

A look ahead

In our judgment, this very long economic expansion in the major economies has further to run. But evidence mounts that we are in the later stages of the cycle.

A moderate slowing in economic momentum, rising trade tensions, and a more complex political backdrop in many countries have made the investment skies cloudier. While we are clearly in the late cycle, reliable leading indicators do not yet point to the risk of an imminent downturn, and 2019 global economic growth should still surpass that of the post-financial crisis average. We think this suggests earnings and share values have room to advance.

But 2019 equity returns could be modest and delivered unevenly. We believe it is appropriate to trim overall equity exposure to a Market Weight or benchmark level in global portfolios from a slight Overweight level. We outline some of the factors to consider when positioning equity portfolios late in the cycle.

The late cycle is also the time to address the de-risking of fixed income portfolios. Reducing exposure to credit risk is a good place to start because compensation for taking those risks is currently minimal and credit quality has weakened.

In this publication, we examine three topics we expect will have an important bearing on the progress of the global economy beyond the current cycle.

Infrastructure investment offers the greatest near-term opportunity, in our opinion. The global demand for new, refurbished, and replacement infrastructure assets is immense—particularly in the world’s two largest economies (the U.S. and China)—and the private sector appears destined to play a greater role than ever before.

Perhaps the most important of the three topics is the dislocation in the China/U.S. relationship. Beneath the visible bilateral tensions lies a deeper shift from 30 years of U.S. hegemonic supremacy to a multipolar world, which could dampen growth prospects.

On a more promising note, we think artificial intelligence offers a number of transformative opportunities for society, governments, and businesses, and has the potential to substantially increase global wealth and prosperity in the coming decades. Factoring its impact into investment decisions will become a “must have” rather than a “nice to have.”

We hope you enjoy this special outlook edition and find it useful.

Global Portfolio Advisory Committee Co-chairs



Jim Allworth
Vancouver, Canada



Kelly Bogdanova
San Francisco, United States



Frédérique Carrier
London, United Kingdom



Table of contents

4 2019 investment stance

Developed economies have the stamina to keep growing in the next year, at least, with recession risks low. For equities, this should support earnings growth, though at a slower pace. Central bank decisions are the linchpin for fixed income markets.

8 Navigating the late cycle

The later stages of this very extended economic cycle have further to run—at least another year, perhaps longer, in our view. What should an equity investor do? “Make hay while the sun shines?” Or prepare to hunker down? Right answer: Some of both.

12 Don’t wait for fear to do the work of reason: Building defense by dialing back risk in fixed income

Prepare for choppier waters while the seas remain calm by charting a course to de-risk portfolios. Reducing credit risk in fixed income portfolios is a good place to start.

16 Next-gen backbone: Infrastructure investing in the 21st century

Infrastructure investing is often brushed off as being yesterday’s story. With the world’s infrastructure in line for a 21st century upgrade, we look at how this theme can enhance the infrastructure of investment portfolios.

20 Uncharted territory: A generational shift in U.S. & China relations

The trade dispute between the U.S. and China is part of a larger struggle over national security. This complex, divisive situation could reshape the relationship between the world’s two largest economies, with implications for financial markets.

24 AI: Welcome to the age of transformation

We shed light on artificial intelligence, separating the hype from reality about what AI can and cannot do today. We dig into the explosion of AI technology and the real opportunities for investment strategy as these transformative innovations are here to stay.

For important and required non-U.S. analyst disclosures, see page 29.

All values in U.S. dollars and priced as of market close, Nov. 6, 2018, unless otherwise stated; distributed Nov. 19, 2018

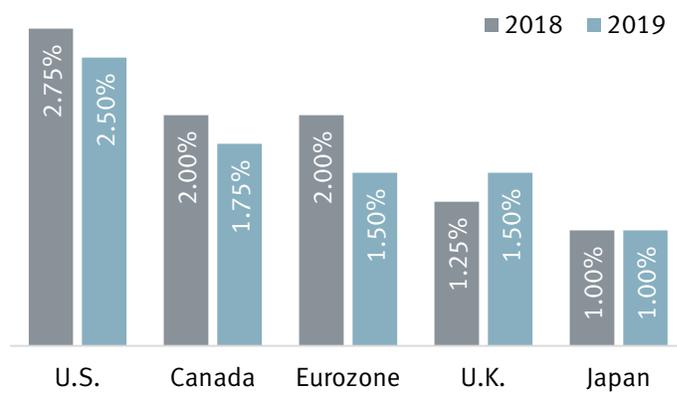


2019 investment stance

Reliable indicators are signaling that developed economies have the stamina to keep growing through 2019. Recession risks remain low despite uneven trends across borders as well as trade and tariff uncertainties. For equities, this should support earnings growth, though at a slower pace. Central bank decisions should be the linchpin for fixed income market performance.

The global and U.S. economic expansions are now in their later stages. While GDP growth seems likely to slow for a number of major economies including the “big 3”—the U.S., Europe, and China—the underlying strength of the U.S. makes it possible this already very extended stretch of growth could last longer than one might think. Central banks will play key roles in determining just how long the expansion plays out. This late cycle stage does not call for dramatic portfolio changes just yet, in our view, but we are moderately trimming equity exposure and shifting toward value areas of the market, while also dialing back credit risk in fixed income. Following are our thoughts about portfolio positioning for 2019.

RBC's annual GDP growth forecasts for developed markets



Source - RBC Global Asset Management

Fixed income

Central banks may diverge as they adjust policies to varying stages of economic activity. We foresee continued growth in developed economies, and inflation holding near targets. This will allow gradual policy adjustments to continue, but the U.S. Federal Reserve and the Bank of Canada may approach their “neutral rate” targets just as the European Central Bank (ECB) begins raising rates later in 2019. Credit will continue to provide selective opportunities, but “late cycle” signs warrant attention to quality and portfolio positioning.

United States

Craig Bishop, Minneapolis craig.bishop@rbc.com

- The Fed is forecasting three rate hikes in 2019. We see the Fed pausing after two hikes when short-term interest rates reach their “neutral rate” target of roughly 3%. Wildcards could be inflation and trade developments.
- The burst of GDP growth in H2 2018 will, in our opinion, give way to slower momentum as the impact from fiscal stimulus wanes. But even if growth pulls back to 2.5%–3.0%, recession risks would remain low.
- 10Y Treasury yields are in a 3.10%–3.40% range and we maintain that 3.50% is likely the speed limit for the 10-year in this economic cycle. Yield curves should remain flat, but not invert, in 2019 as the Fed moves toward pausing.
- Credit spreads will remain subject to equity market volatility. Until five-year average spreads of 125 basis points for IG and 435 basis points for HY are exceeded, we will hold our modest Overweight on IG and Underweight on HY. We recommend preferreds for attractive returns and maintain our bias for 15–20 year higher-coupon munis.

Canada

Christopher Girdler, Toronto christopher.girdler@rbc.com

- The Canadian economy is widely expected to grow at or slightly above its potential in 2019. With core inflation already near the Bank of Canada’s 2% target, the removal of monetary stimulus should continue.
- The Bank of Canada recently signaled there will be more hikes beyond 2019 than the market is currently pricing in. If this becomes the likely outcome, we believe yields would be set to rise across the yield curve. We are more comfortable buying short to intermediate maturities that offer lower expected volatility of returns, good liquidity, and an opportunity to reinvest at more attractive rates if the central bank follows through.
- Our Canadian credit outlook is mixed. Corporate bond valuations have improved somewhat after reaching the most expensive levels in a decade, but this hasn’t changed our view. We continue to recommend upgrading credit quality and liquidity within portfolios. Preferred shares suffered bouts of volatility this year, and with much more reasonable valuations we view any weakness as a buying opportunity.

Europe/United Kingdom

Alastair Whitfield, London alastair.whitfield@rbc.com

- As the ECB comes to the end of its purchase programme, further signs of moderating GDP could unsettle markets in 2019, although ECB President Mario Draghi is unlikely to delay the withdrawal of monetary accommodation. For now, despite a QE slowdown, we see the ECB’s stock of holdings and planned reinvestment strategy continuing to support yields and credit spreads.
- For the UK, rate hike expectations have shifted forward slightly given the possibility of PM Theresa May’s government reaching an agreement with EU leaders. We doubt the path of future interest rate hikes will change much, given estimates of weaker GDP appearing by the end of 2018 or in early 2019. Another notable risk that may materialise after March 2019 is the potential for a leadership challenge within the Conservative party and a general election. This could weigh on UK fixed income; Consumer Cyclical and Financials would be most at risk.

Asia

Chun-Him Tam, Singapore chunhim.tam@rbc.com

- China represents half of the USD-denominated Asian credit market. In our view, fundamentals and market sentiment in China are two of three key drivers of Asian bonds. The third is the Fed’s interest rate policy.
- Onshore funding liquidity in China is tight and issuers struggle to refinance their debt as the government treads along its deleveraging path. The significant market correction in 2018 has opened up selective investment opportunities, but overall we remain cautious and prefer to see a stabilization of liquidity and market confidence before turning risk-on.
- We are also cautious on Indonesia and India. Both run current account and fiscal deficits, and are more exposed to the Fed’s rate hike cycle and a stronger U.S. dollar. We don’t expect a turnaround at least until their elections are held in the first half of 2019.
- We advise sticking to quality and are Overweight defensive countries like Singapore, South Korea and Hong Kong.

Equity

The corrections in 2018 exposed stresses in the global equity market but also reset valuations to more reasonable levels. We think the market has the capacity to absorb economic cooling, ongoing tariff risks, and monetary tightening, albeit with volatility. Our constructive view hinges on low recession risks for major economies, particularly the U.S., and the likelihood corporate earnings growth will persist. But 2019 returns could be modest and delivered unevenly; therefore, it is appropriate to trim equity exposure to a Market Weight level in global portfolios from a slight Overweight position.

United States		Market Weight
Kelly Bogdanova, San Francisco		kelly.bogdanova@rbc.com
	Forward P/E	10-yr Avg.
S&P 500	15.6	14.8
S&P Small Cap 600	16.3	17.9

■ Two factors that influence U.S. stock prices the most over time—economic and earnings growth—will likely be firm enough to push the market at least modestly higher in 2019. We think the economy has the potential to grow above the 2.3% average rate. All of our forward-looking indicators are signaling the expansion will persist for the next 12 months or beyond.

■ Earnings growth is set to slow in 2019 because the boost from tax cuts will fall out of the data, and year-over-year comparisons to 2018's white-hot growth rates will be challenging to jump over. Furthermore, higher input prices due to tariffs, wage growth, and a strong dollar could constrain profit margins. Even with these challenges, we think S&P 500 earnings can grow in the mid-to-high single digits due to strength in the economy.

■ A market shift toward value stocks and away from growth stocks seems likely, in our view. Value tends to outperform when the 10-year Treasury yield rises, inflation expectations move higher, and GDP growth strengthens, as well as during the latter stage of a bull market cycle.

