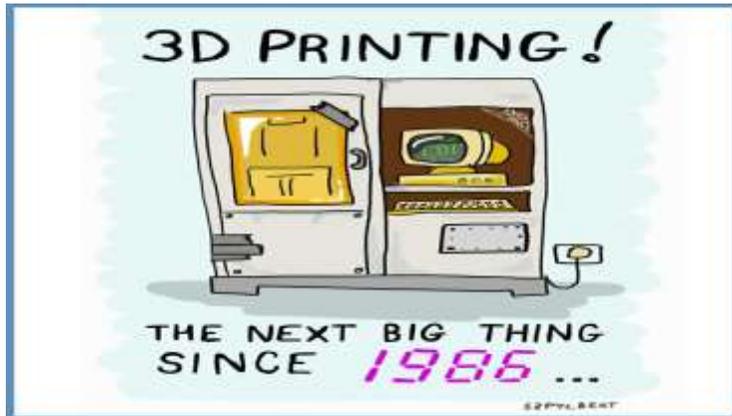


# E.Q Trendwatch™

## Mother of invention



*“Adam Smith's 'invisible hand' is not above sudden, disturbing, movements. Since its inception, capitalism has known slumps and recessions, bubble and froth; no one has yet dis-invented the business cycle, and probably no one will; and what Schumpeter famously called the 'gales of creative destruction' still roar mightily from time to time.”*

*--Former UK Prime Minister Margaret Thatcher (1925-2013)*

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Over the last twenty years, total global debt (household, corporate and government) tripled from \$84 trillion at the end of 1999 to \$250 trillion by the fall of 2018. Up 43% since just 2008, debt outstanding is now some 285% of global output (GDP)—estimated at \$87 trillion in 2018 (Institute of International Finance). If such a large increase in debt were invested in support of productivity improvements, economic strength would have surged with it. Instead global growth has fallen 41% from an annual rate of 5.6% in 2007 to 3.3% today.

The debt was added mostly for counter-productive financial ‘engineering’ in the corporate sector and to enable household consumption. This helped to inflate short-term corporate profits and the price of financed things like homes, education and financial assets at the expense of future gains. Price and profit increases that could have happened over the next decade have now been booked in the last, and spending, revenue and growth potential going forward are lower as a result. This makes repaying debt harder.

Still, it has been wisely observed that necessity *is* the mother of invention, and after years dominated by financial gimmicks the world is keen on tangible solutions. Fortunately, a wave of innovation is on deck that can increase net cash flow and assist in the necessary rebuilding of savings in households, pensions and the economy by helping to reduce waste and cost, increase efficiency and enhance quality of life for the masses.

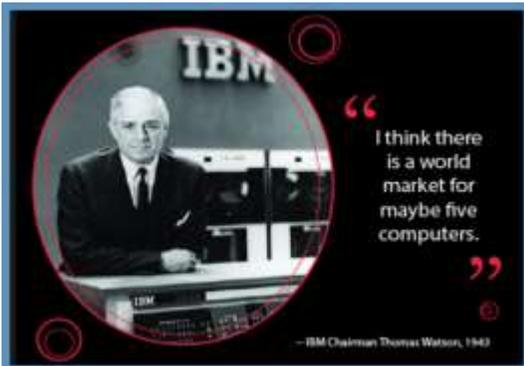
## On-demand printing of goods and materials

*“...the impact of this technology is no longer restricted to simple materials and hobbyists. 3D printing is seeing tremendous growth in the fabrication of tailored prosthetics, medical implants, novel drug formulations and the bioprinting of human tissues and organs.”*

— David K. Mills, Nanomaterials & Nanotechnology (June 2015)

By now many of us have witnessed 3D printers in action, perhaps making crowns out of powder at our dentist’s office. This technology is valuable through all sectors of the economy. Cutting-edge design software combined with on-site production spells huge savings in time, packaging, shipping and other costs, while allowing real-time design and quality modification throughout production. The flexibility to print smaller-scale working models, quickly reconfigure and reprint is a seismic shift from traditional manufacturing with its scheduling issues, outsourced expertise, raw goods management and numerous inefficiencies.

Charles Hull first patented the 3D printer in 1984. This innovative process of printing layers of material from a digital image into a 3D object has taken the predictable path of most innovations. As the “Hype Cycle” (chart below) shows, once the initial dream of having our own *Star Trek* “replicator” gave way to the limitations of first versions, consumers lost interest. It isn’t until industry has time to grapple with how best to use the new innovation that it re-emerges into the mainstream’s imagination.



