

US Economics Analyst Updating Our Outlook to Incorporate Omicron (Briggs)

- The emergence of the Omicron variant increases the risks and uncertainty around the US economic outlook. While many questions remain unanswered, we now think a moderate downside scenario where the virus spreads more quickly but immunity against severe disease is only slightly weakened is most likely. In this scenario, we see three main effects on the US economy.
- First, Omicron could slow economic reopening, but we expect only a modest drag on service spending because domestic virus-control policy and economic activity have become significantly less sensitive to virus spread.
- Second, Omicron could exacerbate goods supply shortages if virus spread in other countries necessitates tight restrictions. This was a major problem during the Delta wave, but increases in vaccination rates in foreign trade partners since then should limit the scope for severe supply disruptions.
- Third, Omicron could delay the timeline for some people feeling comfortable returning to work and cause worker shortages to linger somewhat longer.
- We have updated our GDP forecasts to incorporate our updated virus outlook as well as the latest GDP tracking data. These changes result in a +0.5pp (qoq ar) boost to our Q4 growth forecast based mostly on stronger inventory data, and a -1.5pp cut to growth in Q1 and -0.5pp cut in Q2 due to virus-related drags on reopening and goods supply. We now expect GDP growth of +6.5%/+3.0%/+3.5%/+3.0%/+2.0% in 2021Q4-2022Q4. This implies 2022 GDP growth of +3.8% (vs. 4.2% previously) on a full-year basis and +2.9% (vs. +3.3% previously) on a Q4/Q4 basis.
- We see mixed implications for inflation. Reduced demand for virus-sensitive services such as travel could have a disinflationary impact in the near term, but prior virus waves suggest that such pressures would be temporary and reverse as demand recovers. In contrast, further supply chain disruptions due to Omicron or further delays in the recovery of labor supply could have a somewhat more lasting inflationary impact.

Jan Hatzius

+1(212)902-0394 | jan.hatzius@gs.com Goldman Sachs & Co. LLC

Alec Phillips

+1(202)637-3746 | alec.phillips@gs.com Goldman Sachs & Co. LLC

David Mericle

+1(212)357-2619 david.mericle@gs.com Goldman Sachs & Co. LLC

Spencer Hill, CFA

+1(212)357-7621 | spencer.hill@gs.com Goldman Sachs & Co. LLC

Joseph Briggs

+1(212)902-2163 joseph.briggs@gs.com Goldman Sachs & Co. LLC

Ronnie Walker

+1(917)343-4543 ronnie.walker@gs.com Goldman Sachs & Co. LLC

Updating Our Outlook to Incorporate Omicron

In a <u>note</u> earlier this week, our global economics team outlined four potential scenarios for the Omicron variant and the macro outlook, including 1) a downside scenario where Omicron transmits more quickly than Delta but causes similarly severe disease, 2) a severe downside scenario where both disease severity and immunity against hospitalizations are substantially worse than for Delta, 3) a false alarm scenario where Omicron has little incremental effect on virus spread, and 4) an upside scenario where Omicron is slightly more transmissible but causes much less severe disease.

A wide range of outcomes are still possible, but in a <u>note earlier today</u> our global team analyzed early data and concluded that Omicron is spreading rapidly in South Africa—making the third "false alarm" scenario less likely—but that early data and expert opinion do not point to sharp deterioration in vaccine efficacy against hospitalizations and disease severity—making the "severe downside" scenario also less likely. The latter view—if confirmed by further and more complete data—is particularly good news, since the disease severity or degree of protection offered by existing vaccines is likely the key determinant of the effect that Omicron will have on the US economy. Our global economics team concluded that the "downside" scenario—where the virus spreads more quickly but immunity against hospitalizations declines only slightly more—is the most likely Omicron outcome.

Based on these findings, we have assumed this moderate downside Omicron scenario as our baseline outlook. In this *US Economics Analyst*, we therefore examine three main effects that Omicron may have on the US economy and update our GDP forecasts accordingly.

A Reopening Slowdown

First, Omicron could slow economic reopening of the virus-sensitive service sector if state governments implement policies to control virus spread or if consumers become less willing to engage in normal economic activity. Risks from this channel appear limited for two reasons. First, government policy in the US has become much less sensitive to virus spread since vaccination rates increased this spring, and the US <u>Effective Lockdown Index</u> (ELI) only rose by 2pts during the Delta variant surge in late summer (left chart, Exhibit 1). Second, consumer spending and job growth have become much less sensitive to local virus spread (right chart), likely due to <u>lower Covid risk aversion</u> in the US.