Canada		Market Weight
Patrick McAllister, Toronto		patrick.mcallister@rbc.com
	Forward P/E	10-yr Avg.
S&P/TSX	13.2	14.6

■ We recommend a Market Weight allocation to Canadian equities. Valuations remain discounted relative to the U.S., which we believe provides appropriate compensation for domestic-specific challenges, namely, the impact of higher interest rates on highly leveraged consumers and the housing market, a lack of adequate oil pipeline capacity, and waning economic competitiveness.

■ Resolution of free trade negotiations with the U.S. and Mexico appears poised to reduce uncertainty and potential downside risk to the domestic economy. However, the agreed accord must now be passed into law by the three signatories, which cannot be taken for granted in this contentious political climate.

■ Our outlook for key sectors remains somewhat subdued. Bank valuations have improved on an absolute basis but remain in-line relative to the broader Canadian market and U.S. banks. We remain comfortable with a modest underweight in Canadian banks given our expectation for slowing earnings growth. The outlook for Energy is dimmed by pipeline constraints and an increasingly self-sufficient U.S. oil market.

Europe/United Kingdom		Market Weight
Frédérique Carrier, London		frederique.carrier@rbc.com
	Forward P/E	10-yr Avg.
STOXX Europe 600	12.7	12.9
FTSE All-Share	11.9	12.5

■ European equities should continue to be supported by modestly improving fundamentals, including cyclical low unemployment as well as stronger capital investment and lending environments, while a weak currency should underpin the export sector. Uncertainty regarding the Italian budget is likely to linger, perhaps until the European Parliament elections in May as we suspect European politicians would prefer to avoid conflict before then. Equity valuations are not demanding, trading back in line with long term averages and the steep discount to U.S. valuations remains. We favour the Health Care and Industrials sectors, which benefit from structural trends such as infrastructure spend and digitalization.

■ The fortunes of UK equities will be influenced by the Brexit negotiations' outcome. Should the UK secure a deal with a transition period ensuring the status quo—our base case scenario—we would expect domestic stocks to enjoy a relief rally. An upward rerating is likely given a 2019 P/E ratio of 11.7x and a dividend yield of some 4.5%. Should negotiations fail, and the UK leave the EU without such a transition, the currency would likely weaken, though the

Equity, continued

usual inverse relationship with equities could well break. After all, exporters would have lost tariff-free access to one of their largest markets. Our preferred sectors remain Energy and Life Insurance where cash flows are improving and valuations are attractive.

Asia ex-Japan/Japan	Market Weight/Overweight	
Jay Roberts, Hong Kong	jay.roberts@rbc.com	
	Forward P/E	10-yr Avg.
Hang Seng	10.0	11.3
Shanghai Comp	9.8	12.0
TOPIX	12.2	14.7

- Asian equities had a tough year in 2018 after a very good year in 2017. Most of the weakness came from markets in North Asia, especially China.
- In 2019, we expect that the trade dispute, which in reality encompasses much more than simply trade, may

deepen, or at least continue, and will set the narrative for Asian markets. However, we expect China to roll out policies to support its markets and economy, both of which have been impacted by the dispute and by China's worthy attempts to rein in riskier areas of credit growth. Even though Chinese stocks have declined considerably, we maintain a neutral stance on the equity market given ongoing risks such as U.S. policy, a slowing economy and concerns about the currency. Different to Japan, a weaker Chinese currency is not perceived favourably by investors.

- We recently moved Japanese equities to an Overweight position. The valuation discount of Japanese stocks relative to global peers is attractive. Economic and earnings trends are generally supportive. We forecast the currency to weaken, aiding stocks. Meanwhile, Prime Minister Abe won his party's leadership election in September. We expect the Bank of Japan to maintain its highly accommodative interest rate policy. Risks include a strong currency and the impact of the VAT increases slated for later in 2019.

Note: Data in the equity section reflects forward price-to-earnings (P/E) ratios based on Bloomberg consensus earnings forecasts for the next 12 months. Data as of 11/15/18.

Currencies

Laura Cooper, London laura.cooper@rbc.com

United States dollar – Still see scope for strength

Rising U.S. yields on the back of monetary tightening was a predominant driver of U.S. dollar outperformance in 2018 while a dampening of risk appetite due to a ratcheting-up of U.S.-China trade tensions provided further support. Looking to 2019, supportive factors for sustained dollar strength through the early part of the year remain intact, in our view. Robust economic growth against a tight labour market point to the need for further rate increases by the Federal Reserve. The resultant attractiveness of the U.S. dollar could fade later in 2019, however, when other countries' central banks look poised to withdraw accommodative policy stimulus.

Euro – Low for longer

Eroding risk appetite in the wake of 2018 political developments appears likely to fade; however, pressure on the euro could persist in 2019, in our view. Signs of softer growth in the region due to rising protectionism alongside subdued core inflation suggest the European Central Bank is unlikely to be in a position to alter its current policy stance until later in 2019. As such, with policy rates likely to remain unchanged until Q3 2019, the widening rate differential favouring the U.S. dollar points to euro weakness persisting.

Canada dollar – More hikes in the pipeline

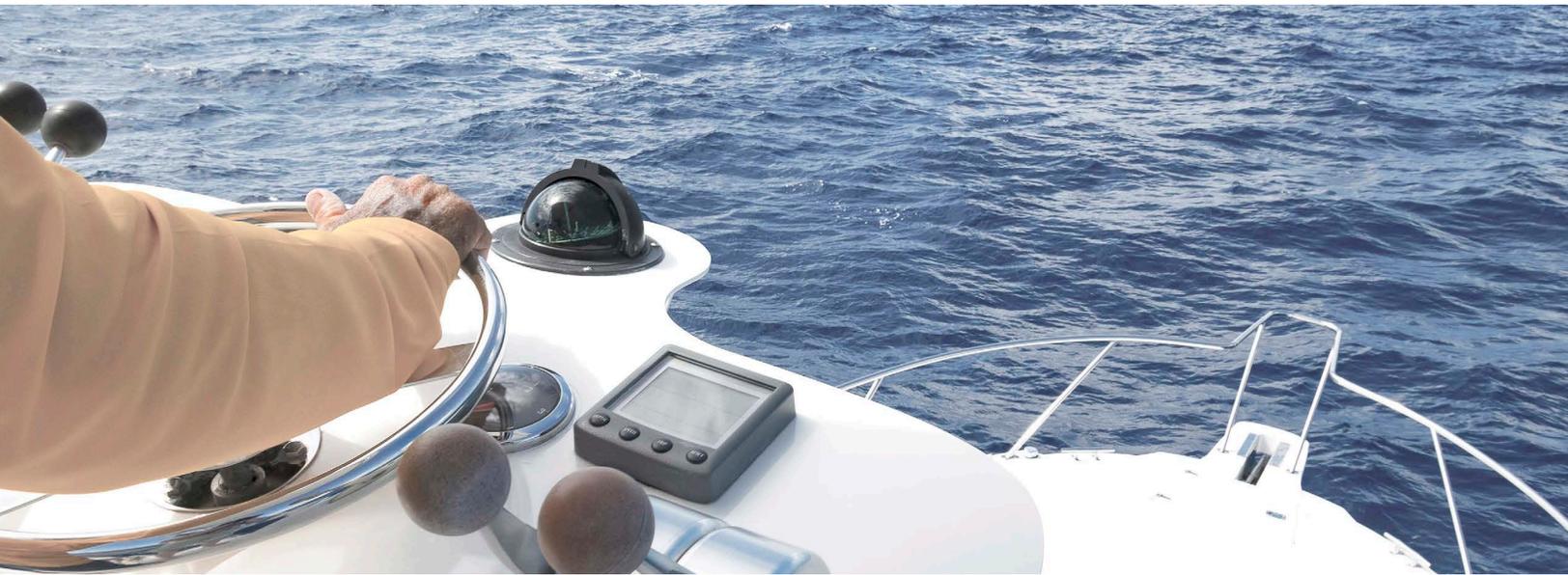
Diminished trade uncertainty in the wake of the USMCA agreement alongside an economy expanding above potential should tee up for the Bank of Canada to raise policy rates twice more in early 2019. The uplift to the currency from rate dynamics could fade, however, with the central bank likely to then pause to assess the impact on elevated household indebtedness.

British pound – All about Brexit

The British pound appears poised to take guidance from the evolving relationship between the UK and the EU in 2019. In our view, pragmatism will prevail with a Brexit deal being reached across the parties. However, lingering uncertainty around the future trading relationship through the planned transition period is likely to keep the pound at depressed levels throughout the year.

Japanese yen – Pressure may prevail

Domestic economic conditions and a cautious outlook from the Bank of Japan suggest ultra-easy monetary policy could persist in 2019. Accordingly, the yen is likely to take direction from external drivers. Notably, rising hedging costs from relatively higher U.S. rates point to Japanese investors further rolling off currency hedges, and in turn, dampening demand for the Japanese yen in 2019.



Navigating the late cycle

The later stages of this very extended economic cycle have further to run—at least another year, perhaps longer, in our view. What should an equity investor do? “Make hay while the sun shines?” Or prepare to hunker down? Right answer—some of both.

A big majority of economists polled see the U.S. economy in the “late cycle” stage. We agree—the U.S. economy and likely the Canadian and British economies are in the late stages of what will probably go down as the longest-ever economic expansion, measuring from the end of the Great Recession in mid-2009.

Eric Lascelles, chief economist at RBC Global Asset Management Inc., assigns scores to 17 different factors as to where they are in their normal cyclical progression (see table on the following page). Overwhelmingly the majority are giving readings typical of the “late” or “end” of cycle. But importantly none are behaving as if the U.S. were already in recession.

The term “late cycle” has an aura of “living on borrowed time” about it. However, the U.S. economy is not yet “that late” in the late cycle. We closely monitor six indicators that have done a good job over many cycles of warning that a U.S. recession was on the way or about to start. None of these is currently signalling that any such economic downturn is as yet nearby.

Three of the six—the shape of the yield curve (i.e., the gap between short- and long-term interest rates); the trend in unemployment insurance claims; and the year-over-year rate of change in the Conference Board’s Leading Economic Index—have all typically given an advance warning of an impending recession 9–12 months ahead of time. None are currently flashing any such warning and it is our assessment that it will be some time before they do.