It is typical that most people have a difficult time imagining the profound impact new

technology will have. In 1943 IBM’s Chairman infamously predicted there would be a global market for maybe five computers. 😊

While 3D printing caught on quickly with hobbyists, initially not much was attempted beyond printed toys and figures. It wasn’t until selective laser sintering (SLS) printers became commercially available that manufacturers took note. In 1987 inventor Carl Deckard pioneered a laser to bind a powder to a solid. Today, the SLS additive printing method remains an extremely efficient way to create small runs of working prototypes in everything from plastics and plant-based materials to metals.

3D printing efficiencies can be quite shocking - take for example GE’s ATP Turbine engine (right). Using a print method similar to SLS, the company was able to redesign and reduce engine weight by 5%, test schedules by 50%, the number of parts from 855 to 12, and increase the engine’s fuel efficiency by 20%, in just one redesign!



For a visual sense of the savings experienced by GE's engine example, consider the three metal yolks pictured on the right. All perform the same task and have the same structural integrity; yet the computer-optimized 3D printed version (on far-right) leapt past human design conventions to render one weighing 75% less and standing about half the height of the conventional part (farthest left).

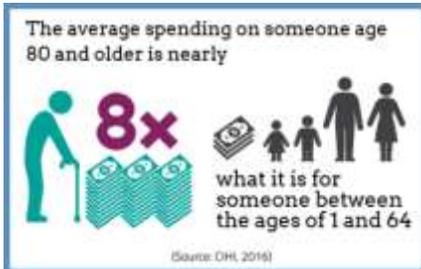


*"With 3D printing, complexity is free. The printer doesn't care if it makes the most rudimentary shape or the most complex shape, and that is completely turning design and manufacturing on its head as we know it."*

--Dr. J. Hoying – Cardiovascular Innovation Institute, August 2014.

**While 3D printing is helping industrial manufacturing companies like GE cut production times and slash waste and cost, the largest beneficiary of the technology is by far the healthcare system.**

Degenerative diseases associated with aging are escalating pressure on tax-funded sick care systems. With thousands of baby boomers turning 65 every day and living well into their 80's in nearly all the world's developed countries, the need for cost savings has never been greater. The graphic on left notes the eight-fold increase in healthcare spending as people move past age 80.



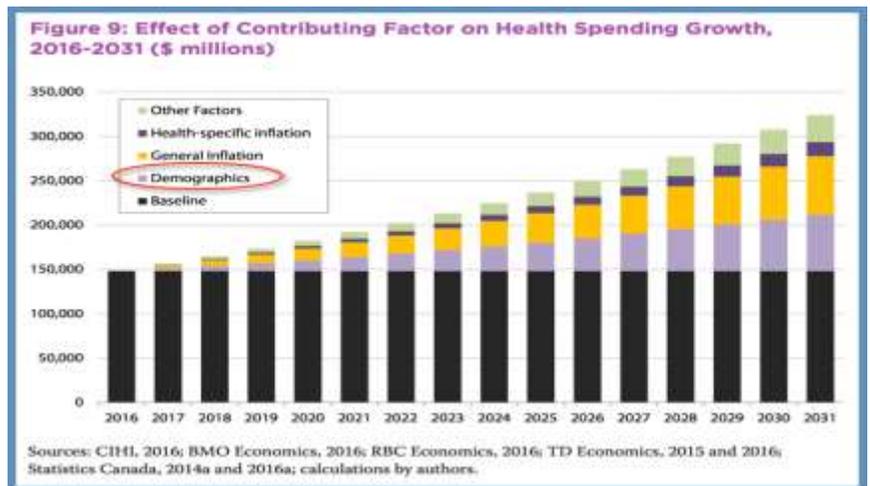
The Statscan study goes on to show three quarters of treatment dollars are going toward circulatory diseases (38%), cancers (19%) and respiratory illnesses (19%). With a further 40% in aging-related expenses (in purple below) forecast over the next 14 years, treatments and medicines that can be made patient specific lead to quicker recovery times, less resource demand and better quality of life.

Further, providing treatments at a cellular level using printed bio material like living tissue, bone and blood vessels, allows less-invasive procedures, risk, and downtime compared with more conventional surgeries.



In the 2014 photo (left) bio-medical technician Stuart Hall holds the

world's first 3D printed titanium replacement heel, made for a 71-year-old patient diagnosed with a localized form of heel cancer. Instead of removing the foot, Chandler's physician Dr. Choong experimented with a 3D printed heel bone. Within weeks of the successful operation, Mr. Chandler was putting 50% of his body weight on the implant and on track to toss his walking sticks within three months.