Count per million Coefficient Across-State Correlation With Coefficient Hospitalizations per Capita, 3MMA 100 560 0.4 0.4 Effective Lockdown Index (left) Monthly Job Growth Daily Change in Fatalities per Million (right outer) 90 Monthly Spending Growth Daily Population Hospitalized per Million (right inner) 480 12 80 0.2 0.2 400 10 70 60 0.0 0.0 8 320 50 240 6 40 -0.2 -0.2 30 160 20 -0.4 -0.4 2 80 10

-0.6

Jul-20

Feb-22

Exhibit 1: Virus-Control Policy and Economic Activity Have Become Increasingly Less Affected by Virus Spread

Source: Centers for Disease Control and Prevention, US Bureau of Labor Statistics, Bureau of Economic Analysis, Goldman Sachs Global Investment Research

Aug-21

To quantify the potential effects of a fourth virus wave on service spending, Exhibit 2 compares service spending growth in the run-up to and during the Delta wave. Although spending growth slowed down somewhat, it remained positive for most service categories outside of air transportation, amusement parks, gambling, and membership & sporting clubs, and declines for those categories were small, suggesting that only the most virus-sensitive services were affected by virus spread (left chart). Furthermore, the right chart shows that service spending ex-housing grew at an 11% annualized rate in 2021Q3, and total real PCE growth would only have been 1.1pp (qoq ar) higher if service spending in August and September (when COVID case numbers reached local highs) continued to grow at its June and July pace.

Oct-20

Jan-21

Apr-21

Jul-21

-0.6

Oct-21

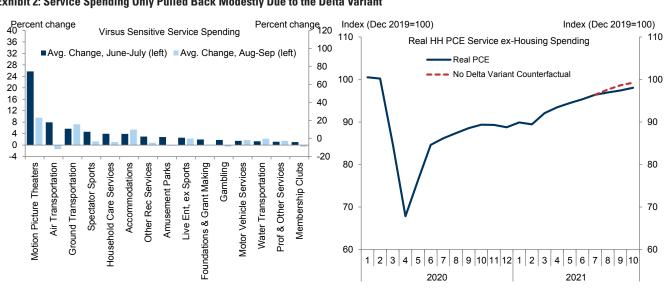


Exhibit 2: Service Spending Only Pulled Back Modestly Due to the Delta Variant

n

Feb-20

Aug-20

Feb-21

Source: Bureau of Economic Analysis, Goldman Sachs Global Investment Research

It is possible that geographic differences in vaccination rates and risk aversion explain some of this low sensitivity. After all, the Delta variant mostly spread in areas with low

4 December 2021 3

vaccination rates where individuals may be predisposed to not adjust behavior due to virus spread, a point raised recently in a <u>research note</u> from the San Francisco Fed. Nevertheless, we expect that there will be little political appetite for tighter virus-control policies, and taken altogether, our findings suggest any spending slowdown due to lower service demand will probably be moderate under our new virus assumption.

A Delay in Supply Chain Normalization

Second, Omicron could exacerbate goods supply shortages if virus spread in other countries has negative spillover effects on the US through supply channels, as happened during the Delta wave in 2021Q3. Survey data from Morning Consult suggests that many prospective buyers had trouble finding various goods (left chart, Exhibit 3), with over half of respondents choosing not to purchase products when confronted with supply shortages. The effects of these shortages were especially pronounced for automobiles, where a sharp decline in real motor vehicle spending (-50.2% qoq ar) drove much of the overall decline in real goods spending (-8.4% qoq ar) in Q3.

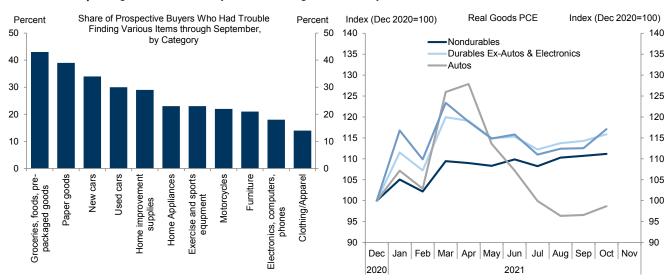


Exhibit 3: Goods Spending Was Constrained by Product Shortages, Particularly For Autos...

Source: Morning Consult, Bureau of Economic Analysis, Goldman Sachs Global Investment Research

As we've previously documented, <u>supply shortages</u> largely reflected <u>supply chain</u> <u>spillovers</u> from Southeast Asia, where increased virus spread led to factory shutdowns that limited the supply of <u>semiconductors</u>, which in turn limited US <u>automobile</u> production and led to a sharp drawdown in <u>inventories</u>. This can be seen in Exhibit 4, where a sharp increase in the semiconductor import-weighted ELI this spring (left chart) coincided with a decline in imports of automotive semiconductors and US motor vehicle assemblies (right chart).

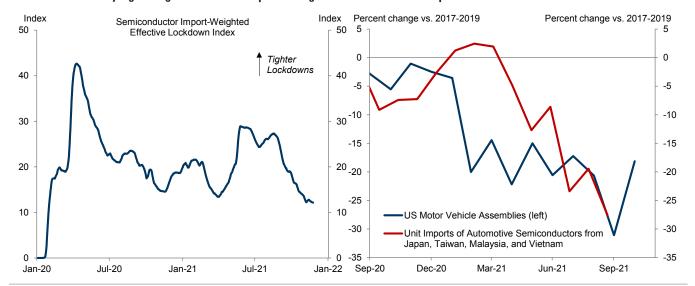


Exhibit 4: ... As Policy Tightening to Control Virus Spread Weighed on Semiconductor Imports from South East Asia

Source: Census Bureau, Federal Reserve, Goldman Sachs Global Investment Research

The good news is that vaccination rates in Southeast Asia have increased dramatically since mid-March, suggesting that virus spread today will likely not result in as much policy tightening as we saw following the spread of the Delta variant earlier this year. For example, the fully-vaccinated population share in Malaysia—the largest exporter of semiconductors and electronic components to the US—increased from less than 10% in June to 78% today, while the share in Taiwan—the second-largest exporter—has increased from 0% to 56%. As a result, we see less scope for severe supply chain disruptions and expect only a moderate hit to the supply of goods, but note that downside risks from this channel are potentially large.