Jim Allworth
Vancouver, Canada
jim.allworth@rbc.com

Navigating the late cycle

U.S. business cycle scorecard

	Start of cycle	Early cycle	Mid cycle	Late cycle	End of cycle	Recession
Inventories		●	○			
Consumer durables		●	●			
Housing			●	●		
Prices			●	●		
Bonds			●	●		
Monetary policy			●	●		
Equity profitability			●	●		
Leverage			●	●	○	
Economic trend			○	●	○	
Credit			○	●	○	
Sentiment				●		
Business investment				●	○	
Employment				●	○	
Equity direction			○	●	●	
Economic slack				●	●	
Volatility				○	●	
Cycle age					●	
Votes for each stage of business cycle	0	2	9	13.5	6.5	0

Legend: ● = most likely stage of business cycle; ○ = alternative interpretation.
Source - RBC Global Asset Management

This suggests GDP, corporate earnings, and share values all have room to advance further for some time yet. We expect all these things will also be true for the economies and markets of Canada, the U.K., the eurozone, and Japan.

... GDP, corporate earnings, and share values all have room to advance further ...

That said, it's worth checking in on investor mentality today. Clearly, things are very different from what they were in the early part of the cycle. From the time the recession ended in mid-2009 all the way through 2014, "risk aversion" was the dominant psychology. Banks all around the world were rebuilding capital, were unsure about the condition of other banks, and were cautious about lending.

Despite a powerful recovery in share prices off the bear market lows and price-to-earnings (P/E) multiples that were at levels indicating above-average future returns, most individuals remained "reluctant investors." Very little, if any, money flowed toward equity funds, but there were massive inflows into bond funds where returns were unusually meagre.

Skepticism prevailed. In the U.S., despite the economy regaining all its lost ground and posting new highs by early 2011, consumer and business confidence readings remained low for another three-and-a-half years.

Navigating the late cycle

Skepticism ... has been replaced by elevated confidence.

Equity markets paid in advance for today's more buoyant conditions.

Today that skepticism, that had lingered for so long, has been replaced by elevated confidence on many fronts. Consumer confidence in the U.S. is at historically high levels while it is at or not far off cycle highs in Europe, Canada, and Japan. Business confidence could also be characterised as buoyant. In the U.S., an unusually high fraction of small and medium-sized businesses, surveyed by the National Federation of Independent Business, rate this a “good time to expand.”

This elevated confidence reflects current conditions—GDP growth is running above trend and has become largely self-sustaining; labour markets are tight in the biggest developed economies, job security is high, and wages are growing; real estate values are elevated; and monetary policies are moving closer to normal.

The stock market, retrenching through much of this year, seems to be out of step with these elevated confidence readings. In our view, that's because equity markets paid in advance for today's more buoyant conditions. Stocks moved up from depressed lows in 2015, through 2016 and 2017, to much higher levels and more expensive valuations by early 2018. But when investors looked forward to 2019 and 2020, a somewhat more challenging view emerged. In the U.S. the additive impact of corporate tax cuts will begin to wane as year-over-year earnings comparisons become much less vigorous. Earnings estimates for next year are already being revised downward, albeit from very high levels. Overall, the massive fiscal stimulus delivered by federal tax cuts and increased spending should diminish over 2019 and turn into a modest drag in 2020.

Stimulus measures everywhere, with the exception of China, are expected to have a diminished impact on growth. Add in a possible first rate hike and the end of quantitative easing by the European Central Bank, a further bank rate increase by the Bank of England, two, possibly three more hikes from the Fed, and the same from the Bank of Canada, and it sounds very much like “late cycle” to us.

We think the appropriate posture for managing an equity portfolio at this juncture in the late cycle is one of “leaning against risk.” We are moving our recommended equity exposure in a global portfolio down to Market Weight from a modest Overweight. While at some point a more significant reduction in equity exposure

Major economic indicators still in expansion mode

RBC Wealth Management U.S. economic indicator scorecard

Indicator	Status		
	Expansion	Neutral	Recessionary
Yield curve (12-month to 10-year)	✓	—	—
Unemployment claims	✓	—	—
Unemployment rate	✓	—	—
Conference Board Leading Index	✓	—	—
ISM new orders minus inventories	✓	—	—
Fed funds vs. nominal GDP growth	✓	—	—
	Expansion	Neutral	Recessionary

No U.S. recession in sight so far.

Source - RBC Wealth Management, Bloomberg, FRED Economic Data St. Louis Fed

Navigating the late cycle

Leaning against
risk.

will be appropriate, we don't think that time has arrived. But below are some things that should be on the agenda for the coming year:

Value over growth

Growth stocks have led the market for much of the last nine years. The ability to post solid revenue and earnings gains plus widening margins over a stretch when the economy was mostly growing at an anemic, below-trend pace attracted an ever-growing investor following. Now, over several quarters, the economic background has shifted in a way that is more supportive of value—GDP growth is above trend, inflation is rising, as is the 10-year yield—while growth P/Es are more stretched relative to those of the value segment than at any time since 2005. A high proportion of growth stocks are found in the Technology, Consumer Discretionary, Communication Services, and Biomedical sectors. More than half of the value component resides in Financials, Energy, Consumer Staples, and parts of Health Care.

Large caps over small caps

Small-cap stocks typically begin to underperform well before the broad market peaks, and fare worse than large caps in a bear market. Small caps have noticeably underperformed in the recent selloff. We do not expect them to resume leadership in what remains of this bull market.

Focus on dividends

Over a full market cycle, dividend payers outperform non-dividend payers and especially dividend cutters. And dividend growers have historically done the best of all. Much but not all of this outperformance typically arrives during bear markets. We believe the focus should be on a company's capability to pay, sustain, and grow its dividend out of cash flow generated by the business. Very often a closer examination of companies that offer a high dividend yield reveals they pay out a very high proportion of their earnings as dividends, are often also buying back shares, and may be borrowing and building up leverage to do so. In an economic downturn this combination can be problematic, in our view.

Identify high operating leverage to GDP

Some companies—many industrials, consumer cyclicals, and commodity cyclicals—enjoy strong revenue growth, widening margins, and robust earnings gains when GDP growth is running above trend. That is often the case in the late cycle. But when the economy slows or dips into recession this dynamic can shift into reverse, often quite painfully. We believe these stocks/groups should be high on the list for cutting when the time comes for defense.

Pay attention to relative strength

Relative outperformance by a stock or group can persist for a considerable time. Often a high proportion of stocks that do better than the market in one year go on to do better the following year as well. And when that trend breaks down it can sometimes usher in an uncomfortably long period of underperformance. Keeping in touch with how a stock is doing relative to its group and to the broad market is a very useful element of portfolio due diligence.



Don't wait for fear to do the work of reason

Prepare for choppier waters while the seas remain calm by charting a course to de-risk portfolios. Reducing credit risk in fixed income portfolios is a good place to start.

You can't predict, but you can prepare

The later stage of the economic cycle is the time to start formulating a game plan to de-risk portfolios. Well-regarded high-yield investor Howard Marks famously says, "You can't predict, but you can prepare." Economic growth remains solid and most indicators we monitor suggest a recession is still some ways off, but it's best to prepare for choppier waters while the seas remain calm. We believe reducing credit risk in fixed income portfolios is a good place to start this process because compensation for taking those risks is currently minimal and credit quality has weakened.

Higher interest rates are usually a feature of the late cycle

Interest rates tend to rise for a considerable period of time in the later part of an economic cycle in response to a strong economy and rising inflation. This process is now well underway; the Fed has moved its benchmark rate from 0.0% to 2.25% over the past three years. Meanwhile, the 10-year U.S. Treasury bond yield is up by almost 200 basis points (bps) since July 2016.



Mikhial Pasic, CFA
Vancouver, Canada
mikhial.pasic@rbc.com

While interest rates rise in response to a strong economy, those higher rates eventually slow down the economy—often pushing it into a recession, ushering in a period of shrinking corporate profits in the process. Bond investors typically experience poor performance as yields rise to a peak prior to a recession, while stocks

Don't wait for fear

Government bond yields typically move higher later in the economic cycle



Source - Board of Governors of the Federal Reserve System, St. Louis Federal Reserve

tend to head into a bear market around the time when the recession actually arrives. The bonds of low-quality issuers often suffer a “double whammy,” losing value as rates rise and then losing even more value when the recession pressures these companies’ already comparatively weak finances and calls their ability to service their debts into question. Conversely, higher-quality bonds tend to perform well in this environment as investors seek more secure cash flow streams.

It is difficult to determine the exact point where higher interest rates will slow down the economy. However, higher bond yields and an eventual recession are two possible scenarios that some of the lower-quality segments of the bond market are poorly positioned for. We believe some of these riskier parts of fixed income portfolios that investors have crowded into in search of higher yields are an appropriate place to start the overall de-risking process.

A better way to de-risk: Reduce low-quality credit exposure

Full valuations for so-called high-yield bonds (defined as bonds rated below BBB) mean that the yield pickup on this debt is modest relative to yields available on higher-rated bonds. We believe this leaves this asset class segment in the unappealing place of being vulnerable to both higher interest rates and a recession. Similar logic can be applied today beyond just High Yield. Lower-rated bonds generally—for example, BBB rated corporate bonds versus A rated corporate bonds—are likely to experience larger price declines as rates rise, and their low rating by definition means that they have less financial capability to cope with an economic slowdown.

This diminished yield advantage offered by high-yield bonds means they offer a smaller margin of safety in the event credit or business conditions deteriorate. Government-backed bonds and high-quality corporate bonds typically experience price gains when central banks reverse course and start lowering rates to support a faltering economy. But low-quality borrowers often experience business dislocations in economic downturns that may call into question their ability to make interest payments and repay principal. This market segment often performs poorly when a recession hits and default rates inevitably rise.

Reducing exposure to lower-rated corporate bonds could leave some money on the table until economic conditions actually deteriorate. But we believe this is a tolerable outcome for investors who maintain equity exposure. The conditions that are supportive of high-yield bonds typically are also supportive of stocks, but stocks offer upside potential that is less constrained. The table below underscores this point. The

Don't wait for fear

S&P 500 outperforms HY bonds when credit spreads are narrow

Data for when spreads fall under 425 bps until the move back above 425

Time frame	S&P 500 return	High-yield bond return	Outperformance of S&P 500
Jan. 1994 – Aug. 1998	120%	44%	76%
Dec. 2003 – Aug. 2007	49%	31%	18%
Nov. 2013 – Dec. 2014	20%	5%	15%
Jan. 2017 – Sep. 2018	35%	10%	25%
Average	56%	23%	34%

Source - Bloomberg, FactSet; data calculated using Bloomberg Barclays US Aggregate High Yield Index total return

upside in high-yield bonds is capped because many are trading near, and in some cases actually above, their call price, which means issuers can redeem the bonds if they are able to refinance that debt on more favorable terms, with investors receiving little benefit.

