in line with the average total return of the stocks in the analyst's (or the analyst's team's) coverage universe.] Underweight [Over the next six to twelve months, we expect this stock will underperform the average total return of the stocks in the analyst's (or the analyst's team's) coverage universe.] Not Rated (NR): J.P. Morgan has removed the rating and, if applicable, the price target, for this stock because of either a lack of a sufficient fundamental basis or for legal, regulatory or policy reasons. The previous rating and, if applicable, the price target, no longer should be relied upon. An NR designation is not a recommendation or a rating. In our Asia (ex-Australia and ex-India) and U.K. small- and mid-cap equity research, each stock's expected total return is compared to the expected total return of a benchmark country market index, not to those analysts' coverage universe. If it does not appear in the Important Disclosures section of this report, the certifying analyst's coverage universe can be found on J.P. Morgan's research website, www.jpmorganmarkets.com.

Coverage Universe: Sur, Harlan: Advanced Micro Devices (AMD), Analog Devices (ADI), Applied Materials (AMAT), Broadcom Inc (AVGO), Cypress Semiconductor (CY), Inphi (IPHI), Intel (INTC), KLA Corporation (KLAC), Lam Research (LRCX), MACOM (MTSI), Marvell Technology Group (MRVL), Maxim Integrated Products (MXIM), Mellanox Technologies (MLNX), Microchip Technology (MCHP), Micron Technology (MU), NVIDIA Corporation (NVDA), NXP Semiconductors (NXPI), ON Semiconductor Corporation (ON), Texas Instruments (TXN), Vishay Intertechnology (VSH), Western Digital (WDC), Xilinx (XLNX)

J.P. Morgan Equity Research Ratings Distribution, as of July 06, 2019

	Overweight (buy)	**Neutral** (hold)	**Underweight** (sell)
J.P. Morgan Global Equity Research Coverage	45%	41%	14%
IB clients*	52%	49%	36%
JPMS Equity Research Coverage	42%	44%	14%
IB clients*	76%	65%	56%

*Percentage of subject companies within each of the "buy," "hold" and "sell" categories for which J.P. Morgan has provided investment banking services within the previous 12 months.
For purposes only of FINRA ratings distribution rules, our Overweight rating falls into a buy rating category; our Neutral rating falls into a hold rating category; and our Underweight rating falls into a sell rating category. Please note that stocks with an NR designation are not included in the table above. This information is current as of the end of the most recent calendar quarter.

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

Equity Valuation and Risks: For valuation methodology and risks associated with covered companies or price targets for covered companies, please see the most recent company-specific research report at http://www.jpmorganmarkets.com, contact the primary analyst or your J.P. Morgan representative, or email research.disclosure.inquiries@jpmorgan.com. For material information about the proprietary models used, please see the Summary of Financials in company-specific research reports and the Company Tearsheets, which are available to download on the company pages of our client website, http://www.jpmorganmarkets.com. This report also sets out within it the material underlying assumptions used.

Analysts' Compensation: The research analysts responsible for the preparation of this report receive compensation based upon various factors, including the quality and accuracy of research, client feedback, competitive factors, and overall firm revenues.

Other Disclosures

J.P. Morgan is a marketing name for investment banking businesses of JPMorgan Chase & Co. and its subsidiaries and affiliates worldwide.

All research reports made available to clients are simultaneously available on our client website, J.P. Morgan Markets. Not all research content is redistributed, e-mailed or made available to third-party aggregators. For all research reports available on a particular stock, please contact your sales representative.

Any data discrepancies in this report could be the result of different calculations and/or adjustments.

Options and Futures related research: If the information contained herein regards options or futures related research, such information is available only to persons who have received the proper options or futures risk disclosure documents. Please contact your J.P. Morgan Representative or visit https://www.theocc.com/components/docs/riskstoc.pdf for a copy of the Option Clearing Corporation's Characteristics and Risks of Standardized Options or http://www.finra.org/sites/default/files/Security_Futures_Risk_Disclosure_Statement_2018.pdf for a copy of the Security Futures Risk Disclosure Statement.

Private Bank Clients: Where you are receiving research as a client of the private banking businesses offered by JPMorgan Chase & Co. and its subsidiaries ("J.P. Morgan Private Bank"), research is provided to you by J.P. Morgan Private Bank and not by any other division of J.P. Morgan, including but not limited to the J.P. Morgan corporate and investment bank and its research division.