A Slowdown in the Labor Market Recovery

Third, based on patterns from the last two Covid waves in the US, Omicron could slow down the labor supply recovery. As shown in Exhibit 5, hiring slowed significantly—particularly for leisure and hospitality jobs—during the Alpha and Delta waves, despite labor demand remaining quite firm. This pattern suggests that labor supply is the main driver of hiring slowdowns during Covid waves.

As we've <u>previously noted</u>, 2.5mn workers still report that concerns about getting or spreading Covid-19 are their main reason for not working, including around 1.6mn prime-age workers. If Omicron delays the timeline for some people feeling comfortable returning to work, <u>worker shortages</u> may linger longer than expected.

Millions Labor Market Performance During Covid Waves* Millions 1.4 14 Payroll Gains (left) 1.2 Delta Leis. and Hosp. Job Gains (left) 12 Job Openings (right) wave 1.0 10 8.0 Alpha 0.6 wave 8 0.4 6 0.2 0.0 *Red shaded regions indicate -0.2periods of increased covid 2 -0.4 spread -0.6 0 Sep Oct Nov Dec Jan Feb Mar Apr May Jun Aug Sep Jul 2020 2021

Exhibit 5: Hiring Slowed but Labor Demand Held up in Previous COVID Waves, Suggesting the Main Labor Market Risk of a Fourth Virus Wave Comes From a Slower Labor Supply Recovery

Source: US Bureau of Labor Statistics, Goldman Sachs Global Investment Research

Updating our GDP Forecasts

We've updated our GDP forecasts to incorporate our updated virus outlook and new GDP tracking data (Exhibit 6). First, for Q4, the sequential easing of supply constraints—including better Southeast Asian chip supply and progress towards unclogging US ports—argue for an increase in our Q4 inventory forecast, and we therefore have boosted our 2021 Q4 growth forecast by +0.5pp (qoq ar) to 6.5%. This upgrade implies 2021 annual growth of +5.6% (unchanged) and Q4/Q4 growth of +5.4% (vs. +5.3% previously).

Second, we've cut our GDP growth forecasts for 2022Q1 by 1.5pp and 2022Q2 by 0.5pp to incorporate Omicron-related drags on reopening and goods supply that we expect will weigh on consumption growth in these quarters. We now expect GDP growth of +6.5%/+3.0%/+3.5%/+3.0%/+2.0 in 2021Q4-2022Q4, which implies 2022 annual growth of +3.8% (vs. 4.2% previously) and Q4/Q4 growth of +2.9% (vs. +3.3% previously).

Percent change, annual rate Percent change, annual rate 12 12 **GDP Growth Forecasts** ■ GS Consensus 10 10 8 8 6.5 5.6 5.4 6 6 3.8 3.5 4 4 3.0 2.9 3.0 2.0 2.2 2 2 0 0 Q2 Full Year Q4/Q4 Full Year Q4/Q4 Q4 Q1 Q3 Q4 Full Year 2021 2022 2021 2022 2023

Exhibit 6: We Now Forecast GDP Will Grow by +3.8% on an Annual Basis and by +2.9% on a Q4/Q4 Basis

Source: Bloomberg, Goldman Sachs Global Investment Research

Risks to Inflation

Additionally, each of the three effects of Omicron discussed above poses a distinct risk to our inflation forecast that <u>makes it difficult</u> to determine the net impact.

A drop in demand for virus-sensitive services would likely result in price declines for services like air and ground transport and accommodation. The left chart of Exhibit 7— which compares inflation in these categories pre- and post-Delta wave—shows that these disinflationary pressures subtracted roughly 12bps from monthly core PCE inflation in August and September relative to the reopening trend, although the monthly drag relative to a no-price-change counterfactual is only 6bps. However, we expect any drag on inflation from lower service demand to mostly reverse after virus spread slows, following the <u>reflation</u> patterns of prior virus waves.

In contrast, we see upside inflation risk from more persistent supply and worker shortages. For example, the right chart of Exhibit 7 shows that auto prices surged around the time semiconductor imports collapsed (Exhibit 4), and the contribution from motor vehicles to core PCE has remained elevated since. While we continue to expect an over-100bp decline in the contribution to core PCE inflation from auto prices alone between now and end-2022, a delay in the easing of supply constraints could keep core goods prices elevated well into the second half of 2022.

Additionally, delays in the easing of worker shortages could mean that the acute wage pressures from 2021Q2 and Q3 persist for longer than expected, with our most <u>recent estimates</u> suggesting that a 1pp acceleration in wage growth boosts core PCE price inflation by about 35bps.