*“Science advances have allowed us to consider 3D printing of bones and we were able to get information from Len’s foot and use that to tell the computers precisely how big his foot is and reproduce that using 3D technology.”—Dr. P. Choong, Surgical Professor*

**The “Thermal Inkjet Printer” (TIJ) has become a game-changer in health care by allowing practitioners to print tiny droplets of “bio-ink” (harvested living cells) with great precision.** TIJ printers produce a “droplet” a mere 10-150 picolitres in size (*for perspective, a single drop of rain contains more than 100,000 picolitres*). For this reason, TIJ printers are indispensable in the area of tissue engineering and regenerative medicines.

Researchers are also working on printing the vascular system. Cardiovascular specialist Dr. James Hoying and his team from CII Therapeutics in Kentucky are making progress using a new BioAssemblyBot (BAB), and believe that within five years, bio and nanoengineers will have devised ways to re-produce the vascular networks that keep bodily systems functioning.

*“Every cell in your body has the same number of genes and the same composition, with a couple of exceptions. So, every cell has the potential to be any other cell.”*

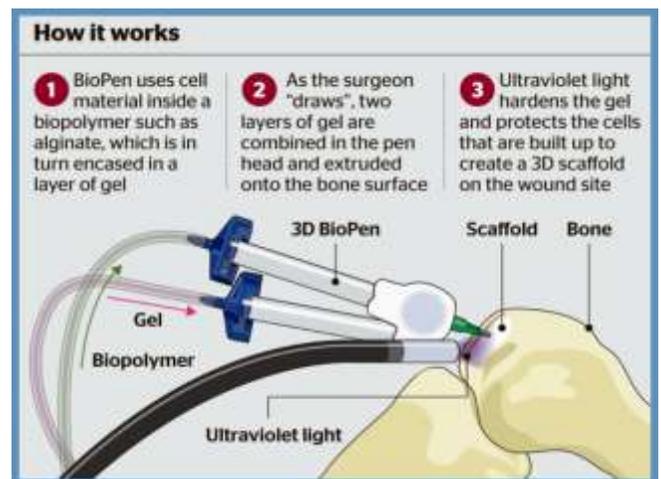
—Dr. J Hoying Chief of Cardiovascular Therapeutics at CII

A major focus currently in bio-printed therapeutics is the re-programming and printing of adult-derived “pluripotent cells” (master cells). The goal is to perfect the conversion of master cells into whatever cell types a patient requires and print them into the form or shape needed.

*“For the past four billion years or so the only way for life on Earth to produce a sequence of DNA—a gene—was by copying the sequence it already had. Sometimes the gene would be damaged or scrambled, the copying imperfect or undertaken repeatedly...That is no longer true. Now genes can be written from scratch and edited repeatedly, like text in a word processor...What cells do and what they can become is engineerable too. Immune cells can be told to follow doctors’ orders; stem cells better coaxed to turn into new tissues; fertilized eggs programmed to grow into creatures quite unlike their parents.”—The Promise and Perils of Synthetic Biology, April 2019*

**A handheld pen for printing connective tissues** is the first of its kind used during surgery to treat damaged cartilage and osteoarthritis. The extrusion-based device (shown on right) prints live cells embedded in a hydrogel. The pen’s two part “ink” produces a 3D scaffold that looks and behaves just like articular tissue.

Cartilage is a highly specialized material that has so far proven difficult to replicate using conventional techniques. The special mechanical properties of cartilage come from the fact that it has only a few cells, contains no blood vessels and has a distinctly organized 3D collagen fibre matrix. The Bio-



pen's specially designed nozzle allows cells and bio-materials to be printed coaxially (similar to a tv cable). The inner core of extruded material contains the cells, while the outer hardened layer creates a cross-linked material that protects the delicate cell material inside.