Legal entity responsible for the production of research: The legal entity identified below the name of the Reg AC research analyst who authored this report is the legal entity responsible for the production of this research. Where multiple Reg AC research analysts authored this report with different legal entities identified below their names, these legal entities are jointly responsible for the production of this research.

Legal Entities Disclosures
U.S.: JPMS is a member of NYSE, FINRA, SIPC and the NFA. JPMorgan Chase Bank, N.A. is a member of FDIC. **Canada**: J.P. Morgan Securities Canada Inc. is a registered investment dealer, regulated by the Investment Industry Regulatory Organization of Canada and the Ontario Securities Commission and is the participating member on Canadian exchanges. **U.K.**: JPMorgan Chase N.A., London Branch, is authorised by the Prudential Regulation Authority and is subject to regulation by the Financial Conduct Authority and to limited regulation by the Prudential Regulation Authority. Details about the extent of our regulation by the Prudential Regulation Authority are available from J.P. Morgan on request. J.P. Morgan Securities plc (JPMS plc) is a member of the London Stock Exchange and is authorised by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority. Registered in England & Wales No. 2711006. Registered Office 25 Bank Street, London, E14 5JP. **Germany**: This material is distributed in Germany by J.P. Morgan Securities plc, Frankfurt Branch which is regulated by the Bundesanstalt für Finanzdienstleistungsaufsich and also by J.P. Morgan AG (JPM AG) which is a member of the Frankfurt stock exchange and is regulated by the Federal Financial Supervisory Authority (BaFin), JPM AG is a company incorporated in the Federal Republic of Germany with registered office at Taunustor 1, 60310 Frankfurt am Main, the Federal Republic of Germany. **South Africa**: J.P. Morgan Equities South Africa Proprietary Limited is a member of the Johannesburg Securities Exchange and is regulated by the Financial Services Board. **Hong Kong**: J.P. Morgan Securities (Asia Pacific) Limited (CE number AAJ321) is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission in Hong Kong and/or J.P. Morgan Broking (Hong Kong) Limited (CE number AAB027) is regulated by the Securities and Futures Commission in Hong Kong. JP Morgan Chase Bank, N.A., Hong Kong is organized under the laws of U.S.A. with limited liability. **Korea**: This material is issued and distributed in Korea by or through J.P. Morgan Securities (Far East) Limited, Seoul Branch, which is a member of the Korea Exchange(KRX) and is regulated by the Financial Services Commission (FSC) and the Financial Supervisory Service (FSS). **Australia**: J.P. Morgan Securities Australia Limited (JPMSAL) (ABN 61 003 245 234/AFS Licence No: 238066) is regulated by ASIC and is a Market, Clearing and Settlement Participant of ASX Limited and CHI-X. **Taiwan**: J.P. Morgan Securities (Taiwan) Limited is a participant of the Taiwan Stock Exchange (company-type) and regulated by the Taiwan Securities and Futures Bureau. **India:** J.P. Morgan India Private Limited (Corporate Identity Number - U67120MH1992FTC068724), having its registered office at J.P. Morgan Tower, Off. C.S.T. Road, Kalina, Santacruz - East, Mumbai – 400098, is registered with Securities and Exchange Board of India (SEBI) as a 'Research Analyst' having registration number INH000001873. J.P. Morgan India Private Limited is also registered with SEBI as a member of the National Stock Exchange of India Limited and the Bombay Stock Exchange Limited (SEBI Registration Number – INZ000239730) and as a Merchant Banker (SEBI Registration Number - MB/INM000002970). Telephone: 91-22-6157 3000, Facsimile: 91-22-6157 3990 and Website: www.jpmipl.com. For non local research reports, this material is not distributed in India by J.P. Morgan India Private Limited. **Thailand**: This material is issued and distributed in Thailand by JPMorgan Securities (Thailand) Ltd., which is a member of the Stock Exchange of Thailand and is regulated by the Ministry of Finance and the Securities and Exchange Commission and its registered address is 3rd Floor, 20 North Sathorn Road, Silom, Bangrak, Bangkok 10500. **Indonesia**: PT J.P. Morgan Sekuritas Indonesia is a member of the Indonesia Stock Exchange and is regulated by the OJK a.k.a. BAPEPAM LK. **Philippines**: J.P. Morgan Securities Philippines Inc. is a Trading Participant of the Philippine Stock Exchange and a member of the Securities Clearing Corporation of the Philippines and the Securities Investor Protection Fund. It is regulated by the Securities and Exchange Commission. **Brazil**: Banco J.P. Morgan S.A. is regulated by the Comissao de Valores Mobiliarios (CVM) and by the Central Bank of Brazil. **Mexico**: J.P. Morgan Casa de Bolsa, S.A. de C.V., J.P. Morgan Grupo Financiero is a member of the Mexican Stock Exchange and authorized to act as a broker dealer by the National Banking and Securities Exchange Commission. **Singapore:** This material is issued and distributed in Singapore by or through J.P. Morgan Securities Singapore Private Limited (JPMSS)