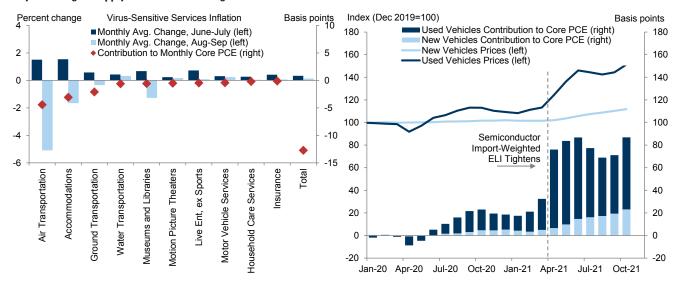


Exhibit 7: We See Some Downside Inflation Risk Due to a Drop in Demand for Virus-Sensitive Services, but Upside Inflation Risk from Delayed Easing of Supply and Worker Shortages

Source: Bureau of Economic Analysis, US Bureau of Labor Statistics, Goldman Sachs Global Investment Research

Taken altogether, we see the near-term effect of Omicron on inflation as ambiguous due to the potentially offsetting effects from lower service and higher goods and labor demand, but we see medium and longer-term risks as mostly inflationary due to potential delays in supply chain normalization and easing of worker shortages.

Still on Track for a Faster Taper and an Early Liftoff

Although we now expect moderate economic impacts from Omicron, we do not believe that these changes are large enough to affect our call for a faster pace of tapering and an early liftoff. The <u>November employment situation report</u>—in which the unemployment rate fell to 4.2%—was sufficiently strong that we continue to <u>expect</u> that the Fed will announce at its December meeting that it is doubling the pace of tapering to \$30bn per month starting in January.

A slowdown in the labor market recovery due to Omicron could make it harder for some participants to square a still-large employment gap relative to the pre-pandemic level with the guidance in the FOMC statement that the committee will not raise interest rates until the labor market reaches maximum employment—which we saw as the largest risk to our Fed forecast even before Omicron emerged. However, we continue to expect the unemployment rate will fall to 3.7% by May of next year, which should be low enough for the FOMC to hike for the first time at the June meeting.

Joseph Briggs

The US Economic and Financial Outlook

THE US ECONOMIC AND FINANCIAL OUTLOOK

(% change on previous period, annualized, except where noted)

	2019	2020	2021	2022	2023	2024		2021			2022			
			(f)	(f)	(f)	(f)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
OUTPUT AND SPENDING														
Real GDP	2.3	-3.4	5.6	3.8	2.2	2.2	6.3	6.7	2.1	6.5	3.0	3.5	3.0	2.0
Real GDP (annual=Q4/Q4, quarterly=yoy)	2.6	-2.3	5.4	2.9	2.0	2.2	0.5	12.2	4.9	5.4	4.6	3.8	4.0	2.9
Consumer Expenditures	2.2	-3.8	8.0	3.2	2.0	2.2	11.4	12.0	1.7	4.9	2.0	2.5	2.0	2.0
Residential Fixed Investment	-0.9	6.8	9.3	1.2	2.6	2.0	13.3	-11.7	-8.3	4.5	4.0	4.0	3.0	3.0
Business Fixed Investment	4.3	-5.3	7.5	4.5	3.4	3.7	12.9	9.2	1.5	4.8	5.9	4.2	3.4	3.2
Structures	2.1	-12.5	-7.6	-0.3	1.6	2.6	5.4	-3.0	-5.0	-0.5	1.0	1.0	1.0	1.0
Equipment	3.3	-8.3	13.2	4.8	2.7	2.8	14.1	12.2	-2.4	5.1	8.0	5.0	3.0	2.5
Intellectual Property Products	7.2	2.8	10.0	6.6	5.0	5.2	15.6	12.5	9.3	7.0	6.0	5.0	5.0	5.0
Federal Government	3.8	5.0	0.9	-1.8	-0.8	-0.1	11.3	-5.3	-4.9	-1.0	-1.0	-1.0	-1.0	-1.0
State & Local Government	1.3	0.9	0.5	2.3	1.6	1.0	-0.1	0.2	4.7	0.6	2.5	2.5	2.5	2.5
Net Exports (\$bn, '12)	-905	-943	-1,275	-1,386	-1,357	-1,325	-1226	-1245	-1312	-1319	-1356	-1384	-1399	-1404
Inventory Investment (\$bn, '12)	75	-42	-75	139	109	60	-88	-169	-73	30	70	130	180	175
Industrial Production, Mfg.	-2.0	-6.6	6.5	5.1	2.3	1.8	2.8	4.9	4.7	8.3	5.0	4.5	3.8	2.5
HOUSING MARKET														
Housing Starts (units, thous)	1,292	1,397	1,612	1,679	1,726		1,599	1,588	1,555	1,706	1,687	1,661	1,640	1,728
New Home Sales (units, thous)	683	828	817	908	934	928	896	737	713	923	931	890	867	946
Existing Home Sales (units, thous)	5,327	5,658	6.070	6,159	6,247	6.324	6,303	5,833	6,057	6,086	6,117	6,146	6,175	6,200
Case-Shiller Home Prices (%yoy)*	3.4	9.5	15.1	9.0	2.7	3.5	12.3	16.9	19.7	15.1	12.5	11.3	10.1	9.0
INFLATION (% ch, yr/yr)														
Consumer Price Index (CPI)**	2.3	1.3	6.8	2.9	2.6	2.5	1.9	4.8	5.3	6.6	6.4	5.3	4.4	3.2
Core CPI **	2.2	1.6	5.4	3.3	2.6	2.5	1.4	3.7	4.1	5.0	5.9	4.9	4.4	3.6
Core PCE** †	1.6	1.5	4.5	2.3	2.1	2.2	1.7	3.4	3.6	4.4	4.4	3.5	3.0	2.4
LABOR MARKET														
Unemployment Rate (%)^	3.6	6.7	4.1	3.5	3.3	3.2	6.0	5.9	4.8	4.1	3.8	3.7	3.5	3.5
U6 Underemployment Rate (%)^	6.8	11.7	7.5	6.8	6.4	6.2	10.7	9.7	8.5	7.5	7.2	6.9	6.8	6.8
Payrolls (thous, monthly rate)	168	-785	547	211	120	99	518	615	651	402	300	214	167	163
Employment-Population Ratio (%)^	61.0	57.4	59.4	60.0	60.1	60.0	57.8	58.1	58.9	59.7	59.7	59.8	60.0	60.0
Labor Force Participation Rate (%)^	63.3	61.5	62.0	62.2	62.1	62.0	61.5	61.6	61.6	62.0	62.0	62.1	62.2	62.2
GOVERNMENT FINANCE														
Federal Budget (FY, \$bn)	-984	-3.129	-2.800	-1.200	-1,250	-1,300								
FINANCIAL INDICATORS														
	454		0.005	0.75.4	40545	4.75.0	0.00-	0.00=	0 0 0=	0.005	0.005	00505	0 5 0 75	0.75.1
FF Target Range (Bottom-Top, %)^	1.5-1.75	0-0.25	0-0.25	0.75-1	1.25-1.5	1.75-2	0-0.25	0-0.25	0-0.25	0-0.25		0.25-0.5		0.75-1
10-Year Treasury Note^	1.92	0.93	1.70	2.00	2.40	2.50	1.74	1.45	1.52	1.70	1.80	1.90	1.95	2.00
Euro (€/\$)^	1.12	1.22	1.13	1.15	1.20	1.25	1.17	1.18	1.16	1.13	1.13	1.14	1.15	1.15
Yen (\$/¥)^	109	103	113	111	107	104	111	111	112	113	115	113	112	111