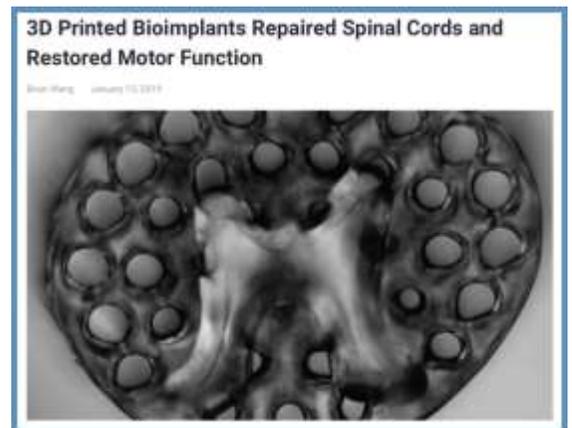
*"Thanks to a series of sophisticated histological, molecular and imaging techniques, we confirmed that the tissue that developed within the construct, forms, appears, and behaves like articular cartilage."*

--Dr. Carmine Onofrillo, Academic-Surgery St. Vincent's Hospital, Melbourne.

With 26% of Japan's population already 65 and over, and adult diapers outselling those for babies in the country, the sense of urgency is high and regulators have approved early stage trials of printed cell therapies targeting heart, spinal cord and macular degeneration. Other research is underway in nerve re-construction therapies, organ printing, lung and kidney repair.

One particular bright spot is the progress being made in spinal cord regenerative therapies. The spinal cord axon bridge (shown on right), has already been used with success in helping bridge the damaged portion of a spinal cord.

*"Using our rapid 3D printing technology, we've created a scaffold that mimics central nervous system structures. Like a bridge, it aligns regenerating axons from one end of the spinal cord injury to the other. Axons by themselves can diffuse and regrow in any direction, but the scaffold keeps axons in order, guiding them to grow in the right direction to complete the spinal cord connection."* --Shaochen Chen, Professor of Nanoengineering, UC San Diego



With so much ongoing, it's hard to imagine what treatments will materialize over the next few years and beyond. Practitioners and lawmakers will need to help define ethical and suitability standards for cutting-edge therapies as options progress.

**Synthetic biology is also being used to replace plastics that are presently 90% made from non-biodegradable fossil fuels.** Researchers recently found a way to melt natural rubber with a plant-based thermoplastic called PHBV which is stronger and easier to form into desired shapes than traditional plastic, and yet fully biodegradable. Replacing toxic-plastic is one of the most pressing needs and opportunities of our time.

A tripling of humans on the earth over the last eighty years (a double in the last fifty years) has greatly intensified demands on the planet's resources. Finding more efficient ways to feed them is another huge growth area. This month, Burger King introduced a beefy but beefless *Impossible Whopper* made from an engineered plant protein that is cheaper and less taxing on environmental resources than traditional beef production. Christopher Finazzo, the chain's North America president, explained at the launch: *"We've done sort of a blind taste test with our franchisees, with people in the office, with my partners on the executive team, and virtually nobody can tell the difference."*

Already, Canada's second largest burger chain A&W reported such strong demand for its plant-based 'Beyond Burger' offering added last summer, that it recently launched a new breakfast sandwich with a plant-based sausage patty. Chief Executive Officer Susan Senecal explained: "It became even more popular than we had expected. Plant-based protein has gained in popularity and really is something people are very interested in."

**Fully 3D printed vehicles and buildings have been produced as proof of concept.** Others are 'growing' buildings from synthetic wood, coral and other materials. As we look to the future, prospects for innovation are limited only by imagination. The gift of this technology is freedom from both conventional design and material constraints, whether printing a concrete wall (shown above), car (below), a home (lower right), or batteries with higher storage and faster charge times (bottom).



The world's first 3D printed supercar.

The *Blade* is a high-performance 3D printed car designed to be manufactured out of carbon fiber tubes and printed aluminum rods! The two components are implemented into the chassis in order to deliver high strength and low weight.

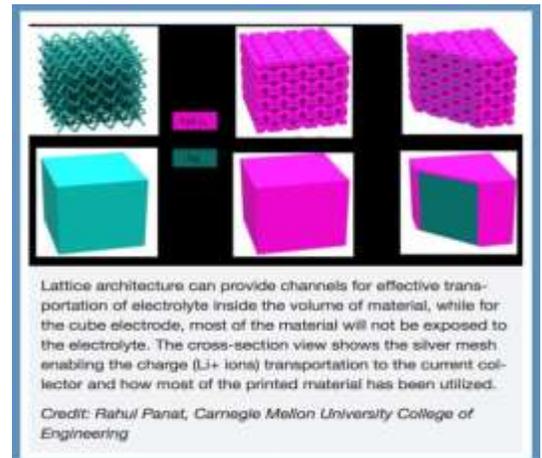


A battery anode/cathode printed in a 3D matrix form (top row pictured below) enables larger amounts of lithium ions (charge) to be held in the same footprint as the solid example (lower row). The larger internal surface area of the 3D material allows a

higher electrical load as well as channels for the lithium to follow - in short, quicker charge times and longer lasting batteries.