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

[MCI (P) 058/04/2019 and Co. Reg. No.: 199405335R], which is a member of the Singapore Exchange Securities Trading Limited and/or JPMorgan Chase Bank, N.A., Singapore branch (JPMCB Singapore) [MCI (P) 046/09/2018], both of which are regulated by the Monetary Authority of Singapore. This material is issued and distributed in Singapore only to accredited investors, expert investors and institutional investors, as defined in Section 4A of the Securities and Futures Act, Cap. 289 (SFA). This material is not intended to be issued or distributed to any retail investors or any other investors that do not fall into the classes of "accredited investors," "expert investors" or "institutional investors," as defined under Section 4A of the SFA. Recipients of this document are to contact JPMSS or JPMCB Singapore in respect of any matters arising from, or in connection with, the document. **Japan**: JPMorgan Securities Japan Co., Ltd. and JPMorgan Chase Bank, N.A., Tokyo Branch are regulated by the Financial Services Agency in Japan. **Malaysia**: This material is issued and distributed in Malaysia by JPMorgan Securities (Malaysia) Sdn Bhd (18146-X) which is a Participating Organization of Bursa Malaysia Berhad and a holder of Capital Markets Services License issued by the Securities Commission in Malaysia. **Pakistan**: J. P. Morgan Pakistan Broking (Pvt.) Ltd is a member of the Karachi Stock Exchange and regulated by the Securities and Exchange Commission of Pakistan. **Saudi Arabia**: J.P. Morgan Saudi Arabia Ltd. is authorized by the Capital Market Authority of the Kingdom of Saudi Arabia (CMA) to carry out dealing as an agent, arranging, advising and custody, with respect to securities business under licence number 35-07079 and its registered address is at 8th Floor, Al-Faisaliyah Tower, King Fahad Road, P.O. Box 51907, Riyadh 11553, Kingdom of Saudi Arabia. **Dubai**: JPMorgan Chase Bank, N.A., Dubai Branch is regulated by the Dubai Financial Services Authority (DFSA) and its registered address is Dubai International Financial Centre - Building 3, Level 7, PO Box 506551, Dubai, UAE. **Russia:** CB J.P. Morgan Bank International LLC is regulated by the Central Bank of Russia. **Argentina:** JPMorgan Chase Bank Sucursal Buenos Aires is regulated by Banco Central de la República Argentina ("BCRA"- Central Bank of Argentina) and Comisión Nacional de Valores ("CNV"- Argentinian Securities Commission")