^{*} Weighted average of metro-level HPIs for 381 metro cities where the weights are dollar values of housing stock reported in the American Community Survey. Annual numbers are Q4/Q4.

** Annual inflation numbers are December year-on-year values. Quarterly values are Q4/Q4.

† PCE = Personal consumption expenditures. ^ Denotes end of period.

Note: Published figures in bold.

Source: Goldman Sachs Global Investment Research

4 December 2021 9

Source: Goldman Sachs Global Investment Research.

Economic Releases

		Time		Estim			
Date		(ET)	Indicator	GS	Consensus	Last Report	
Гие	Nov 07 8:30		Nonfarm Productivity (Q3 final)	-4.9%	-4.9%	-5.0%	
			Unit Labor Costs (Q3 final)	+8.3%	+8.3%	+8.3%	
		8:30	Trade Balance (October)	-\$67.5bn	-\$66.8bn	-\$80.9bn	
Wed	Nov 08	10:00	JOLTS Job Openings (October)	n.a.	10,500k	10,438k	
Thu	Nov 09	8:30	Initial Jobless Claims	200k	225k	222k	
			Continuing Claims	n.a.	1,910k	1,956k	
		10:00	Wholesale Inventories (October final)	n.a.	+2.2%	+2.2%	
-ri	Nov 10	8:30	Consumer Price Index (November)	+0.82%	+0.7%	+0.9%	
			Ex Food and Energy (November)	+0.60%	+0.5%	+0.6%	
		10:00	UMich Consumer Sentiment (December preliminary)	68.4	68.0	67.4	

Source: Bloomberg, Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Jan Hatzius, Alec Phillips, David Mericle, Spencer Hill, CFA, Joseph Briggs and Ronnie Walker, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

Unless otherwise stated, the individuals listed on the cover page of this report are analysts in Goldman Sachs' Global Investment Research division.

Disclosures

Regulatory disclosures

Disclosures required by United States laws and regulations

See company-specific regulatory disclosures above for any of the following disclosures required as to companies referred to in this report: manager or co-manager in a pending transaction; 1% or other ownership; compensation for certain services; types of client relationships; managed/co-managed public offerings in prior periods; directorships; for equity securities, market making and/or specialist role. Goldman Sachs trades or may trade as a principal in debt securities (or in related derivatives) of issuers discussed in this report.