Compensation for assuming credit risk is modest

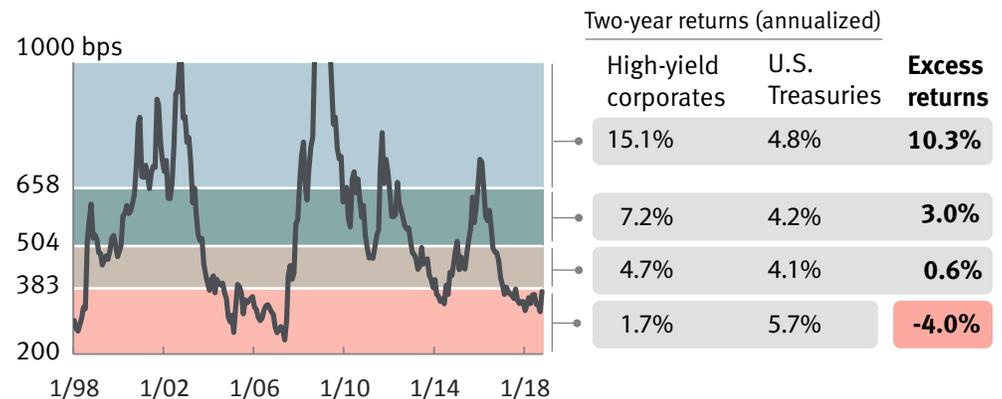
The differential between the yield on a riskier (normally lower rated) category of bonds and that offered by a safer (normally more highly rated) category is referred to as the credit spread. Credit spreads between higher- and lower-quality bonds are extremely narrow today as the amount of incremental yield offered for proportionally more risk is historically modest. This comes after a significant move higher in government bond yields and means a larger portion of the total yield on a bond derives from the government bond component rather than the compensation for assuming greater credit risk.

The chart below highlights that investors typically fare better not reaching for the modest amount of incremental yield in the high-yield bond market when credit spreads are this narrow.

Narrow credit spreads provide investors a number of opportunities to switch into higher-quality, often more liquid bonds at a very modest sacrifice in yields. We think

Credit spreads have been compressing

Range of high-yield credit spreads since 1998 divided into quartiles and historical performance



Source - Bloomberg, FactSet; Data calculated using Average Bloomberg Barclays US Aggregate High Yield Index and Bloomberg Barclays US Aggregate Treasury Index 2-yr total return data

Don't wait for fear

investors should move to take action on this before economic growth eventually stalls, because the yield that is given up to upgrade quality will likely be more substantial at that point.

Reduced compensation has come with weaker investor protection

As riskier bonds have fared well over several years, investors have been open to accepting offerings from a much broader and lower-rated group of issuers. The number of both European corporate bond issuers and emerging market sovereign issuers has doubled since 2003. Meanwhile, in the U.S., BBB issues account for almost 50% of the investment-grade market today, up from only 32% in 2009.

The average term to maturity on U.S. investment-grade new issues has also doubled since 2006, from 7.5 years to 15 years, shifting significant interest rate risk to investors at a time when over \$1T of corporate bonds needs to be refinanced over the next few years. For the first time in a number of years, a wide swath of borrowers are refinancing at rates higher than where they issued debt five years ago.

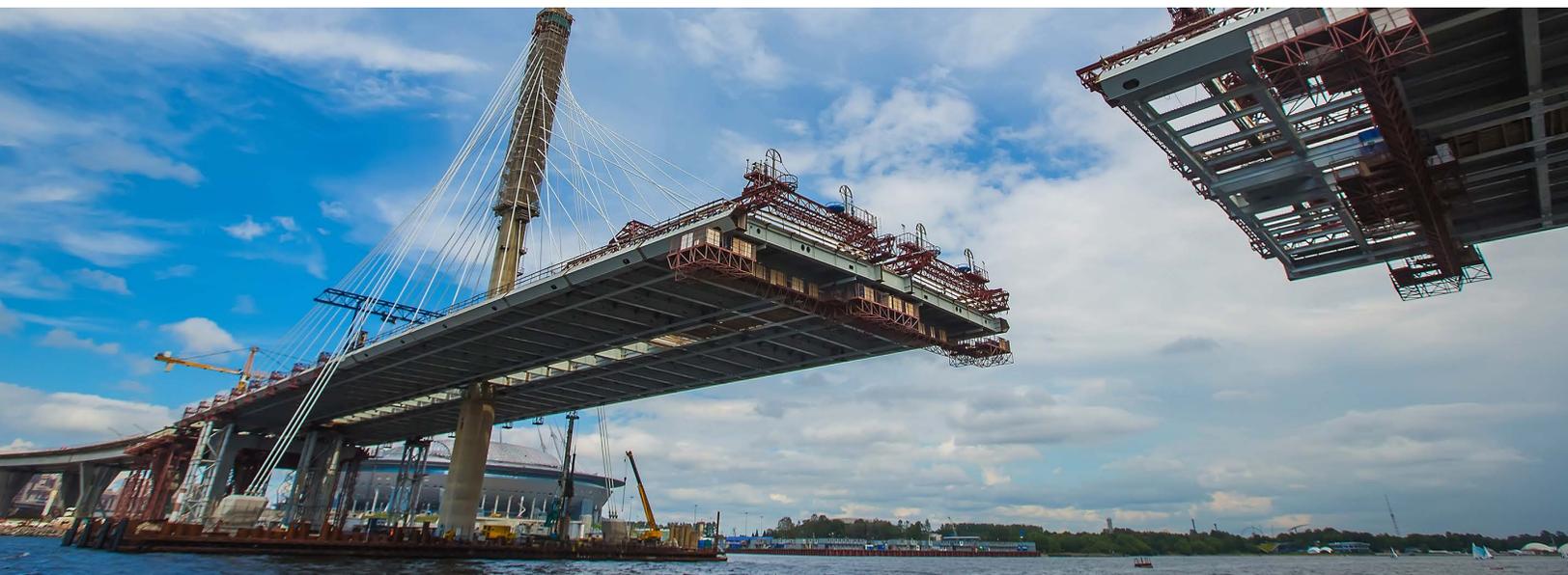
High-yield investors are also contending with more issuer-friendly (i.e., less investor-friendly) terms on new offerings. Given the weakest borrowers are transacting in the high-yield bond and loan markets, investors have usually demanded the greatest protections on these deals. This can be done by including provisions in the loan terms or the bond indenture that limit the borrowers' flexibility in one of the following ways:

- Bonds or loans can be secured by a priority claim on assets
- Prohibiting the incurrence of additional debt or the securing of assets against future borrowings
- Dictating that minimum levels of cash flow are used to reduce debt
- Requiring that cash flow exceeds interest coverage by a set threshold
- Restricting allowable debt to a multiple of cash flow
- Preventing a borrower from selling assets without redeeming debt
- Controlling or limiting the adjustments that borrowers can make to reported cash flow when calculating ratios

Lately, issuers have been able to reduce the protections offered to investors hungry for yield; nor have investors demanded them. Moody's estimates roughly 80% of loans issued in Q1 2018 were considered "covenant-lite"—i.e., not requiring borrowers to uphold certain financial standards, such as a maximum level of indebtedness. Recent examples include borrowers adjusting current reported cash flow figures to include cost savings that are expected to be realized over the next few years and allowing issuers to sell assets and use the proceeds to fund special dividends for shareholders rather than reducing debt.

Start de-risking process with low-quality credits

It's always challenging to gauge the level at which higher interest rates lead to a slowdown in economic activity, but it appears that we are moving into a higher volatility regime as we reach a more advanced stage of the economic cycle. As the maxim goes, "fear does the work of reason," and we think a small dose of fear—perhaps instilled by a few of the spikes in volatility in 2018—might actually provide a healthy "jump-start" for investors to look to their fixed income portfolios as a place to start the de-risking process and move up in quality.



Next-gen backbone: Infrastructure investing in the 21st century

Infrastructure investing is often brushed off as being yesterday's story. With the world's infrastructure in line for a 21st century upgrade, and the private sector filling more and more financing gaps, we look at how this theme can enhance the infrastructure of investment portfolios.

Death and decrepitude

The World Economic Forum estimates the world underinvests in infrastructure each year to the tune of a US\$1 trillion. Commuters everywhere will not be surprised.

Infrastructure spending not only improves convenience and safety, but also productivity, as poor roads and delayed flights hold back economic growth. With such obvious benefits, why the underinvestment?

Years ago, governments found it far easier to approve infrastructure projects. After WWII a strong public consensus developed everywhere as to the desirability of undertaking large projects that would stimulate growth and put people to work, while modernizing the infrastructure asset base to support a rapidly changing industrial society.

The U.S. Interstate Highway System (built out over 35 years from the late 1950s), high-speed auto routes across Europe, bullet trains in Japan followed by high speed trains in Europe, and massive airports everywhere—these projects were not only sources of national pride, but added substantially to wealth and productivity.



Frédérique Carrier
London, United Kingdom
frederique.carrier@rbc.com

Next-gen backbone

But in today's world, long development times mean politicians who authorize infrastructure projects often take criticism for massive budgets, possible cost overruns, and disturbance, but seldom remain in power long enough to take any credit for the benefits. In the U.S. and elsewhere, the complexity of infrastructure projects is compounded by the required involvement of regional, local, and national governments, which often have conflicting priorities.

The need to overcome these challenges is clear to all, and the need to boost infrastructure spending is one of the few areas of bipartisan agreement in the U.S. Yet a split Congress may make it difficult for any substantial infrastructure bill to pass.

Breaking gridlock

Tangible plans to increase infrastructure commitments are emerging in other countries, as shown in the box below. We expect more national infrastructure initiatives in the future. Fiscal policy will likely play a larger role in counteracting the next recession, given interest rates are unlikely to have room to fall far enough to lever the economy higher unaided. Central banks could conceivably play a role: the Bank of England, Bank of Japan, or the European Central Bank could buy infrastructure bonds, or bonds issued by a state-controlled infrastructure bank.

The changing face of infrastructure investment

Two big changes have occurred within infrastructure investment over the past 40 years: firstly, the expansion of the private sector's role; and secondly, the considerable broadening of the asset class.

Faced with the increasing scale, complexity, and financing needs of infrastructure projects, governments have sought more private sector participation. Meanwhile pension funds, sovereign wealth funds, and insurance companies have found

China's ambitions dwarf others' plans

Key national infrastructure plans

CHINA: "One Belt One Road" initiative (OBOR)

Investment: \$5T by 2049*

China intends to build infrastructure in more than 50 countries along the old Silk Road. Formulated by President Xi Jinping, OBOR is now a cornerstone of China's foreign policy.

Examples: China-Pakistan economic corridor (\$60B); China-Singapore high speed rail (\$23B)

GERMANY: Federal Infrastructure Plan

Investment: EUR 265B by 2030

Germany aims to invest one-third of the total in new projects, with the rest aimed at modernizing existing infrastructure, mainly roads and rail.

INDIA: Prime Minister Narendra Modi's plan

Investment: \$250B by 2022

Focuses on roads and the ageing railway system. The plan targets 35,000 km of roads by 2022.