### Implications and opportunities

Traditional Dow Theory holds that shares of transportation companies should rise and fall with those of industrial companies, because raw materials must be transported before they can be manufactured into goods sold and then shipped by industrials. Manufacturing has traditionally been labour intensive, so access to cheap labour has been a defining force in moving production to developing countries often far away from end-product consumers. This adds cost and complexity for shipping and delivery. Going forward, the ability to print goods near both raw materials and customers has the makings of a global game changer in terms of where goods are made as well as reduced time, waste, transportation and packaging needed.



Lattice architecture can provide channels for effective transportation of electrolyte inside the volume of material, while for the cube electrode, most of the material will not be exposed to the electrolyte. The cross-section view shows the silver mesh enabling the charge (Li<sup>+</sup> ions) transportation to the current collector and how most of the printed material has been utilized.

Credit: Rahul Panat, Carnegie Mellon University College of Engineering

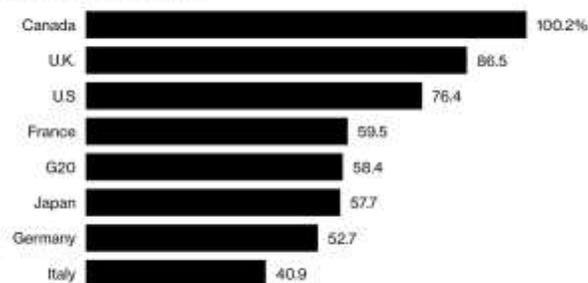
The economy of commodity-rich exporters like Canada have also tended to rise and fall with global demand for raw goods—especially from America, our largest trading partner. 3D printing offers Canada an opportunity to provide not just raw materials but also more domestic production of finished products for our own consumption as well as exports. To repay debt and rebuild our national savings coffers, while also paying more to fund entitlement programs and taxes, we will need to focus on ways to decrease costs for households, businesses and governments.

In the 2003-08 cycle, a US credit bubble drove unsustainable demand for base materials from places like Canada, and depreciating goods manufactured in Asia. However, once the credit bubble burst in the world's largest economy, the world fell into recession and commodity and transportation prices have struggled since. In part, this is because the demand spike in the 2003-08 cycle encouraged over-investment in big ticket items

#### Debt Laden

Canada's households are the most indebted in the G7

■ Household Debt to GDP



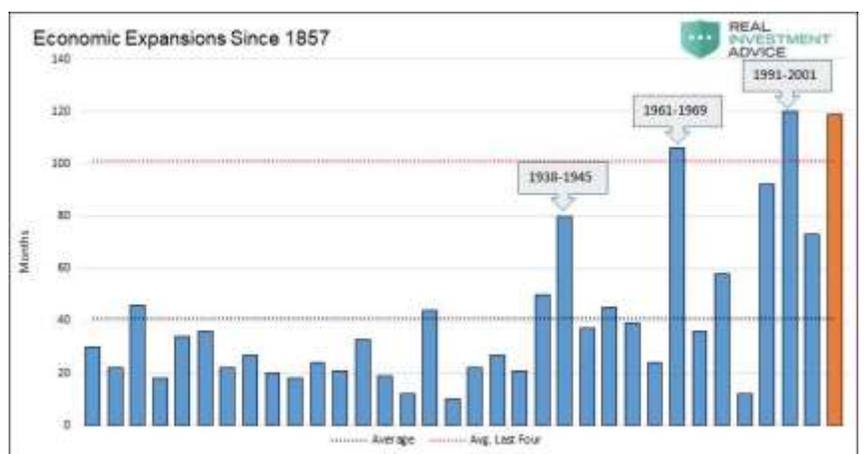
Source: Bank for International Settlements

like machinery, trains, planes, automobiles, trucks, freightliners, and buildings as well as commodity production and capacity. Between 2009-18, ultra-low interest rates and 'simulative' policies reflatened debt-fuelled spending in real estate and related sectors, leading to further mal-investment and record debt levels in economies like Canada as well as the UK and US (**comparative chart of household debt to GDP levels on left**).

Now that debt has maxed out and global demand turned down, an excess supply of goods will pressure prices lower as baby boomers, now a decade older, naturally favour services more than goods, and younger generations, hampered by under-employment and debt, seek experiences more than things. At the same time, deflationary expectations and a naturally lower risk-tolerance are driving aging populations to buy bonds for liquidity and principle-security, and this is helping to drive interest rates lower again.