The following are additional required disclosures: **Ownership and material conflicts of interest:** Goldman Sachs policy prohibits its analysts, professionals reporting to analysts and members of their households from owning securities of any company in the analyst's area of coverage. **Analyst compensation:** Analysts are paid in part based on the profitability of Goldman Sachs, which includes investment banking revenues. **Analyst as officer or director:** Goldman Sachs policy generally prohibits its analysts, persons reporting to analysts or members of their households from serving as an officer, director or advisor of any company in the analyst's area of coverage. **Non-U.S. Analysts:** Non-U.S. analysts may not be associated persons of Goldman Sachs & Co. LLC and therefore may not be subject to FINRA Rule 2241 or FINRA Rule 2242 restrictions on communications with subject company, public appearances and trading securities held by the analysts.

Additional disclosures required under the laws and regulations of jurisdictions other than the United States

The following disclosures are those required by the jurisdiction indicated, except to the extent already made above pursuant to United States laws and regulations. Australia: Goldman Sachs Australia Pty Ltd and its affiliates are not authorised deposit-taking institutions (as that term is defined in the Banking Act 1959 (Cth)) in Australia and do not provide banking services, nor carry on a banking business, in Australia. This research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act, unless otherwise agreed by Goldman Sachs. In producing research reports, members of the Global Investment Research Division of Goldman Sachs Australia may attend site visits and other meetings hosted by the companies and other entities which are the subject of its research reports. In some instances the costs of such site visits or meetings may be met in part or in whole by the issuers concerned if Goldman Sachs Australia considers it is appropriate and reasonable in the specific circumstances relating to the site visit or meeting. To the extent that the contents of this document contains any financial product advice, it is general advice only and has been prepared by Goldman Sachs without taking into account a client's objectives, financial situation or needs. A client should, before acting on any such advice, consider the appropriateness of the advice having regard to the client's own objectives, financial situation and needs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests and a copy of Goldman Sachs' Australian Sell-Side Research Independence Policy Statement are available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. Brazil: Disclosure information in relation to CVM Resolution n. 20 is available at https://www.gs.com/worldwide/brazil/area/gir/index.html. Where applicable, the Brazil-registered analyst primarily responsible for the content of this research report, as defined in Article 20 of CVM Resolution n. 20, is the first author named at the beginning of this report, unless indicated otherwise at the end of the text. Canada: Goldman Sachs Canada Inc. is an affiliate of The Goldman Sachs Group Inc. and therefore is included in the company specific disclosures relating to Goldman Sachs (as defined above). Goldman Sachs Canada Inc. has approved of, and agreed to take responsibility for, this research report in Canada if and to the extent that Goldman Sachs Canada Inc. disseminates this research report to its clients. Hong Kong: Further information on the securities of covered companies referred to in this research may be obtained on request from Goldman Sachs (Asia) L.L.C. India: Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (India) Securities Private Limited, Research Analyst - SEBI Registration Number INH000001493, 951-A, Rational House, Appasaheb Marathe Marg, Prabhadevi, Mumbai 400 025, India, Corporate Identity Number U74140MH2006FTC160634, Phone +91 22 6616 9000, Fax +91 22 6616 9001. Goldman Sachs may beneficially own 1% or more of the securities (as such term is defined in clause 2 (h) the Indian Securities Contracts (Regulation) Act, 1956) of the subject company or companies referred to in this research report. Japan: See below. Korea: This research, and any access to it, is intended only for "professional investors" within the meaning of the Financial Services and Capital Markets Act, unless otherwise agreed by Goldman Sachs. Further information on the subject company or companies referred to in this research may be obtained from Goldman Sachs (Asia) L.L.C., Seoul Branch. New Zealand: Goldman Śachs New Zealand Limited and its affiliates are neither "registered banks" nor "deposit takers" (as defined in the Reserve Bank of New Zealand Act 1989) in New Zealand. This research, and any access to it, is intended for "wholesale clients" (as defined in the Financial Advisers Act 2008) unless otherwise agreed by Goldman Sachs. A copy of certain Goldman Sachs Australia and New Zealand disclosure of interests is available at: https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html. Russia: Research reports distributed in the Russian Federation are not advertising as defined in the Russian legislation, but are information and analysis not having product promotion as their main purpose and do not provide appraisal within the meaning of the Russian legislation on appraisal activity. Research reports do not constitute a personalized investment recommendation as defined in Russian laws and regulations, are not addressed to a specific client, and are prepared without analyzing the financial circumstances, investment profiles or risk profiles of clients. Goldman Sachs assumes no responsibility for any investment decisions that may be taken by a client or any other person based on this research report. Singapore: Goldman Sachs (Singapore) Pte. (Company Number: 198602165W), which is regulated by the Monetary Authority of Singapore, accepts legal responsibility for this research, and should be contacted with respect to any matters arising from, or in connection with, this research. Taiwan: This material is for reference only and must not be reprinted without permission. Investors should carefully consider their own investment risk. Investment results are the responsibility of the individual investor. United Kingdom: Persons who would be categorized as retail clients in the United Kingdom, as such term is defined in the rules of the Financial Conduct Authority, should read this research in conjunction with prior Goldman Sachs research on the covered companies referred to herein and should refer to the risk warnings that have been sent to them by Goldman Sachs International. A copy of these risks warnings, and a glossary of certain financial terms used in this report, are available from Goldman Sachs International on request.