EUROPEAN UNION: The "Juncker Plan"

Investment: EUR 500B to 2020

This programme aims at unlocking private and public investments.

Examples: High-speed fixed broadband, Italy (EUR 0.5B); D4R7 highway, Slovakia (EUR 0.4B)

CANADA: The Canada Infrastructure Bank (CIB)

Investment: CAD 180B by 2029

Creation of the CIB will facilitate federal support to attract private sector investment in new projects.

Example: Montreal light rail expansion (CAD 1.28B)

JAPAN: Prime Minister Shinzo Abe's plan

Investment: \$111B by 2020–21

A \$61B domestic infrastructure program and a \$50B fund to boost infrastructure investment in Asia in response to China's OBOR.

* PwC estimate, if plan is fully implemented. Source - RBC Wealth Management

Next-gen backbone

long life infrastructure assets often match the long-term liabilities they deal with. Infrastructure projects also offer a reliable cash flow once up and running, often including an inflation adjustment mechanism.

The traditional universe of infrastructure projects—bridges, roads, and power generation—has expanded to include rapid transit systems, high speed rail, airports, electricity transmission grids, harbours, and hospitals. Newcomers include: student housing; assisted living accommodation allowing retirees to live closer to healthcare and hospitals; the build-out of 5G, the fifth generation of mobile internet connectivity bringing greater speed and the ability to connect many more devices simultaneously; construction and maintenance of cell tower arrays; and networks of charging stations for electric vehicles.

Infrastructure investing and the economic cycle

Infrastructure investments should perform relatively well in the economic environment we foresee prevailing over the coming decade. Most infrastructure sectors benefit from economic growth and inflation to some extent, while demand tends to be relatively resilient in downturns.

Higher interest rates may make the investment environment more challenging as infrastructure assets tend to be financed by debt, but the impact will depend on the capital structure and return potential of each project.

A diversification tool

Infrastructure investments can offer valuable diversification benefits. Most deliver an income stream from low-risk, stable assets that would be less affected by an

Transport can benefit most from the current environment

Impact of economic growth and inflation

Sector/ Subsector	Higher GDP growth: Impact on revenues	Higher inflation: Impact on revenues	Impact on costs
Communications: Traditional	● Pricing pressures offset impact from higher growth	● Tariffs tend to be linked with inflation	● Established cost base
Communications: 5G infrastructure	● Consumers expected to pay for additional connectivity	● Tariffs tend to be linked with inflation	● Established cost base
Energy: Natural gas & electric lines	● Increased competition from Renewables puts pressure on traditional energy	● Prices tend to increase with inflation	● Established cost base
Energy: Renewables (e.g. solar, wind)	● Secular growth & regulation are biggest drivers	● Subsidies tend to increase with inflation	● Greater efficiency drives costs down
Social: Hospitals, institutions	● Little impact	● Most tariffs are linked to inflation	● Costs increase
Transport: Road, rail, airports	● Volumes affected by GDP growth	● Most tariffs are linked to inflation	● Established cost base
Utilities: Regulated (electric, gas, water)	● Little impact	● Tariffs tend to be linked to inflation	● Costs increase
Utilities: Unregulated (e.g. waste services)	● Demand & prices tend to increase	● Tariffs linked to inflation, but capped by competition and political pressure	● Costs increase

● Positive impact ● Neutral impact ● Negative impact

Source - RBC Wealth Management

economic downturn. This should mean infrastructure investments will hold up better than the overall market in a downturn.

How effective a diversification tool they are will depend on the investment. Like all asset classes, infrastructure projects are subject to a broad spectrum of risks. At one end are less risky projects, such as conventional power generation in developed economies where costs can be controlled, demand can be more confidently assessed, and the regulatory environment can be relied upon. At the other extreme are unconventional “greenfield” projects in emerging economies where costs can escalate, contracts can be more difficult to enforce, sponsoring governments can change abruptly, and currency volatility can make returns unpredictable. Riskier infrastructure investments behave more like risky equities, potentially reducing or eliminating the diversification benefits of the asset class.

Investing in infrastructure

Infrastructure investment options include individual stocks, funds, or a combination of both. For single stocks, investors could focus on listed utilities, pipelines, or railways; industrial companies providing equipment, engineering services, or materials for projects; or companies that manage infrastructure assets.

For funds, the most significant benefit is the ability to diversify across industries, geographies, and the risk spectrum. Experienced fund managers are well-placed to assess not only each project’s complexities, but also political, regulatory, and currency risks. Some factors to consider when choosing a fund include:

- What assets is the fund invested in?
 - Long-life assets with stable cash flows, or riskier assets with projects that are less regulated and may be more exposed to demand risks?
 - Listed, or less-liquid unlisted projects located in developed economies, or in emerging ones with higher risk profiles?
 - Physical assets or service providers or raw materials suppliers that may add cyclicity to returns and variability to any income stream?
 - Established projects, or start-ups that may be riskier but offer higher returns?
- Does the fund look to harvest a long-term income stream, or does it buy undervalued assets to capture its returns via capital appreciation over a shorter time frame?

Conclusion

Infrastructure as an investment theme has a long life ahead of it. The demand for repair, replacement, and upgrading of existing infrastructure assets is immense across the developed world. Emerging economies need equally massive infrastructure investment to achieve economic and social goals.

The private sector has become an important source of infrastructure financing. Long-lived assets that provide a predictable stream of income, often inflation-adjusted, offer an attractive alternative for the trillions earning little or nothing in bank accounts (\$9T in U.S. bank accounts alone), or for the trillions more that have flowed into lower-quality corporate and emerging market debt in recent years. We expect individual investors will discover the attractions of this asset class to a much greater extent over the coming decade.



Uncharted territory:

A generational shift in U.S. & China relations

The trade dispute between the U.S. and China is part of a larger struggle over national security, underpinned by ideological differences. This complex, divisive situation could reshape the relationship between the world's two largest economies, with implications for financial markets.

When Presidents Donald Trump and Xi Jinping met for the first time at Trump's Florida golf retreat, Mar-a-Lago, in April 2017, it was all smiles and bonhomie. China's official Xinhua news agency sounded a note of triumph—even despite Trump informing an unsuspecting Xi that he had just launched 59 missiles at Syria over a “beautiful piece of chocolate cake”—declaring the meeting as positive, fruitful, and a new starting point for the world's most important bilateral relationship. Trump lauded his friendship with Xi and described the relationship as “outstanding.” Progress indeed from the campaign trail comments in 2016.

Since then, and noted in various *Global Insight* publications in 2018, the China hawks in the Trump administration have steadily gained the ascendancy. The Trump administration moved quickly from words to actions. To date, this has culminated in 5%–25% tariffs on \$250B of goods from China with further increases in tariffs planned for January 2019. China has responded in kind with \$160B of its own taxes on U.S. goods, steadfastly underlining its self-belief as a global power that will not kowtow.



Jay Roberts, CFA
Hong Kong, China
jay.roberts@rbc.com

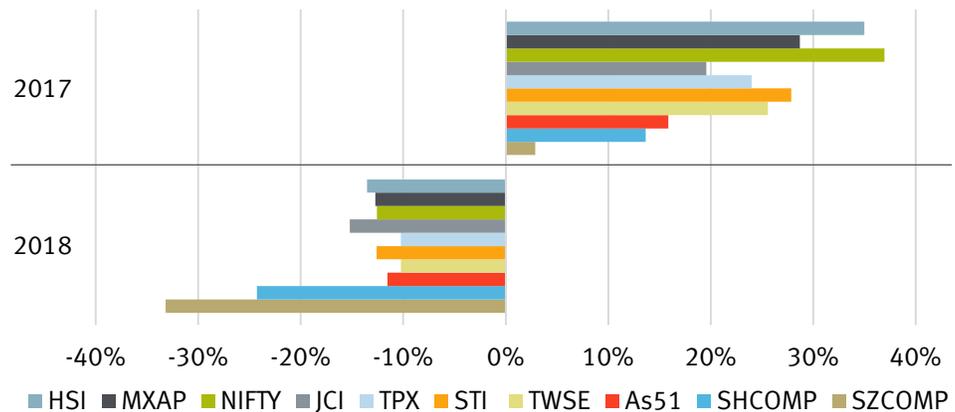
Chinese equity markets have declined deep into bear market territory, although this is amid a backdrop of Chinese policy aimed at financial deleveraging, a clunky term that simply means tackling riskier areas of lending in the economy. China's currency has weakened. More recently, it is beginning to dawn on global investors, including in the dominant U.S. market, that what is happening between the U.S. and China goes far beyond political posturing. Something far larger is afoot.

Uncharted territory

After a powerful rally in 2017, Asian equities have given back some of the gains in 2018, led by mainland China stocks.

Major Asian equity indexes: 2017 & 2018 year-to-date returns

in U.S. dollars



Indexes shown: Hong Kong Hang Seng Index (HSI), MSCI AC Asia Pacific Index (MXAP), NSE Nifty 50 Index (NIFTY), Jakarta Stock Exchange Composite Index (JCI), Tokyo Stock Exchange Tokyo Price Index (TPX), Straits Times Index (STI), Taiwan Stock Exchange Weighted Index (TWSE), S&P/ASX 200 (As51), Shanghai Composite Index (SHComp), Shenzhen Composite Index (SZComp)

Source - RBC Wealth Management, Bloomberg; data through 11/5/18

As Trump accused China in September of interfering in the U.S. midterm elections,¹ he offered that President Xi “might not be a friend of mine anymore.” An understatement, perhaps. How things have changed.

Plan B

What is going on is much more than a trade dispute. It is primarily a national security dispute where the key ingredients are: technology leadership; laws, regulations, and behaviours; an overarching accusation of state interference; and ideological differences.

All U.S. presidents are required to produce a *National Security Strategy*. Trump’s was produced in December 2017 in record time. Of note: “China and Russia challenge American power, influence, and interests, attempting to erode American security and prosperity. They are determined to make economies less free and less fair, to grow their militaries, and to control information and data to repress their societies and expand their influence.”²

The complaints in the U.S. Trade Representative report from March 2018, ordered by Trump in August 2017, revolve around China’s alleged theft of intellectual property, forced technology transfer, limited market access, and state-sponsored cyberattacks.³

As such, it is nigh impossible that all will be resolved in a brief meeting and a handshake between Trump and Xi. At most in the short term, there may be some agreement to postpone tariff increases, for example, or agree to rejoin negotiations (currently minimal). But the U.S. has said that it now refuses to negotiate until China presents a concrete plan on technology.⁴

Moreover, while the dispute has been intensifying over the past year, it has really been many years in the making. The Obama administration discussed similar issues. Even today, with the divide between Republicans and Democrats widening to a chasm, the issue of tackling China is a rarity in that it enjoys unfettered bipartisan support, including some of Trump’s most vocal critics in the Democratic camp.