**After this cycle tying for the longest economic expansion since 1857 (orange bar beside), economic**

**weakness is now global** and the price of expensive homes, goods, and many financial assets are in decline. Many have been caught in the fallacy of believing home prices (and stock markets) always rise, notwithstanding centuries of experience to the contrary. Now a large supply of over-priced assets will shift power to buyers for the next few years as sellers look and need to raise cash and reduce expenses.



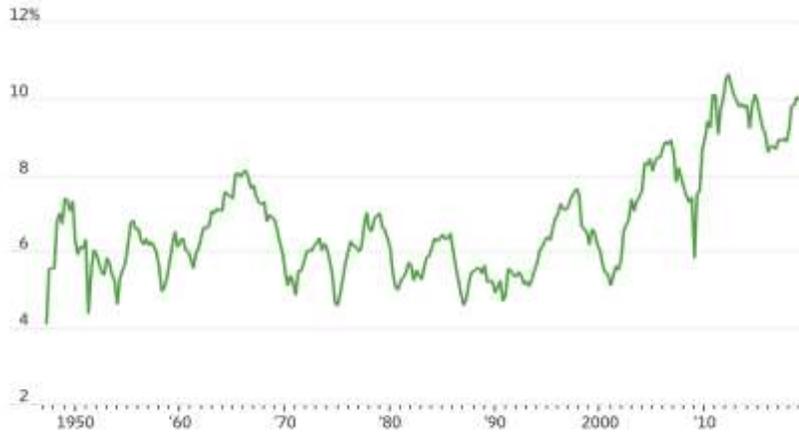
Falling asset prices can erode net worth

quickly, especially where balance sheets include high debts as they do today. Future buyers, meanwhile, have

affordability and investment value to gain in the mean-reversion process now underway.

**Bolstered by stock buybacks and the Trump administration's tax cuts, after-tax US corporate profits now amount to 10% of Gross Domestic Output, up from 6% to 8% during the second half of the 20th century.** Further increases relative to the size of the economy would be unprecedented.

U.S. corporate profits, as a share of gross domestic product



Note: Profits after tax, with inventory valuation adjustment and capital consumption adjustment

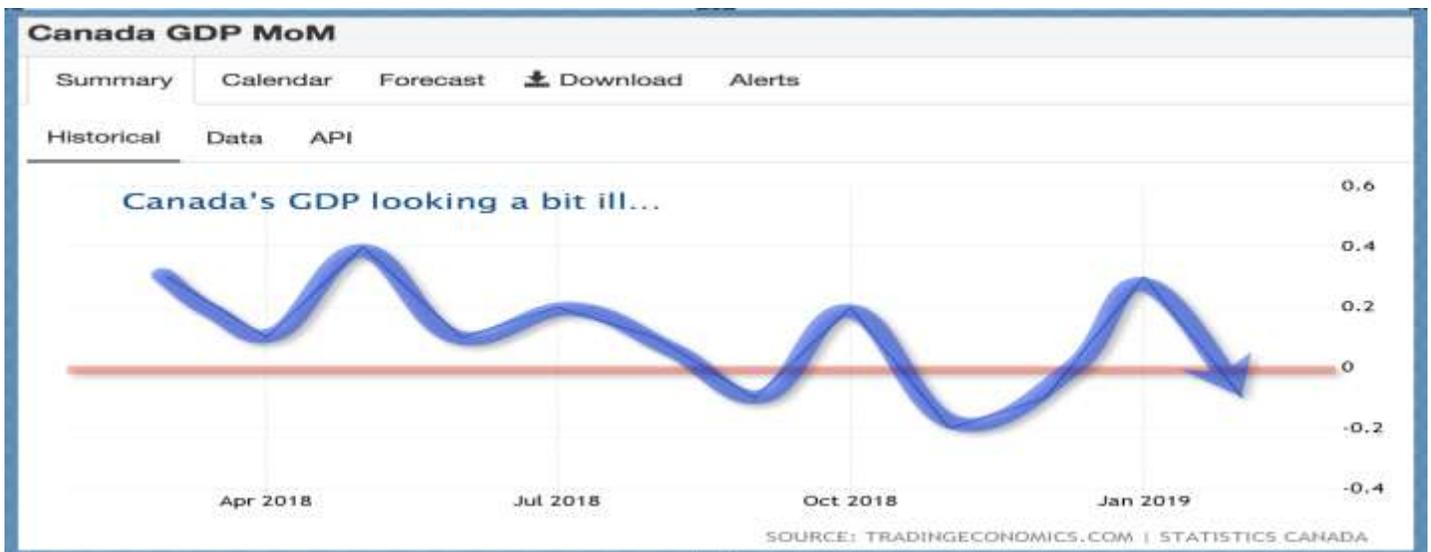
Source: FRED, Federal Reserve Bank of St. Louis

The last decade of unsustainable corporate profit growth on credit-enabled consumption is giving way to an era of less household spending, higher savings rates, better efficiency, productivity and free cash flow.