Country and Region Specific Disclosures
U.K. and European Economic Area (EEA): Unless specified to the contrary, issued and approved for distribution in the U.K. and the EEA by JPMS plc. Investment research issued by JPMS plc has been prepared in accordance with JPMS plc's policies for managing conflicts of interest arising as a result of publication and distribution of investment research. Many European regulators require a firm to establish, implement and maintain such a policy. Further information about J.P. Morgan's conflict of interest policy and a description of the effective internal organisations and administrative arrangements set up for the prevention and avoidance of conflicts of interest is set out at the following link https://www.jpmorgan.com/jpmpdf/1320742677360.pdf. This report has been issued in the U.K. only to persons of a kind described in Article 19 (5), 38, 47 and 49 of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (all such persons being referred to as "relevant persons"). This document must not be acted on or relied on by persons who are not relevant persons. Any investment or investment activity to which this document relates is only available to relevant persons and will be engaged in only with relevant persons. In other EEA countries, the report has been issued to persons regarded as professional investors (or equivalent) in their home jurisdiction. **Australia:** This material is issued and distributed by JPMSAL in Australia to "wholesale clients" only. This material does not take into account the specific investment objectives, financial situation or particular needs of the recipient. The recipient of this material must not distribute it to any third party or outside Australia without the prior written consent of JPMSAL. For the purposes of this paragraph the term "wholesale client" has the meaning given in section 761G of the Corporations Act 2001. J.P. Morgan's research coverage universe spans listed securities across the ASX All Ordinaries index, securities listed on offshore markets, unlisted issuers and investment products which Research management deem to be relevant to the investor base from time to time. J.P. Morgan seeks to cover companies of relevance to the domestic and international investor base across all GIC sectors, as well as across a range of market capitalisation sizes. **Germany:** This material is distributed in Germany by J.P. Morgan Securities plc, Frankfurt Branch which is regulated by the Bundesanstalt für Finanzdienstleistungsaufsicht. **Korea:** This report may have been edited or contributed to from time to time by affiliates of J.P. Morgan Securities (Far East) Limited, Seoul Branch. **Singapore:** As at the date of this report, JPMSS is a designated market maker for certain structured warrants listed on the Singapore Exchange where the underlying securities may be the securities discussed in this report. Arising from its role as designated market maker for such structured warrants, JPMSS may conduct hedging activities in respect of such underlying securities and hold or have an interest in such underlying securities as a result. The updated list of structured warrants for which JPMSS acts as designated market maker may be found on the website of the Singapore Exchange Limited: http://www.sgx.com. In addition, JPMSS and/or its affiliates may also have an interest or holding in any of the securities discussed in this report – please see the Important Disclosures section above. For securities where the holding is 1% or greater, the holding may be found in the Important Disclosures section above. For all other securities mentioned in this report, JPMSS and/or its affiliates may have a holding of less than 1% in such securities and may trade them in ways different from those discussed in this report. Employees of JPMSS and/or its affiliates not involved in the preparation of this report may have investments in the securities (or derivatives of such securities) mentioned in this report and may trade them in ways different from those discussed in this report. **Taiwan**: Research relating to equity securities is issued and distributed in Taiwan by J.P. Morgan Securities (Taiwan) Limited, subject to the license scope and the applicable laws and the regulations in Taiwan. According to Paragraph 2, Article 7-1 of Operational Regulations Governing Securities Firms Recommending Trades in Securities to Customers (as amended or supplemented) and/or other applicable laws or regulations, please note that the recipient of this material is not permitted to engage in any activities in connection with the material which may give rise to conflicts of interests, unless otherwise disclosed in the "Important Disclosures" in this material. **India:** For private circulation only, not for sale. **Pakistan:** For private circulation only, not for sale. **New Zealand:** This material is issued and distributed by JPMSAL in New Zealand only to "wholesale clients" (as defined in the Financial Advisers Act 2008). The recipient of this material must not distribute it to any third party or outside New Zealand without the prior written consent of JPMSAL. **Canada:** This report is distributed in Canada by or on behalf of J.P.Morgan Securities Canada Inc. The information contained herein is not, and under no circumstances is to be construed as an offer to sell securities described herein, or solicitation of an offer to buy securities described herein, in Canada or any province or territory thereof. The information contained herein is under no circumstances to be construed as investment advice in any province or territory of Canada and is not tailored to the needs of the recipient. **Dubai:** This report has been issued to persons regarded as professional clients as defined under the DFSA rules. **Brazil:** Ombudsman J.P. Morgan: 0800-7700847 / ouvidoria.jp.morgan@jpmorgan.com.

General: Additional information is available upon request. Information has been obtained from sources believed to be reliable but JPMorgan Chase & Co. or its affiliates and/or subsidiaries (collectively J.P. Morgan) do not warrant its completeness or accuracy except with respect to any disclosures relative to JPMS and/or its affiliates and the analyst's involvement with the issuer that is the subject of the research. All pricing is indicative as of the close of market for the securities discussed, unless otherwise stated. Opinions and estimates constitute our judgment as of the date of this material and are subject to change without notice. Past performance is not indicative of future results. This material is not intended as an offer or solicitation for the purchase or sale of any financial instrument. The opinions and recommendations herein do not take into account individual client circumstances, objectives, or needs and are not intended as recommendations of particular securities, financial instruments or strategies to particular clients. The recipient of this report must make its own independent decisions regarding any securities or financial instruments mentioned herein. JPMS distributes in the U.S. research published by non-U.S. affiliates and accepts responsibility for its contents. Periodic updates may be provided on companies/industries based on company specific developments or

This document is being provided for the exclusive use of SHIBIN XIE at ALLIANZ GLOBAL INVESTORS US LLC

announcements, market conditions or any other publicly available information. Clients should contact analysts and execute transactions through a J.P. Morgan subsidiary or affiliate in their home jurisdiction unless governing law permits otherwise.

"Other Disclosures" last revised August 10, 2019.

Copyright 2019 JPMorgan Chase & Co. All rights reserved. This report or any portion hereof may not be reprinted, sold or redistributed without the written consent of J.P. Morgan.