¹ <https://www.theguardian.com/us-news/2018/sep/26/trump-china-beijing-election-midterms-interference-claim>

² <https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf>. Page 12.

³ See “See “In the trenches of the trade dispute” *Global Insight Weekly*, published on August 2, 2018

The U.S. long believed that engagement with China would bring about desired changes over time. That belief is being ditched. Plan B is in operation and it does not only include tariffs.⁵ China has responded by refusing to bend publicly. State media labelled U.S. methods as “extreme blackmail.” Xi Jinping gave a speech at a trade fair in Shanghai on November 5 proclaiming a “new round of high-level opening up.” He also commented that the free trade system is under threat and levelled some thinly veiled criticisms at the U.S.

Crossing the Rubicon

Along the way, there have been a number of public comments made by U.S. officials that underline the seriousness of the situation and the commitment of the U.S. to a new strategy.

The most strident was a speech—history might term it *the* speech—delivered by Vice President Mike Pence on October 4 in Washington.⁶ Over the course of 40 minutes, Pence delivered a stinging rebuke to China across a wide range of issues that went well beyond trade. The combination of its smorgasbord of complaints and accusations across multiple spheres including commercial affairs, political ideology, military expansion, and human rights; the length of the speech; the entire focus on China; and the fact that it was delivered by the second-highest U.S. official make this a moment in which the U.S. may have finally crossed the Rubicon. For its part, China questions its role in a unipolar world subject to U.S. hegemony.

The nature of the strategic relationship between the U.S. and China is undergoing a generational sea change, in our view. We expect this divergence to continue as both countries work to remove some interdependencies over time. There is growing mistrust on both sides. We believe that the process will be protracted and peppered with bouts of real tension.

Economic implications & market response

The U.S. is primarily a domestic, consumer-driven economy. If economic measures are restricted to tariffs of moderate levels, we believe the impact on the U.S. should be manageable during expansion periods. However, unpredictable secondary actions, such as restricting market access in China or imposing a series of harsh sanctions, would be more damaging to certain companies, in our view. Additionally, the inflationary effects of tariffs are unclear—at a time when U.S. bond yields are pushing higher on Federal Reserve rate hikes and strong economic data.

For China, the impact of a full-blown trade war would be more pronounced, perhaps reducing growth by up to 0.7%, according to one estimate by the Chinese government. However, the Chinese economy is also more consumer- and services-oriented than many people might think, in our view.

Equity markets in China, Hong Kong, and to some extent elsewhere in Asia have responded rapidly and negatively since the first tariffs hit. Hong Kong's Hang Seng Index has declined in eight out of 10 months in 2018. MSCI China Index earnings have been revised downwards for six consecutive months. This trend needs to halt before investors can become more constructive, in our view.

⁴ <https://www.wsj.com/articles/u-s-wont-resume-trade-talks-without-firm-proposal-from-a-wary-china-1540465201>

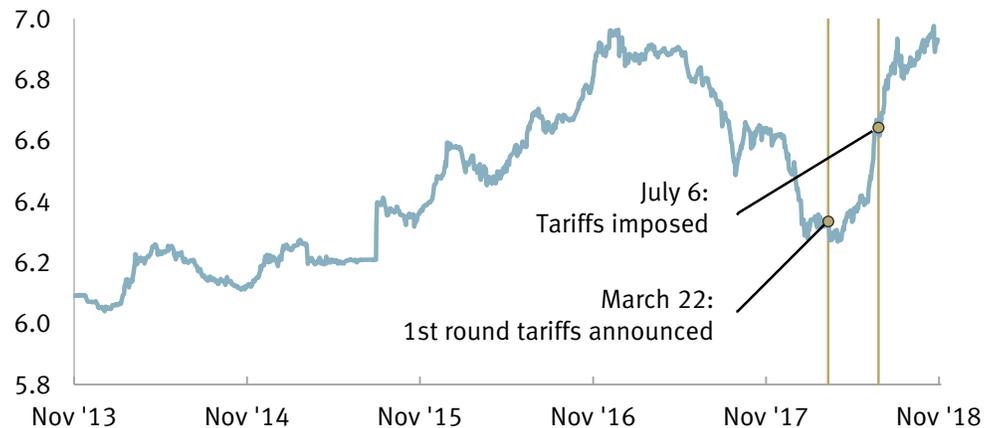
⁵ <https://www.reuters.com/article/us-usa-trade-china-semiconductors/us-restricts-exports-to-chinese-semiconductor-firm-fujian-jinhua-idUSKCN1N328E>

⁶ <https://www.whitehouse.gov/briefings-statements/remarks-vice-president-pence-administrations-policy-toward-china/>

Uncharted territory

China's currency has weakened to its lowest level against the dollar since 2008 due to the U.S. trade tariffs.

U.S. dollar/Chinese yuan exchange rate



Source - RBC Wealth Management, Bloomberg; data through 11/8/18

Unfortunately for China, the dispute comes at a time of financial deleveraging, which itself is impacting the ability of Chinese companies to tap the domestic capital markets. For example, some Chinese property developers are being forced to offer markedly higher yields on new bond issuances.

We have begun to see Chinese policy support for the equity market. Historically, the actual market has bottomed between one to six months after such support is announced, but every situation is different. While we forecast the Chinese currency to weaken through USDCNY7.00, we believe that authorities would not entertain any disorderly selloff.

The dispute has also meaningfully impacted other Asian equity markets. Some of these markets are approaching levels where valuation may become supportive (see the *Global Insight Weekly* published on October 25 for more information).

Going forward, a growing divide between the U.S. and China would have ramifications for economic growth rates (although benefits may accrue to other countries depending on the movement of supply chains). However, we believe this is more likely to be an ongoing erosion of growth rather than a shock. For companies, the impact on some will be negligible, for others potentially significant. Investors should consider this when constructing and managing portfolios.



AI: Welcome to the age of transformation

We shed light on artificial intelligence, separating the hype from reality about what AI can and cannot do today. We dig into the explosion of AI technology and the real opportunities for investment strategy as these transformative innovations are here to stay.

Artificial intelligence (AI) has been dominating the headlines—all the way from the transformative opportunities it can bring to society, businesses, and governments, to the science fiction doomsday scenarios. There is a great amount of hype surrounding AI, and the first step to assess the extent of its impact is to remove the mystery and understand what it has to offer.

AI is an “umbrella” concept, covering a wide range of disciplines and technologies, including machine learning, deep learning, and cognitive computing, among others.

The “intelligence” aspect of AI is at the root of what the technology can do—intelligence is the capacity to connect comprehension with logic, which results in the ability to draw conclusions from previous experiences. Humans process information like this day in and day out, without even thinking about it. As such, AI can be interpreted as a set of algorithms (logic), programs (instructions to a computer), and statistical models that interact to replicate an output very similar to that of human intelligence.

However, AI is unable to connect insights or understand specifically *why* something is happening—another key aspect of human thinking. A book published by *New Scientist* on the topic states that “AI can’t strip us of our jobs, our dignity or our human rights. Only other humans can do that.” This suggests that humans are ultimately responsible for their future. In other words, at this stage it’s humans who control AI, not the other way around.



Iryna Drobysheva
Singapore
iryna.drobysheva@rbc.com



Juan Aronna
Singapore
juan.aronna@rbc.com

Artificial intelligence

Subsets of AI

Artificial Intelligence

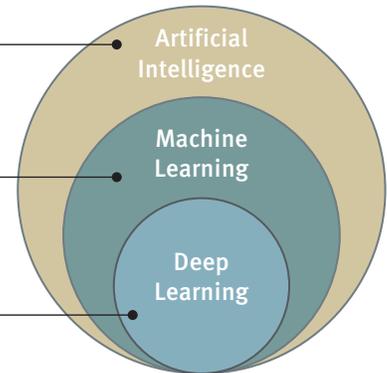
Any technique that enables computers to mimic human behavior

Machine Learning

Subset of AI. Uses statistical methods to enable machines to learn and improve with experience

Deep Learning

Subset of ML. Makes the computation of multi-layer neural networks feasible



Source - Goodfellow, Ian, Bengio, Yoshua, and Courville, Aaron. *Deep Learning*. MIT Press, 2016. www.deeplearningbook.org/contents/intro.html.

Revival of AI

While AI might seem like a very 21st century concept, it is not new. The term was coined in 1956 and AI went through alternating phases of early development followed by hibernation. During the 1970s and later in the 1990s, research progress completely stalled for nearly two decades—what became dubbed the “AI winters”—due to unfulfilled promises and lack of funding.

Its revival has been driven by a simultaneous improvement of factors never seen before: the availability of immensely large volumes of data (big data), the advancement of machine learning algorithms, cheap data storage, and increased computing capacity via graphics processing units (GPUs) that meaningfully reduce computation time. AI would not be fully viable without any one of these improvements. For example, consider the dramatic decline in storage costs that enables AI users to store previously unimagined quantities of data, so much data that it is doubling in size every two years. In 1980 one gigabyte of storage cost \$437,000; by 2016 the cost had plunged to just under \$0.02.

Human + Machine

Even though we can loosely define AI, there is no uniform definition that everyone agrees on. A philosopher would look at it from an existential point of view, but a computer scientist would evaluate a machine’s ability to perform tasks requiring human intelligence and an economist might look at AI’s impact on GDP growth.

In general, most references to AI revolve around three main stages of development: Artificial Narrow Intelligence, Artificial General Intelligence, and Artificial Super Intelligence (all defined in the table on the following page). However, it is crucial to recognize that only one, Artificial Narrow Intelligence, is mature today, while the hype about AI taking over the world refers to the other two areas in nascent stages.

Some see the potential for significant leaps in AI, especially related to the human brain. Futurist and Google’s Director of Engineering Ray Kurzweil suggests that for the last 4,000 years the human brain has been “limited by a fixed architecture of enclosure” and AI has the ability to “expand our neocortex”—the part of the brain responsible for higher functions—in quantity and quality. During a TED Talk he said that “if you need some extra neocortex, you’ll be able to connect to it on the cloud directly from your brain. That additional quantity will again be an enabling factor for another qualitative leap in culture and technology.”

Three main stages of AI development

Stage	Applications	Status
Artificial Narrow Intelligence	Restricted to one function, task, or purpose such as: image and speech recognition, data clustering, optimization, prediction, and natural language understanding.	Most mature
Artificial General Intelligence	Not restricted to one field; it includes problem-solving, reasoning, and cognition. It understands why something is happening and draws on many experiences and conceptualizing models to develop actual scenarios (e.g., action plans, projections, etc.).	Not mature
Artificial Super Intelligence	Covers all fields and surpasses human intelligence in many aspects.	Pre-embryonic

Source - RBC Wealth Management

This prospect might be exciting to some and dreadful to others. While it's intriguing to contemplate future scenarios, it is yet to be seen to what extent far-reaching projections such as these will materialize. Even without massive leaps, today the opportunities for AI are vast and we believe it is evident that human expertise has the potential to be augmented by a combination of human and machine intelligence, which surpasses that of either a human or a machine on a standalone basis.