Synthetic biology, 3D printing and other innovations are here to help with this transition. Canada needs to invest in its ability to provide finished goods and services to meet these trends. The days of easy money and passive asset appreciation are behind us for the

next few years. Using scarce resources more efficiently is the next big boom in the making. The companies and individuals who embrace these trends can prosper amid a period of status quo upheaval.

**Canada's month over month economic growth (GDP) trended lower over the past year (shown below) and contracted 0.1% in the latest data for February, with year over year growth of 1.1%.** 1.6% declines in mining, oil, gas and transportation confirmed weakening global demand. The Bank of Canada (BOC) has lowered its 2019 growth forecast to 1.2% and less than 2% for 2020 and 2021. We suspect they will look for more easing ideas in the months ahead. Starting from a policy rate of just 1.75% leaves them few options.



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**The US\$ continues in an uptrend against the loonie (green line).** From the present \$1.34 CAD per US\$ a longer-term test in the 1.50 area remains probable, as money flows move out of emerging and commodity-centric economies and equities and into US cash and treasuries. The greenback topped against the loonie near the equity market bottoms in 2002 and 2009; a similar pattern is likely this cycle. Not there yet.



**Oil (WTIC) here since 1984 bounced this month but remains significantly below its cyclical top and continues to struggle amid political posturing and weakening global growth in 2019.**



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The top 10 largest S&P 500 companies now make up a whopping 25% of its market value and companies buying back their shares helped reflate the NASDAQ (QQQ) and S&P 500 indices year-to-date, while other barometers like US small cap companies (green), China’s Shanghai (grey), emerging markets (purple), Japan (brown) and Germany (black) remain well below their 2018 peaks shown below. Non-confirmation by the other indices belie the artificial, unsustainable nature of large cap price gains year to date.