European Union and United Kingdom: Disclosure information in relation to Article 6 (2) of the European Commission Delegated Regulation (EU) (2016/958) supplementing Regulation (EU) No 596/2014 of the European Parliament and of the Council (including as that Delegated Regulation is implemented into United Kingdom domestic law and regulation following the United Kingdom's departure from the European Union and the European Economic Area) with regard to regulatory technical standards for the technical arrangements for objective presentation of investment recommendations or other information recommending or suggesting an investment strategy and for disclosure of particular interests or indications of conflicts of interest is available at https://www.gs.com/disclosures/europeanpolicy.html which states the European Policy for Managing Conflicts of Interest in Connection with Investment Research.

Japan: Goldman Sachs Japan Co., Ltd. is a Financial Instrument Dealer registered with the Kanto Financial Bureau under registration number Kinsho

69, and a member of Japan Securities Dealers Association, Financial Futures Association of Japan and Type II Financial Instruments Firms Association. Sales and purchase of equities are subject to commission pre-determined with clients plus consumption tax. See company-specific disclosures as to any applicable disclosures required by Japanese stock exchanges, the Japanese Securities Dealers Association or the Japanese Securities Finance Company.

Global product; distributing entities

The Global Investment Research Division of Goldman Sachs produces and distributes research products for clients of Goldman Sachs on a global basis. Analysts based in Goldman Sachs offices around the world produce research on industries and companies, and research on macroeconomics, currencies, commodities and portfolio strategy. This research is disseminated in Australia by Goldman Sachs Australia Pty Ltd (ABN 21 006 797 897); in Brazil by Goldman Sachs do Brasil Corretora de Títulos e Valores Mobiliários S.A.; Public Communication Channel Goldman Sachs Brazil: 0800 727 5764 and / or contatogoldmanbrasil@gs.com. Available Weekdays (except holidays), from 9am to 6pm. Canal de Comunicação com o Público Goldman Sachs Brasil: 0800 727 5764 e/ou contatogoldmanbrasil@gs.com. Horário de funcionamento: segunda-feira à sexta-feira (exceto feriados), das 9h às 18h; in Canada by either Goldman Sachs Canada Inc. or Goldman Sachs & Co. LLC; in Hong Kong by Goldman Sachs (Asia) L.L.C.; in India by Goldman Sachs (India) Securities Private Ltd.; in Japan by Goldman Sachs Japan Co., Ltd.; in the Republic of Korea by Goldman Sachs (Asia) L.L.C., Seoul Branch; in New Zealand by Goldman Sachs New Zealand Limited; in Russia by OOO Goldman Sachs; in Singapore by Goldman Sachs (Singapore) Pte. (Company Number: 198602165W); and in the United States of America by Goldman Sachs & Co. LLC. Goldman Sachs International has approved this research in connection with its distribution in the United Kingdom.

Effective from the date of the United Kingdom's departure from the European Union and the European Economic Area ("Brexit Day") the following information with respect to distributing entities will apply:

Goldman Sachs International ("GSI"), authorised by the Prudential Regulation Authority ("PRA") and regulated by the Financial Conduct Authority ("FCA") and the PRA, has approved this research in connection with its distribution in the United Kingdom.

European Economic Area: GSI, authorised by the PRA and regulated by the FCA and the PRA, disseminates research in the following jurisdictions within the European Economic Area: the Grand Duchy of Luxembourg, Italy, the Kingdom of Belgium, the Kingdom of Denmark, the Kingdom of Norway, the Republic of Finland, Portugal, the Republic of Cyprus and the Republic of Ireland; GS -Succursale de Paris (Paris branch) which, from Brexit Day, will be authorised by the French Autorité de contrôle prudentiel et de resolution ("ACPR") and regulated by the Autorité de contrôle prudentiel et de resolution and the Autorité des marches financiers ("AMF") disseminates research in France; GSI - Sucursal en España (Madrid branch) authorized in Spain by the Comisión Nacional del Mercado de Valores disseminates research in the Kingdom of Spain; GSI - Sweden Bankfilial (Stockholm branch) is authorized by the SFSA as a "third country branch" in accordance with Chapter 4, Section 4 of the Swedish Securities and Market Act (Sw. lag (2007:528) om värdepappersmarknaden) disseminates research in the Kingdom of Sweden; Goldman Sachs Bank Europe SE ("GSBE") is a credit institution incorporated in Germany and, within the Single Supervisory Mechanism, subject to direct prudential supervision by the European Central Bank and in other respects supervised by German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) and Deutsche Bundesbank and disseminates research in the Federal Republic of Germany and those jurisdictions within the European Economic Area where GSI is not authorised to disseminate research and additionally, GSBE, Copenhagen Branch filial af GSBE, Tyskland, supervised by the Danish Financial Authority disseminates research in the Kingdom of Denmark; GSBE - Sucursal en España (Madrid branch) subject (to a limited extent) to local supervision by the Bank of Spain disseminates research in the Kingdom of Spain; GSBE - Succursale Italia (Milan branch) to the relevant applicable extent, subject to local supervision by the Bank of Italy (Banca d'Italia) and the Italian Companies and Exchange Commission (Commissione Nazionale per le Sociétà e la Borsa "Consob") disseminates reséarch in Italy; GSBE - Succursale de Paris (Paris branch), supervised by the AMF and by the ACPR disseminates research in France; and GSBE - Sweden Bankfilial (Stockholm branch), to a limited extent, subject to local supervision by the Swedish Financial Supervisory Authority (Finansinpektionen) disseminates research in the Kingdom of Sweden.