AI transformation journey has just begun

AI is already beginning to make its mark in a wide variety of industries. For the first time in its decades-long history it has become commercialized. Internet giants use it for search optimization and product recommendation, among other applications, while businesses outside of the technology industry have begun to implement AI for uses such as fraud detection, facial recognition, mapping the customer journey, and much more. It has even made some headway in art and media—a painting created by AI recently sold at a Christie's auction for \$432,500 and the world's first AI news anchor has gone live in China.

Currently, the global market for AI is estimated to be approximately \$7.3B and is forecast to reach some \$90B by 2025, based on Statista data. North America is expected to be the biggest consumer in the market with its widening usage of AI applications across numerous business verticals, while Asia Pacific will likely experience the fastest growth in uptake of the new technology, according to Reuters. AI is rapidly emerging as an industry in itself.

Impact of AI on major sectors

Because AI's commercialization and presence in public equity markets are relatively new, so far AI offers limited opportunities for pure-play investment. The direct beneficiaries are confined to areas like software, where some companies have established a first-mover advantage. As time passes, as happened with previous technological breakthroughs (e.g., the internet), the massive number of private AI startups likely will be reduced to only a comparatively few winners, in our view.

Another approach would be to invest in indirect beneficiaries, companies that would benefit from incorporating AI technologies in their business. In addition to Technology and Communication Services, we expect five industries to benefit in the near future: Health Care, Transportation, Manufacturing, Retail, and Financials.

Artificial intelligence

Health Care

New AI innovations in the Health Care industry are appearing with great rapidity, making it the most promising industry, in our view, where image recognition has dramatically improved diagnostics—detecting melanoma skin cancer with 95% accuracy, for example—adding decision-making support and improved patient monitoring. Big data combined with AI is opening up the possibilities of customized, individual therapies replacing the “one-size-fits-all” protocols that have characterized cancer treatment for decades. Heart disease diagnosis and treatment could benefit in the same way. Deep learning and predictive analytics tools are reducing the costs and time of drug development by predicting the therapeutic use of new drugs, thus driving significant efficiency gains.

Transportation

Industry practitioners expect autonomous vehicles to transform the future of transport along with other AI solutions that will: predict traffic flow and analyze pedestrian patterns to reduce accidents, speed traffic flow and the efficient movement of goods, reduce congestion, air pollution, and energy consumption; not to mention free up valuable land and physical assets currently dedicated to housing and storing autos that are often in use for less than an hour each day.

Manufacturing

AI supports production forecasting and quality control with robotics and sensor technologies. In its 10-year strategic plan, “Made in China 2025,” China is revamping its industrial base, and the International Federation of Robotics expects China to account for 40% of the total worldwide sales of robots by 2019.

Retail

AI’s applications in e-commerce include product discovery tools such as visual search, 3D virtual reality, customized product recommendations, targeted marketing, and potentially delivery through AI-powered drones or other self-driving vehicles. Importantly, AI’s predictive analytics could provide, and in some cases already are, the rapid just-in-time inventory management that would permit brick-and-mortar retailers the capacity to compete more effectively against the online threat.

Financials

AI is making strides in the form of virtual assistants, chatbots, speech recognition, alternative data sources, sophisticated trading models, real-time risk assessment, the development of innovative new financial instruments, and much more.

Investments ex machina

We believe AI offers transformative opportunities for society, governments, and businesses, even though the state of the technology still lags the hype. Like other periods of rapid industrial/technological change, we expect AI’s emergence will create a substantial increase in global wealth in the coming decades. However, it is unlikely that increased wealth will be delivered equitably or “fairly.” There will undoubtedly be large dislocations that produce both winners and losers.

What is clear to us is that AI is here to stay. As with the arrival of computers, automation, and the internet, those companies that pursue the opportunities AI presents and understand the competitive threats it may pose, will likely fare better than those who choose to ignore it or fight a rearguard action to forestall it. We believe factoring its impact into investment decisions and choices will rapidly become a “must have” rather than a “nice to have.”

Research resources

This document is produced by the Global Portfolio Advisory Committee within RBC Wealth Management's Portfolio Advisory Group. The RBC Wealth Management Portfolio Advisory Group provides support related to asset allocation and portfolio construction for the firm's investment advisors / financial advisors who are engaged in assembling portfolios incorporating individual marketable securities. The Committee leverages the broad market outlook as developed by the RBC Investment Strategy Committee, providing additional tactical and thematic support utilizing research from the RBC Investment Strategy Committee, RBC Capital Markets, and third-party resources.

Global Portfolio Advisory Committee members:

Jim Allworth – Co-chair; Investment Strategist, RBC Dominion Securities Inc.

Kelly Bogdanova – Co-chair; Portfolio Analyst, RBC Wealth Management Portfolio Advisory Group – U.S. Equities, RBC Capital Markets, LLC

Frédérique Carrier – Co-chair; Managing Director, Head of Investment Strategies, Royal Bank of Canada Investment Management (U.K.) Limited

Mark Bayko, CFA – Head, Portfolio Management, RBC Dominion Securities Inc.

Craig Bishop – Lead Strategist, U.S. Fixed Income Strategies Group, RBC Wealth Management Portfolio Advisory Group, RBC Capital Markets, LLC

Laura Cooper – Head of FX Solutions and Strategy, Royal Bank of Canada Investment Management (U.K.) Limited

Janet Engels – Head of Portfolio Advisory Group U.S., RBC Wealth Management, RBC Capital Markets, LLC

Tom Garretson, CFA – Fixed Income Portfolio Strategist, RBC Wealth Management Portfolio Advisory Group, RBC Capital Markets, LLC

Christopher Girdler, CFA – Fixed Income Portfolio Advisor, RBC Wealth Management Portfolio Advisory Group, RBC Dominion Securities Inc.

Patrick McAllister, CFA – Canadian Equities Portfolio Advisor, RBC Wealth Management Portfolio Advisory Group – Equities, RBC Dominion Securities Inc.

Jay Roberts, CFA – Head of Investment Solutions & Products, RBC Wealth Management Hong Kong, RBC Investment Services (Asia) Limited

Alan Robinson – Portfolio Analyst, RBC Wealth Management Portfolio Advisory Group – U.S. Equities, RBC Capital Markets, LLC

Alastair Whitfield – Head of Fixed Income - British Isles, Royal Bank of Canada Investment Management (U.K.) Limited

The RBC Investment Strategy Committee (RISC) consists of senior investment professionals drawn from individual, client-focused business units within RBC, including the Portfolio Advisory Group. The RISC builds a broad global investment outlook and develops specific guidelines that can be used to manage portfolios. The RISC is chaired by Daniel Chornous, CFA, Chief Investment Officer of RBC Global Asset Management Inc.

Additional Global Insight authors:

Chun-Him Tam – Head of UHNW Solutions & Head of Fixed Income Asia, Royal Bank of Canada, Singapore Branch

Mikhial Pasic, CFA – Fixed Income Portfolio Advisor, RBC Wealth Management Portfolio Advisory Group, RBC Dominion Securities Inc.

Iryna Drobysheva – Director, Product Innovation and Strategy, Royal Bank of Canada, Singapore Branch

Juan Aronna – Head of Investment Solutions & Products Asia, Royal Bank of Canada, Singapore Branch

Required disclosures

Analyst Certification

All of the views expressed in this report accurately reflect the personal views of the responsible analyst(s) about any and all of the subject securities or issuers. No part of the compensation of the responsible analyst(s) named herein is, or will be, directly or indirectly, related to the specific recommendations or views expressed by the responsible analyst(s) in this report.

Important Disclosures

In the U.S., RBC Wealth Management operates as a division of RBC Capital Markets, LLC. In Canada, RBC Wealth Management includes, without limitation, RBC Dominion Securities Inc., which is a foreign affiliate of RBC Capital Markets, LLC. This report has been prepared by RBC Capital Markets, LLC which is an indirect wholly-owned subsidiary of the Royal Bank of Canada and, as such, is a related issuer of Royal Bank of Canada.

Non-U.S. Analyst Disclosure: Jim Allworth, Mark Bayko, Christopher Girdler, Patrick McAllister, and Mikhial Pasic, employees of RBC Wealth Management USA's foreign affiliate RBC Dominion Securities Inc.; and Frédérique Carrier, Laura Cooper, and Alastair Whitfield, employees of RBC Wealth Management USA's foreign affiliate Royal Bank of Canada Investment Management (U.K.) Limited; Jay Roberts, an employee of RBC Investment Services (Asia) Limited; and Chun-Him Tam, Iryna Drobysheva, and Juan Aronna, employees of Royal Bank of Canada, Singapore Branch; contributed to the preparation of this publication. These individuals are not registered with or qualified as research analysts with the U.S. Financial Industry Regulatory Authority ("FINRA") and, since they are not associated persons of RBC Wealth Management, they may not be subject to FINRA Rule 2241 governing communications with subject companies, the making of public appearances, and the trading of securities in accounts held by research analysts.

In the event that this is a compendium report (covers six or more companies), RBC Wealth Management may choose to provide important disclosure information by reference. To access current disclosures, clients should refer to <https://www.rbccm.com/GLDisclosure/PublicWeb/DisclosureLookup.aspx?EntityID=2> to view disclosures regarding RBC Wealth Management and its affiliated firms. Such information is also available upon request to RBC Wealth Management Publishing, 60 South Sixth St, Minneapolis, MN 55402.

References to a Recommended List in the recommendation history chart may include one or more recommended lists or model portfolios maintained by RBC Wealth Management or one of its affiliates. RBC Wealth Management recommended lists include the Guided Portfolio: Prime Income (RL 6), the Guided Portfolio: Dividend Growth (RL 8), the Guided Portfolio: ADR (RL 10), the Guided Portfolio: All Cap Growth (RL 12), and former lists called the Guided Portfolio: Large Cap (RL 7), the Guided Portfolio: Midcap 111 (RL 9), and the Guided Portfolio: Global Equity (U.S.) (RL 11). RBC Capital Markets recommended lists include the Strategy Focus List and the Fundamental Equity Weightings (FEW) portfolios. The abbreviation 'RL On' means the date a security was placed on a Recommended List. The abbreviation 'RL Off' means the date a security was removed from a Recommended List.

Distribution of Ratings

For the purpose of ratings distributions, regulatory rules require member firms to assign ratings to one of three rating categories - Buy, Hold/Neutral, or Sell - regardless of a firm's own rating categories. Although RBC Capital Markets, LLC ratings of Top Pick/Outperform, Sector Perform, and Underperform most closely correspond to Buy, Hold/Neutral and Sell, respectively, the meanings are not the same because our ratings are determined on a relative basis.