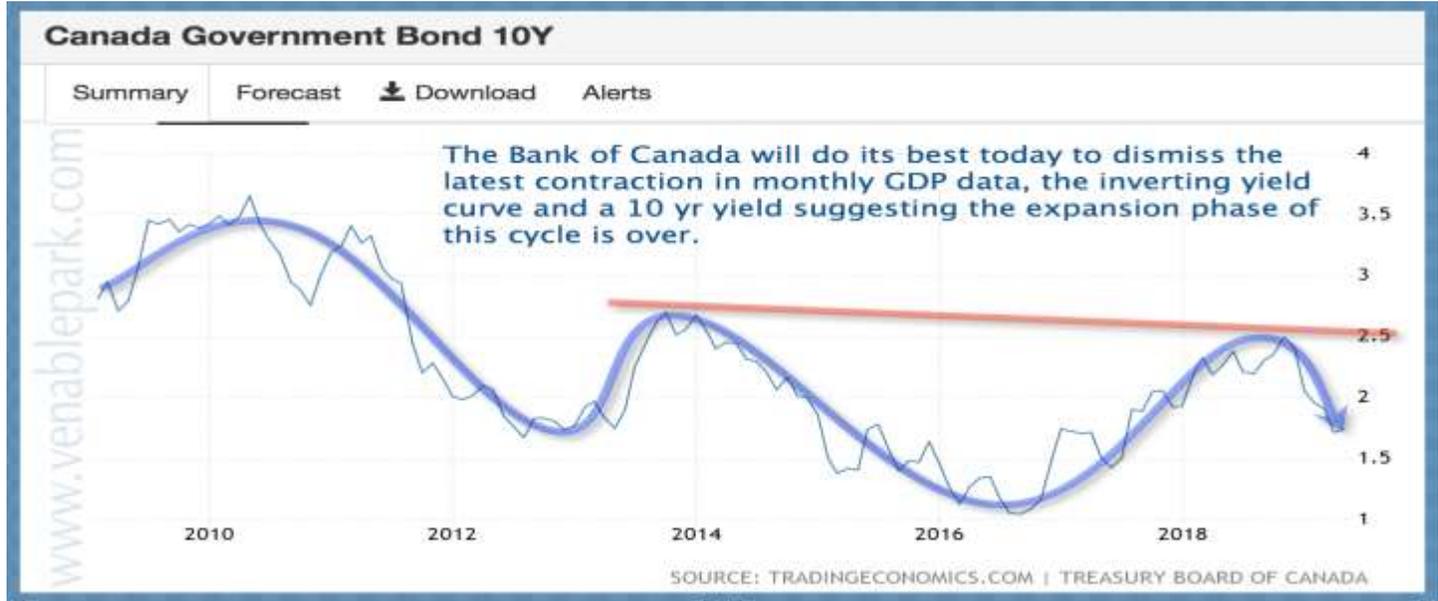


Canada’s TSX has also rebounded year to date in a three-point topping pattern very similar to one completed before the 2008-09 bear market. Strong intermittent rallies were part of the TSX’s 50% decline in both the 2000-02 and 2007-09 bear markets. We expect similar moves as Canadian stocks move to their next bear market bottom where investment value will be found with dividend yields 2 and 3 x current levels.



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**Canada's 10-Year Treasury yield, here since 2009, fell further this month as government bonds rose in value.** Despite the Bank of Canada (BOC) hoping they had time to raise rates further before the next recession, the economy has already turned down, and working at a multi-quarter lag, the five hikes implemented since 2017 are only just starting to bite.



**The highest-grade corporate bonds (LQD index here) continued to receive inflows this month driving their prices higher, despite the buyback induced bounce in stock prices.** Corporate bonds will present attractive value once prices have fallen much further with equities, typically 20-50% from the cycle peak, and yields are north of 7% as they were in 2002 and 2009.



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**US 10-year Treasury Yield here since 1999.** The US Fed's hiking cycle and Trump tax cuts into 2018 caused treasury yields to rise in anticipation of higher growth and inflation, but the effects were fleeting. In response, the Fed has ended its rate hiking plans and fund flows are moving back into treasuries pushing yields lower once more. Bond investors are voting that the economy will slow enough to prompt more central bank easing in the not-too-distant future. A retest of 2012 and 2016 rate cycle low is likely.



The first quarter 2019 US job cut report released this week confirmed the highest quarterly layoffs since 2015. From cycle lows in 2018, the unemployment rate (blue line below since 1994) is turning higher. Household spending and economic growth naturally wane as it does. Policymakers then cut short-term interest rates, and the 10-year less 2-year yield spread (red line below) widens once more as recessions commence.



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**Happy May! Quotes of the month:**

*“We have to understand that monetary policy doesn’t create economic growth that wouldn’t have happened otherwise. It just shifts around the timing. It tries to convince people to buy a house today instead of tomorrow, buy a car today instead of tomorrow to take advantage of these ‘new low interest rates’; but that growth would have happened anyway. And in fact, it would have happened more through savings rather than encouraging excessive borrowing. So, at the end of the day we’re left with too much debt and we’re left with a damaged banking system because low rates or zero rates or a flat curve, doesn’t provide the impetus for a profitable bank...Also, we have already too much debt, so lowering the cost of money further is not going to be the answer.”* –Peter Boockvar, CNBC, April 10, 2019

*“...at these debt levels, anticyclical fiscal and monetary policy alone will not solve the problem. You also need to allow writing off the debt and restructure it. You must identify which debt is not serviceable and take steps to make sure that it is written off. The supervisors in the banking system have to force the banks to restructure as opposed to provide support to zombie firms. In the next recession, we should have a combination of fiscal stimulus and a credible longer-term debt sustainability target and pay much greater attention to debt restructuring. But nobody likes to talk about this.”* -- William White, CD Howe, Apr 9, 2019

*“...the world-wide suppression of interest rates over the past ten years has been not only inadvisable but, on moral grounds, something very near to a crime. By that I mean that the suppression of interest rates has served to advantage one class of people: The savers have been disadvantaged whereas big banks have been very greatly advantaged, and the financial community has been advantaged. In short: the saver’s loss has been the speculators’ gain. So, the ordinary working person has been disadvantaged and that is apolitical. To speak metaphorically but, I still think truthfully, that kind of policy is bordering on criminal – and I stand by that.”*—James Grant, Grant’s Interest Rate Observer, April 4, 2019



Don't forget to visit our blog [www.jugglingdynamite.com](http://www.jugglingdynamite.com) for daily charts and commentary.