General disclosures

This research is for our clients only. Other than disclosures relating to Goldman Sachs, this research is based on current public information that we consider reliable, but we do not represent it is accurate or complete, and it should not be relied on as such. The information, opinions, estimates and forecasts contained herein are as of the date hereof and are subject to change without prior notification. We seek to update our research as appropriate, but various regulations may prevent us from doing so. Other than certain industry reports published on a periodic basis, the large majority of reports are published at irregular intervals as appropriate in the analyst's judgment.

Goldman Sachs conducts a global full-service, integrated investment banking, investment management, and brokerage business. We have investment banking and other business relationships with a substantial percentage of the companies covered by our Global Investment Research Division. Goldman Sachs & Co. LLC, the United States broker dealer, is a member of SIPC (https://www.sipc.org).

Our salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies to our clients and principal trading desks that reflect opinions that are contrary to the opinions expressed in this research. Our asset management area, principal trading desks and investing businesses may make investment decisions that are inconsistent with the recommendations or views expressed in this research.

We and our affiliates, officers, directors, and employees, will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives, if any, referred to in this research, unless otherwise prohibited by regulation or Goldman Sachs policy.

The views attributed to third party presenters at Goldman Sachs arranged conferences, including individuals from other parts of Goldman Sachs, do not necessarily reflect those of Global Investment Research and are not an official view of Goldman Sachs.

Any third party referenced herein, including any salespeople, traders and other professionals or members of their household, may have positions in the products mentioned that are inconsistent with the views expressed by analysts named in this report.

This research is focused on investment themes across markets, industries and sectors. It does not attempt to distinguish between the prospects or performance of, or provide analysis of, individual companies within any industry or sector we describe.

Any trading recommendation in this research relating to an equity or credit security or securities within an industry or sector is reflective of the investment theme being discussed and is not a recommendation of any such security in isolation.

This research is not an offer to sell or the solicitation of an offer to buy any security in any jurisdiction where such an offer or solicitation would be illegal. It does not constitute a personal recommendation or take into account the particular investment objectives, financial situations, or needs of individual clients. Clients should consider whether any advice or recommendation in this research is suitable for their particular circumstances and, if appropriate, seek professional advice, including tax advice. The price and value of investments referred to in this research and the income from them may fluctuate. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Fluctuations in exchange rates could have adverse effects on the value or price of, or income derived from, certain investments.

Certain transactions, including those involving futures, options, and other derivatives, give rise to substantial risk and are not suitable for all investors. Investors should review current options and futures disclosure documents which are available from Goldman Sachs sales representatives or at https://www.theocc.com/about/publications/character-risks.jsp and

https://www.fiadocumentation.org/fia/regulatory-disclosures_1/fia-uniform-futures-and-options-on-futures-risk-disclosures-booklet-pdf-version-2018.

Transaction costs may be significant in option strategies calling for multiple purchase and sales of options such as spreads. Supporting documentation will be supplied upon request.

Differing Levels of Service provided by Global Investment Research: The level and types of services provided to you by the Global Investment Research division of GS may vary as compared to that provided to internal and other external clients of GS, depending on various factors including your individual preferences as to the frequency and manner of receiving communication, your risk profile and investment focus and perspective (e.g., marketwide, sector specific, long term, short term), the size and scope of your overall client relationship with GS, and legal and regulatory constraints. As an example, certain clients may request to receive notifications when research on specific securities is published, and certain clients may request that specific data underlying analysts' fundamental analysis available on our internal client websites be delivered to them electronically through data feeds or otherwise. No change to an analyst's fundamental research views (e.g., ratings, price targets, or material changes to earnings estimates for equity securities), will be communicated to any client prior to inclusion of such information in a research report broadly disseminated through electronic publication to our internal client websites or through other means, as necessary, to all clients who are entitled to receive such reports.

All research reports are disseminated and available to all clients simultaneously through electronic publication to our internal client websites. Not all research content is redistributed to our clients or available to third-party aggregators, nor is Goldman Sachs responsible for the redistribution of our research by third party aggregators. For research, models or other data related to one or more securities, markets or asset classes (including related services) that may be available to you, please contact your GS representative or go to https://research.gs.com.

Disclosure information is also available at https://www.gs.com/research/hedge.html or from Research Compliance, 200 West Street, New York, NY 10282.

© 2021 Goldman Sachs.

No part of this material may be (i) copied, photocopied or duplicated in any form by any means or (ii) redistributed without the prior written consent of The Goldman Sachs Group, Inc.