Rating	Count	Percent	Investment Banking Services Provided During Past 12 Months	
			Count	Percent
Buy [Top Pick & Outperform]	859	54.33	251	29.22
Hold [Sector Perform]	646	40.86	125	19.35
Sell [Underperform]	76	4.81	5	6.58

Explanation of RBC Capital Markets, LLC Equity Rating System

An analyst's "sector" is the universe of companies for which the analyst provides research coverage. Accordingly, the rating assigned to a particular stock represents solely the analyst's view of how that stock will perform over the next 12 months relative to the analyst's sector average.

Ratings: Top Pick (TP): Represents analyst's best idea in the sector; expected to provide significant absolute total return over 12 months with a favorable risk-reward ratio. **Outperform (O):** Expected to materially outperform sector average over 12 months. **Sector Perform (SP):** Returns expected to be in line with sector average over 12 months. **Underperform (U):** Returns expected to be materially below sector average over 12 months. **Restricted (R):** RBC policy precludes certain types of communications, including an investment recommendation, when RBC is acting as an advisor in certain merger or other strategic transactions and in certain other circumstances. **Not Rated (NR):** The rating, price targets and estimates have been removed due to applicable legal, regulatory or policy constraints which may include when RBC Capital Markets is acting in an advisory capacity involving the company.

Risk Rating: The **Speculative** risk rating reflects a security's lower level of financial or operating predictability, illiquid share trading volumes, high balance sheet leverage, or limited operating history that result in a higher expectation of financial and/or stock price volatility.

Valuation and Risks to Rating and Price Target

When RBC Wealth Management assigns a value to a company in a research report, FINRA Rules and NYSE Rules (as incorporated into the FINRA Rulebook) require that the basis for the valuation and the impediments to obtaining that valuation be described. Where applicable, this information is included in the text of our research in the sections entitled "Valuation" and "Risks to Rating and Price Target", respectively.

The analyst(s) responsible for preparing this research report received compensation that is based upon various factors, including total

revenues of RBC Capital Markets, LLC, and its affiliates, a portion of which are or have been generated by investment banking activities of the member companies of RBC Capital Markets, LLC and its affiliates.

Other Disclosures

Prepared with the assistance of our national research sources. RBC Wealth Management prepared this report and takes sole responsibility for its content and distribution. The content may have been based, at least in part, on material provided by our third-party correspondent research services. Our third-party correspondent has given RBC Wealth Management general permission to use its research reports as source materials, but has not reviewed or approved this report, nor has it been informed of its publication. Our third-party correspondent may from time to time have long or short positions in, effect transactions in, and make markets in securities referred to herein. Our third-party correspondent may from time to time perform investment banking or other services for, or solicit investment banking or other business from, any company mentioned in this report.

RBC Wealth Management endeavors to make all reasonable efforts to provide research simultaneously to all eligible clients, having regard to local time zones in overseas jurisdictions. In certain investment advisory accounts, RBC Wealth Management will act as overlay manager for our clients and will initiate transactions in the securities referenced herein for those accounts upon receipt of this report. These transactions may occur before or after your receipt of this report and may have a short-term impact on the market price of the securities in which transactions occur. RBC Wealth Management research is posted to our proprietary Web sites to ensure eligible clients receive coverage initiations and changes in rating, targets, and opinions in a timely manner. Additional distribution may be done by sales personnel via e-mail, fax, or regular mail. Clients may also receive our research via third-party vendors. Please contact your RBC Wealth Management Financial Advisor for more information regarding RBC Wealth Management research.

Conflicts Disclosure: RBC Wealth Management is registered with the Securities and Exchange Commission as a broker/dealer and an investment adviser, offering both brokerage and investment advisory services. RBC Wealth Management's Policy for Managing Conflicts of Interest in Relation to Investment Research is available from us on our Web site at <https://www.rbccm.com/GLDisclosure/PublicWeb/DisclosureLookup.aspx?EntityID=2>. Conflicts of interests related to our investment advisory business can be found in Part II of the Firm's Form ADV or the Investment Advisor Group Disclosure Document. Copies of any of these documents are available upon request through your Financial Advisor. We reserve the right to amend or supplement this policy, Part II of the ADV, or Disclosure Document at any time.

The authors are employed by one of the following entities: RBC Wealth Management USA, a division of RBC Capital Markets, LLC, a securities broker-dealer with principal offices located in Minnesota and New York, USA; by RBC Dominion Securities Inc., a securities broker-dealer with principal offices located in Toronto, Canada; by RBC Investment Services (Asia) Limited, a subsidiary of RBC Dominion Securities Inc., a securities broker-dealer with principal offices located in Hong Kong, China; and by Royal Bank of Canada Investment Management (U.K.) Limited, an investment management company with principal offices located in London, United Kingdom.

Third-party disclaimers

The Global Industry Classification Standard ("GICS") was developed by and is the exclusive property and a service mark of MSCI Inc. ("MSCI") and Standard & Poor's Financial Services LLC ("S&P") and is licensed for use by RBC. Neither MSCI, S&P, nor any other party involved in making or compiling the GICS or any GICS classifications makes any express or implied warranties or representations with respect to such standard or classification (or the results to be obtained by the use thereof), and all such parties hereby expressly disclaim all warranties of originality, accuracy, completeness, merchantability and fitness for a particular purpose with respect to any of such standard or classification. Without limiting any of the foregoing, in no event shall MSCI, S&P, any of their affiliates or any third party involved in making or compiling the GICS or any GICS classifications have any liability for any direct, indirect, special, punitive, consequential or any other damages (including lost profits) even if notified of the possibility of such damages.

References herein to "LIBOR", "LIBO Rate", "L" or other LIBOR abbreviations means the London interbank offered rate as administered by ICE Benchmark Administration (or any other person that takes over the administration of such rate).

Disclaimer

The information contained in this report has been compiled by RBC Wealth Management, a division of RBC Capital Markets, LLC, from sources believed to be reliable, but no representation or warranty, express or implied, is made by Royal Bank of Canada, RBC Wealth Management, its affiliates or any other person as to its accuracy, completeness or correctness. All opinions and estimates contained in this report constitute RBC Wealth Management's judgment as of the date of this report, are subject to change without notice and are provided in good faith but without legal responsibility. Past performance is not a guide to future performance, future returns are not guaranteed, and a loss of original capital may occur. Every province in Canada, state in the U.S., and most countries throughout the world have their own laws regulating the types of securities and other investment products which may be offered to their residents, as well as the process for doing so. As a result, the securities discussed in this report may not be eligible for sale in some jurisdictions. This report is not, and under no circumstances should be construed as, a solicitation to act as securities broker or dealer in any jurisdiction by any person or company that is not legally permitted to carry on the business of a securities broker or dealer in that jurisdiction. Nothing in this report constitutes legal, accounting or tax advice or individually tailored investment advice. This material is prepared for general circulation to clients, including clients who are affiliates of Royal Bank of Canada, and does not have regard to the particular circumstances or needs of any specific person who may read it. The investments or services contained in this report may not be suitable for you and it is recommended that you consult an independent investment advisor if you are in doubt about the suitability of such investments or services. To the full extent permitted by law neither Royal Bank of Canada nor any of its affiliates, nor any other person, accepts any liability whatsoever for any direct or consequential loss arising from any use of this report or the information contained herein. No matter contained in this document may be reproduced or copied by any means without the prior consent of Royal Bank of Canada. In the U.S., RBC Wealth Management operates as a division of RBC Capital Markets, LLC. In Canada, RBC Wealth Management includes, without limitation, RBC Dominion Securities Inc., which is a foreign affiliate of RBC Capital Markets, LLC. This report has been prepared by RBC Capital Markets, LLC. Additional information is available upon request.

To U.S. Residents: This publication has been approved by RBC Capital Markets, LLC, Member NYSE/FINRA/SIPC, which is a U.S. registered broker-dealer and which accepts responsibility for this report and its dissemination in the United States. RBC Capital Markets, LLC, is an indirect wholly-owned subsidiary of the Royal Bank of Canada and, as such, is a related issuer of Royal Bank of Canada. Any U.S. recipient of this report that is not a registered broker-dealer or a bank acting in a broker or dealer capacity and that wishes further information regarding, or to effect any transaction in, any of the securities discussed in this report, should contact and place orders with RBC Capital Markets, LLC. International investing involves risks not typically associated with U.S. investing, including currency fluctuation, foreign taxation, political instability and different accounting standards.

To Canadian Residents: This publication has been approved by RBC Dominion Securities Inc. RBC Dominion Securities Inc.* and Royal Bank of Canada are separate corporate entities which are affiliated. *Member-Canadian Investor Protection Fund. ©Registered trademark of Royal Bank of Canada. Used under license. RBC Wealth Management is a registered trademark of Royal Bank of Canada. Used under license.

RBC Wealth Management (British Isles): This publication is distributed by Royal Bank of Canada Investment Management (U.K.) Limited and RBC Investment Solutions (CI) Limited. Royal Bank of Canada Investment Management (U.K.) Limited is authorised and regulated by the Financial Conduct Authority (Reference number: 146504). Registered office: Riverbank House, 2 Swan Lane, London, EC4R 3BF, UK. RBC Investment Solutions (CI) Limited is regulated by the Jersey Financial Services Commission in the conduct of investment business in Jersey. Registered office: Gaspé House, 66-72 Esplanade, St Helier, Jersey JE2 3QT, Channel Islands, registered company number 119162.

To Hong Kong Residents: This publication is distributed in Hong Kong by Royal Bank of Canada, Hong Kong Branch which is regulated by the Hong Kong Monetary Authority and the Securities and Futures Commission ("SFC"), and RBC Investment Services (Asia) Limited, which is regulated by the SFC. Financial Services provided to Australia: Financial services may be provided in Australia in accordance with applicable law. Financial services provided by

the Royal Bank of Canada, Hong Kong Branch are provided pursuant to the Royal Bank of Canada's Australian Financial Services Licence ("AFSL") (No. 246521).

To Singapore Residents: This publication is distributed in Singapore by the Royal Bank of Canada, Singapore Branch, a registered entity licensed by the Monetary Authority of Singapore. This material has been prepared for general circulation and does not take into account the objectives, financial situation, or needs of any recipient. You are advised to seek independent advice from a financial adviser before purchasing any product. If you do not obtain independent advice, you should consider whether the product is suitable for you. Past performance is not indicative of future performance. If you have any questions related to this publication, please contact the Royal Bank of Canada, Singapore Branch. Royal Bank of Canada, Singapore Branch accepts responsibility for this report and its dissemination in Singapore.

© 2018 RBC Capital Markets, LLC - Member NYSE/FINRA/SIPC

© 2018 RBC Dominion Securities Inc. - Member Canadian Investor Protection Fund

© 2018 RBC Europe Limited

© 2018 Royal Bank of Canada

All rights reserved

RBC1524